Third international Conference on Sustainable Built Environment
Faculty of Civil Engineering and Planning Islamic University of Indonesia

ISTEcS
International Seminar on Tropical Eco Settlements
The Research Institute for Human Settlement Ministry of Public Works, Indonesia

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CONFERENCE PROCEEDINGS

3rd International Conference on Sustainable Built Environment (ICSBE)

"Resilience and Risk Reduction Towards Well Being Society"

4th International Seminar on Tropical Eco-Settlements (ISTEcS)

"Bringing Coastal Cities Into The Future: Challenges, Adaptation, and Mitigation"

Editors:
Mochamad Teguh - Islamic University of Indonesia, Indonesia
Anita Firmanti - Ministry of Public Works, Indonesia
Thomas Boving - University of Rhode Island, USA
Akihisha Kitamori - Kyoto University, Japan
Thanongsak Imjai - Rajamangala University of Technology, Thailand

Inna Garuda Hotel
Yogyakarta, October 21-22, 2014

CONFERENCE PROCEEDINGS

The 3rd International Conference on Sustainable Built Environment (ICSBE)

RESILIENCE AND RISK REDUCTION TOWARDS WELL-BEING SOCIETY

In collaboration with:

The 4th International Seminar on Tropical Eco-Settlements (ISTEcS)

BRINGING COASTAL CITIES INTO THE FUTURE: CHALLENGES, ADAPTATION, AND MITIGATION

Inna Garuda Hotel, Yogyakarta, Indonesia
October 21-22, 2014

icsbe 2014
Third International Conference on Sustainable Built Environment

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International Seminar on Tropical Eco Settlements

Faculty of Civil Engineering and Planning
Islamic University of Indonesia

Research Institute for Human Settlements
Agency of R&D Ministry of Public Work, Indonesia

International University Partners:

University of Rhode Island
Disaster Research Center Gadjah Mada University
RMUTTO
University of Hawai'i Mānoa
Kyoto University

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Welcome Speech

The Chairman of Organizing Committee

Assalamu'alaikum warrahmatullahi wabarakatuh,

The honorable;

- Rector of UII, Ir. Harsoyo, M.Sc., Ph.D.,
- Director General of Spatial Planning, Ministry of Public Works, Indonesia, Dr. M. Basoeki Hadimoeljono,
- Director General of Agency for Research and Development, Ministry of Public Works, Indonesia, Ir. Waskito Pandu, MSc.,
- The Head of Research Institute for Human Settlement, Ministry of Public Works Indonesia, Prof. Dr. Ir. Anita Firmanti, MT.,
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- Keynote speakers: Prof Thomas Boving, Ph.D., Prof. Farhad Atash, Ph.D., Prof. Mochamad Teguh, Ph.D., Dr. Dadang Rukmana, Prof. Dr. Ir. Anita Firmanti, MT., Prof. Aris Marfa'i, Thanongsak Imjai, Ph.D.
- Participants of the 3rd ICSBE 2014 and the 4th ISTECS.
- Distinguished Guest, ladies and gentlemen,

Welcome to Yogyakarta!

The International Conference on Sustainable Built Environment (ICSBE) was first launched in 2010 with the theme "Enhancing Disaster Prevention and Mitigation". The second conference was launched in 2012 with the theme "Livable Cities in the Fast-Growing Countries". This year, the third ICSBE 2014 presents the theme "Resilience and Risk Reduction Towards Well-Being Society", which is a fine match with the position of Yogyakarta as the one of resilient cities in Indonesia due to its prone disaster location. A resilient city is able to survive a traumatic blow to its physical infrastructure, its economy, or its social fabric.

A resilient city bends but does not break; it absorbs impacts without shattering. Even if the bridges and roads are ruined and the buildings toppled, the resilient city's core institutions survive; its social fabric holds; and in time, its economy rebounds. Resilience can be difficult or even impossible to gauge a city's true rebound capacity until an actual disaster is at hand. A city"s degree of resilience can also change over time; the same kind of event can yield very different outcomes depending on prevailing socioeconomic conditions. The conference aims to better understand how resilient is perceived in the societies. What problems need to be tackled in the planning and design of the built environment in order to achieve such resilient? The conference presents five sub themes comprising urban/rural environments and settlements, building and constructions, infrastructures, policies and management, and coastal cities.

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The Organizing Committee received 140 abstracts coming from 9 different countries and covering in 5 specified sub-topics. The scientific committee members blindly reviewed to all submitted abstracts and have provided technical comments to the author/s with regard to ensure that the submitted full paper is qualified. After reviewing process to overall submitted papers, the scientific committee has decided to receive 69 papers only and the authors were invited to present his/her paper in the conference. It should be noted that papers not presented in the conference session are excluded in the conference proceedings. Finally, there are 54 presented papers included in the conference proceedings covering the sub-topics as follows:

1. Urban/rural Environments and Settlements: 16 papers
2. Building and Constructions: 19 papers
3. Infrastructures: 8 papers
4. Policies and Management: 6 papers
5. Coastal Cities: 5 papers

This program will not take place without the generous support from our partners. Therefore, I would like to extend my gratitude to Bank Mandiri, Bank Syariah Mandiri, Bank Muamalat for co-sponsoring this event.

My gratitude also goes to our international invited speakers: Prof. Thomas Boving, Ph.D. and Prof. Farhad Atash, Ph.D. – University of Rhode Island (URI), USA, Prof. Mochamad Teguh, Ph.D. – Universitas Islam Indonesia (UII), Prof. Aris Marfa'i – Gadjah Mada University, Prof. Dr. Ir. Anita Firmanti, MT. – Ministry of Public Works (PUSKIM), Indonesia, Dr. Dadang Rukmana – Director of Urban Planning and Development, Directorate General of Spatial Planning and Development, Ministry of Public Works. Thanongsak Imjai, Ph.D. – Rajamangala University of Technology, Thailand. Finally, I must thank all members of the organizing committee for making this event possible.

Wassalamu'alaikum warrahmatullahi wabarakatuh

Yogyakarta, October 21, 2014

ICSBE General Chair of Organizing Committee

Suparwoko, Ph.D.

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Welcome Speech

Director of Research Institute for Human Settlements

4th. International Seminar on Tropical Eco-Settlements

“Bringing Coastal Cities into the Future: Challenges, Adaptation, and Mitigation”

It is a great pleasure to welcome you at the 4th. International Seminar on Tropical Eco-settlements (ISTEcS), which is held in the beautiful city, Yogyakarta. To our overseas participants, let me welcome you once again to our country, Indonesia.

The ISTEcS is a bi-annual event since 2006 with the only exception of 2008, hosted by Research Institute for Human Settlements (RIHS) Ministry of Public Works Indonesia. As previous seminars in the series that each had emphasis on specific issues related to tropical settlements, this year’s ISTEcS will also focus on the sustainability challenges of coastal cities in tropical zones arising from sea level rise, climate change, and land subsidence. These phenomena have become a global concern as they could put populations of these cities at greater risk of flooding and other climatic disasters. Adaptation and mitigation are thus two fundamental terms within this context.

Efforts must be taken to bring coastal cities to the future. We believe all adaptative and mitigating measures require every stakeholder to hold hand together in collaboration. With this seminar, we therefore seek to establish a forum for government officials, researchers, academicians, industry practitioners, non-governmental and multinational organization staff members to share their views and experiences on managing sustainable coastal cities. No less important is an opportunity to build collaborative partnerships with experts of different scientific areas and country of origins.

The 2014’s ISTEcS is also special in the way that this event is organized in collaboration with the 3rd. International Conference on Sustainable Built Environment (ICSBE), hosted by Islamic University of Indonesia (UII), following a previous cooperative agreement signed not long ago between UII and RIHS. Such a collaboration, rather than rivaling one another, would have benefited both institutions as well as prospective participants. Not only could we share our resources for mutual goal, we could also take advantage on enhanced networks for our future works.

Our secretariats have received about 60 technical papers covering different aspects of urban/rural settlements, including coastal cities as a special issue of the joint seminars. To ensure the quality of papers to be published in the conference proceedings, all accepted papers have undergone a blind review process by our scientific committee members and professionally been edited in accordance with the given template. These papers will be presented in parallel sessions for two consecutive days.

We sincerely hope that these joint seminars will prove beneficial and valuable for you, all the seminar participants. Besides attending the seminars, you may also find time to visit many local attractions of Yogyakarta.

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Finally, as the RIHS Director, I wish you productive discussions during paper presentations and a very pleasant stay in Yogyakarta.

Yogyakarta, October 21, 2014

Director of Research Institute for Human Settlements

Prof. Dr. Ir. Anita Firmanti, MT.

Welcome Speech

The Dean, Faculty of Civil Engineering and Planning, Universitas Islam Indonesia

Assalamu'alaikum warrahmatullahi wabarakatuh

The honorable:

- Rector of UII, Ir. Harsoyo, M.Sc., Ph.D.,
- Director General of Spatial Planning, Ministry of Public Works, Indonesia, Dr. M. Basoeki Hadimoeljono,
- Director General of Agency for Research and Development, Ministry of Public Works, Indonesia, Ir. Waskito Pandu, MSc.,
- The Head of Research Institute for Human Settlement, Ministry of Public Works Indonesia, Prof. Dr. Ir. Anita Firmanti, MT.,
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- Keynote speakers: Prof. Thomas Boving, Ph.D., Prof. Farhad Atash, Ph.D., Prof. Mochamad Teguh, Ph.D., Dr. Dadang Rukmana, Prof. Dr. Ir. Anita Firmanti, MT., Prof. Aris Marfa'i, Thanongsak Imjai, Ph.D.
- Participants of the 3rd ICSBE 2014 and the 4th ISTEcS.
- Distinguished Guest, ladies and gentlemen,

First of all, praise is to Allah, the Cherisher and Sustainer of the world, for His blessing for all of us. He who has provided us a chance so that we could be here to share knowledge, ideas, solutions and experiences in the Third International Conference on Sustainable Built Environment (ICSBE) 2014. To the academic, our colleagues from the overseas universities, guests, participants, students and so on, please accept our gratitude, warm welcome and appreciation.

In the last decade, there were several disasters occurred in Indonesia. Yogyakarta, as one of big cities in Indonesia, had been facing two great disasters in 2006 and 2010. The first disaster was an enormous M 5,9 earthquake, the victims was very devastating, more than 5.700 deaths and 37.000 injuries. The total financial losses was USD 3,1 billions. The second disaster was Merapi Volcano Eruption, which killed hundreds of people in 2010. These disasters have given us extra experiences how to protect our communities and the environment.

Resilience and risk reduction has been a really important part in order to overcome the disasters in future, and then societies have the key role to play that. The disasters were causing many casualties, injuries, and financial losses because the societies do not know the proper action. Many parties take involve in activities of resilience and risk reduction, they teach the resilience and risk reduction to societies living in the prone disaster areas. A city with a robust, diversified economy, for example, will rebound much more quickly than a city with a narrowly specialized or weak economy. Planning, too, can dramatically bolster a city"s resilience. Well-rehearsed evacuation and emergency management plans can enable a city to endure a crisis with minimal loss of life. Cities that invest in hazard mitigation planning and action can also reduce their vulnerability.

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The Third International Conference on Sustainable Built Environment (ICSBE) 2014 takes issues in this urgent agenda of “resilience and risk reduction towards well-being society”. The conference takes role as the media to share wisdom and experiences, and develop knowledge as well as skill and recent technologies on applied built environment sciences and technologies. This conference conducted with participants from different background study is expected to have integrated solution of resilience and risk reduction towards well-being society. We will discuss five sub themes comprising urban/rural environments and settlements, building and constructions, infrastructures, policies and management, and coastal cities.

Let me deeply state a special appreciation to the Research Institute for Human Settlement, Ministry of Public Works (PUSKIM) who has fully support this conference so that joint host of this conference between FCEP UII and PUSKIM is well managed. It is a great pleasure to acknowledge the invited speakers; Prof. Thomas Boving, Ph.D. and Prof. Farhad Atash, Ph.D. – University of Rhode Island (URI), USA, Prof. Mochamad Teguh, Ph.D. – Universitas Islam Indonesia (UII), Prof. Aris Marfa'i – Gadjah Mada University, Prof. Dr. Ir. Anita Firmanti, MT. – Ministry of Public Works (PUSKIM), Indonesia, Dr. Dadang Rukmana – Director of Urban Planning and Development, Directorate General of Spatial Planning and Development, Ministry of Public Works, Thanongsak Imjai, Ph.D. – Rajamangala University of Technology, Thailand. I also would like to extend my special thanks and high appreciation to our sponsors: Bank Mandiri, Bank Syariah Mandiri, Bank Muamalat for their generous support to take place this conference. Our appreciation is also for all participants who have actively written excellent research papers.

Finally, my special thanks go to Rector of UII, all the steering and organizing committees for making this conference possible. It is desired to have a sustainable conference to be held continually in future times, as we are challenged by daily minor and major disasters to make a well-being society.

Wassalamu'alaikum warrahmatullahi wabarakatuh

Yogyakarta, October 21, 2014

Faculty of Civil Engineering and Planning (FCEP)

Universitas Islam Indonesia

The Dean

Dr.-Ing. Widodo Brontowiyono.

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Welcome Speech

The Rector of Islamic University of Indonesia

Assalamu'alaikum Warahmatulahi Wabarakatuh

- The Honorable, Dean of Faculty of Civil Engineering and Planning Universitas Islam Indonesia, Dr.Ing. Widodo Brontowiyono,
- Director General of Spatial Planning, Ministry of Public Works, Indonesia, Dr. M. Basoeki Hadimoeljono,
- Director General of Agency for Research and Development, Ministry of Public Works, Indonesia, Ir. Waskito Pandu, MSc.,
- The Head of Research Institute for Human Settlement, Ministry of Public Works Indonesia, Prof. Dr. Ir. Anita Firmanti, MT.,
- Respectable all of the keynote speakers and participants,

Distinguished guests, ladies, and gentlemen,

On this special occasion, let us offer our praise and gratitude to Allah SWT for it is with His mercy and grace that we are able to attend the 3rd International Conference on Sustainable Built Environment (ICSBE) today.

On behalf of the university, we are honored and very pleased to have your visit today especially to the keynote speakers and all participants. It is also a pleasure for me to extend everyone a warm welcome to Universitas Islam Indonesia (UII), the oldest national university in the country.

Distinguished speakers, ladies, and gentlemen,

We are also honored to inform you that this program is jointly hosted by Faculty of Civil Engineering and Planning, UII and The Research Institute for Human Settlements, Agency of Research and Development Ministry of Public Work, Republic of Indonesia (PUSLITBANGKIM KEMEN PU RI). We hope that this activity will establish closer ties and cooperation between the two institutions in the future.

This 3rd International Conference on Sustainable Built Environment (ICSBE) is conducted under the topic 'Resilience and Risk Reduction towards Well-Being Society' in association with the 4th International Seminar on Tropical Eco-Settlement (ISTEcS) under the theme 'Bringing Coastal Cities into the Future: Challenges, Adaptation and Mitigation.

Distinguished guests, ladies, and gentlemen,

We are fully aware that the population growth in the last centuries grows rapidly. A growing population leads to several environmental issues as well as social problems. This means that a better setting of the settlement is very important to make a city become livable. Inspired by that notion, this conference in one hand is aimed to better understand how livability is perceived in the fast-growing cities.

In the other hand, this conference will provide the opportunity to government officials, researchers, academicians, industry practitioners, non-governmental and multinational organization staffs and other stakeholders to share their views and experiences to build

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international collaborative networks on managing sustainable coastal cities. Some important issues that will be presented on this seminar are about how to handle all the problem of the urban/rural environment, how to assess the risk of building and construction, infrastructure, politics management, and coastal cities. All that issues are intended to build a well-being society with a good reduction of risk and reliance.

Distinguished speakers, ladies, and gentlemen,

To conclude, once again I extend everyone my warm welcome to this conference. I hope that this conference will inspire us to enhance our awareness to explore any possibilities in building resilient society. Also, I look forward to fruitful discussions and hope we can be inspired by the best practices we will hear from our distinguished speakers.

I thank you.

Wassalamu'alaikum Warahmatullahi Wabarakatuh.

Yogyakarta, October 21, 2014

Rector

Dr. Ir. Harsoyo, M.Sc.

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KEYNOTE SPEAKERS

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EXPERIENCES WITH RIVERBANK FILTRATION IN JORDAN AND INDIA

Thomas BOVING[1], Pamela CADY[2], B.S. CHOUDRI[3], Kavita PATIL[4]

ABSTRACT: In many countries, like Jordan and India, access to clean water is a major factor limiting economic development. Environmentally and financially sustainable water treatment solutions are needed to provide clean water - especially in mostly underserved rural farming communities or as a response to natural disasters that have disrupted conventional water treatment systems. A versatile and resilient water treatment technology known as a Riverbank Filtration (RBF) system can turn heavily polluted surface water into clean irrigation water or, possibly, drinking water. Thus, RBF can permit the reuse of surface water resources that otherwise should not be used for irrigation or domestic purposes. While RBF technology is already widely utilized in many developed countries, it is only recently that this technology has attracted the attention of water treatment professionals in the developing world. This paper provides an overview of two RBF projects carried out in Jordan and India, respectively. The principal goal of these projects was to determine the feasibility of a small-scale RBF system under environmental and economic conditions typical for many developing regions. In Jordan, it was demonstrated that water can be improved by RBF - even if the main source of surface water is a river heavily contaminated with sewage water. Tracer tests in the RBF catchment area showed that the treatment is predicable, which is a major prerequisite for implementing additional RBF systems within the same watershed. At the Indian site, extensive hydrogeological and geochemical investigations were carried out together with household surveys conducted before and after introduction of RBF. These surveys gauged the acceptance of RBF technology by the community and provided insights into financial support of RBF systems. The hydrogeological and geochemical investigations demonstrated that RBF systems can be engineered to meet water quality standards while also satisfying local water quantity requirements.

KEYWORDS: Riverbank filtration, water treatment, sustainable technology, water quality.

1. INTRODUCTION

Riverbank Filtration (RBF) technology offers an inexpensive, widely applicable means to remove large amounts of contaminants (including pathogens) without the use of chemicals. This is possible because RBF relies on natural filtration processes, such as biotransformation and predadation, in combination with smart hydrogeological engineering. There are many advantages of using RBF for water treatment (Schubert, 2004), including removal of particles and turbidity, removal of bacteria, viruses, parasites, biodegradation of micro-pollutants, avoidance of mutagenic disinfection byproducts as well as smoothing out variations in temperature and concentration, particularly compensation for peaks and shock loads.

In RBF systems (Figure 1), water is withdrawn from one or more wells near a river. Wells may either be vertical or horizontal and ideally are installed more than 50 meters away from the river. By pumping an RBF well, the river water (together with some groundwater) is forced to flow through porous riverbed (alluvial) sediments. As raw surface water travels towards the RBF well, pathogens and dissolved/suspended chemicals are removed or

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[4] The Energy and Resources Institute (TERI), Coastal Ecology and Marine Resources Centre, Southern Regional Centre, Vasudha Housing Colony, Alto Santa Cruz, Goa-403 202, India.

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significantly reduced via a combination of physical, chemical, and biological processes. These natural treatment processes are auto-regenerative so that a properly engineered RBF system can essentially remain effective indefinitely (Schubert, 2002). By relying on natural treatment processes and without using chemicals, pathogen and heavy metal concentrations as well as toxic organic chemical levels are reduced or eliminated. Furthermore, by abstracting from surface water, stressed local groundwater resources are protected. From the RBF well, water flows in metered pipes towards the end-user or storage tanks. By implementing gravity flow to the degree possible, energy costs can be saved and continuous service can be maintained should the power grid fail.

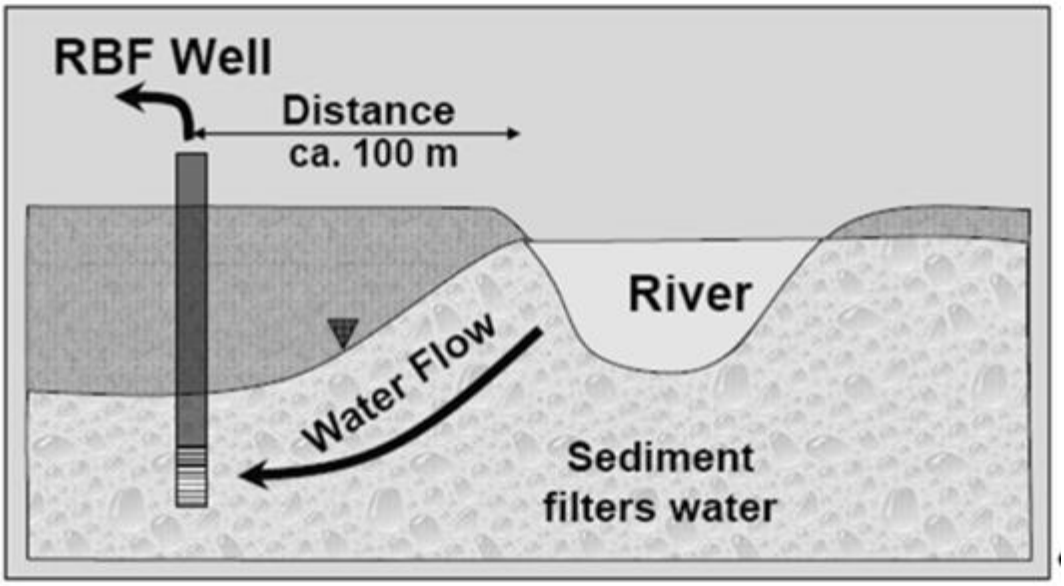

Figure 1. Cross section of a Riverbank Filtration (RBF) system.

RBF has been used in Europe for over a hundred years and is now a widely accepted pre-treatment technology preceding more advanced treatment operations (e.g. Schmidt et al., 2003; Ray et al., 2002). For example, RBF provides 75% of the water supply of the German capital Berlin (Hiscock, 2005). In the Netherlands, RBF contributes ca. 7% (80 Mm^3/a) of the national drinking water supply, through a total of 26 well fields (Stuyfzand et al., 2004). Compared to Europe, the United States has adopted RBF only much more recently. In the US, it is estimated that 67 million people can potentially be served by riverbank filtration (Hubbs et al., 2004). Current regulations pertaining to RBF systems, such as the Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR) (US EPA 2003), focus primarily on the removal of microbial pathogens.

There are a number of reasons why RBF technology is well suited for use in both developing and industrial countries (Boving et al., 2014). For instance, RBF can be i) implemented along most rivers and even lakes; ii) is a mechanically simple, easily understood technology that can be inexpensively designed and built; and iii) is scalable so it can meet the needs of small farms, rural villages or even larger urban areas. In fact, RBF might be the only viable option for many remote villages that cannot afford more complex and expensive water treatment technologies, such a reverse osmosis. Additionally, given favorable hydrogeological conditions, installing RBF systems might be an appropriate first response to natural disasters that disrupted conventional water treatment systems.

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2. DESCRIPTION OF FIELD SITES AND METHODS

2.1. JORDAN

Approximately 90% of Jordan is arid or semi-arid. This climate severely limits the amount of available water resources, particularly groundwater. The study area was located in the Amman-Zarqa River Basin (3,918 km^2). This is the most important basin in Jordan because it covers the transitional areas between high lands in the west and deserts in the east. This transition reflects not only the climatological changes, but also changes in habitat and land use patterns. The major hydrologic problems in this basin are declining groundwater levels due to over-pumping and resultant increasing total dissolved solids (TDS) (> 2,500 ppm at present). The Zarqa River water quality has deteriorated to the extent that it is no longer suitable for unrestricted irrigation.

The RBF well and five monitoring wells were installed in unconsolidated alluvial deposits with depths ranging from 16.7 m to 21.6 m below ground surface (bgs). Depth to bedrock was approximately 21 m bgs. All wells were completed with 10 inch steel casing. Welded holes served as screen from the bedrock to top of the aquifer located approximately 4 m bgs. Each wellhead was encased in concrete and capped for protection. A 4 inch, 5 horsepower electrical pump (Grundfos brand model 85S50) and a certified, calibrated flow meter was installed. The pump produced water at a steady flow rate of 10 to 15 m^3/hr. Aquifer and tracer tests were conducted to characterize the well field and the amount of water pulled in from the river. Water quality samples were collected periodically, including for fecal indicator microorganisms (*Escherichia coli* and *Enterococci*) and bacteriophages [somatic coliphages (SOMCPH), F-specific bacteriophages (FPH) and somatic salmonella phages (SOMSPH)]. The results were used to rate the removal performance of the RBF well field. Details about the mirobiological and hydrogeological studies are summarized by Boving et al. (2010).

2.2. INDIA

The RBF study was conducted in a rural area alongside the perennial Kali River in northwestern Karnataka, India. The Kali River flows 185 km from the Western Ghats to the Arabian Sea. Its average annual discharge rate is 197 m^3 per second at its lower reaches (Radhakrishna and Vaidyanadhan, 1997). At the study site, the river's maximum depth was about 8 meters and, according to local fishermen, varies by 4 meters or more during the seasons. The RBF well field was installed approximately 5 km downstream from the town of Dandeli (population 46,760) and near the small village of Kariyampalli (population ~1,000). Industrial and municipal effluents released upstream cause water pollution throughout the year. Due to lack of other options and weak enforcement of existing water quality regulations, contaminated river water serves many uses here, including drinking and flood irrigation of rice paddies (Boving et al., 2014).

Four wells were drilled approximately perpendicular to the river with the farthest well (MW4) 79 m away from the riverbank. An existing open well (KOW) is located 125 m away from the river. Although one RBF well would have been sufficient, multiple wells were installed to systematically study the well field hydraulics and changes in RBF water quality with distance from the river. The well depths ranged from 20 m to 25 m bgs. The static water levels were approximately 4 m bgs in all wells. The pumping rate at principal RBF well (MW3; 52 m from the river) was 8 m^3/hr on average. Aquifer and tracer tests were conducted to describe the hydraulics of the well field. More technical and hydrogeological information is provided by Boving et al. (2014). Water quality samples were collected for one year, covering both wet (Monsoon) and dry seasons. Microbial test parameters included fecal indicator

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microorganisms *Escherichia coli (E.coli*) and total coliform. Details about these studies are summarized in Cady et al. (2013).

3. RESULTS AND SUSTAINABILITY

Both, in Jordan and India, the RBF well fields yielded sufficient water to meet the needs of the local communities. In Jordan, most of the water was utilized by a nursery for irrigation of crops and plants. In India, the RBF substituted for the existing open well and primarily served domestic needs.

The results from Jordan indicate a very good hydraulic connection between the RBF well and the nearby Zarqa River. The comparison of RBF well water and the Zarqa River showed that fecal indicator bacteria and bacteriophages were removed by 3.4 – 4.2 $\log_{10}$ and 2.7 - 3.3 $\log_{10}$, respectively. The removal was accomplished within 5 meters from the river's edge. The data set indicates that a substantial reduction of microbial matter can be achieved even over short distances and short travel times between the RBF well and the river (Boving et al., 2010).

In India, the hydraulic testing and hydrogeochemical investigations demonstrated that the RBF water quality and quantity meets and exceeds most local water quality standards. RBF water fecal bacteria concentrations were orders of magnitude lower than in the river water. The removal of heavy metals and improved water turbidity produced water that complied with theIndian drinking water standards (Cady et al., 2013). The yield of the principal RBF well was sufficient to supply at least 4,000 people with 55 L/day/capita as required by the Indian government. Between 27% and 73% of the RBF water originated from the river. This is similar to results found in other RBF studies (Grischeck et al., 2010; Hoppe-Jones et al.; 2010, Kelly and Rydlund, 2006; Schmidt et al., 2003; Schubert, J., 2002). A fraction of the RBF well water was drawn in from nearby rice paddies that were irrigated with river water (Boving et al., 2014).

3.1. TECHNICAL SUSTAINABILITY

RBF technology is sustainable and protects water resources because treatment by RBF permit re-use of surface water that otherwise cannot be used without risking human health. Also, when RBF water substitutes for groundwater, it helps relieve stress on aquifers due to over-pumping groundwater.

For the management of RBF systems, the catchment and infiltration zone, mixing proportions in the raw pump water, flowpaths, and flow velocities of the bank filtrate need to be known (Hiscock, 2005). Many of these factors and processes are well understood, but there are a number of site specific parameters that must be investigated at each potential RBF site. For example, an important factor affecting the performance of an RBF system is the formation of a *schmutzdecke* (colmation layer) at the interface between ground- and surface water. This layer can reduce hydraulic conductivity due to clogging from the input of sediment particles, microbial matter, or geochemical reactions within the aquifer/riverbed interface. This process of riverbed clogging can be offset by the regenerative process of streambed scouring (Schubert, 2002). Or, biomass growth can affect the performance of a Riverbank Filtration system (e.g. von Gunten and Zobrist, 1993; Baveye et al., 1998; Kildsgaard and Engesgaard, 2002; Ray, 2002; Engesgaard et al., 2004). All these processes can impact the dynamic and static hydraulic forces and may vary significantly in space and time. Together, they affect the amount and quality of water that can be produced. Therefore, the identification of a proper RBF site and the design and installation of an RBF well needs to be supervised by an experienced hydrogeologist or engineer.

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3.2. ECONOMIC SUSTAINABILITY

For a single small-scale farmer in India or Jordan, installing an individual RBF system typically does not make economic sense. However, if communities pool their financial resources, RBF technology is within reach. Based on our studies, we project that rural Indian villages of at least 500 households present a financially viable market for RBF technology. Our project demonstrated that revenue can be generated by fee-based access to the RBF water distribution system. Further, while more applicable to larger RBF systems, water fees can be set up as alternative increasing block tariffs (AIBT) – "use more, pay more". Such a fee structure is likely to encourage the efficient use of water, which is an environmental benefit. We investigated the willingness to pay for RBF water. The vast majority of interviewed villagers agree to support a water fee system if the collection and handling of the fees is fully transparent and multiple trusted people are in charge (Water User Association) (Boving et al., 2012).

Direct effects of switching to RBF water instead of relying on polluted river water are (1) crops grown with high quality irrigation water can demand higher prices in the market and (2) clean water improves the health of people. Higher income together with improved health lifts living standards. Another benefit is job creation, i.e. to operate and maintain an RBF system, technicians and water quality controllers need to be hired. This diversifies job opportunities in the mostly agricultural communities investigated in our study areas. Also, we postulate that women are likely to benefit indirectly from RBF because when clean water is delivered closer to their homes, women spent less time collecting water from the river or other sources. This frees them up to spend more time to seek paid work or supervise the schooling of their children.

4. CONCLUDING REMARKS

Many different water treatment technologies exist but most are not available or cannot be utilized by communities in developing or emerging economies. In many cases, this is due to a lack of understanding of the end users' needs or simply because of high cost and technological complexity of the treatment methods. Implementing low-cost, low-tech RBF systems – especially small scale ones – in countries like India or Jordan may help to alleviate these problems such as financing and maintaining water treatment systems.

Our studies showed that RBF treatment can turn polluted rivers into useful water resources. Also, an RBF system can be effectively managed by a local community if trained appropriately in matters of quality control, budgeting, and management. But, more research is needed to test the sustainability of small, community operated RBF systems in developing countries. In this context, we encourage an investigation of RBF systems in the Circuit Rider Model, in which a small group of qualified water technicians rotate through a circuit of RBF communities, sharing resources (testing equipment etc.) and providing advice and training to local operators on issues of sustainability, governance, treatment technologies, operations and maintenance.

Finally, RBF is a mechanically simple, easily understood technology that can be inexpensively and quickly built along most rivers and even lakes. This can make RBF technology a viable option for remote villages that cannot afford more complex and expensive water treatment or groundwater access technologies. For the same reasons, installing RBF systems might be an appropriate first response to natural disasters where the conventional water treatment systems have been destroyed.

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EARTHQUAKE RESISTANT CONSTRUCTION PRACTICES IN INDONESIA: A RECONNAISSANCE ON VULNERABLE BUILT-CONVENTIONAL HOUSES FOR SUSTAINABLE DEVELOPMENT

Mochamad TEGUH[1]

ABSTRACT: Indonesia is geographically and geologically located at the juncture of four major world tectonic plates; i.e., the Asian plate, Indian Ocean plate, Australian plate, and Pacific Ocean plate. Subsequently, most part of the country is seismically active and the geomorphology is extremely fragile affecting to Indonesia major earthquake disasters. Conventional houses built in the area are enormously vulnerable to the disaster producing main problems for sustainable development. This paper discusses earthquake resistant construction practices in Indonesia focusing on conventional houses due to the 2009 Padang Earthquake. The survey was undertaken in urban, suburban, and rural devastated areas focusing on the weakness structural components of conventional houses that were traditionally built without considering earthquake resistant design concept. It has been observed that the awareness for designing earthquake-resistant construction practices in Indonesia plays an important role in conservation of conventional houses. Discussion and recommendation were extensively carried out to overcome the existing problems and educate or train people living in the prone area of earthquake disaster. The result shows that seismic vulnerability of conventional housing construction for sustainable development has been the main cause of excessive human and economic losses in the past earthquakes. These earthquakes affected both rural and urban areas and most fatalities resulted from inadequate seismic performance of housing construction.

KEYWORDS: earthquake, conventional house, vulnerability, and construction practice

1. INTRODUCTION

The aftermath of earthquake disaster has directly caused loss of human and animal lives, economic loss in terms of damages to crops and infrastructure, loss of live hood, and damage to housing and habitat. In general, natural disasters have frequently been occurring throughout the world history of mankind and their occurrence has become special attention to the government policy makers, non-government organization (NGO), designers, engineers, and researchers to plan most effective disaster mitigation and management in order to reduce the risks associated with the disasters. Indonesia has experienced major disasters with intense frequency during last decades. The government of Indonesia started working on formulation of its national disaster management policy after Great Earthquake and Tsunami of 2004 in Nangro Aceh Darussalam. Establishment of National Agency for Disaster Management (BNPB) and its subsidiary organizations at provincial and district level have brought the new paradigm shift from relief-oriented approach to prevention, mitigation, and preparedness, commonly referred as disaster management cycle.

Earthquake falls in the category of hazards, which have low frequency probability of occurrence in a given area but highly disastrous consequences. The occurrence of an earthquake cannot be prevented nor predicted with any precision at present (Arya 2008). The catalogue of earthquakes in Indonesia has shown more than thousand earthquakes of magnitude ≥ 5 on the Richter scale, which have occurred in Indonesia from the year 1900 to 2009. According to Irsyam and Team (2010), earthquake-zoning map of Indonesia classifies into 6 zones of land area prone to earthquakes (see Figure 1). Thousands of masonry

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buildings have been damaged or totally destroyed in some of the moderate to major earthquakes with Magnitudes 6.0 to 8.7 on Richter scale. The experience in the recent earthquakes in Sumatra and Java Islands of Indonesia has created high concern about earthquake damages in the government circles in the country.

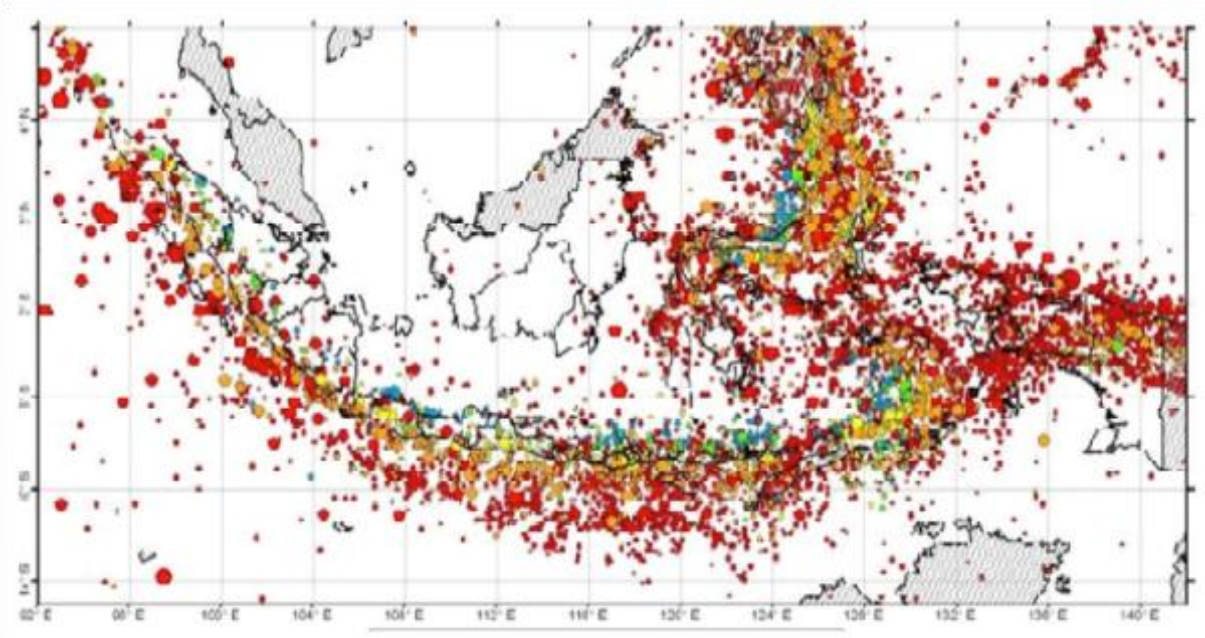

Figure 1. Epicenter data in Indonesia with magnitude *M* > 5.0 (1900-2009)

Most of Indonesian people living in different Island face the risk of being struck by a disaster of one type or another, including natural disasters such as floods, draughts, landslides, wildfires, volcano eruptions, tsunamis, and earthquakes on a regular basis. This country has experienced natural hazards having variety of disasters occurred in different zones, however, it is dependent on geographically and geologically location as well as environmental condition (Teguh 2011). In general, increased urbanization has led to more people residing in hazardous areas. Based on the World Bank report (2005), Indonesia is recently ranked 12th highest among countries with high mortality risks from multiple hazards and has approximately 40% of the population, or 90 million people, is at risk from disasters. When a kind of disasters strikes, it can wreak destruction on a community destroying homes and businesses, leaving people homeless and out of work. Nationwide, property damage from disasters has been increasing gradually, in part because of larger disaster events, but also because more and more people are living in hazard-prone areas (EDPP 2009). Earthquake damages on houses in urban, suburban, and remote areas have cost the nation billions of dollars.

On the 30th September 2009, a Moment Magnitude Mw7.6 earthquake occurred off the Island of Sumatra, Indonesia, near the city of Padang. This earthquake had a devastating effect on many of the buildings and affected infrastructure and communities in that area. The epicenter of the event occurred in the same region as the 2004 Sumatra-Andaman earthquake that generated a Tsunami resulting in the deaths of over 200,000 people. When an Mw 7.6 earthquake struck the West Coast of Sumatra on September 30, 2009, at 5:16 p.m, a populated area of 1.2 million people, including 900 thousands in Padang and 80 thousands in Pariaman was directly affected this natural disaster. Padang is the capital city of West Sumatra, situated on the coast of the Indian Ocean between the Sumatra fault and the Sunda Trench fault. The earthquake caused 1,195 deaths and significant damage to about 140,000 houses and 4,000 other buildings (Satkorlak 2009). The casualties consisting of 383 deaths and 431serious injuries in Padang were mostly due to building damage and collapse. The number of casualties would likely has been higher had the earthquake struck earlier, when schools and offices were in session. The seismic vulnerability of buildings such as conventional houses in developing country of Indonesia can be observed from the recent earthquakes. The well-known engineer society saying that earthquakes do not kill people, buildings do, holds particularly true for developing countries where lives lost are generally a result of poorly constructed structures. In general, however, this is most likely caused by some problems at all levels, such as lack of competence (knowledge), lack of motivation for proper engineering and construction, lack of awareness about codes and seismic requirements, lack of monitoring mechanism, and lack of punitive measures. The social, economical, and political makeup of these countries make them more susceptible to loss of human lives and property damage (Khalfan 2013). As presented in Figure 2, the map is based on a 1:250.000 scale map sheet from Bakorsurtenal, the Indonesian National Mapping Agency showing that shaded topographic map with orange color are the main affected areas after the 2009 Padang Earthquake (Map Action 2009). The Map Action is grateful for support of DFID (Department for International Development) and ECHO (European Commission for Humanitarian Aid). Sengara et al. (2009) have identified the site-classification for Padang City. Much of the land on which Padang is built would be classified as site classes: D (deep or soft soil sites) and E (very soft soil sites) under NZS 1170.5 (2004) or AS 1170.4 (2007), while some of the better areas may be site class C (shallow soil sites).

Figure 2. Topographic map of main devastated area subjected to the 2009 Padang Earthquake

With respect to the post-earthquake program in West Sumatera Province, the implementation of rehabilitation and reconstruction program in West Sumatra Province covered 12 districts (Kabupaten/Kota), with the City of Padang and Padang Pariaman district, the most severely affected areas (Maarif, Pranoto et al. 2012). The breakdown of the damage is listed in Table 1. This paper discusses on various different factors that contribute to the vulnerability of non-engineered housing or conventional houses in Padang and surroundings. In order to provide a thorough insight to the issue, the major components that constitute the problem are separately discussed. Additional to this information, the basic principles of conventional-houses vulnerability are briefly presented. This paper considers the impact of a catastrophic earthquake that devastated non-engineered houses resulting to structural damages.

Table 1. Damaged houses affected by the 2009 Padang Earthquake (Maarif, Pranoto et al. 2012)

No	Level of damage	Total damaged houses	Percentage
1	Heavy	114,797	45.949
2	Moderate	67,198	26.898
3	Light	67,830	27.153
	Total	249,833	100.000

2. HISTORY OF BUILDING CODE FOR SEISMIC DESIGN PROVISION

In Indonesia, the first earthquake loading code was initially introduced in 1970, known as Indonesian Loading Guidelines N.I.-18; taking into account the design accelerations of 0.1g applied to working stress design especially for Padang regions. This code, however, was not used in a common design practice of buildings because of lack experience on moderate earthquake occurrences. The government of Indonesia has paid attention and continuously concerns on the development of seismic code for all Indonesia regions. Later in 1987, the Indonesian National Standard (SNI) for seismic design (SNI 03-1726-1987) requirements was changed to incorporate inelastic response modification factors and more stringent detailing requirements. This code adopted the New Zealand and ACI-318 Codes to introduce six seismic hazard zones in Indonesia and two specified soil conditions with the design PGA (Peak Ground Acceleration) ranging from 0.28g to 0.36g.

In respond to recent earthquake occurrences during last years where the earthquake in Indonesia has shown its intensity, the code SNI 03-1726-1987 was updated into SNI-1726-2002 to satisfy the earthquake resistant design standard. The 2002 code was referred to the 1997 UBC (Universal Building Code), the 1999 ACI-318 (American Concrete Institute) for concrete design provisions. In contrast, the 2002 code was revised the seismic zone designations, where Zone 1 is now being the lowest and Zone 6 is the highest seismic hazard. The soil designations were extended into three conditions, i.e, soft, medium, and hard. The design spectrum was modified in the short period range. This code, however, was computed by utilizing two-dimensional system considering limited earthquake parameters, whilst the soil condition at its earthquake source location was not taken into account in designing the seismic hazard map and may affect to the resulted spectra response for defining the earthquake loads. In the history of Indonesian code development for earthquake resistant design, unfortunately, the code was not updated periodically. A new earthquake resistant design standard of Indonesia has recently updated in 2012 by revising the 2002 code, considering the 2010 seismic hazard map, altering the ASCE 7-05 and IBC-2009, and other related standards. The SNI 03-1726-2012 was recently published based on probabilistic hazard studies conducted by the ITB (Bandung Institute of Technology) and USGS team. It was suggested that the PGA design values on soft soil sites in Padang should be increased to about 0.4 to 0.5g (Petersen, Dewey et al. 2004).

3. ENFORCEMENT OF BUILDING CODES

Lack of understanding on earthquake disaster and its disturbances that causes building damage and loss of life has become a special attention to the government authority, researchers, and engineers in educating people to the basic concept of earthquake resistant building. Increasing recent earthquake frequencies in Indonesia, efforts in raising awareness and disaster risk reduction initiatives upon earthquake resistant housing at the community level are essential tasks for disaster mitigation strategies. A main strategy of the disaster

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mitigation is to disseminate earthquake resistant building codes continuously to the local government officer, community leader, builder, designer, and people and to assess the existing buildings to check their remaining structural performance in withstanding the future earthquake disasters. It should be noted that disseminating building codes is an effective tool to safeguard buildings, houses, infrastructures, and other important public facilities from earthquake disaster.

In general, enforcement of building codes should be widely socialized to all stakeholders including the designers, builders, government officials, researchers, community leaders, and other related organizations/institutions. Based on the site investigation, observations, and interviews with engineers, enforcement of building codes and construction quality assurance are still lacking in the earthquake devastated areas, such as Padang, Aceh, Yogyakarta, and other regions in Indonesia. While the national building code standards have been strengthened in the seismic design provision, the extent to which this that has been implemented in Padang remains unclearly adopted in either design or construction procedures. More importantly, enforcement problems are most serious with buildings and their renovations, which are often not checked by city building department officials, producing deficiencies in both the design engineering and construction quality assurance.

Two moderate earthquakes struck Padang City and surrounding in 2007 and 2009 have evidenced that non-engineered and engineered buildings were significantly damaged and many government buildings were totally collapsed due to insufficient strength of the building structures. The UII (Islamic University of Indonesia) reconnaissance team investigated in the devastated area showing that a few older masonry buildings such as hospitals, commercial buildings, government buildings, were multistory concrete frames with brick exterior walls and infilled partitions. Based the site investigation on damaged buildings, most of typical structure damages was found in the devastated area such as shear failures on beam and column, beam-column joint, soft story and pounding problems. Other indication shown an old masonry building constructed in1900s had moderate damage to the masonry walls including a couple that failed out-of-plane, whilst the low story buildings constructed in 1970s, had a first-story collapse due to a combination of weak columns and seismically deficient steel reinforcement. In contrast, the newer buildings tended to have more glass on the exterior and combinations of infill brick and dry wall interior partitions.

Non-compliance of construction with the current design codes or with the construction drawings and the use of poor quality materials caused the collapse of many buildings (Weller and Team 2009). Therefore, increased enforcement of building code especially for conventional houses is required during the process of building permit review and during construction. The latest Building Codes and Standards such as SNI 03-2847-2013 (National Standard Association 2013) and SNI 03-1726-2012 (National Standard Association 2012) should be enforced to the people including government officials, academicians, and designers so that the seismic design of new buildings is designed based on the new standards. In addition to improve the capacity building of government local staff on better understanding in new standards, training of trainers from experts and professionals is significantly a priority program. Particular focus should be made on multi-story construction, schools, medical facilities, ambulance stations, bridges, major roads and other important post-disaster recovery and lifeline structures.

4. EARTHQUAKE RESISTANT CONSTRUCTION PRACTICES

Seismic vulnerability of non-engineered housing construction has been the main cause of excessive human and economic losses in the past earthquakes (Figure 3). Many homes were damaged because of old construction, unreinforced bricks, and poor mortar quality. The earthquakes affected both rural and urban areas and most fatalities resulted from inadequate seismic performance of housing construction. In rural areas, building damage and fatalities were mainly caused by the vulnerability of traditional unreinforced masonry construction. In urban areas, on the other hand, the losses were mainly due to non-engineered or inadequately engineered concrete construction, such as reinforced concrete frames with masonry infill walls. With a growing urban population and more extensive use of reinforced concrete and cement-based masonry construction both in urban and rural areas, it is expected that future earthquakes will continue to confirm significant vulnerability of these modern forms of non-engineered construction. Detailed information about housing construction practices worldwide is available in the World Housing Encyclopedia (www.world-housing.net), which documents both vulnerable construction practices that performed poorly in earthquakes and good practices that performed well in earthquakes.

Generally speaking, well-intentioned people who are actively involved in the construction industry develop building codes. Their original purpose is to provide minimum standards for the protection of life, limb, property, environment, and for the safety and welfare of the consumer, general public and the owners and occupants of residential buildings regulated by this code. However, it is important to keep in mind that building codes are adopted, modified and enforced by local politicians, engineers, and government officials. In reality they do not intend to limit the appropriate use of materials, appliances, equipment or methods of design or construction practices whereas it is not specifically prescribed by the specific code. The building official alternates the proposed materials, appliances, equipment or methods of design or construction, which are, at least equivalent of that prescribed in the code. In other words, the satisfaction of the building official may be able to use different construction methods or materials as good or better than what the codebook prescribes.

(a) Conventional building

(b) Non-engineered building

Figure 3. Damaged school buildings due to the 2009 Padang Earthquake

Principles of reliable seismic behavior on low-rise and multi-story building structures comprise simplicity and symmetry, length in plan, shape in elevation, uniformity and continuity, stiffness, materials, and possible failure modes. These principles should be in line with all requirements for seismic design as suggested by current codes, i.e., SNI 03-2847-2013, SNI 03-1726-2012, and other relevant standards. In fact, the National Standardization Agency of Indonesia (Badan Standardisasi Nasional - BSN) has found so far that there are huge gaps between engineering methods and actual construction conducted by manual laborers. Whilst it is focused on the issues of implementation of engineering technologies into practices in order to mitigate the damage of earthquake disasters. Figure 3 shows the out-of-

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plan bending or shear failure of wall as a result of conventional construction practices without considering the anti-seismic design concept.

In general buildings in Padang City consists of timber-framed, masonry or reinforced concrete framed structures and the infill walls are made of brick type and the roof is corrugated iron sheets. Timber-framed or masonry structures are quite common in the rural areas, while reinforced concrete framed structures for multi-story buildings are common in Padang and Pariaman Cities. The unreinforced masonry buildings are found in the China town and old buildings from Colonial period of Indonesia by Holland (Aydan 2009). Damaged or collapsed buildings during the earthquake were mostly non-engineered buildings, consisting of one or 2 stories houses, house shops, religious and school buildings. Some engineered buildings were also severely damaged or collapsed but the number was small compared to the non-engineered ones. The damaged buildings (Figure 3) were scattered and some areas had more damage, such as Padang and Padang Pariaman. The scattered areas of damage might be caused by either geologic conditions, quality of building material and structure, or workmanship quality. In addition to the low rise masonry buildings with or without thin column will perform very badly during the earthquake (Figure 3a). Most of these buildings collapse or heavily damage were mainly caused by out-of plane failure of masonry walls due to poor constructed thin column and ring beam (Figure 3b).

The local government has continuously enforced the recent building codes for seismic design and construction, however some problems in construction practices were still found in the reconstruction work. Figure 4 presents some examples of lack of understanding on the seismic safe housing, such as insufficient confinement ratio, improper reinforcement detailing, and no hooks at the long beam-column joint. Figure 4 shows that the only partial code has been adopted producing venerability of damage against future earthquake disasters.

According to Kusumastuti et al. (2008), the available seismic standards for non-engineered structures in Indonesia have not been fully adopted by local workers/masons due to an ineffective law enforcement of the codes. This phenomena shows how much important to educate or to train people especially workers/masons in order to improve their knowledge on earthquake resistant structures. A couple of built-house structures is insufficiently resistance to seismic actions because of the owners have conventionally built their houses by occupying less knowledge local masons and using low materials quality and traditional construction methods. In fact, those built-houses were improperly constructed neglecting building codes and technical controls. For this reason, engineers were not involved in the design and construction process and building inspection before issuing the building permits were never happened. This condition causes the built-buildings found with poor detailing, low material quality, low quality of workmanship, and wide variety of construction methods. Subsequently, the structures are more susceptible or vulnerable to damage subject to seismic ground motion.

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(a) No reinforced concrete roof band (b) Poor ties, rebar detailing and no hook at joint

Figure 4. Construction practices in reconstruction site

The main problem on non-engineered structures is augmented by inappropriate structural design without taking into account seismic design concept. A huge number of built-houses in suburban were built based on the owner's traditional layouts and plans. Some conventional houses were originally made of woods or bamboo with respect to have flexible joint and lightweight material in performing well under seismic load. Recently, people living in urban, suburban, and rural areas are more likely to build their houses using reinforced concrete (RC) frames and masonry walls rather than wood and bamboo. These RC and masonry structures are considered more modern and show the prosperity of the owners. When the concept of the traditional houses is adapted to modern structures, the building shapes and layouts are usually maintained, but the traditional materials (Figure 5a) are replaced with concrete and bricks (Figure 5b). Moving on the traditional to modern or common materials without considering the seismic design code has resulted vulnerable houses to seismic damage. This creates problems due to structural irregularities, as well as heavy masses for roofs and facades. As a result, more and more non-engineered structures were built with poor quality and to be vulnerable to earthquake. Considering large number of non-engineered buildings and their vital functions, as well as the high occupancy rates of these structures, efforts on making these buildings safer are significant in reducing the number of casualties and economic losses (Kusumastuti, Pribadi et al. 2008).

(a) River stone material (b) Un-reinforced masonry brick wall

Figure 5. Material change

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5. DISCUSSION ON SUSTAINABLE DEVELOPMENT OF CONVENTIONAL HOUSES

Post severe earthquakes, numerous engineering inspections and investigations have been performed to assess the degree of structural damage and to evaluate the performance of various construction materials. Irrespective of such reviews, there is an ongoing need to assess acceptable performance and damage control for different structures during seismic events. As a result, failures on main structural components of non-engineered houses affected by the recent earthquakes have led to considerable effort being directed towards safer civil infrastructure, particularly in the seismic zones in Indonesia (Teguh, Duffield et al. 2007). Reducing vulnerability of non-engineered buildings by conducting laboratory tests on structural and non-structural components and developing design models of precast non-engineered building-component is essential to improve seismic structural performance and sustainable development (Teguh and Makrup 2014). A research dissemination will be published in elsewhere journal publication.

The devastated areas visited by the UII Team were Padang City, Padang Pariaman, and Padang Panjang. The reconnaissance team also traced the places along the beach of Padang City and the damage in the area was scattered. The most damaged houses were at Padang City and Padang Pariaman District, whilst the rest few numbers of damaged houses with the damage level from light to heavy was spread out over the other districts as listed in Table 2 (Maarif, Pranoto et al. 2012).

Table 2. Detail of damaged houses affected by the 2009 Padang Earthquake

No	City/District	Level of Damage			Total	%
		Heavy	Moderate	Light		
1	Padang City	33,597	35,816	37,615	107,028	42.840
2	Padang Pariaman District	57,931	16,291	12,945	87,167	34.890
3	Pariaman City	6,685	4,115	2,605	13,405	5.365
4	Agam District	11,796	3,797	4,353	19,946	7.984
5	Pesisir Selatan District	1,156	3,596	5,510	10,262	4.107
6	Solok District	145	243	357	745	0.298
7	Kepulauan Mentawai District	3	0	136	139	0.056
8	Pasaman Barat District	3,240	3,046	2,862	9,148	3.662
9	Pasaman District	197	13	931	1,141	0.457
10	Padang Panjang District	17	164	413	594	0.238
11	Solok City	2	2	6	10	0.004
12	Tanah Datar District	28	115	105	248	0.099
Total		114,797	67,198	67,838	249,833	100.000

5.1. SEISMIC VULNERABILITY AND STRUCTURAL PERFORMANCE

This seismic risk component reflects the degree of damages (or losses, more generally) to buildings, or people, or any other element at risk, should they experience a certain level of seismic hazard. The vulnerability representation of exposed systems is facilitated through their sub-division into classes, according to the characteristics that most influence their response. Buildings may be classified into distinct types, whose performance in earthquakes is likely to be similar both in nature, and in degree. There exists a basic set of characteristics to determine the damageability of buildings.

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The type of load-bearing structure (e.g. load-bearing masonry, reinforced concrete frame, etc.) is the most important factor affecting earthquake damage. The SNI 03-1726-2012 provides a classification of the construction types found in many seismic areas of Indonesia as well as a similar detailed categorization of load-bearing systems. The vulnerability of these construction types, on average, can be expected to decrease it, for instance, non-engineered structures are more vulnerable than engineered ones, and rubble stone and earthen structures are more vulnerable than timber ones, within the category of non-engineered structures.

It is evident that high seismic vulnerability is assigned to buildings without earthquake resistant design (ERD). Such buildings include both engineered and non-engineered construction. Engineered buildings of this type are typically the case in regions of low seismicity, where earthquake design regulations are non-existent, or are present only in a recommendatory manner. Nevertheless, engineered structures with modern structural systems, but not specifically designed against lateral seismic loads, can still provide a certain level of earthquake resistance, which can be comparable to the level incorporated in engineered buildings with ERD. On the other hand, well built, non-engineered wooden, or masonry structures can behave in a fashion comparable to buildings with ERD. Vulnerability factors, related to the construction form, include: non-symmetrical, or irregular plans, height-wise stiffness differentials, unidirectional orientation of the lateral force resisting system, combination of different construction systems within the same structure, excessive wall openings, heavy roofs and inadequate roof-to-walls connections, inadequate foundations' design, and design faults.

In studying the skills of local tradesmen responsible for the construction of masonry housing throughout the seismic regions, a number of problems affecting the vulnerability of the houses have been documented; low masonry and carpentry skills; inadequacy of joints in design, execution and fastening; weak splicing techniques, depending only on nailing for strength; lack of bracing, no diagonal bracing in gabled ends, use of bracing in tension that tends to separate with movement, construction of wall bracing at angles which are insufficient to provide adequate rigidity and no lateral bracing of support posts; improper use and sizing of structural components; improper wall alignment, both vertically and horizontally; insufficient or improper foundation; poor mortar; poor craftsmanship; poor quality of bricks; poor concrete mix (Boen 2008). The common practice of incremental house, where initial construction added by new construction as the household has produced an increasing vulnerability because of the insufficient connections to the existing part and the created unsymmetrical configuration.

Unfortunately, many catastrophes in developing countries such as Indonesia, India, and Pakistan are the result of the collapse of such type of non-engineered buildings. Such condition of vulnerability that produces so many disasters in most cases is a result of the poverty, which increases in time due to uncontrollable population growth, mass urbanization, political instability, debt crisis, some of which vary in intensity from country to country. With regard to improve structural performance of the conventional-houses, the following law enforcement of the seismic building codes should taken into account in the construction consideration: (1) non-compliance to be policed; (2) re-construction and repair should be supervised in respond to issue building permits; (3) improve design controls; (4) training for all levels of construction industry; (5) professional engineer licensing; (6) and materials inspection. To achieve the better structural performance of buildings in the future, regulatory recommendations should be well managed, for instance, review of building codes (design earthquake hazard may be increased), building back better (new construction should be better than what went before), post-disaster recovery facilities improved (e.g. medical), tsunami hazard incorporated into planning and in design of recovery facilities, non-engineered buildings to have minimum standard design, hazard based spatial planning, and careful geotechnical investigation (building foundations) improved.

5.2. TYPES OF CONSTRUCTION OBSERVED

It is noted that non-engineered buildings are defined as those that are spontaneously and informally constructed in various countries in the traditional manner without any or little intervention by qualified architects and engineers in their design. These vernacular houses are proportioned based on experience (rules of thumb passing from one generation to the other) and they are mostly made out of wood, clay, concrete blocks, sundried clay bricks, field (or rubble) stone and brick, as well as combinations of these locally available materials. Cement, lime, and/or clay-mud are generally used for mortar compositions. In addition to these traditional structures, non-engineered reinforced concrete (RC) frame buildings are also part of the bulk of buildings built today in an informal way, by semi-skilled professional builders. The quality of concrete and the placement of reinforcement are usually considered to be low (Aydan 2009).

Most population of the buildings in the earthquake stricken areas is masonry non-engineered buildings consisting of half brick thick confined masonry walls. The confinement comprises reinforced concrete framing with “practical or thin” columns and beams. Structural columns, size 120x120mm or 150x150mm with four 10 or 12 mm diameter longitudinal rebars and confined with 8 mm stirrups spaced at 150-200 mm, are commonly cast after completing the construction of the masonry walls, and sometimes the practical columns were cast first before constructing the masonry walls. Structural beams, size 120x150mm or 150x200mm with four 10 or 12 mm diameter longitudinal rebars and confined with 8mm stirrups spaced at 150-200 mm, are cast directly on top of the foundation and served as tie beams. Similar beams, size 120x150mm or 120x200mm with four 10 or 12 mm diameter longitudinal rebars and confined with 8 mm stirrups spaced at 150-200mm, are cast directly on top of the brick wall and served as ring beams. Almost all buildings have timber roof trusses with galvanized iron sheets roofing. Few buildings used clay tiles for roofing. The buildings mostly used saddle type roof trusses.

Typical concrete compression strengths for RC framing range from 12.5 MPa to 15.0 MPa with rebar having a yield capacity of 240 MPa. The masonry infill wall is made of 50 x 100 x 200 mm brick using running bond with mortar thickness ranging from 8-15mm. The mortar mix usually consists of ranging from 1 sand: 3 cement to 1 sand: 4 cement. The walls are plastered on both sides with sand and cement mortar of approximately 10 mm thickness using the same volume ratio of mortar. These masonry construction types have become a new culture all over Indonesia and from past earthquakes it is evident that provided they were built with good quality materials and good workmanship, they survived the most probable strongest earthquake in accordance with the Indonesian seismic hazard map (Boen 2008).

However, like in other areas in Indonesia, the reinforcement of the practical beams is mostly not in accordance with the requirements as mentioned earlier. The reinforcing steel rebars detailing are also not appropriately done for earthquake resistance. The buildings are not designed well and constructed based on the wrong prevailing practice (Figure 6). Non-engineered masonry buildings failures due to seismic shaking are usually caused by out-of-plane bending failure of walls, and/or in plane shear failure and resulted either in total structural collapse or could result in typical damages. Factors contributing to such failures are weak connection between wall and wall, wall and roof, wall and foundation; seismic forces are not properly transferred into the supporting walls and frames.

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As aforementioned, rapid growing urban areas of the developing countries is quite common that the owners themselves construct their homes. In the best cases, the construction takes place under the guidance of a head-mason, or a carpenter who, nevertheless, lacks comprehensive knowledge on earthquake-resistant principles. Occasionally, these local and often self-taught builders may adopt improved construction practices derived from the observed behavior of such buildings during past earthquakes. In the case of traditional buildings, ought to both the inherent weakness of the materials used, and to fundamental construction mistakes, these structures are extremely prone to collapse due to earthquakes. Non-engineered buildings usually do not go through the building permit process and are prevalent in rural areas and in the periphery of large urban centers. In particular, some characteristics of the rural communities in Indonesia that contribute to the vulnerability of non-engineered houses include lack of proper access roads to the rural areas; lack of a wide coverage of public services; lack of education; poverty; lack of political influence and social isolation in some cases; difficulties in receiving information, and little access to knowledge; settlements located in high risk areas, usually on slopes and in proximity to water resources; and lack of building codes and construction supervision.

(a) Improper reinforced concrete canopy

(b) New built-house with wrong prevailing practice

Figure 6. Unsafe conventional-houses

Detailed engineering recommendations and standards should produce the single story common types of construction. These common building types appear to be favored due to the cheapness of the construction and the availability of the materials used in their construction. Simple improvements in their design and execution may lead to a significant increase in resilience to earthquake of the general population of buildings (Figure 7).

(a) Newly built-house considering ERD

(b) No damage found at local government office

Figure 7. Well-constructed non-engineered buildings

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The survey team has found the building types fitted into a number of broad descriptions related to design and construction methods. There are three main types included:

- confined masonry where load bearing brick masonry walls with a confining practical concrete beam and column frame cast directly against the brick;
- concrete frame with masonry infill walls, this type is included single story buildings where the concrete frame serves to confine the brick masonry and major multistory buildings with a large column and beam structure; and
- traditional single story construction utilizes timber frame with infill of either masonry or cement daub on “K-wire” mesh.

5.3. TYPICAL STRUCTURAL DAMAGES ON CONVENTIONAL-HOUSES

Traditional stone masonry houses have proven to be extremely vulnerable to earthquake shaking, thus leading to unacceptably high human and economic losses, even in moderate earthquakes. The seismic vulnerability of these buildings is due to their heavy weight and, in most cases, the manner in which the walls have been built. Human and economic losses due to earthquakes are unacceptably high in areas where stone masonry has been used for house construction. Both old and new buildings of this construction type are at risk in earthquake-prone areas of the world.

In common practice, masonry buildings failure modes due to seismic shaking can be characterized as out-of-plane toppling of wall, for unreinforced masonry walls; and out-of-plane bending failure of walls, and / or in-plane shear failure, for reinforced masonry walls. Both failure modes could result in wholesale structural collapse or could result in typical damages such as walls tend to tear apart; walls tend to collapse; failure at corners of walls; failure at corners of openings; walls tend to shear off diagonally and additional shear due to twisting or warping for unsymmetrical building. Factors contributing to such failures are weak connection between wall and wall, wall and roof, wall and foundation; seismic forces are not properly transferred into the supporting walls and frames (Boen 2001).

It has been observed that damage to conventional-houses resulted from poor quality materials, improper structure geometry, poor reinforcement detailing of main structures to lack of building control and available seismic building codes. These problems were probably caused by soft bricks, mortar substituted for concrete, aggregates rounded and too large, low cement content in concrete, poor traditional structures, site located in prone to liquefaction or landslide, less technical inspection, and poor detailing in joints and structural components. Evidence of liquefaction was noted at widely varying locations within the City of Padang. Liquefaction has caused ground settlement up to 300mm noted at one location. This type of settlement triggered serious damage to building structures. It affected the larger heavier structures and was more prevalent on the loose to medium sands near the coastline and along the edges of rivers. It is considered to have triggered the collapse of some large buildings due to the magnitude of displacements to building frames resulting from non-uniform levels of settlement throughout the structure. In the mass of evidence from past earthquakes, a few facts stand out and although they may be elementary, they are worth reiterating. The typical damages to non-engineered buildings particularly conventional-houses are as follows:

- dislodged and separate from its roof supports,
- tear apart, shear off diagonally in direction, collapse, and failure at corners of walls,
- additional shear due to twisting or warping for unsymmetrical building,
- failures at corners of wall openings and at sudden change in mass or stiffness,

- failures at rigid joint and insufficient strength of structural elements and connections,
- crack damage propagation due to stress concentration in wall openings,
- damage at structural/non-structural components due to poor quality of construction as well as material and workmanship,
- pounding between two adjacent buildings,
- shear damage due to weak connection between wall and wall, wall and roof, wall and foundation,
- buckled column due to excessive bending moment,
- damage on walls and frames due to large seismic forces not properly transferred into the supporting walls and frames,
- shear crack damage due to unreinforced gable wall,
- potential damage due to secondary moment as a result of un-symmetry and complex building plan.

6. CONCLUDING REMARKS

Based on the aforementioned brief discussion on sustainable development of conventional houses, the concluding remarks can be drawn as follows:

- Unsafe conventional houses kill people due to improper location, faculty design, use of poor quality materials, sub-standard construction practices, non-compliance to building codes, lack of awareness of safe construction practices, and disaster resistant practices.
- In many instances the typical failure of conventional houses in the seismic prone area has been attributed to poor quality of construction, substandard materials, poor workmanship, e.g., inadequate skill in bonding, absence of through stones or bonding units, and improper and inadequate construction.
- Reducing the number of deaths, injuries and economic losses from future house/building collapses in Padang's seismic areas should be manageable by enabling people to build safe houses now and in the future, through skills training, greater awareness, and access to capital. In addition, the move to modern materials has lead to a reduction in seismic resistance. If buildings are to be constructed from either masonry or reinforced concrete there must be the knowledge to design them and the skills to construct them to a high standard.

7. ACKNOWLEGMENT

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ADVANCED COMPOSITES FOR CIVIL ENGINEERING APPLICATIONS

Thanongsak. IMJAI[1]

ABSTRACT: Since the introduction of Fibre Reinforced Polymer (FRP) reinforcements into the construction industry, the use of these materials has been growing exponentially. Owing to their distinctive material properties, FRPs can offer an ideal solution for specialist applications where the use of steel reinforcement might be undesirable. On-going research around the world has addressed, and continues to address, these various areas of concern. This paper highlights advantages and disadvantages of composite materials and discusses their potential applications in the civil construction industry. Finally on-going research work on FRPs at Rajamangala University of Technology Tawan-Ok is addressed and comment upon.

KEYWORDS: Fiber Reinforced Polymer, FRP, Reinforced Concrete, Pre-stressed Concrete

1. INTRODUCTION

Advanced composites, or Fibre Reinforced Polymer (FRP) materials as they are commonly known in the construction industry, have proved to possess superior mechanical properties and have been used extensively in the aerospace, automobile and defence industries for several decades. Civil engineers, however, have only relatively recently begun to gain confidence and experience in applying this technology. FRP products made an extraordinary entry into the construction market 20 years ago and since the first demonstration projects were constructed in the late 80's and early 90's (Taerwe 1997) the interest in these materials has grown exponentially. The main reasons behind the rapid growth of the use of FRPs in construction were the light weight of the reinforcing products and their electromagnetic neutrality. The earliest commercial applications were as non-magnetic or radio-frequency transparent reinforcement for advanced transport systems, in specialized defence applications and in structures housing magnetic resonance imaging medical equipment (American Concrete Institute 1996). Nowadays, repair and strengthening of existing structures with FRP reinforcement is undoubtedly the most attractive application of FRPs.

This paper gives a brief overview of the physical and mechanical properties of FRP products and discusses areas where the use of advance composites as reinforcing material for concrete structures can benefit the construction industry.

2. USE OF FRP IN CIVIL ENGINEERING APPLICATIONS

Manufactured from a combination of natural or synthetic fibers within a polymeric matrix, FRPs display excellent resistance to environmental factors such as freeze-thaw cycles, chemical attack and temperature variations. Carbon, glass and aramid fibers, immersed in a thermosetting resin, are the constituents most widely used in the manufacture of the various types of reinforcement for concrete structures. New types of fibers and resins, however, are being developed continuously and new products comprising basalt fibers have recently been made commercially available.

FRP materials are manufactured using different techniques such as pultrusion, filament winding, moulding, braiding and manual lay-up. They also can be produced in various

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shapes. Reinforcing products for concrete, however, are usually manufactured in the form of rebars, sheets, grids and links to resemble the more familiar shapes already available for steel reinforcement (Figure 1).

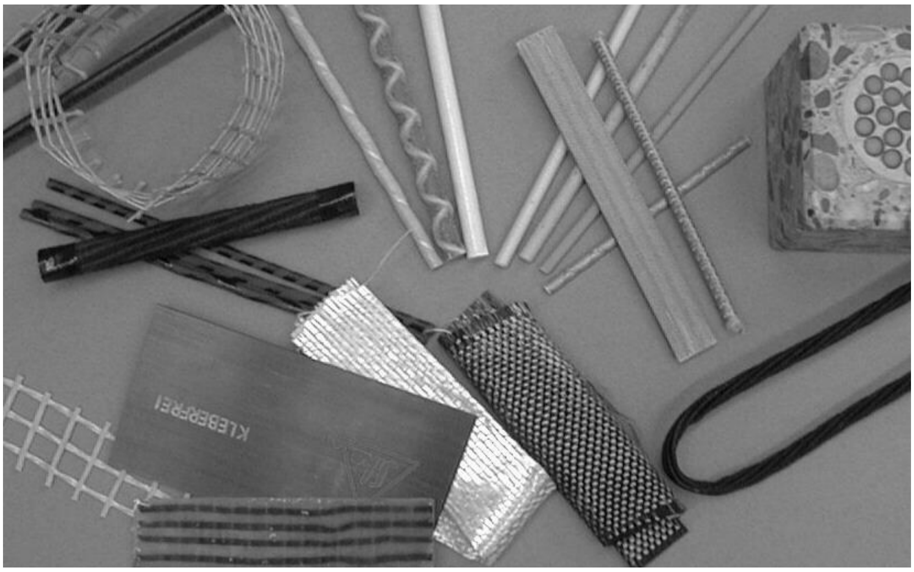

Figure 1. Various available commercial FRP products

The mechanical characteristics of FRPs differ in many respects from that of conventional steel reinforcement and depend on the type of fibers and resins used as well as the selected manufacturing process. FRP products are characterized by perfectly elastic behavior up to failure and can develop higher tensile strength than conventional steel in the direction of the fibers. The elastic modulus of FRP materials used in construction generally varies between 20% of that of steel for glass fibers and 75% of that of steel for carbon fibers (Figure 2). High strength, lightweight and a low modulus of elasticity, together with the fact that FRPs, unlike steel, do not display plasticity, are the key properties that differentiate the performance of these materials.

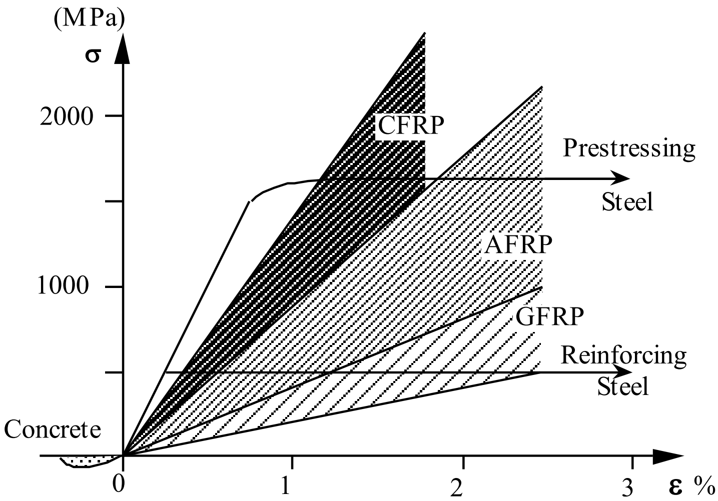

Figure 2. Stress-strain characteristics for concrete and reinforcing materials

High strength, light weight and low modulus of elasticity, together with the fact that FRP bars, unlike steel, do not display plasticity, are the key properties that differentiate the performance of these materials. The main advantages and disadvantages of these advanced composite materials compared to steel are listed in Table 1.

Table 1. Advantages and disadvantages of FRP reinforcement.

Advantages	Disadvantages
Higher strength to self-weight ratio (10-15 times greater than steel)	Higher raw material cost and relatively poor availability
Excellent fatigue characteristics (carbon and aramid FRPs only)	Lower elastic modulus (except some Carbon FRPs)
Excellent corrosion resistance and electromagnetic neutrality	Glass FRP reinforcement suffers from stress corrosion
Low axial coefficient of thermal expansion	Lack of ductility; durability issues in alkaline environments

Due to the distinctive mechanical properties of the reinforcement, the behavior of concrete structures reinforced with FRPs is normally governed by large deformations and brittle modes of failure (Pilakoutas et al. 2002), which are generally considered to be undesirable. As a result, engineers rarely choose to use FRP reinforcement unless substantiated by comparable successful applications. FRPs are often mistakenly perceived by the engineer as a direct replacement for steel reinforcement and the same design philosophy is applied without due consideration of the advantages that these materials can offer in particular applications and environmental contexts. The lack of confidence, knowledge and experience in the use of FRPs is one of the most difficult obstacles to overcome in order to expand the use of this relatively new technology. An additional major barrier to the use of FRPs in construction is the lack of design codes. Although national design tools for concrete structures, reinforced or strengthened with advanced composites are already available to the public (e.g. Institution of Structural Engineers 1999; International Federation of Concrete 2001; ISIS Canada 2001a, 2001b; American Concrete Institute 2002, 2003), these are still ‘guidelines’ and have not yet achieved formal standard status. Nonetheless, the interest in FPRs is still high and their use in specialist applications could greatly benefit the construction industry.

Composites in reinforced concrete construction: The crucial need to find durable and cost effective solutions to the problem of corrosion in RC structures is one of the main driving forces behind the use of advanced composites in newly built structures. FRP reinforcement represents a valid and competitive alternative to epoxy-coated and stainless steel reinforcement for anti-corrosive purposes and it has many possible applications in structures in or near marine environments, in or near the ground, in chemical and other industrial plants and in places where good quality concrete cannot be achieved (Pilakoutas 2000).

The exceptional durability of FRPs gives the possibility of reducing the concrete cover needed to protect the reinforcement. This could promote the development of novel designs and the optimization of pre-cast elements. Owing to their inherent physical properties, FRP reinforcement can also be used successfully in applications where electromagnetic neutrality is required, as in structures situated in the vicinity of transmitting stations or receiving devices (Figure 3).

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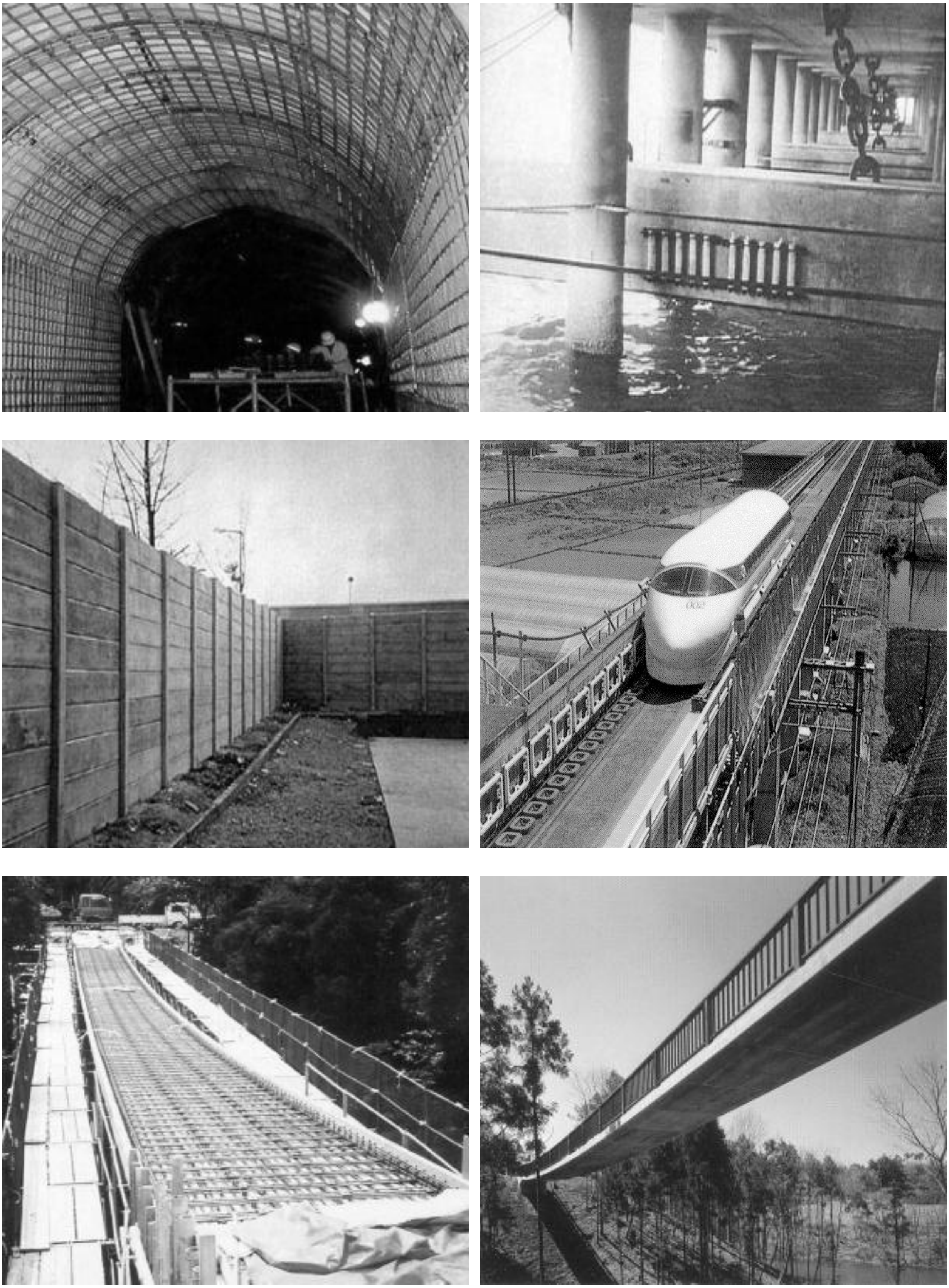

Figure 3. Various application of FRP products in reinforced concrete constructions

Composites in Prestressed Concrete construction: One of the most important properties of FRPs is the very high strength that they can develop, allowing a reduction in the amount of reinforcement needed in certain applications. High strength can only be achieved, however, when high strains are developed in the reinforcement, making FRPs the ideal material for prestressing applications (Figure 4). When prestressing techniques are adopted, not only can high strength be reached, but also a lower loss of prestress can be achieved due to the lower elastic modulus of the material (Zou 2003). Because of the stress corrosion that affects FRP materials, particularly glass fibre based products, however, only carbon and aramid FRPs are likely to dominate the applications in this field. FRP prestressing tendons and cables have been used successfully in cable stay bridges and in other anchoring applications such as ground anchors or rock bolts.

Figure 4. Various composites in prestressed concrete bridge construction

Externally Bonded Reinforcement: The light weight of FRP reinforcement has important practical advantages in construction, especially in specific applications in which work must be carried out in confined spaces and lightweight reinforcement can speed up construction. The light weight of FRPs becomes particularly relevant when dealing with externally bonded

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reinforcement for repair purposes. Given the ease-of-application, the commercial interest in FRP reinforcement for externally bonded applications is considerable and the use of FRP fabrics and plates is rapidly replacing both conventional plate bonding and jacketing techniques (Figure 5).

Figure 5. Use of FRPs as externally bonded reinforcement

Research at Rajamangala University of Technology Tawan-Ok: Research on the use of advanced composite materials have been carried out at Rajamangala University of Technology Tawan-Ok on various aspects. Research activities include development of curved FRP reinforcement, experimental and analytical evaluation of the structural resistance and durability of concrete elements reinforced internally or strengthened externally with FRP reinforcement, and development of design methodologies. The research group participates to the activities on the use of advanced Composite in civil engineering applications and carries out collaborative research through the University and Thai Government Council Research Grant. Figure 6 illustrates the research work at Rajamangala University of Technology Tawan-Ok on advanced composites.

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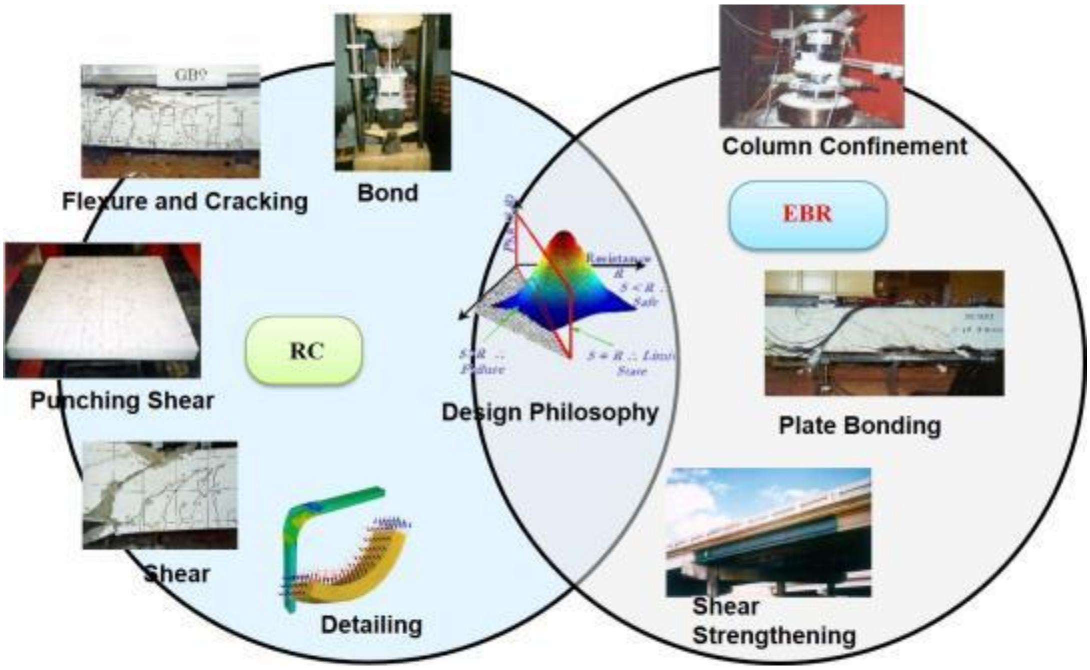

Figure 6. Research activities at Rajamangala University of Technology Tawan-Ok

3. CONCLUDING REMARKS

The use of FRP reinforcement can offer significant structural and economical advantages and should not be considered as a mere replacement for steel reinforcement. Use of FRPs benefits primarily specialist applications where their particular chemical, physical and mechanical properties will lead to more practical and economic solutions. FRP materials offer an effective solution to the problem of steel durability in aggressive environments and where the magnetic or electrical properties of steel are undesirable. They also appear to be highly suited for the manufacture of non-structural precast elements where the combined weight of the reinforcement and concrete necessary to provide adequate cover is a major concern. Prestressing applications can make optimal use of the high stresses and strains that can be developed in FRP reinforcement. The use of FRP materials for strengthening and rehabilitation of deficient structural elements is quickly pervading the construction market and the available commercial systems already have proved an economically competitive alternative to traditional repair solutions. A concerted effort towards the development of recognized design standards for the use of composites in construction together with the education and training of professional engineers is paramount to facilitate the acceptance of this innovative, promising technology. Moreover, high mortality and extensive damage in recent major earthquakes in developing countries have highlighted the seismic vulnerability of many existing reinforced concrete (RC) buildings. As demolishing the existing structures may prove to be an uneconomic solution, their seismic vulnerability can be mitigated by strengthening and upgrading their structural performance. Among the different retrofitting techniques currently available for strengthening systems, fibre reinforced composites (FRP) have demonstrated to offer effective and attractive solutions.

On-going research at Rajamangala University of Technology Tawan-Ok on various aspects include development of curved FRP reinforcement, experimental and analytical evaluation of the structural resistance and durability of concrete elements reinforced internally or strengthened externally with FRP reinforcement, and development of design methodologies.

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The research group participates to the activities on the use of advanced Composite in civil engineering applications and carries out collaborative research through Thai Government Research Grant.

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URBAN / RURAL ENVIRONMENTS AND SETTLEMENTS

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POVERTY AND POLLUTION IMPACTS IN JAKARTA'S FISHING VILLAGES (VULNERABILITY ASSESSMENT AND SCENARIO OF LIVABILITY)

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ABSTRACT: Jakarta Bay and coastal areas have key roles as Java's main port, industrial, residential, and tourism spots. These roles will be even reinforced as the government of Jakarta has agreed to perform further reclamation (Jakarta's master plan 2030) and rapid developments have already increased pressures on the coastal areas. One of the growing pressures over the last decade is the volume and heavy load of pollutants that are being disposed of into the Bay and coastal areas. These areas, conversely, have a long history of traditional fish production. Currently, about 40,000 fishermen residing along the coast use the bay as their fishing areas and this community includes some of the poorest people being directly exposed to water pollution. For decades, the issue of water pollution in Jakarta Bay has been gaining attention from experts citing evidence from extensive studies in biophysical sciences. However, the impacts of water pollution from the perspective of fishermen's livelihoods have not been researched. Understanding to what extent water pollution in Jakarta Bay shapes the social and economic behaviour and views of traditional fishermen is important. The community whose livelihood and liveability depends on the way natural resources are used by others is an environmental justice issue. Vulnerability assessment at bay and household scales in several fishing villages (Muara Angke and Marunda) using combinations of qualitative (interview and questionnaire to acquire socio-economic information) and quantitative approaches (spatial model synthesis using environmental and socio-economic data) are an appropriate method. These methods provide an assessment of the vulnerability of traditional fishermen due to water pollution and bring to the surface the conceptual model of fishermen and policy-influencers while building plausible future scenarios of the socio-ecological system. The development of scenario models with initial inputs from fishermen is expected to be a source of information on liveability for stakeholders and policy-makers.

KEYWORDS: Development, Jakarta Bay, livelihood, research methods, scenario planning, traditional fishermen, vulnerability, water pollution

1. INTRODUCTION

Coastal areas of metropolitan cities around the world are continuously dealing with pressures triggered by growing activities inland, around the coastal areas and in the water itself. Industrial and residential developments, tourism and commerce activities, and transportation networks have rapidly increased to meet the demands and needs of human well-being. These developments and activities result in benefits in terms of the economic growth and provision of employments. However, on the other hand, these often cause adverse effects on the coastal environments and several communities who rely directly on the natural sources provided by the environment.

One of the prominent adverse effects from unsustainable manner of developments to the coastal and ocean environments is water pollution (UNEP, 2005). Nellemann, *et. al*(2008) predicted an increasing level of pollution in Southeast and East Asia waters in the forms of sediments, nutrients, and sewage that could potentially threaten marine ecosystem such as coral reefs. The impacts of water pollution on humans include reduced aesthetic value, indirect impacts on the work of resource-dependent communities (fishermen and farmers), and increased health risk through direct or indirect contact with pollutants (UN, 2011). As for the ecosystem, water pollution includes toxic materials such as heavy metals or pathogens

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that could be harmful to marine organisms, disrupting organisms habitats and behaviours for example through increased turbidity rate and eutrophication (Van Lavieren*et. al.*, 2011).

Jakarta, the capital city of Indonesia, is an example of a coastal city experiencing vast growth in developments and population. However, the growth also results in an alarming level of environmental damage. The developments, despite situating the city as the largest contributor to the country's Gross Domestic Product (BPS, 2014), have increased pressures on the environment. This is particularly true for the coastal areas and Jakarta Bay that have become disposal sites for the waste produced from inland and coastal activities. The Bay has been deteriorating from domestic sewage, industrial and shipping waste that contains heavy metals, excessive nutrients, and organic compounds that result in levels of pollution that cause concern (Putri *et. al.*, 2012 and Rinawati, *et. al*., 2012).

As a coastal country which has an enormous fishery potential, the fisheries sector plays an important role in the economic growth and food security in Indonesia. The sector contributes to 21% of the agricultural economy as well as providing 54% of the animal protein for consumption (FAO, 2013). Hence, the water pollution problem is considered as a serious issue that could threaten the ecosystems and bring adverse impacts on the fisheries sector. There is extensive evidence of how pollution causes damage to species diversity and decline in fisheries productivity in many regions of the world (Van der Meij *et. al.*, 2009; Islam and Tanaka, 2004). Furthermore, the damage and decline may affect the resource-dependent communities such as the traditional fishermen of Jakarta who utilise the Bay as their main source of protein and income (Mustaruddin, 2013 and Padawangi, 2012).

While there has been extensive research conducted on biophysical impacts of water pollution in Jakarta Bay, the assessment of water pollution impacts to the community received much less research attention. This paper will discuss and review the literature that would make it possible to answer the question of "How does water pollution that occurs in Jakarta Bay affects the traditional fishery-based resource community?". As a community whose livelihood depends heavily on natural resources provided by the Bay, traditional fishermen of Jakarta are potentially exposed and are expected to be more vulnerable to water pollution than others.

The first part of the paper will provide a brief narrative of the literature about water pollution in Jakarta Bay in biophysical terms which will leads to the examination of water pollution impacts to the coastal community. The paper will discuss the concept of vulnerability which has been used and argued widely in various disciplines in the efforts of deepening the understanding of human livelihood-environmental linkages. In the context of this research, vulnerability assessment will be conducted to obtain a better understanding of the impacts of water pollution to the socio-economic aspects, views, and behaviour of the traditional fishermen community. It will also provide a brief background on the scenario planning literature used in the on-going research to evaluate the future livability paths of the community.

2. WATER POLLUTION AND TRADITIONAL FISHERMEN OF JAKARTA BAY

2.1. POLLUTED WATER OF JAKARTA BAY

Jakarta spatial planning 2030 (Regional Spatial Planning, 2012), which includes a further reclamation plan along with the project of giant sea wall in Jakarta Bay, has emphasized the crucial roles of the Bay and the coastal area to Jakarta's future. Currently, the areas are being used for a variety purposes include shipping, industries, tourism, residential area, fishing and mariculture efforts. Further development could cause additional pressures that lead to adverse consequences for the environment of Jakarta Bay. One of these, already evident in the Bay, is the deterioration in water quality as the result of waste discharge from the activities. There are thirteen rivers that contribute both treated and untreated waste waters into Jakarta Bay. The waters contain nutrient residues from agricultural activities, traces of heavy metals from industries, harmful pathogen from septic tanks, and household garbage which finish up in the Bay and become the source of pollution (BPLHD, 2012). The impacts of these pollutants flowing to the waters and the ecosystems of Jakarta Bay have been observed for decades.

Verstappen (1988) suggested that the environmental damages which are caused by heavy pollution and coral mining have affected the coral reef covers and the existence of small islands within the Bay area. Hutagalung (1987) study found that mercury concentration in Muara Angke estuary was much higher above the standard quality for fisheries i.e. 0.023-0.027 mg/l (maximum standard value is 0.002 mg/l). Numerous studies since then have focused in understanding the sources, distribution, concentration and the impacts of heavy metals in the waters, sediments, and organisms (Putri, *et. al.*, 2012 and Riyadi*, et. al.*, 2012). Heavy metals are one of the concerning pollutant forms due to its hazardous bioaccumulation effect in marine organisms. This effect could be more dangerous for humans when they are consuming contaminated organisms such as fish or mussels. Therefore, heavy metal contamination has received particular concern from the government through stricter waste management regulation that aims to control the potential adverse impacts (Hosono, *et. al.*, 2011) in the ecosystems and humans. In the biological field, a comparative study of molluscan species revealed that there has been a significant decrease in the richness of the species in Jakarta Bay and Thousand Islands from 171 species in 1937-1938 to 58 species in 2005 due to increased sewage and sediment (Van der Meij, *et al.,* 2009). These shifts in biophysical conditions, that indicate a collapse in ecosystem form and function, are attributed to anthropogenic activities that have been occurred over the past decades. These conditions could be exacerbated by other events such as climate change and extreme weather.

With such shifts in the waters and the ecosystems, regular and continuous water quality measurements in the Bay (Figure 1) have been performed by the Bureau of Environmental Management (BPLHD) to monitor the water quality. The evidence suggests the importance and functions to the economic, social, and natural resources support of the Bay and coastal area of Jakarta is well understood by the government. In their annual report, BPLHD (2012) stated that the measurements of several water quality parameters have shown values which are above or below the standard values defined by the Ministry of the Environment. Concentrations of some parameters such as ammonia, phosphate, and phenol are higher than the standard values allowed for marine organisms, particularly in the area close to river mouths. High concentrations of ammonia and nitrate sources mainly come from domestic and agricultural effluents through rivers, while phenol indicates the dumping activities from industries and domestic sewage. At high concentrations (>0.01 mg/L) phenol has devastating and poisoning impacts on fish. Ammonia and phosphate contribute to the eutrophic level of the waters that could lead to algal bloom and fish kills (BPLHD, 2012). The concern for water quality, monitoring, and improvement is likely to grow yet it is important to consider the socio-economic aspects that define this problem.

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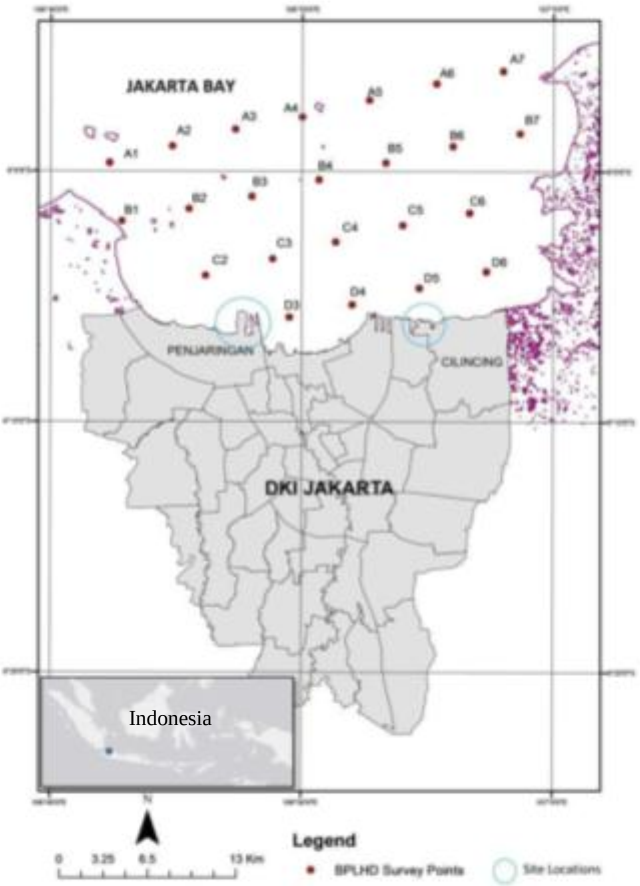

Figure 1. Muara Angke (Penjaringan sub-district) and Marunda (Cilincing sub-district) research sites locations (blue circles) and water quality survey points of BPLHD in Jakarta Bay

2.2. WHAT DOES WATER POLLUTION MEANS FOR THE TRADITIONAL FISHERMEN OF JAKARTA BAY?

The impact of pollution on ecosystems and people is well recognised yet a critical issue, that receives less attention than the biophysical studies, is how the deterioration of water quality and the environments of Jakarta Bay affect the resource-dependent communities in the coastal area such as traditional fishermen. Currently, there are 40,000 fishermen in Jakarta and 95% of them rely on the fisheries sector as their main source of income (BPS, 2012). Therefore, considering the sustainability of this sector is crucial and the changing exposure to pollution risk, fishing as a means of subsistence, affordable protein sources, and employment support for these fishermen is a difficult and important issue for the community, government, and others.

Water pollution in the coastal area is recognised as one of the prominent stressors of the marine environment along with climate change, habitat loss, over-harvesting, and species invasion (Nellemann, *et. al,* 2008; Hazin, *undated*) which could influence the fishery sectors. The significant consequences of fish mortality, habitat degradation, or reduced recruitment caused by water pollution affects the fisheries productivity due to declined fish catch (Islam and Tanaka, 2004). Furthermore these consequences could be converted into decreased economic profits of fisheries activity using the bio-economic model (Anna and Fauzi, 2007). This latter study asserted that the potential economic net loss of demersal fish due to water pollution in Jakarta Bay could reach Rp700 million per year. However the research did not

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analyse further to what extent this loss was suffered by traditional fishermen who utilise the Bay as their fishing ground.

The potential impacts arise not only from the market value. Water pollution could also increase the health risk for the fishermen through the exposure of polluted water while performing coastal activities (fishing, farming, swimming), through contaminated fish and mussel consumptions, or through bioaccumulating toxins. In 2010, the Jakarta Bureau of Fisheries and Farming has advised of the risk of consuming green mussels from Jakarta Bay due to possible contamination by heavy metal pollutants (Padawangi, 2012). In the research conducted by Mustaruddin (2013), the water and demersal fish samples that were taken from the fishing ground around Marunda reveal high concentration of mercury (Hg) and lead (Pb). Mercury and lead concentrations in the water samples are 0.0131 mg/l and 0.0240 mg/l where the recommendation should be less than 0.001 mg/l and 0.008 mg/l, respectively as set by the Ministry of Environment. As for the fish samples, the concentrations are 0.680 mg/l and 1.185 mg/l where it should be less than 0.500 mg/l and 1.000 mg/l, respectively as set by the Indonesian Department of Health. This contamination is expected to increase communities health risk and cause deterioration in the quality, quantity, and value of fishery products. Moreover, these problems combine to exacerbate living conditions of the poor traditional fishers and mariculture farmers since they depend directly on the catch results to support their livelihood.

Figure 2 illustrates how development variables (indirect drivers) and developments impacts (direct drivers, such as pollutants) act as drivers of changes for the services provided by the Jakarta Bay ecosystems and specifically for the traditional fishing communities relying on the services. The disturbances caused by water pollution on the provisioning (fishing ground and water source), supporting (primary production and nursery ground for marine organisms living support), cultural (aesthetic and recreation means), and regulating (water regulation) services are evident, as can be seen from the literatures. However, there has been less research and little discourse about how these changes impact the traditional fishing communities. While Tomascik *et. al.* (1997, p1167) asserted that "*One of the many challenges facing Indonesia today is the reconciliation of development objectives and conservation aims in the marine and coastal sector"*, it could also be said that the current challenges to equity in development should count, and that sustainability of the community's livelihood was an essential concern.

In this specific context, it is important to perform water pollution impact studies on fishing communities in the north of Jakarta that could be used to inform further research and to provide information for policy makers about the current state of fishery-based resource community, their livelihood vulnerability and sustainability. Moreover, in a much wider context, this will provide crucial perspective on how the past and on-going developments in the urban area of Jakarta could affect the sustainability of other community's livelihood and more importantly the sustainability of the environment which actually support the developments and wider communities in Jakarta themselves. Identifying these issues and analytical capability is an important research task.

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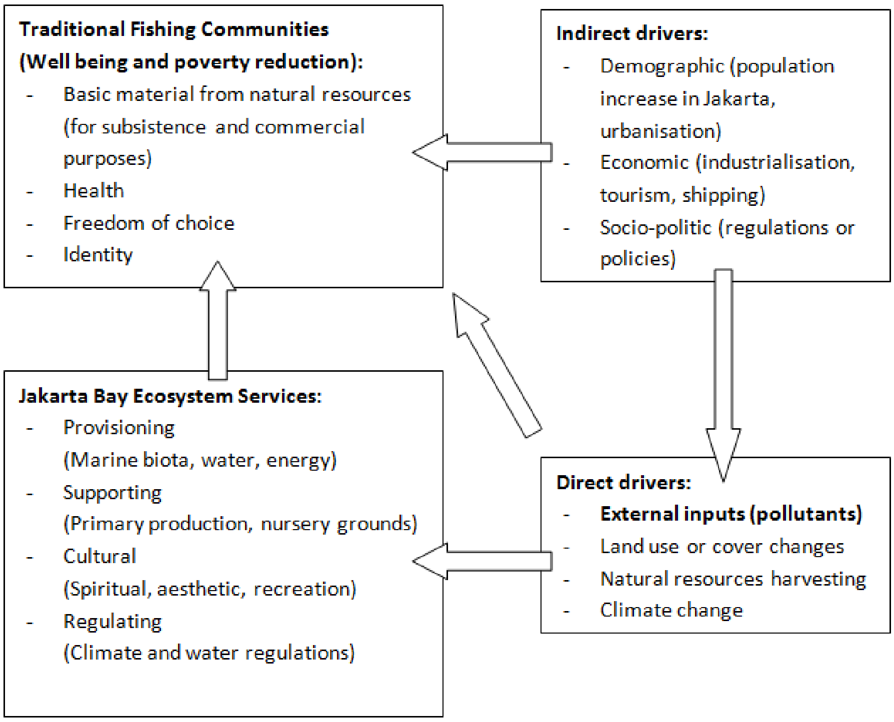

Figure 2. Water pollution as one of the direct drivers of changes for the services provided by the bay and the impacts on traditional fishing communities (Source: adapted from MEA, 2005)

3. VULNERABILITY OF THE TRADITIONAL FISHERMEN TO WATER POLLUTION

Even without the external disturbance of water pollution, traditional fishermen are already one of the most vulnerable groups among other coastal communities. This is due to the high uncertainty of the catch yielded from every fishing trip, higher risks from a hazardous environment often with having no health or life insurance, and in the limitation on the ownership and access of land and other livelihood components (Bene, 2006). In addition to the water pollution problem, the fishermen in Jakarta Bay are exposed to a number of natural and human-induced problems that also threat their environment such as floods from storm surge, sea level rises, land subsidence, salt water intrusion, and the loss of wild life habitats (Firman, et. al., 2011 and Nur, et. al., 2001). Moreover, ninety five percent of the traditional fishing community of Jakarta can be considered as “specialised” meaning that they depend on fishing activity as their main income (BPS, 2012). This specialisation by fisherman has been seen as a weakness in terms of their sole dependency on fisheries that increases risk of exposure to pollution and vulnerability of the fishermen to external shocks that may occur (Bene, 2009) such as fish deaths and profit declines caused by marine pollution. Padawangi (2012) highlighted another disadvantage of this community because of the lack of their participation in the development program as indicated by Jakarta’s master plan 2010-2030. The Plan makes additional uncertainty about the places traditional fishermen can be because their fishing villages and fisheries area will be converted into industrial and upper-class residential zones. In addition to these facts, several others limitations confront this community such as a lack of educational outcomes, ad hoc and poor physical infrastructures, low levels of access to health care and clean water that may contribute to their increased vulnerability to water pollution and inability to mitigate this impact.

It is important to consider the meaning of “vulnerability “in the context of this research and how will it be used to add insights and understanding about water pollution impacts on traditional fishermen. The term vulnerability has been interpreted and reformulated within

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various disciplines such as sustainable development and natural resource management within the social-environmental perspectives (Huang, *et. al.,* 2012; Hughes, *et. al.,* 2012; and McLaughlin, 2011). In the scope of this research, vulnerability is defined as the state to which the traditional fishermen community is susceptible to harmful pressure as a result of changes in environment and social systems caused by water pollution and the lack of adaptive capacity (adapted from Adger, 2006). Cinner, *et. al.* (2011) argued that vulnerability could be used as an all-prevailing concept for understanding and describing the susceptibility of social and environment systems and its use could provide results that can be analysed further to produce applicable action plans in reducing the vulnerability.

Several studies in other countries have assessed the vulnerability of fishery-dependent societies specifically due to climate change in global, regional, and local scales. Cinner, *et. al.,* (2011) developed a vulnerability index and action strategies in response to the impacts of climate change on coral reef fisheries based on the analysis of the exposure, sensitivity, and adaptive capacity in 29 coastal societies in five countries (Kenya, Tanzania, Madagascar, Seychelles, and Mauritius). Another research project on climate change impact on coral reef fisheries from the perspective of food security was conducted by Hughes, *et. al.* (2012) where a set of vulnerability indices among 27 countries, including Indonesia, was produced.

In Indonesia, there has been very little research conducted to examine specifically the vulnerability of fishing communities. Most of the studies on coastal vulnerability have focused on the assessment of biophysical systems (such as ecosystems or infrastructures) and human-environmental systems due the potential of sea level rise with regards to climate change (Joseph, *et. al.,* 2013; Ristianto, 2011; and Rositasari, 2011). Other research at a national scale was performed to assess the social vulnerability due to combined natural hazards in the district level (Siagian, *et. al.,* 2014). The diversity of research applications of vulnerability show that there is as yet no single set of parameters in defining the vulnerability of a system to certain stressor. This is because so far, the effects of social-environment interactions are sufficiently different with regards to social groups and the nature of external stressors to require local modification. Further research on specific sectors, samples, and different scales of vulnerability research is needed to provide insights, theoretical contributions, and actionable knowledge (Hughes, *et. al*., 2012).

3.1. THE DEVELOPMENT OF VULNERABILITY INDEX OF TRADITIONAL FISHERMEN TO WATER POLLUTION

In order to assess the impact of water pollution to the socio-economic aspects, behavior, and views of traditional fishermen, three components of vulnerability will be used i.e. exposure, sensitivity, and adaptive capacity. Exposure refers to the nature of water pollution, encountered by the traditional fishing community that is characterized by its magnitude, frequency, duration, and exposure area of the pollution (adapted from Adger, 2006). The combination of Geographic Information System (GIS) and existing field measurement data of water quality parameters will be used to build the spatial model. This model will illustrate the exposure zones of water pollution (for example, zone of high pollutants, medium pollutants, and low pollutants) in Jakarta Bay. There are several water properties, both physical (suspended sediment and dissolved oxygen), chemical (phenol, ammonia, phosphate, and heavy metal concentration), and biological (chlorophyll-a) properties, that would contribute as layers in the development of the exposure map of Jakarta Bay. An important insight sought in this research is the view of fishermen on water qualities and contributing that records to a broader understanding of water quality than that currently measured in biophysical research. This expected to include colour, odour, fish mortality, algal blooms, floating debris, and the fishermen's views on productivity (quality and quantity measures).

The sensitivity component of the research relates to the degree to which the traditional fishing communities can absorb the influences of water pollution while adaptive capacity is the capability of these communities to adjust and cope with the transformation in the socio-economic and environmental aspects caused by water pollution (adapted from Gallopin, 2006). These two components of vulnerability will be developed from socio-economic variables of traditional fishing community in Muara Angke and Marunda in the household level. Existing data complemented by primary information from interviews and/or questionnaires will be used. Vulnerability indices produced from the composite of the three components (Figure 3) can be used to measure the nature and extent of water pollution impact on traditional fishermen, investigate the features that form vulnerability in this context, and assess their mechanisms of adaptation to the changes caused by water pollution.

The assessment will contribute to deepening the understanding of the consequences of water pollution for traditional fishing communities. It will explore the issue of pollution to this fisheries dependent and marginalized community. It will also provide an understanding of their adaptability to the changes in water quality that could be used further to support the empowerment efforts by the governments or non-government organisations (NGOs).

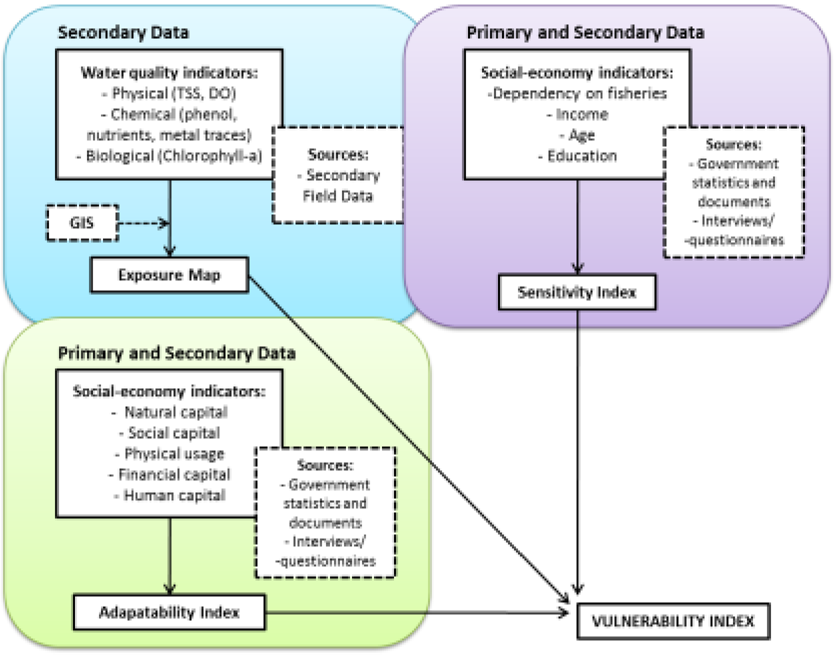

Figure 3. Community vulnerability components due to water pollution

4. THE FUTURE OF THE FISHERY-BASED RESOURCE COMMUNITY AND THE ENVIRONMENT OF JAKARTA BAY (SCENARIO OF LIVABILITY)

Discourse from research on social vulnerability often involves efforts to reduce the level of vulnerability through plans and action that are derived from the explicit identification of vulnerability components. Reduction of vulnerability could be achieved through lessening or mitigating the exposure or increasing the community capacity to adapt to the exposure. This is links to the sphere of livelihood sustainability defined comprehensively by Chambers and Conway (1991, p6) "… *a livelihood is sustainable which can cope with and recover from stress and shocks, maintain or enhance its capabilities and assets, and provide sustainable livelihood opportunities for the next generation …*".

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One of the essential reasons for conducting the vulnerability assessment is to contribute to the construction of pathways to the desirable sustainability states. In the context of this research, the assessment of vulnerability of the traditional fishing community gives shapes their desired livelihood sustainability. Even though the desirable sustainability states are not single conditions and are expected to be debatable, it is likely that the more vulnerable a community is the less sustainable the community's livelihood will be (Cannon *et. al.*, undated). In other words, an attempt in reducing the vulnerability of the traditional fishing community might play a part in the enhancement of their sustainable living.

Examining the concept of sustainability of these traditional fishing communities requires consideration of the future perspectives. For example consideration of whether this community will be able to preserve or increase their livelihood well-being, cope with external stressors such as water pollution, and provide acceptable prospects of livelihood for their next generations. There is another important research result of discussing future with this community from the perspective of water pollution as a disturbance. It will inform discussions about the sustainability and livability of Jakarta Bay environment that provides services not only for the dependent communities but also for wider community. The research will make use of the scenario planning approach to assess several future options of livability of the traditional fishing community and the broader environment of Jakarta Bay.

Scenario planning is a decision-making support tool that can be described as a "*systemic method for thinking creatively about possible complex and uncertain futures"* (Peterson, *et. al.,* 2003). This scenario approach does not seek to predict or forecast but instead through the inclusion of uncertainties and assumptions it seeks to create plausible future options using systemic method combining with relevant and best available evidence (Pirani and Tolkoff, 2013). The approach is appropriately applied in systems where there is a high level of uncertainty and several drivers of change that could influence the state of a system (Peterson, 2003).

The scenario approach has been broadly implemented in a wide range of fields within various scales from global, regional, and local. In the global context, prominent example is the Millennium Ecosystem Assessment (2005) that used four scenarios of plausible futures of how the ecosystem and its services, and human well-being may respond to several key drivers of changes such as water and air pollution, land use changes, water and food security, economic and technology growth. Another illustration of the scenario approach implementation is the scenario workshop carried out to a group of coastal communities in Thailand. The communities had to discuss several challenges including environmental issues, climate change, governance and politics that affected their livelihood (Bennett *et. al.*, 2014). They were engaged in the scenario-making processes to define key problems and drivers of changes, generate desired future options, and identify realistic actions. These studies emphasise the strength of scenario planning in terms of the flexibility in defining the key drivers of changes and representing the complexity of human-environment system and its responses to the changes. Another advantage is the flexibility due to inclusion of wider participant base that could inspire creative responses to the future that could contribute to the enhancement of the system adaptive capacity, sustainability, and livability.

The future of the fishing community and Jakarta Bay environment in the context of water quality changes is potentially influenced by several key drivers of changes. The drivers might include governance and politics (with regards to the management and policies), infrastructure development, utilization of certain technology, population growth, and social-cultural factors. The human-environment system of Jakarta Bay might respond differently to each key driver. For an instance, better waste management and technology or more strict regulation on waste management might reduce the pollutants contamination in Jakarta Bay leading to the

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improvement of water quality. This could positively affect the fishing community due to healthier and improved ecosystem quality. Increased economic activities if it is not coupled with appropriate waste management, on the other hand, could add pressure to the Bay and the community through intensified waste effluents and habitat degradation. The scenarios of livability, therefore, will be a useful supporting tool to be utilised in policy and management decision-making processes. A futures approach offers a useful discussion that encompasses potential drivers for the human-environment system of the Bay, risks (upside and downside), and possible future outcomes of the system. This flexibility and inclusion of uncertainty could be seen as an opportunity to encourage the development of more sustainable and livable planning of the system.

In the case of current Jakarta Bay development planning discussions, the uncertainty is seen from the omissions in Jakarta's development master plan 2010-2030. The spatial plan includes further reclamation of the coastal regions that will be utilized as industrial, tourism, and residential areas (Sampono, *et. al.,* 2012). However, according to Padawangi (2012), it is not clear how traditional fishermen will fit with this future plan. The master plan make uncertain the location and existence of traditional fishermen as a part of Jakarta in the future. It leads to another concern whether the development plan would exacerbate water pollution that already occurs in Jakarta Bay. Scenario planning in the research, therefore, will contribute to the identification of possible livability options of traditional fishermen and the environment of Jakarta Bay. Analysis of the key drivers of changes could be useful to provide better understanding of how each driver impact the human-environment system of Jakarta Bay. Moreover, the understanding could be applied for further research or used to bridge the dialogue among policy makers in the attempt of finding best solutions to improve the sustainability and livability of the system.

The process of scenario building generally includes the identification of key drivers of changes, the development of scenarios, and the representation of the scenarios. In several studies, these involve a review panel to ensure the plausibility and credibility of scenarios (Priess and Hauck, 2014 and Pirani and Tolkoff, 2013). In this research, due to the nature of this initial investigation, a desire to avoid over-building expectations and limitations in time and funding, a simplified scenario building will be used.

Interviews with relevant stakeholders (local governments and NGOs) and participation from the local community replace the more formal review panel in order to accommodate the feasibility and acceptance level of this study to be used as a source of information for decision-makers and policy-influencers. The scenarios will be developed by the researcher-as-facilitator using integrative top-down scientific approach and bottom-up approach to gather qualitative data. Figure 4 provides the general description of scenario building stages in the research.

The process of scenario development, identification of key drivers and uncertainties will engage relevant stakeholders (governments, experts, and traditional fishermen) and improve the discovery of knowledge and views on pollution impacts. Once the scenario logics are built based on selected key drivers and uncertainties, scenario storylines of the socio-environmental system of Jakarta Bay will be developed. Geographic information system will be used to support the visualisation of the scenario storylines for example through using the existing spatial planning of Jakarta Bay and coastal areas. Statistics such as population growth, number of fishermen, and pollutant volume from rivers will provide foundation assumptions on trends to assist and provide baselines for the development of scenario storylines. These storylines are substantial contributions to build the future scenarios of socio-ecological system in Jakarta Bay based on previously defined scenario logics and identified key drivers.

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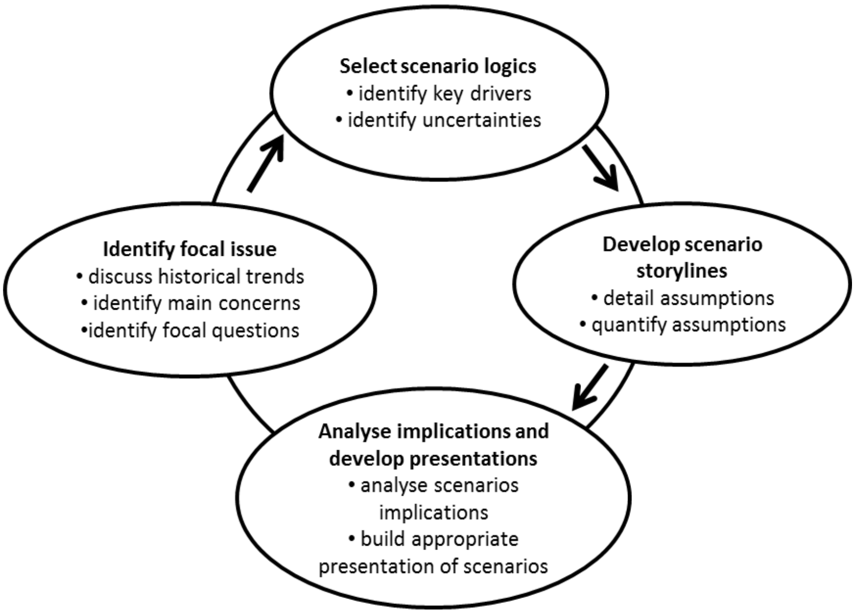

Figure 4. Scenario planning stages (Source: adapted from Henrichs, *et. al.,* 2010)

5. CONCLUSIONS

Water pollution has become one of concerning issues in Jakarta Bay where numerous studies cited in the paper have shown how the pollution has had adverse impacts on the biophysical system of Jakarta Bay. This paper reveals and discusses the gap that exists in the literature to investigate the impacts of water pollution to the fishers as a resource-dependent community. This is the field addressed in this on-going research.

Vulnerability assessment will be used to measure and understand to what extent water pollution that occurs in Jakarta Bay shapes the socio-economic, behavior, and views of traditional fishermen as a community whose livelihood particularly depends on natural resources. Community vulnerability values will be considered important in the context of social and environmental justice, due to the nature of water pollution as a human-induced stressor prompted by unsustainable manner of the developments. However, inspite of its well-known applicability in defining the relationship of social-natural-physical systems, the selections of variables and weighting which will be applied in the research still requires thorough consideration in the light of fishermen and other resource managers. That is because the factors that shape the vulnerability are unique and varied for each different system.

In addition, there is also a crucial need to look to the future of the traditional fishing community and the environment of Jakarta Bay. This is important in terms of providing the perspectives of sustainability and livability of the community-environment system. The scenario approach will be used since it allows the engaged analysis and the evaluation of how the community and the environment responds to changes triggered by water pollution. Thus, the research is likely to contribute appropriate and applicable actions that could be undertaken to ensure the sustainability of the community-environment system in Jakarta Bay based on the identification of the drivers and the responds of the system.

The assessment of community vulnerability in this research could assist in the identification of the strength and weakness of traditional fishing community regarding water pollution exposure. In addition, it could also provide information about the level of severity experienced by the community due to water pollution pressure. This would be valuableas baseline information to support the empowerment efforts of the community as well as for the mitigation efforts of water pollution. The scenario planning would be able to provide insights on the possible future sustainability and livability states of human-environment system in Jakarta Bay which could be used as a source of information for policy-makers and policy-influencers level for future planning or decision making.

The research contributes to the emerging vulnerability and livelihoods theories used in developing areas to link natural resource condition to human needs and wants. The interviews and future scenarios used to integrate this research provides an additional thread to link pressures, current and desired states with the communities and managers.

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HYDROLOGICAL STUDY TO PROVIDE A MODEL OF SURFACE AND GROUNDWATER POLLUTION FROM LEUWIGAJAH LANFILL DISPOSAL IN WEST JAVA INDONESIA

Chusharini CHAMID[1], ELFIDA[2], YULIADI[3], ISWANDARU[4], Eli AMBARINI[5]

ABSTRACT: Leuwigajah landfill final disposal has been abandoned in 2005 due to a landslide of waste heap therefore the closure of this landfill was not carried out properly where there was not covered with immpermeabel material for protecting the trash from rainwater. The catchment area of trash and the landfill are 28.4 hectare and 75.4 hectare respectively. The water balance of the study is consisted of rainfall oof 2,535 mm/year, evapotranspiration of 1,205 mm/year, infiltration of 1,275 mm/year and runoff of 55 mm/year. Groundwater recharge and river baseflow are 1,015 mm/year and 1,260 mm/year respectively. Water quality analysis shows that surface water and goundwater have been contaminated inwhich have a high value of metals concetration, total dissoved solid, and electrical conductivity. The pollutants movement from the landfill to groundwater pass through andesite rock fractures.

KEYWORDS: landfill disposal, water balance, pollution, groundwater, rock fractures, water quality

1. INTRODUCTION

Leuwigajah landfill disposal as administrative is located between district of Bandung and Cimahi city. It is occupied in abandoned andesite mine site with an area of about 25 hectare, and the height is between 650 to 775 meters above sea level. It is located between Mt. Leutik at north and Mt. Gajahlangu at southeast. The landfill was operated since 1986 untill 2005 due to the occuring of a big landslide of waste heap. It is about 25,550 metric tons of waste has been dump into this landfill. The source of waste was from Bandung City, Bandung district dan Cimahi City. There is no dam structure for preventing landslide then when the landslide occurred, it burried some villages under the landfill area. Picture 1 provides a location of the Leuwigajah landfill and it's surrounding areas. The s[3]tudy objectives are to find out hydrogeological conditions of the study area and to predict contamination distribution from the landfill in groundwater. This study carried out by using descriptive analysis method.

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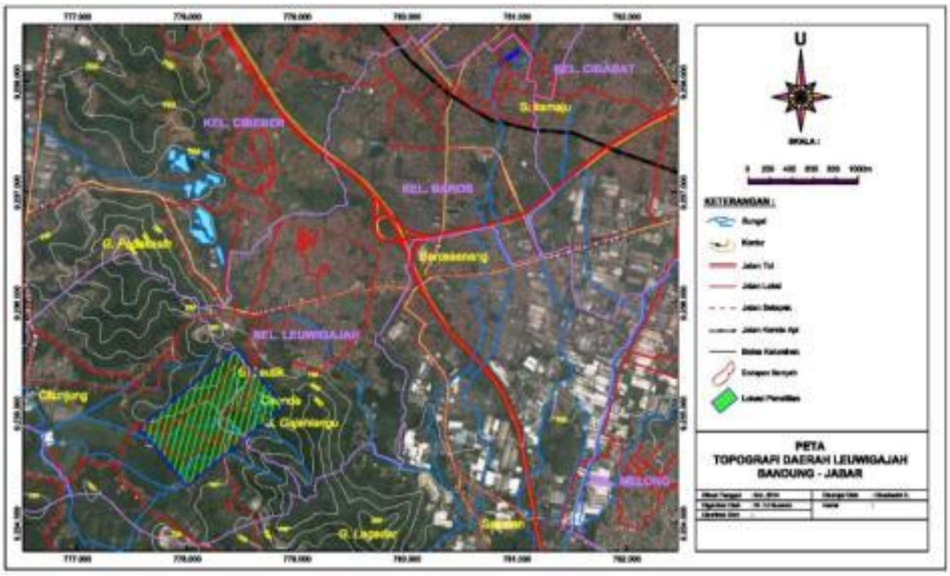

Figure 1. Location of the Leuwigajah Landfill

2. GEOLOGY AND HYDROLOGY CONDITIONS OF THE LEUWIGAJAH LANDFILL

Since the beginning operation, there was no base liner applied under the landfill then the waste contact directly with andesite rock which has been mined out. The landfill is on andesite rock formation and there is a lake sediment formation (Ql) at soutwest with 0 to 125 meters thickness. The rock formation of the study area mostly is intrusion of andesite lava with slightly interception of tuff breccia (Pb). Basalt intrusion (b) occupies at west site of the study area (see Figure 2).

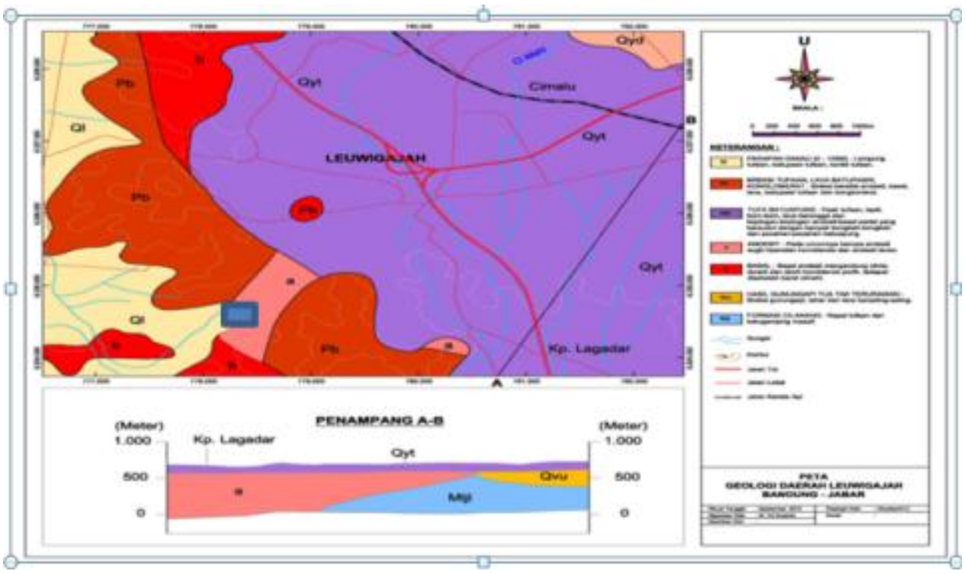

Figure 2. Geology Map of the Study Area

The hydrology of the study area is on rock which has a low permeability which is a vlufiatil limmic formation. It is intercepted with fan sediment. So, naturally the hydrology condition in this area is appropriate for a landfill operation due to it has a low permeability which will prevent groundwater pollution from leaching infiltration (see Figure 3).

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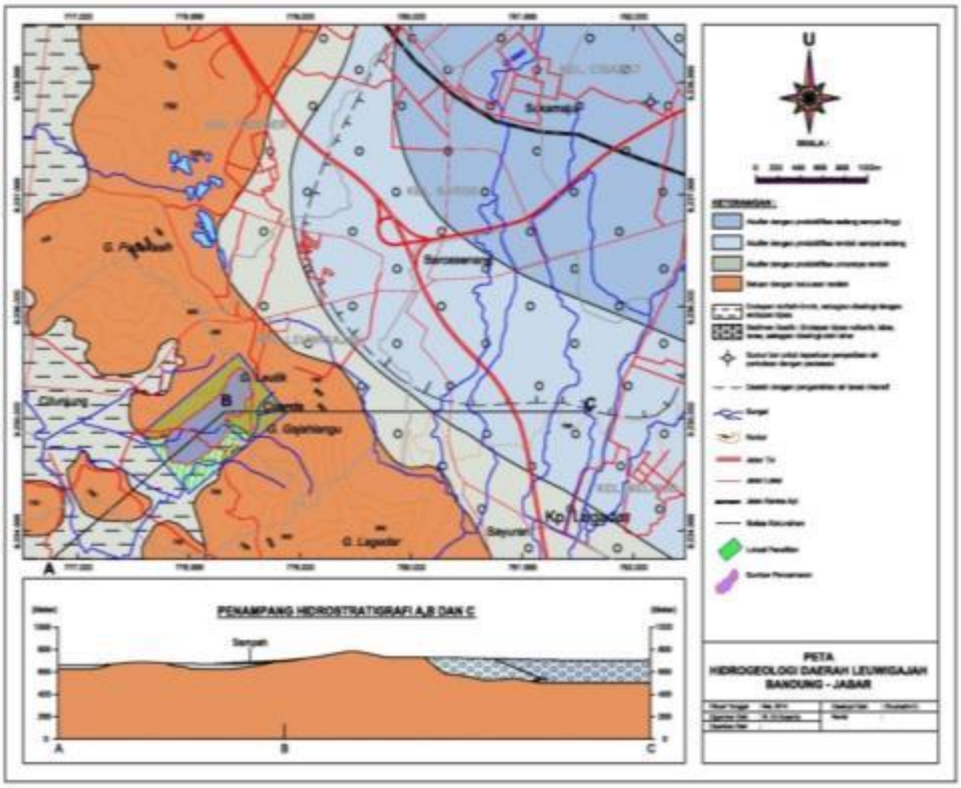

Figure 3. Hydrological Map of the Study Area

2.1 RAINFALL

Rainfall data is provided from year of 2009 to 2013. The rainfall number per year is between 1,788 to 3,683 mm. The average rainfall per month can bee seen in Table 1. Meanwhile the number of rainfall day per year is between 215 to 240 days with average rainfall day per year is 232 days (see Table 2).

Table 1. Data of Rainfall (mm) in 5 years (2009 – 2013)

Tahun	Jan	Feb	Mar	Apr	Mei	Jun	Jul	Agt	Sept	Okt	Nov	Des	Jumlah
2009	208.5	200.5	365.7	165.6	183.8	101	24.2	0.5	24	243.5	234.5	253	2004.8
2010	353.3	505.3	562	92.9	350.6	131.9	220.8	105.2	430.4	292.2	401.4	237.5	3683.5
2011	63	76.7	89.4	381.5	193.4	117.6	77.2	3.1	102.8	103.6	321.4	259	1788.7
2012	82.9	304.6	155.5	290.8	267.6	60.5	34.2	-	26.2	124.5	534.5	637.5	2518.7
2013	216.9	250	305	286	171	231.5	159	74	171.7	233.9	164	418	2681
Rata^2	184.9	267.4	295.5	243.4	233.3	128.5	103.1	36.6	151	199.5	331.1	361	2535.3

Table 2. Data of rainfall day number (days) in 5 years (2009 – 2013)

Tahun	Jan	Feb	Mar	Apr	Mei	Jun	Jul	Agt	Sept	Okt	Nov	Des	Jumlah
2009	19	26	22	23	23	15	7	3	8	21	19	19	205
2010	27	25	31	17	21	18	20	21	26	25	28	26	285
2011	21	16	22	26	24	9	12	5	11	16	26	27	215
2012	27	25	20	24	20	10	6	1	12	18	27	29	219
2013	26	23	24	26	23	16	16	9	10	21	19	27	240
Rata^2	24	23	23.8	23.2	22.2	12.2	12.2	7.8	13.4	20.2	23.8	25.6	232.8

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2.2 CATCHMENT AREA AND TEMPERATURE AMBIENT OF LEUWIGAJAH LANDFILL AND ITS SURROUNDING AREAS

The catchment area of landfill and its surrounding areas are determined with a topographycal map. Then the heap of waste catchment area is 28.4 hectare and the catchment area of landfill and its surrounding is 75,4 hectare. The average temperature ambient is 23.1^{0}C. These data will be used for calculating the hydrological components of water balance in the study area.

2.3 EVAPOTRANSPIRATION

The values of evapotranspiration was calculated by using the formula below.

$$Et = \frac{N}{\left[0,9 + (N/Jt)^2\right]^{0.5}} \tag{1}$$

Where :

Et = Evapotranspiration (mm/month)
N = average rainfall (mm/month)
Jt = 300 + 25 t + 0,05 t^3 , (t is temperature)

JT = {(300 + (25 x 23,1) + (0.05 x 23,1^3)/365} x 31 = 126,87 (for January). Other values can be seen in Table 3.

Tabel 3. Values of Evapotraspiration at Leuwigajah Landfill and Its Surrounding Areas

Parameters	Months											
	Jan	Feb	Mar	Apr	Mei	Jun	Jul	Agt	Sept	Okt	Nov	Des
Rainfall (mm)	184.9	267.4	295.5	243.4	233.3	128.5	103.1	36.6	151	199.5	331.1	361
Value of JT	126.9	114.6	126.9	122.8	126.9	122.8	126.9	126.9	122.8	126.9	122.8	126.9
Evapotranspiration (mm)	106.3	106.2	117.5	110.7	112.7	91	82.5	36.9	97.2	115.8	115.8	120.4

Source: research findings, 2014

2.4 BASEFLOW

The value of baseflow is calculated by using the formula below.

$$BF = \frac{Q_{\min ave}}{Area} x 86.4 x \sum \text{ days in a month}$$

Where :

BF = Base Flow (mm/month)
Q $_{\text{min ave}}$ = Average debit minimum of river (m^3/second)
Area = Cathment area (km^2)

$$BF = \frac{0,0624}{0,75} x 86,4 x 31 \text{ (mm/moth) = 22,1 (mm/month)}$$

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Table 4. The value of Baseflow per Month

Parameters	Jan	Feb	Mar	Apr	Mei	Months Jun	Jul	Agt	Sept	Okt	Nov	Des
Rainfall (mm)	22.1	20	22.1	21.4	22.1	21.4	22.1	22.1	21.4	22.1	21.4	22.1

R'Source: research findings, 2014

2.5 Run Off

Value of runoff is calculated by using the formula below.

$$RO = \frac{Q_{ave} - Q_{ave\min}}{Area} x86,4x\sum \text{ days in a month}$$

Where :

RO = water runoff (mm/month)
Q_{ave} = Average river debit (m^3/second)
$Q_{ave\ min}$ = Average river debit minimum (m^3/second)
Area = Cathment area (km^2)

$$RO = \frac{0{,}0749 - 0{,}0624}{0{,}75} x86{,}4x31 = 4{,}61 \text{ mm/month}$$

Table 5. Runoff Values (mm/month) at Leuwigajah Landfill and Its Surrounding Areas

Parameters	Jan	Feb	Mar	Apr	Mei	Months Jun	Jul	Agt	Sept	Okt	Nov	Des
Run off	4.61	4.16	4.60	4.50	4.60	4.50	4.60	4.60	4.50	4.60	4.50	4.60

Source: research findings, 2014

2.6 GROUNDWATER RECHARGE

Value of groundwater recharge (□S) is calculated by using the formula below.

□S = RF – (Et + RO + BF) mm/month

□S = 184,9 – (106,3 + 4,61 + 22,1) = 51,84 mm/month

Tabel 6. Groundwater Recharge Values (mm/month) at Leuwigajah Landfill and Its Surrounding Areas

Parameters	Jan	Feb	Mar	Apr	Mei	Months Jun	Jul	Agt	Sept	Okt	Nov	Des
Groundwater Recharge (mm)	51.84	137.10	151.27	106.72	93.78	11.65	-6.20	-27.06	27.94	64.15	189.46	213.89

Source: research findings, 2014

The negative values of groundwater recharge mean there is no groundwater recharge due to infiltration is not occure because all rainfall transforms into runoff and evapotranspiration only.

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2.7 WATER BALANCE

From the above hydrological components, it can be calculated the water balance at the landfill and its surrounding areas. Inwhich, infiltration is baseflow plus groundwater recharge. The complete water balance per months shows in Table 7.

Table 7. Water Balance at Leuwigajah Lanfill and Its Surrounding Areas (mm/mont)

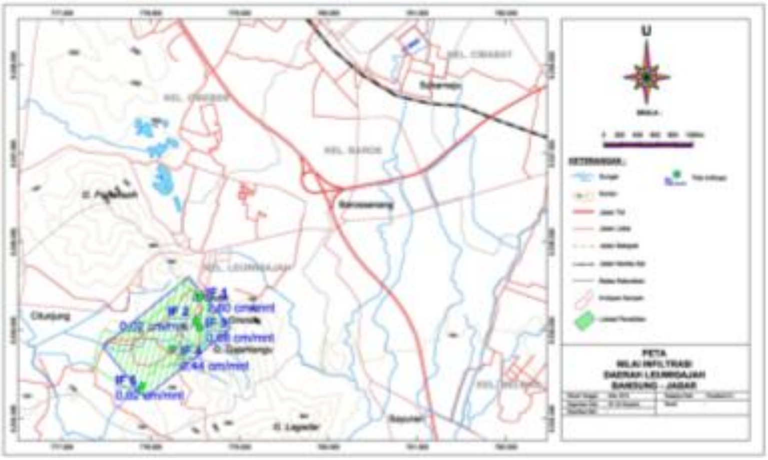
Parameters	Months											
	Jan	**Feb**	**Mar**	**Apr**	**Mei**	**Jun**	**Jul**	**Agt**	**Sept**	**Okt**	**Nov**	**Des**
Rainfall (mm)	184.9	267.4	295.5	243.4	233.3	128.5	103.1	36.6	151	199.5	331.1	361
Evatranspiration (mm)	106.3	106.2	117.5	110.7	112.7	91	82.5	36.9	97.2	108.6	115.8	120.4
Base flow (mm)	22.1	20	22.1	21.4	22.1	21.4	22.1	22.1	21.4	22.1	21.4	22.1
Run off (mm)	4.61	4.16	4.60	4.50	4.60	4.50	4.60	4.60	4.50	4.60	4.50	4.60
Groundwater Recharge (mm)	51.88	137.10	151.32	106.71	93.83	11.63	-6.15	-27.01	27.90	64.20	189.42	213.94
Infiltration (mm)	73.98	157.10	173.42	128.11	115.93	33.03	15.95	-4.91	49.30	86.30	210.82	236.04

Source: research findings, 2014

2.8 INFILTRATION

Data of infiltration are also obtained by measuring directly in field by using Double Rings Infiltrometer. This equipment consists of two cylinders, a midlle cylinder with diameter of 30 cm and an outer cylinder diameter of 60 cm (see Figure 4). Then the cylinders are filled up with water. There were 5 infiltration measuring. The values of infiltration are between 0.02 to 2.60 cm/minutes. Locations and findings of infiltration measuring can be seen in Figure 5. These values are very high compare to the infiltration values which calculated with water balance formulas, because in insitu infiltration measuring, water is kept in cylinders and waited untill it penetrates into ground surface. This value can be used during flooding condition then groundwater contamination due to pollutans infiltration becomes higher.

Figure 4. Double Rings Infiltrometer for Insitu Infiltration Measuring



Source: research findings, 2014

Figure 5. Locations and Results of Infiltration Measuring in Field

The total infiltration on heap of waste and on the surrounding areas (clay sediment) are:

$I_{tot\ (waste)}$ = (2.6+0.08+0.44)/3 = 1.04 cm/minutes= 10,4 mm/minute

$I_{tot\ (clay)}$ = (0.02+0.02)/2 = 0.02 cm/minutes= 0.2 mm/minute

By assuming that rainfall occurres 2 hours per day then multiply by number of rainfall days per month then the infiltration values every month can be seen in Table 8. The average infiltration rate in waste is 290,534 mm/year, while in clay is 5,587 mm/year.

Table 8. Insitu Infiltration Values (mm/month)

Parameters	Infiltration (mm/day)	Months												Average (mm/month)	Total (mm/year)
		Jan	Feb	Mar	Apr	Mei	Jun	Jul	Agt	Sept	Okt	Nov	Des		
Average rainfall (day/s)	-	184.9	267.4	295.5	243.4	233.3	128.5	103.1	36.6	151	199.5	331.1	361	19	252
Evatranspiration (mm)	10.4	106.3	106.2	117.5	110.7	112.7	91	82.5	36.9	97.2	108.6	115.8	120.4	24211	290534
Base flow (mm)	0.2	22.1	20	22.1	21.4	22.1	21.4	22.1	22.1	21.4	22.1	21.4	22.1	466	5587

Source: research findings, 2014

2.9 INSITU WATER QUALITY MEASUREMENT

Insitu water quality measurement has been carried out by using portable water checker. The parameters measured are total dissolved solid (TDS), electical conductivity (EC), temperature, and water acidity. The water can be grouped as surface water, groundwater, and leaching. Groundwater is assumed identical to dig well water which is owned by community. Table 9 and 10 show findings of insitu water quality measurement. Most of surface water has a high electrical conductivity and TDS. It means that the surface water has a high concentration of heavy metals. It shows that pollutants movement from the landfill is quite intensive. Groundwater quality is better than surface water quality because polutants movement into groundwater is hindered by rock layers, these are andesite rock and clay sediment.

Figure 6. Insitu Water Quality Measurement using portable water checker

Table 9. The findings of insitu surface water quality measurement

No.	Sampels	Coordinate (UTM WGS 84)	pH	Quality DHL (µS/cm)	TDS (mg/L)	T (°C)	Debit (ltr/sec) Besaran
1	MA 1	48 M 778131 9234968	6,8	4140	2080	34,7	-
2	MA 2	48 M 778091 9235011	6,8	2370	1120	30,7	0,014
3	MA 3	48 M 778093 9235023	6,7	2440	1220	29,8	0,14
4	MA 4	48 M 778332 9234943	6,8	2870	1370	32,7	-
5	MA 5	48 M 778037 9234246	7,2	320	180	27,3	-
6	MA 6	48 M 777759 9234387	7,1	530	270	29,2	-
7	Leaching	48 M 778253 9234763	6,4	2310	1170	26,4	0,08
8	River	48 M 778037 9234246	6,7	420	210	26,6	6,24

Table 10. The findings of insitu groundwater quality measurement

No.	Villages	Sampels	Coordinates (UTM WGS 84)	Quality pH	DHL (µS/cm)	TDS (mg/L)	T (°C)
1	Cirendeu	SM1	48 M 778623 9234951	7,4	540	270	29,5
2	Cirendeu	SM2	48 M 778626 9234932	6,8	600	290	29,8
3	Cirendeu	SM3	48 M 778636 9235001	7,5	670	330	25,5
4	Cirendeu	SM4	48 M 778645 9235041	7,4	630	310	25,5
5	Cirendeu	SM5	48 M 778672 9235064	7,5	180	90	25,6
6	Cirendeu	SM6	48 M 778649 9235131	7,1	410	200	26,1
7	Batujajar Timur	SM7	48 M 777500 9234742	7,1	550	250	27,2
8	Batujajar Timur	SM8	48 M 777484 9234905	7	580	290	29,3
9	Batujajar Timur	SM9	48 M 777891 9234934	6,2	550	270	28,7

Some water sampels are tested in laboratory as many as 13 samples. The quality standard is based on Ministry of Health No. 907/MENKES/SK/VII/2002 (see Table 11). It shows that the quality of surface and ground water around the Leuwigajah landfill is above the quality standard from Ministry of Health for drinking water. Samples have a high concentration of calcium, magnesium, mangan, iron, potassium, and bicarbonate which those are heavy metals. Dig well water should be treated first before it is used for drinking water to remove heavy metals. If it is used without treatment then it will induce kidney problems in future.

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Parameters	Units	Quality Standard	River	River +Leaching	Leaching	MA-1	MA-2	MA-3	MA-4	MA-5	MA-6	SM-6	SM-7	SM-8	SM-9
Turbidity	NTU	5	16,3	6,3	338	876	55,5	31,8	4450	0,2	29,3	0,4	0,6	0,4	5,8
Coulor	TCU	15	22	85	77	1023	176	219	357	0	151	0	7	0	1
Smell	-	No	tb	tb	tb	tb	tb	tb	tb	tb	tb	tb	tb	tb	tb
Taste	-	No	tb	tb	tb	tb	tb	tb	tb	tb	tb	tb	tb	tb	tb
Electrical conductivity	µS/cm	-	511	538	2962	4600	2683	2718	3334	398	630	425	1057	688	645
pH	unit pH	6,5 - 8,5	7,4	7,3	7	7,8	7,3	8	7,4	6,9	7,3	6,6	6,7	6,7	6,4
Kesadahan	mg/L $CaCO_3$	500	93,4	154,4	683,3	1590,6	370,6	484,5	492,2	181,4	206,9	179,1	319,7	227,8	241,7
$Ca2^+$ (Kalsium)	mg/L	-	36,4	39,5	42,9	111,9	57,9	74,1	158,3	18,8	32,1	19,5	50,3	27,5	29,6
Mg2+ (Magnesium)	mg/L	-	0,6	13,3	138,2	314,5	54,2	71,8	23,2	32,2	3,4	31,3	46,5	38,2	40,2
Fe3+ (besi)	mg/L	0,3	1,25	1,79	12,44	12,46	7,78	3,73	13,9	0,14	1,08	0	0	0	0,11
Mn2+ (Mangan)	mg/L	0,1	0,29	0,55	6,05	0,76	0,8	0,46	1,83	0,01	1,46	0,01	0,15	0,01	0,02
K^+ (Kalium)	mg/L	-	36,5	22,7	41,9	225,6	137	140,6	189	1,5	16,5	1,5	12,7	5	2,2
Na^+ (Natrium)	mg/L	200	46	27,9	155	154,3	135,1	163	226,6	12,2	26,8	13,8	71,2	39,3	25,9
Li^+ (Litium)	mg/L	-	0	0	0	0	0	0	0	0	0	0	0	0	0
NH_4^+ (Amonium)	mg/L	1,5	0	0	10,7	7,8	9,2	7,9	8,7	0	0,7	0	0	0	0
$CO_3^=$ (Karbonat)	mg/L	-	0	0	0	0	0	0	0	0	0	0	0	0	0
HCO_3^- (Bikarbonat)	mg/L	-	167,1	189,4	817,2	1596,4	710,5	947,1	1199,4	181,8	194,4	115	236,6	137,3	76,9
Cl^- (Klorida)	mg/L	250	33,2	39,4	392,2	513,1	248,8	261,2	299,6	11,2	33,2	40,6	145,1	61	24
$SO_4^=$ (Sulfat)	mg/L	250	21,8	11,5	8,8	19,5	8	4,5	4,5	58,5	59,3	25,3	43,5	65,8	122,9
$NO2^-$ (Nitrit)	mg/L	3	0,05	0,71	1,11	0,25	0,71	0,49	0,36	0,04	1,72	0,15	1,23	0,01	0,05
$NO3^-$ (Nitrat)	mg/L	50	19,5	4,4	22,8	18,7	5,4	5,9	9,3	1,6	0	19,1	2,3	32	61,2
Total Dissolved Solid	mg/L	1000	344	360	1978	3068	1790	1814	2224	268	430	286	706	460	430

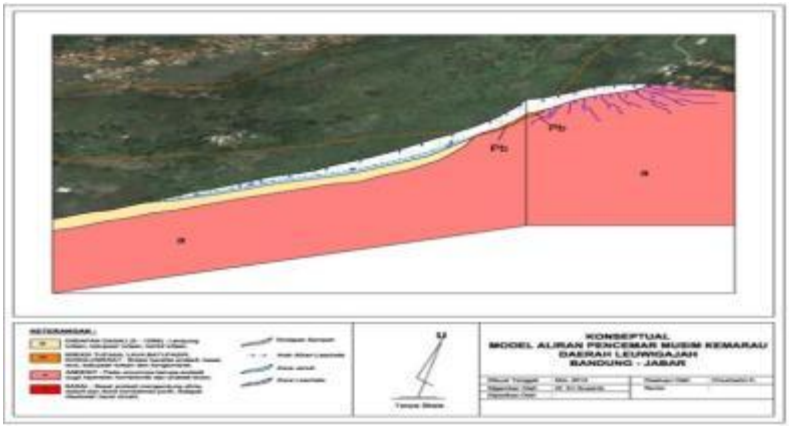
Source: research findings, 2014

Figure 7. Table of Water QRiveruality Analysis from Laboratory Test

2.10 POLLUTANTS MOVEMENT

Pollutants movement, especially into groundwater, is influenced by rock or soil layers under the landfill. Since that the landfill has no base impermeable layer then andesite rock plays significant role of pollutants movement into groundwater. The andesite rock has been mined then it will have a lot of fractures which will be as a media transport of pollutans. The size and direction of fractures will influence pollutans movement.

Pollutans movement into groundwater is also influenced by climate. During dry season pollutants movement into groundwater will mostly through andesite fractures. Meanwhile, during rainy season pollutants will move more intensively into groundwater due to saturated condition of rock or soil. This condition similar with insitu infiltration test which has a high value of infiltration. Figure 7 and 8 shows predicted pollutans movement during dry and rainy seasons.



Source: research findings, 2014

Figure 8. Predicted Pollutants Movement During Dry Season

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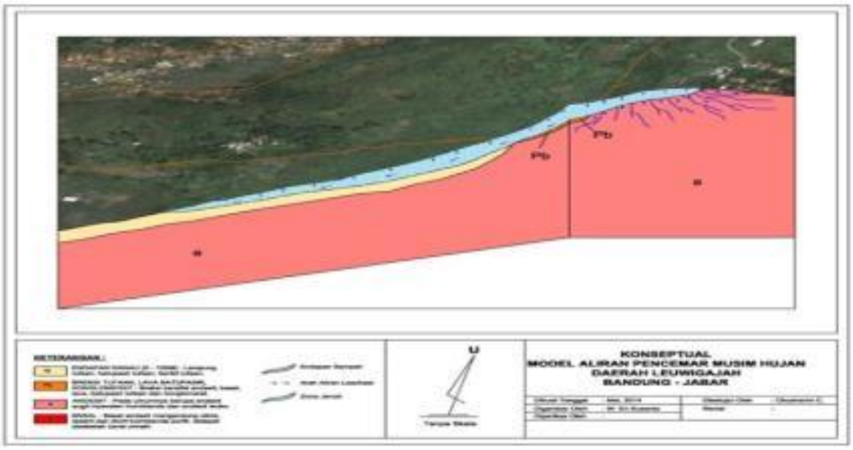

Source: research findings, 2014

Figure 9. Predicted Pollutants Movement During Rainy Season

3. CONCLUSIONS

1. The water balance at Leuwigajah Landfill and its surrounding area is rainfall of 2.535 mm/year, evapotranspiration of 1.205 mm/year, infiltration of 1.275 mm/year and runoff of 55 mm/year.
2. Hydrological components of Leuwigajah Landfill and its surrounding area is base flow of 1.260 mm/year and groundwater recharge 1.015 mm/year.
3. Insitu infiltration test can be used to predict pollutants movement during rainy season. The average infiltration rate in waste is 290,534 mm/year, while in clay is 5,587 mm/year.
4. Water samples have a high concentration of calcium, magnesium, mangan, iron, potassium, and bicarbonate which those are heavy metals. Dig well water should be treated first before it is used for drinking water to remove heavy metals.
5. The Leuwigajah landfill site is a source of pollutants which induce surface and groundwater contamination in its surrounding areas.

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THE SPATIAL OF DAM RESPONSIVENESS BASED ON PEAK GROUND ACCELERATION (PGA) MODEL, REGIONAL GEOLOGY AND OBSERVATION OF INSTRUMENTS SURROUNDING AT SERMO DAM

Nugroho Budi WIBOWO[1], Arif GUNAWAN[2]

ABSTRACT: This study is a comprehensive-descriptive analysis elaboration to seismic hazards on Sermo Dam, while in terms of microtremor characteristic (PGA model), its regional geology and observation of instrumentation on it. Sermo Dam is the only one huge water resources infrastructure which lies in Yogyakarta Province at time of earthquake disaster happened on May 2006. Basic theories used in this case are HVSR methods, determining sediment thickness, and Kanai Method for Maximum Ground Acceleration, Then, based on these we can analyze characteristics of responsiveness dam in the form of local spatial region focused by amplitude (A), dominance frequency (fo), time period (T), sediment thickness (H) and Peak Ground Acceleration (PGA). Besides, by an analysis on regional geology that can be obtainable the characteristic of Sermo Dam foundation which lies on the Old Andesite (Kebo Butak) Formation. They are relatively robust when subjected to seismic vibration of middle class to below (less than 7 Richter scale on design). Also it has some declining periodic trends by main dam whereas there is still in the initial stage of design tolerance. The final result is zoning classification of damage potential with: (1) region by PGA values of 0,04≤ a < 0,15g which they are minor impact damage on their buildings; (2) region by PGA values of 0,15≤ a < 0,34g which they are medium impact damage on their buildings. The damage level is comparable by inclining of filler material thickness at dam site.

KEYWORDS: dam responsiveness, PGA, geology, instrumentation, Sermo

1. INTRODUCTION

Dam is one of civil structures which concerns of water resources. It has some functions such as reservoir for irrigation system, electricity, water treatment and also tourism. Sermo Dam lies on Ngrancah River, Sermo-Hargowilis Village, Kokap Sub-District, Kulonprogo Regency. It was established on November 20th 1996 after construction phase for almost 32 months (1994-1996).

As reviewed from construction aspect and the ICOLD (International Commission on Large Dam) classification, Sermo Dam has been classified into one of rockfill dam with inclined core with water capacity is about 25 million m3 (Source: The Detailed Design, 1996) as seen on Figure 1.

Dam has an important function so that its sustainability should need to be maintained. Geologically, Sermo Dam lies on the old-Andesite Formation or Kebo Butak Formation (from upper-Oligocene to mid-Miocene or Oligo-Miocene) which was layered as disconformity on Nanggulan Formation and located the fault zone nearby. Relating to natural disaster in the year 2006, the existence of Sermo Dam lying on the affected area that is very prone to seismic impact. For this, then it needs to be a review about how far responsiveness of dam during and afterwards seismicity in the future. The seismic hazard potential is able to get near to measuring microtremor and studying of the regional geology at surrounding Sermo Dam.

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2. PROBLEM STATEMENTS

After the Yogyakarta's Earthquake on May 27th 2006, many infrastructures had been damaged along with a number of casualties (i.e. fatalities and serious injuries). One of them is about Sermo Dam which lies in earthquake-prone areas. And data on 2006 show that the dam is still in good condition despite it shocked when disaster occurred. Reviewing for this, we need to know the extent patterns of behaviour in Sermo Dam after disaster. In order that, by this study we can find out more precisely ground response surrounding the dam when seismic waves happened again.

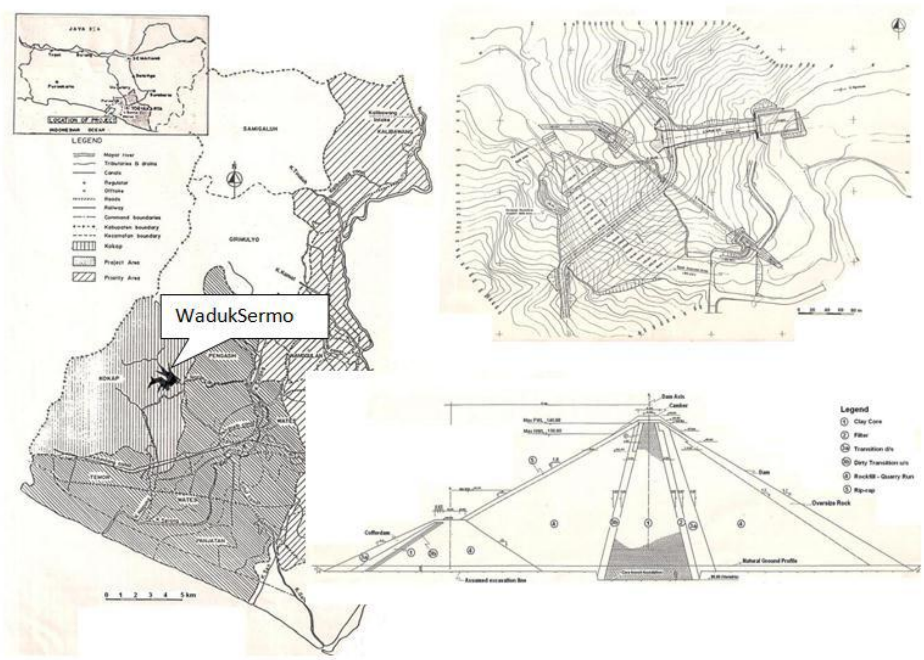

Figure 1. The Site of Sermo Dam and Layout including cross section (Source: The Dam Safety Unit, Ministry of Public Works, 2012)

This study aimed to know how potential of seismic hazards by analyzing of dam responsiveness to PGA (Peak Ground Acceleration) model, characteristic of regional geology and analysis of result for dam instrumentation. By knowing the part of dam body (i.e. crest, foot and buffer) which has the potential for damage can be known beforehand therefore making preventive measures and reducing the risk of damage can be determined later.

3. RESEARCH METHOD

The study was conducted by using microtremor measurement at eleven observation points surrounding Sermo Dam. In order that, we need equipments which consist of the portabel seismograph (TDS-303), geological compass, global positioning system (GPS), and mobile computer- laptop. Operational standard on the measurement tools are based on SESAME European research project [SESAME,2004] within the length of duration 30 minutes for every point. Data processing by using software NetRec, DataPro, Geopsy, Surfer, Global Mapper and Google Earth. Microtremor data processing method is using HVSR (Horizontal to Vertical Ratio) in order to gain main variable such as dominant frequency (fo) and amplification factor (A). Both of them derived from them to produce the other ones, sediment thickness (H) and ground acceleration (PGA). In that case, we can conclude to the

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Yogyakarta's earthquake on May 27 2006. This is the largest and the most powerful disaster after independence moment (the year of 1945).

3.1. BASIC THEORY

1. HVSR (Horizontal to Vertical Ratio)

As reviewed from the theory, the HVSR formula for vibration measured at the surface be avowed:

$$HVSR = \frac{\sqrt{(A_{(U-S)}(f))^2 + (A_{(B-T)}(f))^2}}{(A_{(V)}(f))} \quad (1)$$

HVSR = Horizontal to Vertical Ratio

$A_{(U-S)}(f)$ = Amplitude Value based on frequent spectrum-component North-South

$A_{(B-T)}(f)$ = Amplitude Value based on frequent spectrum- component West-East

$(A_{(V)}(f))$ = Amplitude Value based on frequent spectrum- vertical component

2. Sediment Thickness (H)

From the spectra ratio H/V, we can count sediment thickness with:

$$H = Vs / 4fo \quad (2)$$

whereas:
H (thickness in m), Vs (secondary velocity in m/s) dan fo (dominant frequency in Hz)

3. Peak Ground Acceleration (PGA)

The model of ground acceleration used Kanai method (1966), which it stated:

$$a_g = \frac{5}{\sqrt{T_0}} 10^{0.61M - \left(1.66 + \frac{3.6}{R}\right) \log R + 0.67 - \frac{1.83}{R}} \quad (3)$$

whereas:
(PGA in gal), To (dominant period in second), M (Magnitude in Richter's scale) dan R (hypocenter in km).

4. RESULTS AND DISCUSSION

4.1. MICROTREMOR CHARACTERISTIC OF SERMO DAM AT KULONPROGO

Sermo Dam is lying at Ngrancah River, Sermo-Hargowilis village, Kokap sub-district, Kulonprogo regency and launched on November 20th 1996. Sermo dam is one of dominant typical dams in Indonesia by earth-rockfill dam type that can accommodate the volume of water as many as 25 million m3. Microtremor measurements at Sermo Dam aimed to know how characteristic of microtremor onto dam body and its surrounding. Variables resulting from the measurements and data processing are dominant ground frequency data (fo), amplification factor (A), dominant ground periods (To), and sedimentary thickness (h).

These variables, frequency and period of dominant ground showed characteristic of the constituent material layers. The results of the measurements and data processing indicate that constituent materials of dam body are soft ones may vary 1.04 – 1.50 Hz (dominant frequency) and 0.67 – 0.96 s (dominant period). Identification of soft materials in accordance with the conditions that exist in the field and also Figure 2.c. describes that the main constituent of dam body is claystone with reddish brown. Zoning dominant frequency and period gives some informations about condition at surrounding dam site in which consist of hard rock material with frequency variation 8.00 – 10.16 Hz and 0.09– 0.13 s.

Those values are range that obtained from the detailed on-site measurements.

This is becoming one of the main parameters of the study. While the thickness of the sediment layer is based on a model of microtremor varies from 12-94 m.

Then for the amplification factors contained in the variation around the dam are at low to moderate amplification, which are 1,03 – 4,94.

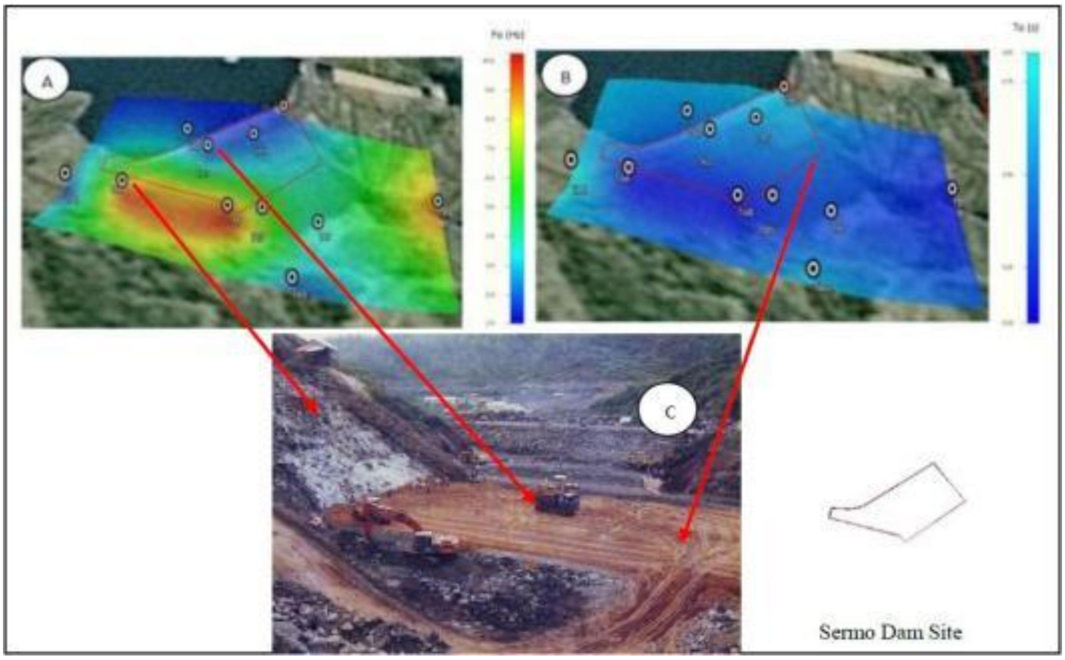

Figure 2. a. variation of dominant frequency of ground (fo), b. variation of dominant period of ground (To) at Sermo Dam body and c. photograph of construction phase. (Sources: Analytical results, 2013 and Documentation of Construction Dam, 1996)

The thickest layer of sediment that contained in the body of the dam and reservoir area. Microtremor characteristic based on amplification factor and the thickness of the sediments showed a linear relationship, which means that the thicker some layers, the higher amplification factor on site.

This shows that the area with a thick layer and high amplification factors will provide vibration response / longer and larger shocks in the event of earthquakes or artificial sources of vibration.

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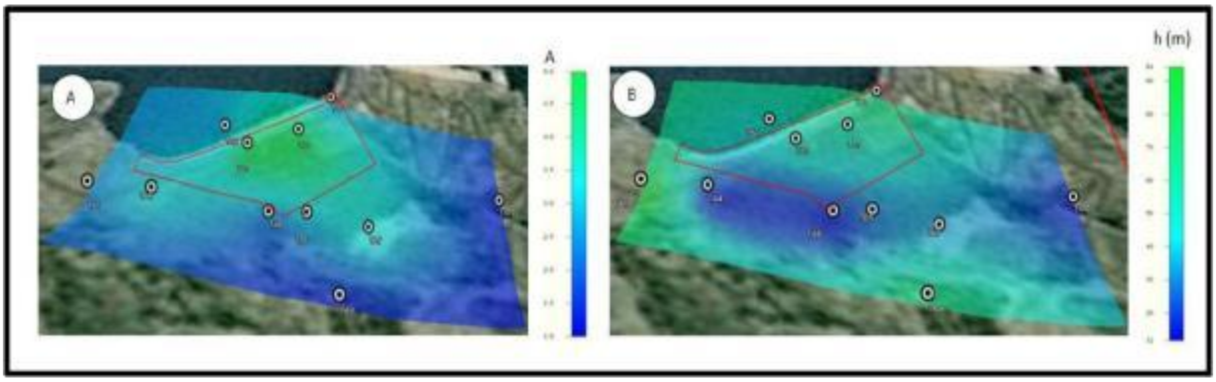

Figure 3. a. Variation of amplification factor values (A) and b. Variation of sedimentary thickness (h) (Sources: Analytical Result, 2013)

4.2. REGIONAL GEOLOGY CHARACTERISTIC AND REVIEW OF INSTRUMENTATION OBSERVATION AT SERMO DAM (KULONPROGO)

Sermo Dam was lying on one of lowlands at Kulonprogo Mts. Based on the regional stratigraphy study which driven by Mulyaningsih et.al (2006) indicated that there are many recorded data. Those included the intensively activities process of tectonism at least during in the early Tertiary-Quarterly (100.000-20.000 years ago), especially for Kulonprogo Mts., which indicated with the fault zones due to response of up-willing process. Because of these, it would also be probably re-activated by tectonism effects such as subduction of Indo-Australia plate into Eurasia plate (it is then creating the Java island). Van Bemmelen (1949) had reconstructed how Kulonprogo Mts. Formed in the past by block diagram. It had been symbolized as dome (in term of geomorphology). Whereas the peak of this dome was plateau of Jonggrangan (forming Jonggrangan Fm. that lies on the Old-Andesite Fm.). The dome then by van Bemmelen had a dimension which located from the south-west to north-east with length about 32 km and width 15 - 20 km. On the other hand, the toes of the dome located and founded some fault zones (i.e. normal and thrust) radially (Figure 4).

The existence of fault zones which later became concern is the main phase of Sermo Dam construction during 1994-1996. Records of minor damage due to the earthquake disaster phenomena on May 27th, 2006 ago and at least a further hypothesis strengthens and emerges about vulnerability of main dam as one of vital infrastructures against the disaster of seismic/ tectonic.

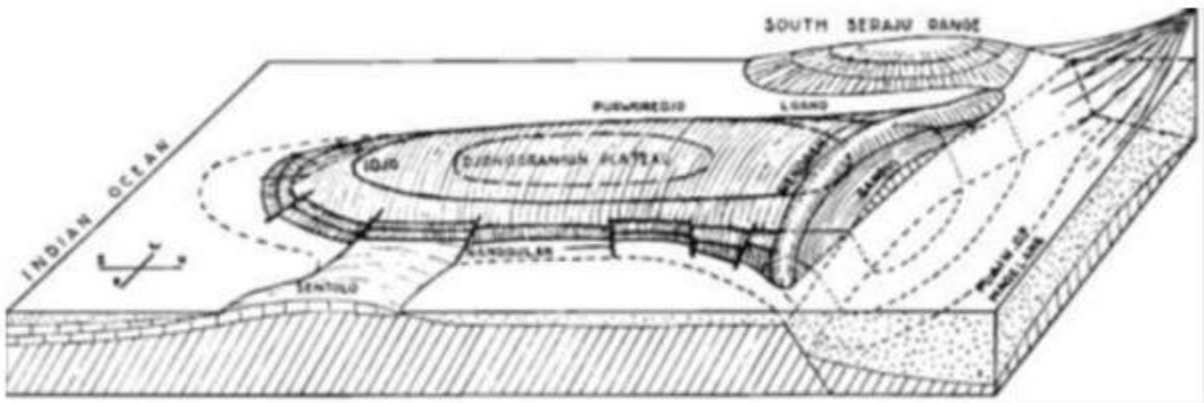

Figure 4. Block Diagram of Kulonprogo Mts. (Source: van Bemmelen, 1949).

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As reviewed based on regional geology, the foundation of dam lay on the Old-Andesite Formation or in other name called Kebo-Butak Formation (Oligo - Miosen) which deposited as unconformity layer on Nanggulan Formation (Mulyaningsih et.al, 2006). The composition of lithology consist of volcanic breccia with andesite fragment, tuff-lapilli, tuff, lapilli, and inserted andesite lava flow/agglomerate also sandstone. Distribution of this formation could be found in the north, middle land and southwest of Kulonprogo. It is then forming mountainous geomorphology with slope 15˚-45˚ (field data, 2013) and the thickness is about up to 600 m. Meanwhile the reservoir lies on Nanggulan Fm which dominated by quartz sandstone and claystone including numerous of Mollusca fossils. Figure 5.a and 5.b show that some rock outcrops which is a material constituent of the area around the location of the main dam and its reservoir.

Gambar 5.a. SingkapanBatuanAndesit (FormasiKeboButak) pada*abutment* kananBendunganSermo (Data Lapangan, 2012)

Gambar 5.b. SingkapanBreksiVulkanik (FormasiKeboButak) padasalahsatutebingwaduktidakjauhdari*as Dam* (Lap,2012)

The installation of instruments at Sermo Dam are complicated because of various kinds as well as its functions. Relating to anticipation of seismic disaster by installation of Seismograph (Strong Motion Seismograph) on main dam in order to know the movements which caused by huge earthquake with strength and time while it happened. Also, it combined with inclinometer and settlement gauge as each of which is intended for monitoring the movement of the horizontal into dam body in which distributed as embankment (i.e. clay as well as rock), while the movements on the left onto the right as well as upstream to downstream and determining declining of dam movement as well. At Sermo at least be presented characteristic condition since 1996 (when it launched) based on observation point (OP) as shown in Table 1.

And based on observation result which has been driven by settlement gauge, we can see that since after construction phase in the late of 1996 to near the time of the occurrence of the earthquake disaster in 2006 (on May 26th) which tended stable.

However since the earthquake happened, observational data indicate that a decline began periodically though still in its early stages of design calculations tolerance initially. Dam design is adapted to the conditions of up to approximately 7.0 on the Richter Scale (Design, 1996).

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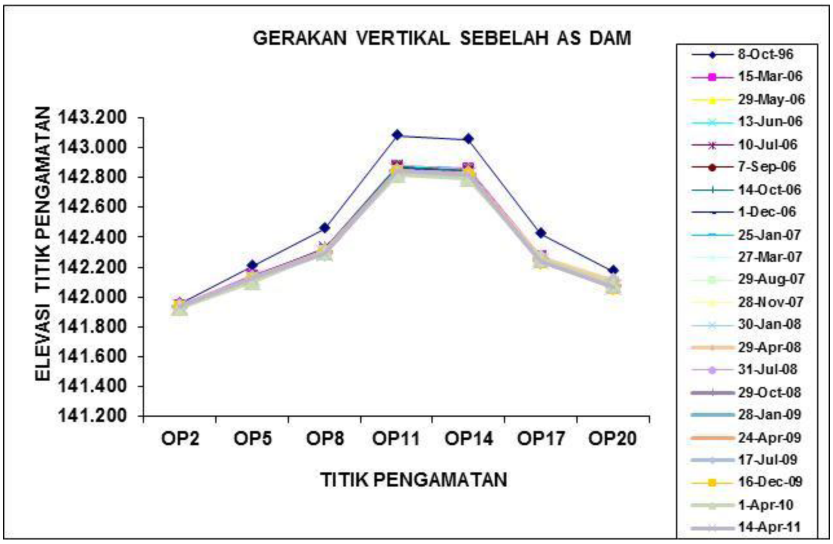
Table.1. Results of observation instrumentation (elected), which describes the characteristics of Sermo Dam post-construction until a few years after the 2006 earthquake

PENGAMATAN GERAKAN VERTIKAL PERMUKAAN TUBUH BENDUNGAN SERMO SEBELAH AS DAM

STA.	7	9.5	12	14.5	17	19.5	22
	OP2	OP5	OP8	OP11	OP14	OP17	OP20
8-Oct-96	*141.953*	*142.205*	*142.454*	*143.074*	*143.056*	*142.417*	*142.172*
15-Mar-06	141.942	142.140	142.321	142.883	142.858	142.274	142.085
29-May-06	141.941	142.138	142.317	142.881	142.855	142.264	142.077
13-Jun-06	141.937	142.134	142.322	142.881	142.851	142.266	142.088
10-Jul-06	141.939	142.136	142.324	142.874	142.847	142.263	142.085
7-Sep-06	141.938	142.131	142.320	142.869	142.843	142.261	142.075
14-Oct-06	141.935	142.133	142.309	142.868	142.848	142.260	142.086
1-Dec-06	141.936	142.131	142.313	142.860	142.832	142.253	142.082
25-Jan-07	141.939	142.128	142.304	142.852	142.822	142.246	142.086
27-Mar-07	141.936	142.122	142.302	142.847	142.822	142.248	142.081
29-Aug-07	141.937	142.124	142.307	142.847	142.821	142.249	142.081
28-Nov-07	141.937	142.123	142.299	142.844	142.819	142.246	142.077
30-Jan-08	141.937	142.123	142.299	142.844	142.819	142.246	142.077
29-Apr-08	141.937	142.126	142.305	142.848	142.824	142.268	142.106
31-Jul-08	141.937	142.123	142.301	142.847	142.817	142.243	142.077
29-Oct-08	141.935	142.119	142.296	142.846	142.817	142.242	142.075
28-Jan-09	141.935	142.121	142.296	142.840	142.819	142.243	142.073
24-Apr-09	141.934	142.120	142.298	142.841	142.817	142.244	142.073
17-Jul-09	141.932	142.118	142.294	142.836	142.812	142.240	142.068
16-Dec-09	141.934	142.117	142.294	142.837	142.815	142.227	142.058
1-Apr-10	141.924	142.105	142.301	142.822	142.795	142.254	142.084
14-Apr-11	141.937	142.124	142.292	142.841	142.817	142.239	142.068
6-Jun-12	141,936	142124	142292	142841	142819	142239	142067
Penurunan (m)	**-0.016**	**-0.081**	**-0.162**	**-0.233**	**-0.239**	**-0.178**	**-0.104**



(Sources: BPSDA Sermo-BBWS Serayu Opak, 2012)

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4.3. RESPONSE OF DAM BASED ON PGA MODEL (PEAK GROUND ACCELERATION)

The potential for disaster in surrounding of dam could be identified with microtremor characteristic in order to determine the value of PGA. The case study of earthquake which is used knowing further dam response to PGA was disaster on May 27th 2006. It had epicenter on 8.26 SL;110.31 EL with magnitude on 5.9 Richter and depth of 33 km that caused significant damage in the region of Yogyakarta and Central Java.

The PGA Model which based on Kanai methods has been considered the characteristics of the dominant period of local soil. Result of PGA model shows the direct correlation while the highest PGA is about 0.354 g at TA 4 meanwhile the lowest of PGA is 0.123 g at TA 1.

Based on the classification of damage potential, the PGA model lies into the category of mild damage class (0.04 ≤ a < 0.15 g) up to middle (0.15 ≤ a < 0.34 g). The middle damage located on the west side of the dam (comparable to the thickness of embankment material which fulfilled on the toe of dam), whilst at dam body it had the potential for mild of damage.

Information of the potential damage resulting from PGA modeling used to be determining maintenance priorities of dam as well as became reference for the owner due to operation and maintenance. Aspect of O-M then becoming crucial for immediately considered treatment.

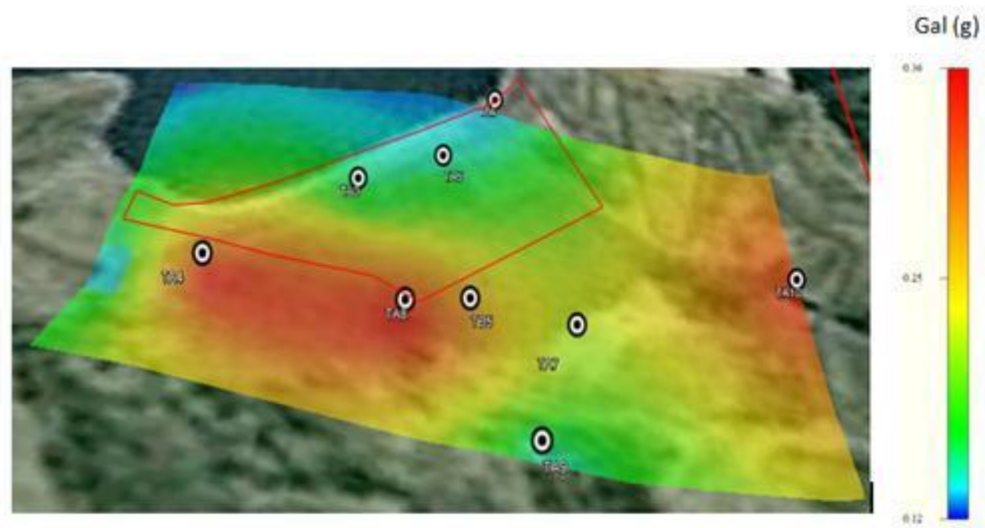

Figure 6. Zoning of Damage Potential Classification based on PGA Model surrounding Sermo Dam (field data, 2013).

5. CONCLUSIONS

1. Constituent materials of dam body are red soil and may vary 1.04 – 1.50 Hz of dominant frequency as well as 0.67 – 0.96 s of dominant period.
2. Amplification factor of surrounding dam may vary 1.03-4.94 (i.e. mild-middle) with sediment depth 12 – 94 m. Hazard potential to seismic waves is directly proportional to the thickness of sediment /embankment.
3. The study of regional geology indicates that foundation of main dam lying on Old-Andesite Fm. or Kebo-Butak Fm. (Oligo - Miosen). This characteristic generally is brittle as well as stable to seismic effects such as earthquake.

4. After May 27th 2006 earthquake, there has been a tendency of vertically decreasing movements at dam body periodically despite it still in tolerance level of initial design calculation.
5. Plotting the measuring point produces a zoning potential classification based on PGA model. Spatial zoning at Sermo Dam is correlated with mild damage class ($0.04 \le a < 0.15$ g) up to middle ($0.15 \le a < 0.34$ g).

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GREEN BUILDING MATERIALS IN COASTAL CITIES

PURWITO[1]

ABSTRACT: Buildings are large entities and they impact upon the environment in various way. Now the building designs clearly consume large quantities of physical resources such as materials, energy, money in their construction, maintenance and use. In line with the technological development, green building design and construction has emerged as a significant trend in the last 10 years. The green building design refers to structure and material efficient and consider a building's life cycle begin from architecture design, construction, operation, maintenance, renovation and demolition. All of this reduced impacts on human health, a building energy and use material efficiency. Urban population growth result in an increased demand for housing, which in turn requires a lot of building materials are cheap but durable and strong. Now the development of materials technology is so advanced using various kinds of material such as naturally materials, artificial or waste so that allows us to choose the material according to the needs. This is a good solution because disposing of building materials from waste materials has huge environmental impacts and can cause serious problems. For most building materials, the major environmental impacts occur such as hole in the ground, old quarries specially dug caused by producing building materials. Develop the utilization of building materials from industrial waste materials will reduce resources, energy used and saves money. In addition, integrating green building materials into building projects can help reduce the environmental impacts. Research the utilization of Industrial waste materials conducted at RIHS, is an effort to obtain alternative building materials that meet the technical requirements of industrial waste

KEYWORDS ; Industrial waste materials, green materials, green building

1. INTRODUCTION

The shift in economic structure from an agricultural to an industrial economy throughout Indonesia has resulted in increased energy consumption and corresponding environment pollution. Urbanization and industrialization have seen a move towards the manufacturing sector and the remaining population in plain area is still very high meanwhile the arable land area there is reducing rapidly due to housing. Now the building designs clearly consume large quantities of physical resources such as materials, energy and money in their construction, maintenance and use. Building and infrastructure in mountainous and coastal area has its own problems such as conservation of soil and water, maintenance of soil fertility and deterioration of environmental for example, in Indonesia, export of timber causes inflation accelerated change from timber traditional houses to masonry houses, along with domestic production of cement and bricks, which were also basic conditions of housing strategies supplying block houses. However, in future, requirements for appropriate material flow will imply new models for housing and town planning, which will be evaluated through built of house with green materials.

Typically more than 80% of the total energy consumption takes place during the use of buildings and less than 20% during construction of the same.

Since we know this could be happen as soon as 30 years from now, we must act now to prevent it from happening. One of the acts is, study using some of green materials such as materials from waste of industrial product (drymix mortar, conblock, paving block etc).

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This entire problem should be solved especially in the contexts of preparing the new building materials in the replacement of the role of general materials in building constructions. Buildings can significantly increase the quality of the environment through the use of innovative low-impact materials. These materials include permeable, recycled, recyclable, reflective and non-toxic materials. Using these materials can minimize consumption of newer materials, enable a continual reuse of limited natural resources, and decrease waste and environmental pollution.

The idea of "green materials" has been performed by researchers RIHS, by conducting research industrial waste materials as building components. This paper presents a brief account of the our institute experience in the testing and utilization waste of mining industry like, Fly Ash from Steam Power Centre (PLTU Suryalaya), tailing and Textile Industry, RCC (Residual Cracking Catalyst) from Pertamina, Drilling Cutting and Slag (product of home industry).

2. METHODOLOGY

This research was undertaken by desktop study which included reviewing literature and materials testing in RIHS laboratory. In order to achieve the objective, all of the research uses stratified random sample, description method, exploration, designing and constructing, experimental with the following activities:

- Identification of raw materials;
- Mix design of the composition with the optimum proportion ;
- Laboratory testing of raw materials, and composition of mortar;
- Design and preparing the model of medium small scale industry;

All of the activities were carried out in laboratory test of building materials (RIHS) and other institution associated with the activity.

3. INDUSTRIAL WASTE MATERIALS

Industrial waste is the waste produced by industrial activity which includes any material that is rendered useless during a manufacturing process such as waste of oil drilling, gold mining, steam power plant (fly ash, bottom ash), slag etc. From definition of this waste, the industrial waste is a waste product resulting from the production process in an industry. There are two kinds of industrial waste, namely waste in liquid form and in the form of solid waste is also commonly called trash. Both types of industrial waste is not a little that contain hazardous and toxic materials. Because of its industry then the amount is greater than the domestic waste or household scale. Required serious treatment for industrial waste, because of its impact on the environment is greater than the domestic waste and called toxic and hazardous (B3 wastes).

Definition of B3 based BAPEDAL (1995) is, any waste material a product of process activities that contain hazardous materials and toxic (B3) because of, the nature (toxicity, flammability, reactivity, and Corrosivity) as well as the concentration or amount that is either, directly or indirectly can directly damage, pollute the environment, or harm to human health (Bapedal 1995).

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What is a green building material products?

Green building materials are composed of renewable, rather than nonrenewable resources. Green materials are environmentally responsible because impacts are considered over the life of the product (Spiegel and Meadows, 1999).

4. THE CONDITIONS OF COASTAL CITIES

Model building in the coastal city is rapidly growing adapt or adjust to the natural conditions of the surrounding environment and strongly influenced by the various elements of culture, both the original culture and the cultures of migrants. Because it is a tidal area, the general type of building is stage construction or use a high floor of the building .The materials used come from natural materials (wood or bamboo) and does not harm the environment such as use of traditional plastering and the use of rocks and burnt bricks and clay on the walls of the building with the use of curved model at entrances, windows, and porches. Nowadays, technology and building materials are growing very rapidly so that, many changes occur such as brick walls have been replaced couple walls with reinforced concrete columns. The use of cement and metal became popular when cement and metal is the biggest contributor to CO2 emissions, especially in the manufacturing process.

Key Issues of green materials used for coastal construction are;

- The durability of a coastal home relies on the types of materials used to construct it.
- The Material and construction methods should be resistant to flood and wind damage,
- Driving rain, corrosion, moisture, and decay
- All of coastal buildings will require maintenance and repairs (more so than inland construction)

5. RESEARCH OF WASTE MATERIALS IN RESEARCH INSTITUTES FOR HUMAN SETTLEMENT

In principle, testing of raw building materials (coarse or fine aggregate) or waste materials (agricultural or industrial wastes), starting from the physical properties of the raw materials and then designed into a mortar. manufacture of mortar as a reference to the form of the actual building materials (conblock or paving). Specimen in the form of mortar as a reference to the form of the actual building materials (conblock or paving).

Indonesian National Standards used are ;

- SNI 03-6820-2002, concerning on Fine Aggregate of Mortar
- SNI 03-6882-2002, concerning on Specification of Bricklaying Mortar
- SNI 03 3449 2002 planning procedures with a high mix of portland cement with fly ash
- SNI 03-6889-2002 concerning aggregate sampling procedures

Waste materials used are generally derived from the landfill at the plant site. Retrieval techniques and utilization follow Government Regulation (PP No. 85 year 1999 on toxic and hazardous materials (B3) and Classification B3 (PP No. 74/2001) for poison contents of materials, using TCLP method (toxicity characteristic leaching protection).

The specimen treatment is done in accordance with the method used such as, identification of raw materials, mix design of the composition with the optimum proportion, laboratory testing of raw materials, composition of mortar and design/preparing the model of laboratory scale size.

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6. WASTES FROM MINING AND OIL DRILLING

RCC (residual cracking catalyst) is the waste materials from petroleum cracking process conducted by PT. Pertamina UP-VI Balongan in Indramayu, West Java. This material powder shaped smooth grayish white, extremely light (specific gravity of 2.35 to 2.38) with the main elements of, silica and alumina and categorized as Pozzoland artificial ingredients.

Tailing is the waste materials from gold mining located in Pongkor (West Jawa). Referring to the laboratory test result by Ceramic Industry Laboratory, the tailings did not contain poison and dangerous substances but, the silica, alumina and ferro minerals contains are more then 70%. The table below is shown the strength of mortar by mixing ingredients with maximum use of waste.

Table 1. Test results of waste material from the process of mining and oil drilling

No	Type of waste	Potential ton/day	Produk resources	Model of test	Compressive test (kg/cm²)
1.	RCC	10.000 till 16.000	Petroleum Cracking process PT. Pertamina	Dry mix mortar	12,62 - 23,85 (type S) 7,76 - 14,85 (type O)
2.	Tailing	480	Gold mining PT. Aneka Tambang	Dry mix mortar	15,92 - 18,74 (type S) 4,00 - 9,47 (type o)
3.	Slag	No data	Home industry	Paving block	14,9 kg/cm2

Note:

- Mortar Type S : the base composition is 1PC : 0,3 xx : 3 Fine Aggregate, minimum strength is 12,50 MPa
- Mortar Type O : the base composition is 1PC : 1 xx : 4,5 Fine Aggregate, minimum strength is 2,40 MPa

Waste of RCC and Tailings are produced as **Drymix** has compressive strength over the above requirements = > 12.5 MPa and for type O = > 2.4 MPa so that, it can be used as wall plastering material.

The result study showed that the main elements of the RCC in the form of SiO2 + + AL2O3 FeO3 was 89.32% greater than that required as a Pozoolan (min. 70%). In general that the addition of RCC material can accelerate time binding, increase the density of concrete, reducing the void content and increase the weight of its contents. Thus the RCC material utilization as an additive or replacement part cement in concrete, can give a positive value other than, as a result of the impact of environmental problem-solving.

Tailings are recommended as fine aggregate of mortar, because the fineness modulus, chemist contains, organic pollutant, even the density are allowed of standard

Figure 1. Waste of RCC (Pertamina-Balongan) and Tailing (Pongkor).

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Slag is a waste from metal processing industries (home industry) containing radioactive nuclear (B3) average of 90 to 100 cm. Nuclear content of thorium and uranium in the form of relatively small despite of a dangerous threshold <1000 cm. Finely granular slag as sand mixed with metal, like charcoal and carbon black.

The test results show that, the compressive strength of slag mortar with a mixture of 1 PC: 3 slag aggregate and 40% and 60% has the highest compressive strength of 58.46 kg / cm 2 and the composition 1 PC: 4 aggregate and 40% slag was 39.02 kg /cm2.

The compressive strength of conblock = 9.45 - 14.90 kg/cm2 and meet the requirements. Test results paving block 1PC: 3 sand and 40% slag was = 24.10 kg/cm2 while the mixture 1PC : 3 stone dust and 20% slag was = 35.74 Kg/cm2 (still under standard). Although slag included in the category B3, after mixed with other ingredients (cement) level of cadmium, copper, lead and zinc was reduced to below the standard. Although this research has not met the requirements, this material can still be used for footpaths.

6.1. FLY-ASH AND BOTTOM-ASH

Fly-Ash is a by-product on burning coal for energy used in the Steam Power Plant Suryalaya, (Banten West Jawa) and textile mills (Bandung, West Jawa). Fly-Ash can be used as a pozzoland ingredient in the manufacture of building components. Visually apparent difference between the waste from the power plant and textile mills because of the burning process of coal at the plant have not yet reached the optimal high temperature so that, more calories are burned yet perfect.

Based of a Government regulation (PP.85 – 1999), Fly-Ash included in the toxic or hazardous materials (B3) because it contains heavy metal oxides that pollute the environment.

The test result described in table bellows;

Table 2. Test results of Fly-Ash and Bottom-Ash from Steam Power Plant and Textile mills

No	Type of waste	Potential ton/month	Product resource	Model of test	Compressive strength Kg/cm2
1	Fly - Ash	Suryalaya = 33.000 – 35.000 Paiton = 43.000 ton/month Tanjung Jati = 35.000 .	Steam Power Plant (PLTU) Suryalaya West Jawa. Steam Power Plant (PLTU) tanjung jati Centre Jawa, Steam Power Plant (PLTU) Paiton. East Jawa..	Mortar, conblock and paving block	138,27
2	Bottom – Ash	20 ton/days	Textile mills. Bandung. West Jawa	Mortar, conblock and paving block	> 36,2

Note :

- Number product of Steam Power Plant consists of 80% Fly Ash and 20 % Bottom Ash.
- Number product of textile mills consists of 20% Fly Ash and 80% Bottom Ash.

Tests carried out in the form of mortar, conblock and paving block as a standard for determining the quality of materials, conforming with SNI 03-0349-1989.

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The compressive test results of mortar composition with 60% bottom ash: 20% Fly-Ash: 20% sand, has a compressive strength = 138.27 kgf / cm2 that means meet for quality of concrete block class III (SNI 03-0349-1989 = 36.27 kg / cm2).

Bottom ash waste from textile mills have a greater carbon content of approximately 50 - 55%, based on Government Regulation (MOE) should be reduced to 15%. This will be quite an effect on the compressive strength of approximately 30% product.

Figure 2. building components from RCC (waste of oil)

Mineral content of hazardous industrial waste materials particularly those categorized in B3 can be reduced when it is bound by other minerals such as cement. Therefore, the utilization of this waste as a building component is perfect.

Use of Fly Ash and Bottom-Ash as a substitute material for building components, the mechanical/physical properties that produce were better (lower water absorption value) compared to conventional materials.

7. CONCLUSION

- Tailling and RCC is the waste industrial and most of those material is buried and landfills but there is enormous to “beneficially” used for drymix mortar or concrete in a manner health and the environment. Reducing and recycling industrial waste materials conserves landfill space, reduces the environmental impact with producing new materials and creates jobs. Changing how we think about these materials will create a more sustainable future.
- The advantage of utilizing fly ash and bottom ash as building components are:
  - Strength of building components made with calcium enriched fly ash increases with aging and indicates better durability and suitable for coastal areas.
  - Utilization of fly-ash/bottom ash reduces the cost of the product where fly ash is cheaper than cement.
- Test result of TCLP (Toxicity Characteristic Leaching Protection) for heavy metals used was still below the threshold of the required quality (PP No. 85 tahun1999) and this indicates this material is not harmful if it is bound to other materials that can be used as building materials.

- Trend of rising role of coal in national energy supply, will be a serious environmental problem in the future, if the waste fly ash and bottom ash produced from coal combustion is not used optimally.
- Optimizing the utilization of industrial waste materials for purposes in the field of civil engineering, which can assist the government in addressing the impact of environmental pollution and also as an additional source of income and foreign countries.

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ENERGY CONSUMPTION AND THERMAL COMFORT FAVORED BY THE OCCUPANTS IN THE AIR CONDITIONED HOUSE

SUGINI[1], Jaka NUGRAHA[2]

ABSTRACT: This paper is part of a research report sponsored by the Indonesia Higher Education titled PMVtapsem Model of Thermal Comfort Saving Energy in Air Conditioned Building. Phase previous studies have found the best PMVtapsem thermal comfort models. From the test results it can be concluded that the model PMVtapsem models are models that can explain the concept of the relationship of thermal comfort hierarchical veriabel appropriately. However, for the determination of comfortable thermal range in order to thermally comfortable standard setting, it turns out the model PMVtap Sugini 2007 more precision and more simple than the models PMVtapsem. The next research phase will include the following steps: (1) Looking for a model of the relationship between the energy consumption of air conditioned homes with thermal comfort settings favored by the occupants; (2) Test the comfortable range of thermal based thermal index PMVtap Sugini 2007 experimentally in controlled air conditioned room; (3) Connect a comfortable thermal range of the result of step (2) with a model of the relationship of energy consumption in homes air conditioned in step (1). Observation in the air conditioned house is the method being used in this research. The variable observed are the thermal comfort indicated by the Air Conditioned option and energy consumption variable indicated by the raising of electricity account as the result of AC usage per unit AC loads. The population in this research are the air conditioned house with its occupants. The data collection involve 234 family. The second is to determine the setting of thermal comfort in the air conditioned room and the relation between the energy consumption and thermal comfort setting in air conditioned room to figure out the increasing energy consumption due to the favorite thermal comfort option. The conclution of this research shows that the relation between the comfort thermal (AC setting) with the energy consumption could be shown in the pattern y= 0.342 + 0.00432 x and y = 1.44 – 0.0291 x. Thermal comfort range perceived comfortable by 80% of occupants between PMV-0,75 up to 1,7 or PMVtap-1,29 up to PMVtap 1,21 and 23º ET up to 30,5 º ET in AC setting with the temperature 25 and fan 1 and 5 up to 30 and fan 1. The increasing of energy consumption on the thermal comfort option of 0,45 % per one unit workloads (per day per PK) for 25 degree Celcius temperature setting with the low fan. 0,882 % per unit workloads for 25 degree Celcius temperature setting with the maximum fan and 0,47% per unit workloads with 30 degree celcius temperature with low fan. By ignoring the fan setting, thus with the 25 degree celcius fan setting will increase the energy consumption for 2,3% per unit workload.

KEYWORDS : Sustainability, thermal comfort, energy consumption, air-conditioned house

1. INTRODUCTION

1.1. BACKGROUND OF THE PROBLEM

Global warming happening nowadays have a strong relation with the number of world energy consumption. The whole world energy consumption was used 45,36% for the building. Out of the highest energy used for the building operational was used for the artificial air in the air conditioned room (Wigginton dkk, 2006). Thus, this research was directed to the operational of artificial air energy efficient using air conditioned is urgent and important.

The development of index model of the energy efficient thermal comfort become very urgent and fundamental to be done. By this research, the standart range of comfort thermal could

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be composed by considering the physical-physiological and psychological aspect, also the aspect of energy efficient will be the correction of the existing standart thermal quality. In the end, the corrective standar of comfort thermal will reduce the air-condition (AC) workload in a air-conditioned room. The regression of one AC for 600 watt by one hour in a day will save the operational expenses for the Rp 130.000.000,00 energy a year and reduce the pollutan gas production CO2 by 160 kg/ year. This saving would be multiplied with the number of AC operated in Indonesia. Next, the thermal comfort standart based on this energy efficient thermal index PMVtapsem will be the basic of the development of design direction.

Sugini, 2007 based on the index model of PMVtap already construct the thermal comfort range. This range will be decreased mathematically. By mathematic calculation, Sugini assumed the resulted range will have the chance to reduce the thermal energy workload in air-conditioned room. The question is how the reality in the real operational level? Comfort thermal for the air-conditioned room measured by several index. SNI put the thermal comfort standart on ET while ISO put the standart on PMV index thermal. Those standart developed by SUgini 2007 into the PMVtap and expanded its development on 2013-2014 by Sugini and Jaka Nugraha on research funded by higher education directorate using Fundamental Scheme research. This paper were part of those research

The attainment of the comfort thermal air-conditioned room done by the occupants by the option of AC setting on the temperature and fan. While the energy consumption due to the AC usage could be seen on the amount of electricity account bill.

1.2. THE FORMULATION OF THE PROBLEM

- How is the relation pattern between the thermal comfort setting air-conditioned house with the increasing of energy consumption?
- How was the range of favourite comfort thermal in the air-conditioned house?

1.3. THE PURPOSE OF THE RESEARCH

- To figure out the relation pattern between the thermal comfort setting air-conditioned house with the increasing of energy consumption
- To find out the favourite comfort thermal range in a air-conditioned house
- To find out the energy consumption due to the favourite AC setting

2. THEORITICAL FRAMEWORK

2.1. STATE OF ART THERMAL RESEARCH THE RANGE OF THERMAL COMFORT AND ENERGY EFFICIENCY

Study about the range of comfort thermal has been done inside and outsine Indonesia. Based on Sugini's research (Sugini, 2007) can be concluded that based on the equation of PMVtap Sugini and the regression relationship between PMW with ta and ET* for the scope of case on the air conditioned room group could be known that every increasing 0,1 degree PMW would impact the increasing temperature for 0,56 Celcius Degree. This meant that by principle the standart of thermal comfort in air conditioned room could be increase by 2,968 degree celcius.

If this theory being implemented in a practical level, especially in a air-conditied building, it will give a significant impact. According to Oseland (1994) every one degree regression on AC usage it will reduce at least 10% energy consumption of the artificial operational air in the building, save 5 % or household energy consumption and 3% save the office operational

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expenses. Thus the increasing air temperature for 2,968 degree celcius will save 29,68 energy consumption on operational building artificial air. The next question arise, by using the analysis SEM model is it possible to produce the thermal index model PMVtapsem which have more chance to formulate the range of the energy-efficient comfort thermal? This research was trying to answer that question.

Muhammad Nur Fajri Alfata Fanny Kusumawati, 2011, compare two of the Triharsokaryono research on 1998 and 2011. In 18 years range on the same object and group sample shows the similarity that comfort thermal based on thermal index PMV and PPD was not suitable with the range of thermal comfort by the occupants. Respondent could receive the higher comfort thermal range. The conclution of those research shows that there are still enormous opportunity to develop better standart seen from the demands of the occupants nor the energy conservation. The next question that should be answered are (1) how high the range of thermal comfort range which is acceptable so it can give significant impact on the decreasing energy need for the air control; (2) If the index PMV and PDD can not be used to predict the range of comfort thermal, what is the suitable index thermal for the Indonesian condition? These two question can be answered by this research.

Sujatmiko Wahyu, 2010 found out that based on perception of the occupant condition thermal comfort of the observation area below the neutral poin. This research shows the same indication that during this time the building operation with the setting of comfort thermal setting has not suitable with the potention of the occupant ability to adapt with the comfort thermal room. Thus, the real search of the comfort thermal range suitable with the ability of human psyschological to adapt and the pursuit the better index thermal will be an important thing to do. So this research is significant to be done because it will give significant effect.

In the previous year, this research already produce the index model of thermal comfort PMVtapsem (Sugini, Jaka Nugraha, 2013). However, for the interest of the thermal comfort range prediction, prove that Sugini's model, 2007 more appropriate compare with those PMVtapsem

3. DESIGN AND RESEARCH METHOD

3.1. POPULATION AND SAMPLE

The Purpose of this research require building unit could technically controlled. The unit which technically observed with the relative variable could be controlled by the limitation of the research is the air-conditioned house.

The observation step on energy consumption done by transversal way by increasing the number of respondent into 240 family. Questionner being distributed were 350. The searching of the range favourite thermal were done by the experiment method of controlled room with 15 conditioning involving 30 respondents. From this stage, 450 unit data were being processed.

4. RESEARCH FINDING

4.1. THE CONTROLLED RANGE OF THERMAL COMFORT IN AIR-CONDITIONED ROOM

Based on this research, the description of the sample are as follows; out of 450 data, only 399 up to 400 data could be analysed with the setting of the combination of experiment room which has the range of comfort thermal based on ET index with mean 28.045º ET by the range 21.100 º ET and 33.000 º ET. Based on PMV index room have the thermal comfort

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level by mean of 0,917 or inclined to warm with the value range between PMV -1,9600 dan PMV 2,1400. Based on the index PMVtap for the air-conditioned room formula by the thermal comfort 0,3755 or nearly warm with the scope of values between -2,4900 and 1,6100. However, based on the respondents perception, thus the combination of experimental room have the thermal comfort -0.1654 or rather cool.

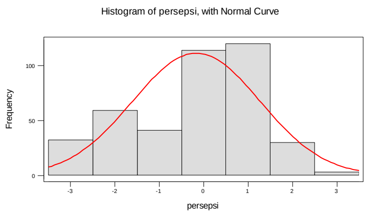

Figure 1. Room Thermal Comfort Profile based on Occupants Perception

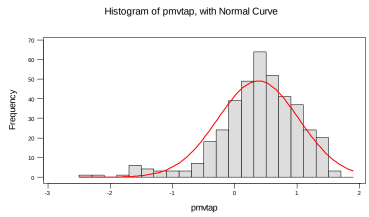

Figure 2. Room Thermal Comfort Profile based on thermal index PMVtap

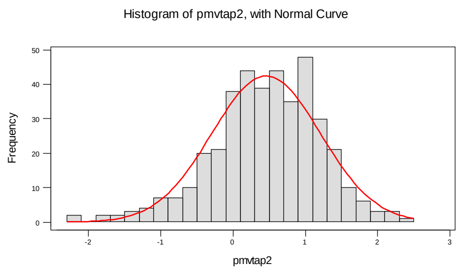

Figure 3. Room Thermal Comfort Profile based on thermal index PMVtap2

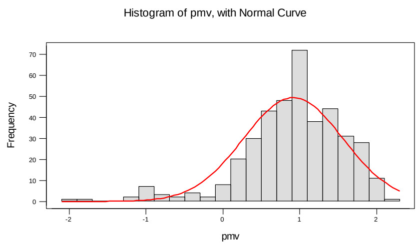

Figure 4. Room Thermal Comfort Profile based on thermal index PMV

The following table 1 explains setting and respondent percentage distribution on the perception of -3 (cold), -2 (cool), -1 (pretty cool), 0 (netral), 1 (pretty warm), 2 (warm), 3 (hot). If the perception tolerance considered to accept the thermal condition is between pretty cool (-1) and pretty warm (1), so the result of measurement result analysis shows that thermal comfort range that can be accepted by 80% room occupants is as showed on the following table:

Table 1. Setting and occupant percentage that can accept the thermal comfort

Setting	Perception							sum	% recieve
	-3	-2	-1	0	1	2	3		
AC25fan1	1	2	2	10	13	2	0	30	25
	3,333333	6,666667	6,666667	33,33333	43,33333	6,666667	0	100	83,33333
AC25fan5	0	1	2	11	12	4	0	30	25
	0	3,333333	6,666667	36,66667	40	13,33333	0	100	83,33333
AC30fan1	0	0	1	5	19	4	1	30	25
	0	0	3,333333	16,66667	63,33333	13,33333	3,333333	100	83,33333

From the table above, it can be known that experiment setting favored by 80% respondents are setting AC25fan1, AC25fan5 and C30fan1.

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Based on probability analysis, lower limit and upper limit of thermal comfort range can be formulated based on ET, PMV, PMVtap. Based on analysis, it can be inferred that thermal comfort range which is perceived comfortable by 80% room occupants is from PMV-0,75 to 1,7 or PMVtap-1,29 to PMVtap 1,21 on air-conditioner setting of 25 temperature degree and fan 1 and 5 until 30 temperature degree and fan 1.

4.2. THE SEARCH OF ENERGY CONSUMPTION OF AIR-CONDITIONERITIONED HOUSE TO DETERMINE ENERGY SAVING THERMAL COMFORT RANGE

4.2.1. The Implementation of Data Networking, Processing and Formulation of Relationship Model of Energy Consumption and Life Style of Air-conditioneritioned Thermal

As explained on the research method, energy consumption observation is conducted with transverse observation. From the data networking that was designed for 350 respondents, based on the data inputted, there were 234 people/house involved as respondents. Based on the data, filtering was done and finally central tendency could be obtained from sample characteristic.

The data above is the result of remuneration from raw data enclosed. From the raw data of air-conditioneritioned thermal life style signed by air-conditioner setting variable as independent variable (X1), while the dependent variable (Y2) is energy consumption variable. To get equivalent value, energy consumption variable is obtained by dividing the increase of electrical expense caused by the usage of air-conditioner with the workload. Burden is obtained by multiplying air-conditioner operation time variable (hour/month) and AC Capacity (PK).

The analysis of relationship model searching is done by using Regression Analysis. From the data, based on analysis, relationship pattern between thermal life style attitudes measured based on AC setting and energy consumption.

4.2.2. Sample Description

Based on sample average, the tendency can be described as following:

- *Air-conditioneritioned Thermal Life Style*

Thermal Life Style viewed from the usage of air-conditioner can be explained as following. Air-conditioner setting of overall respondent average i 21,59ºC. However, house air-conditioner setting outside Yogyakarta Spesial District, which is 23,25 ºC, tends to be higher than in Yogyakarta, which is 21,4ºC. Fan setting tends to be chosen by house occupants is *medium 76,36%.* The duration of air-conditioner average usage in one day is 8,66 hours, while the frequency of air-conditioner usage per month is 26,25 days. Therefore, the air-conditioner average workload is 233,54 hours/month. Air-conditioner capacity dominantly used on air-conditioner with 1 PK capacity is 59,49 %, while the one with 0,5 PK capacity is 34,8% and another is 6,32%. From three reason backgrounds (comfort, savings, both comfort and savings) to choose, the result shows 44% because of comfort, 48,9% because of both comfort and savings and 7,1% because of savings.

- *The Increase of Energy Consumption*

The increase of energy consumption shown by % increase of electricity expense caused by air-conditioner usage on the house research sample is 80,16%%. In detail, the increase as shown on the following table 4 and figure 3:

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The increase actually relates to temperature setting, fan setting, capacity and workload. In detail, it can be seen on the table 5, table 6, and figure 4 and 5. Therefore, to calculate the search for relationship between the increase of energy consumption and air-conditioner setting, the measures are equalized by using the increase parameter per workload unit. Workload unit itself is multiplication between the air-conditioner capacity and the duration of air-conditioner usage (hour/month).

4.2.3. The Model of Relationship between Energy Consumption and Air-conditioneritioned Thermal Life Style

The Model of Relationship is sought by analyzing linear regression. In this case, % of increase per workload unit is Y2 dependent variable and air-conditioner setting is independent variable. Air-conditioner setting in this case is measured using temperature parameter, fan and its multiplication (x1).

1. The Model of Regression between Y2 and air-conditioner setting (x1)

   From two models, linear and quadratic (enclosed), based on R value, the best one is following model on regression equation 1 as following illustration on figure 6.

   $$y = 0.342 + 0.00432\,x \qquad (1)$$

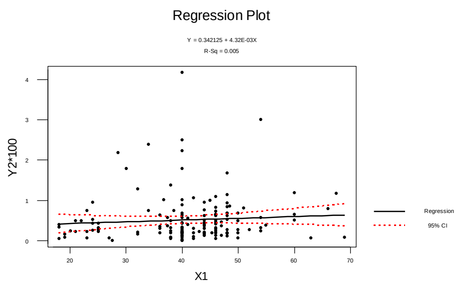

Figure 5. The Model of Regression between the increase percentage of energy consumption measured by using the increase of electricity expense and air-conditioner setting (the multiplication between temperature setting and fan setting)

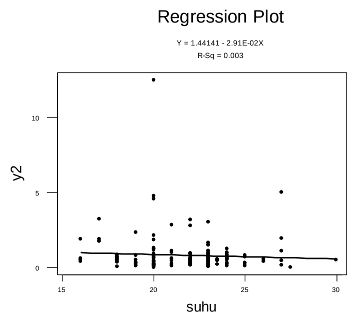

Figure 6. The Model of Regression between the increase of energy consumption and temperature setting

2. The Model of Regression between Y2 and temperature setting

   The detailed model on regression equation 2 as illustrated on figure 7.

   Regression Equation 2

   $$y = 1.44 - 0.0291\,x \qquad (2)$$

4.3. THERMAL COMFORT RANGE AND ENERGY CONSUMPTION

Based on analysis and discussion on 4.3 and 4.5, it can be simulated the calculation of energy consumption consequence seen from regression forumula 1 and 2, also setting range, as following.

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Table 2. Setting and the increase of energy consumption

Setting	Temperature	Fan	Fan Temperature	Increase of Energy Consumtion	
				Regresion 1 (temperature x fan)	Regresion 2 (temperature)
				y = 0.342 + 0.00432x	y = 1.44 – 0.0291x
AC25fan1	25	1	25	0,45	2,1675
			0	0,342	1,44
AC25fan5	25	5	125	0,882	2,1675
			0	0,342	1,44
AC30fan1	30	1	30	0,4716	2,313

From the table above, it can be explained that air-conditioner setting of 25ºC with low fan will increase the energy consumption 0,45% per one unit of workload (per day per air-conditioner per PK). Air-conditioner setting of 25 ºC with high fan increases the energy 0,882% per workload unit. Air-conditioner setting of 30 ºC with low fan increases the energy 0,47% per workload unit. If seen from temperature setting by ignoring fan setting, fan setting of 25 ºC will increase the energy consumption 2,2% per workload unit and fan setting of 30 ºC increases the energy consumption 2,3% per workload unit.

5. CONCLUSION

Based on the research, it can be concluded that:

1. Thermal Comfort Range perceived comfortable by 80% room occupants is from PMV-0,75 to 1,7 or PMVtap-1,29 to PMVtap 1,21 and 23º ET to 30,5 º ET on air-conditioner setting of 25 and fan 1 and 5 to 30 and fan 1.
2. Relationship pattern between thermal comfort and energy consumption can be described as model of y = 0.342 + 0.00432 x1 and y = 1.44 - 0.0291 x. In which y is the increase percentage of energy consumption for each air-conditioner, each PK and hour/month usage and x1 is temperature setting and fan, x2 is temperature setting.
3. The increase of energy consumption on the thermal comfort setting of 25ºC with low fan is 0,45% per one unit of workload (per day per air-conditioner per PK). 0,882% per workload unit on the setting of 25ºC with maximal fan setting and 0,47% per workload unit on the setting of 30ºC with low fan. If ignoring fan setting, fan setting of 25 ºC will increase the energy consumption 2,2% per workload unit and setting of 30 ºC will increase the energy consumption 2,3% per workload unit

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REMOVAL OF HEXAVALENT CHROMIUM IN AQUEOUS SOLUTION BY ALGINATE GEL BEADS WITH ENTRAPPED ACTIVATED CARBON

Rizki Anggraini PERMANA[1], Ali AKBAR[2], Andik YULIANTO[3], and SUPRIYANTO[4]

ABSTRACT: Biosorption is a technology which can be used to remove heavy metal at a small concentration. One of the most widely used biopolymer for metal ions biosorption from aqueous solution is alginate. The mixing of alginate with activated carbon was investigated to increase its adsorption ability and avoid activated carbon released into water. AG was prepared by dripping sodium alginate solution into calcium chloride solution. AC was prepared by crushing granular activated carbon. AG-AC was prepared by mixing sodium alginate solution with AC. Adsorption process was done in batch reactor. AC characterization shown water content 0,653%; volatile matter content 10%; and surface area 340,62 m^2/g. Batch process shown the highest Cr(VI) ions removal by AC (89,9%), followed by AG-AC (80,54%), and AG (27,34%). The highest x/m value was also shown by AC (5,231 mg/g), followed by AG-AC (0,159 mg/g) and AG (0,083 mg/g). The increment of adsorbent mass will increase the removal of Cr(VI) which mostly followed logarithmic trend, meanwhile the value of x/m will decrease following logarithmic trend by the increase of adsorbent mass.

KEYWORDS: Adsorption, alginate gel beads, activated carbon, hexavalent chromium

1. INTRODUCTION

Heavy metal contaminations in soil, water, and air have triggered the research of many kinds of technology to remove the contaminants from environment. Chromium is a heavy metal with oxidation numbers vary from -2 until +6. However +3 and +6 are the most common oxidation numbers in the aqueous forms. The most common procedures for removing Cr (VI) ions from dilute aqueous streams are chemical reduction, precipitation, electrochemical treatment, ion exchange, reverse osmosis and evaporative recovery etc. Such processes are ineffective or extremely expensive, when initial heavy metal concentration was in the range of 10-100 mg/l (Bishnoi, Kumar, & Bishnoi, 2007)

One technology which can be used to remove heavy metal ions in low concentration is biosorption. Alginate is a biopolymer commonly used to adsorb dissolved metal ions. Alginate can be changed into hyrogel by cross linking with divalent calcium ions which can be explained by egg box model where each divalent metal ion binds two carboxyl groups. The presence of carboxyl groups in alginate structure can enhance the adsorption capacity of various metal ions (D.Nayak & S.Lahiri, 2006).

Activated carbon is a material commonly used in the adsorption process. This is because activated carbon has a good adsorption capacity besides it is easy to obtain. However, the use of powdered activated carbon will require further treatment remember it will be removed after adsorption process is done. Mixing alginate with activated carbon was aim to increase its adsorption capacity and to immobilize activated carbon into a biopolymer so that the activated carbon did not release into water.

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2. MATERIALS AND METHODS

2.1. RESEARCH FLOWCHART

Generally, research flowchart can be explained by this following figure.

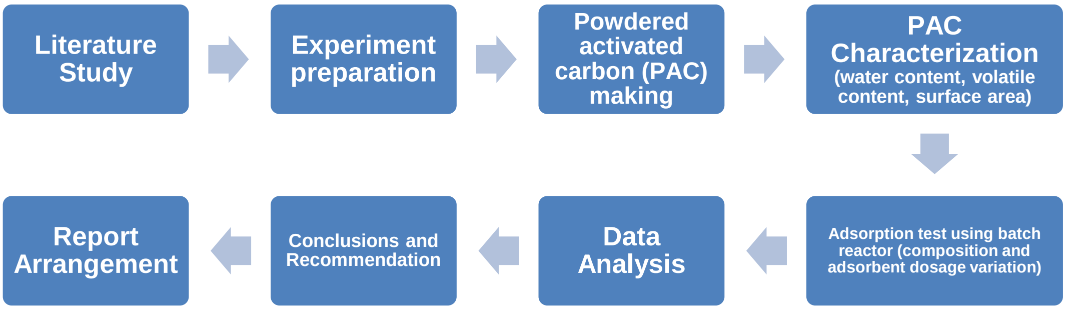

Figure 1. Research Flowchart

2.2. EQUIPMENTS AND MATERIALS

Jartest type JLT 6 (VELP Scientificia), Magnetic Stirrer type Cimarex (Thermo Scientific), Spectrophotometer UV-Vis type Genesys 20 (Thermo Scientific), analytical scale type Adventurer^{TM} Pro (Ohaus), Atomic Adsorption Spectrophotometer (type Avanta (GBC), pH indicator strip (MERCK), oven, furnace, sodium alginate, granular activated carbon (Brataco Chemical), potassium dichromate ($K_2Cr_2O_7$) (MERCK), calcium chloride ($CaCl_2.H_2O$) (MERCK), methylene blue ($C_{16}H_{18}ClN_3S.2H_2O$) (MERCK.), sulfate acid (MERCK), and distilled water.

2.3. METHODS

a. Powdered Activated Carbon Making

Powdered activated carbon was made by activate technical granular carbon (produced by Brataco Chemical) by immersing the granular carbon into 1N Sodium hydroxide solution for 24 hours. Carbon drained and heated at 600°C for 2 hours. Activated carbon then mashed and sieved with a sieve # 40.

b. Activated Carbon Characterizations

- **Water Content** 5 grams of sample was weighed carefully and placed in an evaporating dish. Sample was dried at temperature 105°C, and cooled in desiccator for 15 minutes. This procedure was repeated until constant weight was obtained (Sudradjat & Pari, 2011).

$$\text{Water content (\%)} = \frac{\text{Weight loss}}{\text{Initial sample weight}} \times 100\% \qquad (2.1)$$

- **Volatile Content** Basically, this method relies on the evaporation of substances inside charcoal other than water. 20 grams of sample was heated at temperature 800 - 900°C for 15 minutes, and cooled in a desiccator. Then cooled sample was weighed (Sudradjat & Pari, 2011).

$$\text{Volatile content (\%)} = \frac{\text{Initial weight} - \text{Final weight}}{\text{Initial sample weight}} \times 100\% \qquad (2.2)$$

- **Surface Area** 0,5 grams of powdered activated carbon was immersed with 100 mL methylene blue solution with concentration 5 mg/L. Mixture was stirred with speed of 125 rpm for 60 minutes. After 60 minutes, mixture was filtered to separate supernatant and charcoal. The absorbance of methylene blue in supernatant was measured using spectrophotometer UV-Vis with wave length 664 nm. Adsorbent's surface area was determined using equation bellow.

$$S = \frac{x/m \,.\, N.\, A}{Mr} \quad \ldots\ldots (2.3)$$

Whereas "S" is surface area (m^2/gram); "x/m" maximum adsorbed substances mass (mg/g); "N" Avogadro number ($6{,}022 \times 10^{23}$ mol^{-1}); "a" closure area by 1 molecule of methylene blue (197×10^{-20} m^2/mol); "Mr" relative atomic mass (320,5 g/mol).

c. Batch experiment of hexavalent chromium adsorption

- **Preparation of Cr(VI) solution** 200 mg/L Cr(VI) stock solution was made by dissolving 0,294 g of potassium dichromate ($K_2Cr_2O_7$) into 500 mL distilled water. Furthermore, solution was diluted into lower concentration, 5 mg/L, for adsorption test.
- **Preparation of alginate gel beads (AG)** Sodium alginate solution 1% was made by dissolving 5 grams sodium alginate into 500 mL distilled water. Mixture was stirred using magnetic stirrer for 1 hour. Gel beads were made by dripping sodium alginate solution into calcium chloride solution 10%, and set for 30 – 60 minutes before washed by distilled water.
- **Preparation of alginate-activated carbon gel beads (AG-AC)** AG-AC were made by mixing AC with sodium alginate solution with concentrations 0,01; 0,02; 0,03; 0,04; and 0,05 g AC/ mL AG. Mixture was dripped into calcium chloride solution 10%, and set for 30 – 60 minutes before washed by distilled water.
- **Experiment of Cr(VI) adsorption using AG adsorbent** Experiment was done by weighing AG with variations 1; 2; 3; 4; and 5 grams. AG was immersed into 100 mL of 5 mg/L Cr(VI) solution and stirred using jar test with stirring speed 100 rpm for 30 minutes. Final Cr(VI) concentrations were measured using AAS instrument.
- **Experiment of Cr(VI) adsorption using AC adsorbent** Experiment was done by weighing AC with variations 0,07; 0,14; 0,21; 0,28; and 0,35 grams. AC was immersed into 100 mL of 5 mg/L Cr(VI) solution and stirred using jar test with stirring speed 100 rpm for 30 minutes. Final Cr(VI) concentrations were measured using AAS instrument.
- **Experiment of Cr(VI) adsorption using AG-AC adsorbent** Experiment was done by weighing AG-AC 1; 2; 3; 4; and 5 grams for each variation of 0,01; 0,02; 0,03; 0,04; and 0,05 AC g/ mL AG. AG-AC was immersed into 100 mL of 5 mg/L Cr(VI) solution and stirred using jar test with stirring speed 100 rpm for 30 minutes. Final Cr(VI) concentrations were measured using AAS instrument.

3. RESULT AND DISCUSSION

3.1. ACTIVATED CARBON CHARACTERISTICS

Activated carbon characterization showed water content 0,653%; volatile content 10,0% (met requirement of activated carbon quality standard SNI 06-3730-1995) and surface area 340,62 m^2/g.

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3.2. THE PERFORMANCE OF AG ADSORBENT

Hexavalent chromium adsorption by alginate gel beads tended to increase by the increasing of adsorbent dosage. This is because the increase in adsorbent dosage will be directly proportional to the increase of the active sites which are used in adsorption (Devi, Jahagirdar, & Ahmed, 2012) . The lowest Cr (VI) metal removal percentage was 16.56 % for adsorbent mass 1 gram, with initial metal concentration 5 mg/L, and stirring time 30 minutes. The increase in removal percentage could be explained through the exponential equation y = $0,149e^{0,119X}$ with a correlation coefficient (R) 0.884. The percentage tended to increase with no significant changes. The decrease in adsorbed metal mass could be described by the equation y = logarithmic -0,03ln (x) + 0.078 with a correlation coefficient (R) 0.966. The figure bellow showed the relation of the increase of AG adsorbent mass toward Cr(VI) metal removal percentage.

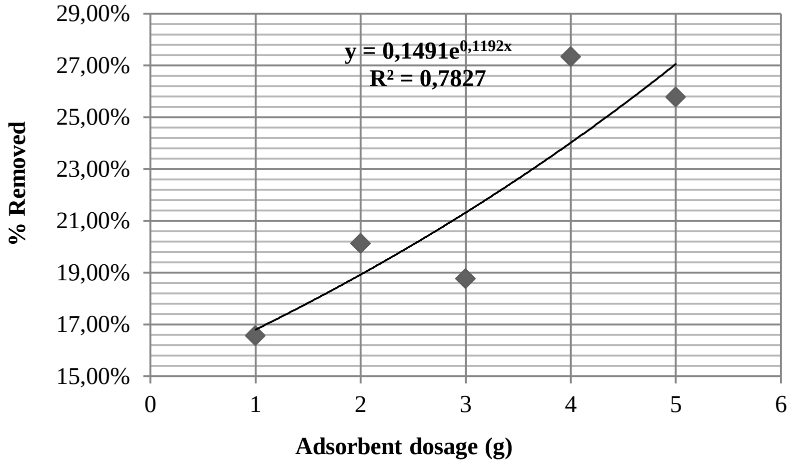

Figure 2. The relation of the increase of AG dosage toward Cr(VI) metal ions removal percentage

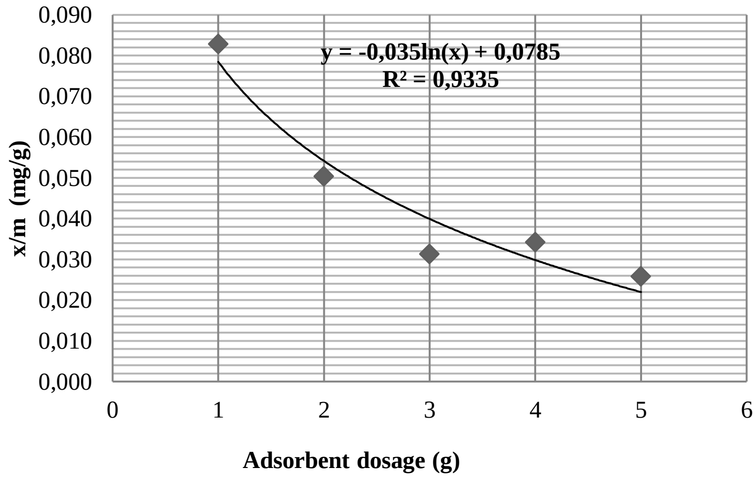

Figure 3. The relation of the increase of AG dosage toward x/m value

The structure of alginate gel containing free carboxyl group (-COOH) which can freely interact with metal ions. The presence of carboxyl groups in alginate structure can enhance the adsorption capacity of various metal ions compared with polyvinyl alcohol and 2 - hydroxyethyl methacrylate. In calcium alginate, carboxyl groups will be ionized at pH greater than 4.0 so that the rate of absorption of Cr (VI) will decrease at high pH (Khorramabadi, Soltani, Rezaee, & Godini, 2011).

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3.3. THE PERFORMANCE OF AC ADSORBENT

Hexavalent chromium adsorption by activated carbon tended to increase by the increasing of adsorbent dose. The lowest Cr (VI) metal removal percentage was 73.24 % for adsorbent mass of 0.07 grams with initial metal concentration 5 mg / L, and stirring time 30 minutes. The percentage tended to increase up to 89.90 % with activated carbon mass 0.21 grams. This indicated the increase in adsorbent dosage will be directly proportional to the increase of the active sites, thus the adsorption capacity of adsorbent increased. However in the next adsorbent dosage variation experiment, metal ions removal percentage decreased to 79.46 % for adsorbent mass 0.35 grams.

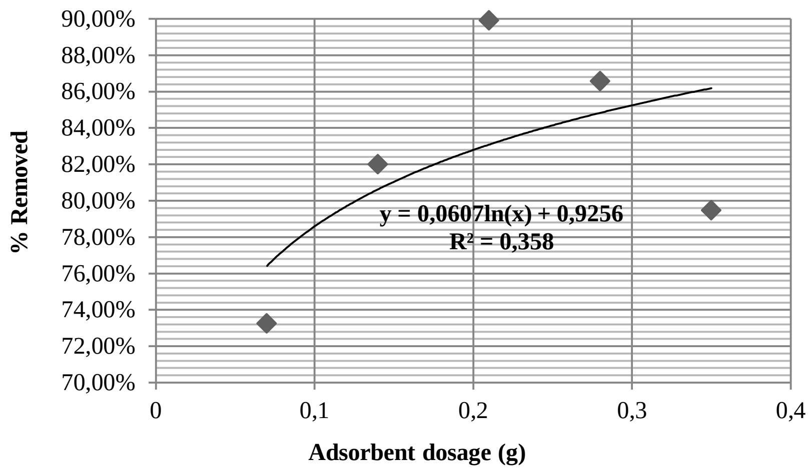

Figure 4. The relation of the increase of AC dosage toward Cr(VI) metal ions removal percentage

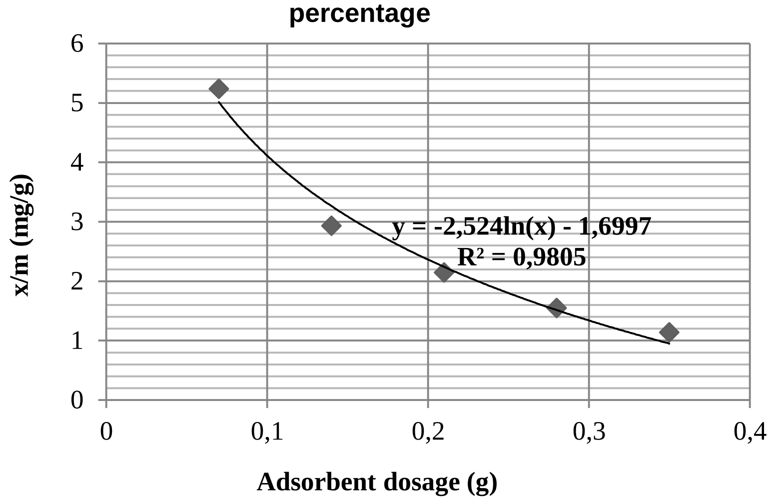

Figure 5. The relation of the increase of AC dosage toward x/m value

Compared with the performance of AG which only reached 27.34 %, Cr (VI) metal ions removal percentage using the AC tended to be higher, which was 89.90 %. The relationship between the percentage of metal ions removal with adsorbent dose can be explained through the logarithmic equation y = 0,060ln (x) + 0.925 with correlation coefficient (R) 0.598. Figure 5 showed the decrease in quantity of adsorbed Cr (VI) with increasing adsorbent mass. The maximum Cr(VI) adsorbed mass by the adsorbent AC was 5.231 mg per gram of activated carbon. When compared with the adsorbent alginate gel beads (AG) which was only 0.083 m /g, activated carbon tended to be more effective in Cr (VI) removal. The decrease of adsorbed metal ions mass can be explained through the logarithmic equation y = -2,52ln (x) -1.699 with correlation coefficient (R) 0.989.

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3.4. THE PERFORMANCE OF AG-AC ADSORBENT

Hexavalent chromium metal adsorption by alginate gel beads with entrapped activated carbon (AG-AC) tended to increase by the increasing of adsorbent dosage. Graphics A, B, C, D, and E, showed AG-AC performance in Cr(VI) metal ions removal. Based on figure 6, Cr(VI) adsorption tended to increase by the increasing of activated carbon dosage contained in alginate gel. The best performance was shown by the chart C, which was at activated carbon dosage 0.03 g/mL AG, with Cr (VI) metal ions removal percentage reached 80.54 %. Compared with alginate gel beads (AG) adsorption capacity had a significant increase.

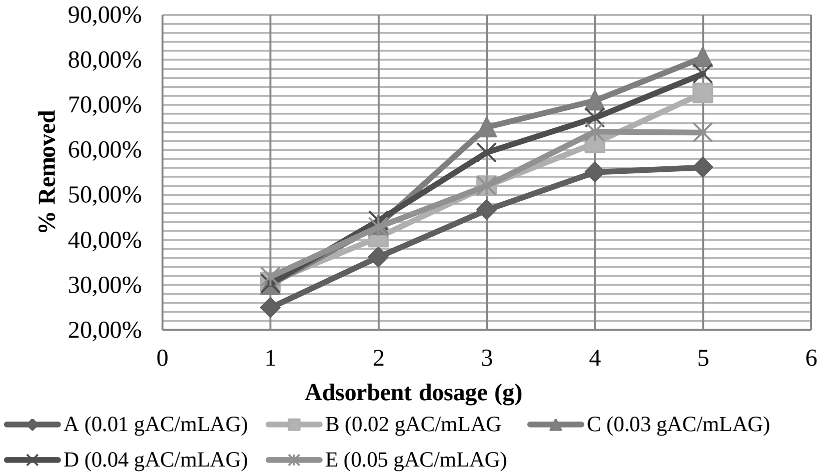

Figure 6. The relation of the increase of AG-AC dosage toward Cr(VI) metal ions removal percentage

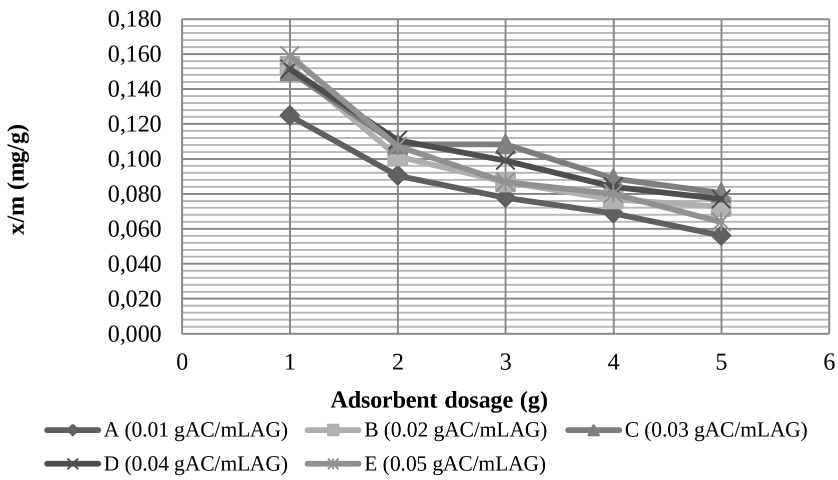

Figure 7. The relation of the increase of AC dosage toward x/m value

The maximum x/m value was 0.159 mg/g by 1 gram dosage at E variation. This condition showed that the more addition of activated carbon, the higher quantity of adsorbed metal ions in each gram. The value of x/m tended to decrease logarithmically with increasing adsorbent dosage.

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4. CONCLUSIONS AND RECOMMENDATIONS

4.1. CONCLUSIONS

Based on the experiment the authors concluded:

a. AC adsorbent showed the best performance , followed by adsorbent AG - AC , and AC .
b. Cr (VI) metal ions removal by AG showed an exponential trend. Meanwhile AC showed a logarithmic trend, and AG - AC showed a logarithmic trend (variation A, C, and E) and linear (variation B, and D).
c. The maximum of adsorbed Cr (VI) metal ions mass per gram adsorbent mass showed a logarithmic trend for all type of adsorbents (AG, AC, and AG – AC).
d. The addition of activated carbon dosage 0.05 g/mL AG showed the best performance in terms of x/m value.

4.2. RECOMMENDATIONS

Based on the experiment the authors recommended:

a. The preparation of alginate gel beads should use calibrated tools to ensure the uniformity of alginate gel beads produced.
b. The addition of adsorbent dosage variations is needed to minimize the deviations that may occur, so that correlation coefficient value of regression equation will be increased. Thus the trend that may happen be more accurate.
c. Looked from their performance in Cr (VI) metal ions adsorption, alginate gel has lower ability compared with active carbon, so further research is expected to apply alginate gel as binding agent for powder adsorbent.

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LOW-COST ADSORBENT BASED ON SOLID WASTE MATERIAL OF PAPER INDUSTRY FOR REMOVAL OF HEAVY METAL IONS IN WATER

Eko SISWOYO[1] and Shunitz TANAKA[2]

ABSTRACT: The purpose of this study was to investigate the removal capacity of a low-cost adsorbent based on solid waste of paper industry to remove cadmium and lead ions in water. Some parameters such as pH of solution, shaking time and chemical modification with phosphoric acid with the different impregnation ratio were investigated in order to know the optimum condition and adsorption ability of the adsorbent. Based on the Langmuir isotherm adsorption model, the adsorption capacity of the raw adsorbent for cadmium ion was 5.2 mg/g. After modification with phosphoric acid, the adsorption capacity of the adsorbent for Cd(II) and Pb(II) was 29 and 139 mg/g, respectively. The increase in the adsorption capacity after modification with phosphoric acid may be due to some possible reasons. First, after treatment with phosphoric acid, it was found from the FTIR spectra that the adsorbent had phosphate functional group which contributed to the adsorption of Cd(II) and Pb(II) ions. Second, calcium in the paper sludge reacted with phosphoric acid to form calcium phosphate which also had a binding ability with some metal ions such as Cd(II) and Pb(II).

KEYWORDS: Heavy metal ions, low-cost adsorbent, paper sludge, chemical modification, phosphoric acid.

1. INTRODUCTION

The environmental contaminations with heavy metals such as cadmium (Cd) and lead (Pb) have been considered as one of the serious environmental problems and attracted public concern because of the potential damage to human health and ecosystem. Even the low concentration of cadmium and lead in water is still potential for kidney and bone damage, cancer, disturbing the respiratory and reproduction system due to the accumulation. Contamination with cadmium, one of the most toxic metal ions, is a worldwide environmental concern, since it is a toxic heavy metal and does not have a clear function for living organisms (Clabeaux et al., 2011).

Recently, around 5 million tons of paper sludge is discharged annually as solid waste from paper industry in Japan (Prasetyo J., et al., 2011). The disposal of paper sludge to the landfill or the treatment by incineration is high cost and may cause other environmental problems. Application of the paper sludge as a raw material of adsorbent has multi advantages, reducing amount of solid waste and cost for treatment and also providing a low cost adsorbent for removal of heavy metals. Paper sludge and other organic waste materials from paper industry could be considered as a material of adsorbent due to their high carbon content and cellulose fibres proportion (Mendez A., et al., 2009). The adsorbent from paper sludge has the ability as an adsorbent for the removal of various kinds of heavy metal ions in water (C. Ochola and H. Moo-Young, 2004). However, the application of paper sludge as adsorbent for adsorption of heavy metal ions is still limited. In order to improve the adsorption ability of adsorbent, chemical modification by using phosphoric acid as an effective activated

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agent for some adsorbent materials was employed by some researchers (V. Fierro, et al, 2010 and Olowoyo, et al, 2012).

The purpose of this study was to investigate the ability of paper sludge as a raw material of adsorbent to adsorb cadmium and lead ions in water and also to investigate the effect of modification with phosphoric acid.

2. MATERIALS AND METHODS

2.1 PREPARATION OF ADSORBENT

The eco-adsorbent used in this study was prepared using paper sludge, a solid waste of a paper industry. The paper sludge was provided from Doh-Ei Paper Mfg. Co., Ltd. in Sapporo city, Japan, where paper is produced from the used paper as the main raw material. The paper sludge was produced during the paper production process. After dehydration and dryness of the paper sludge, it was treated at 950ºC to form paper sludge carbon. The paper sludge carbon was washed with distilled water and dried at 100 ºC for 24 hours. After cooling it at room temperature, the paper sludge carbon was crushed into powder form and then sifted with a 1 mm sieve. The powdery paper sludge carbon was used as the adsorbent to adsorb cadmium ion from the water. The phosphoric acid modification was employed for the adsorbent. The impregnation ratio (R) for this modification was from 0.25 (0.25 g adsorbent was added to 1 g adsorbent) to 1.5. The mixed adsorbent and phosphoric acid then dried in oven and continued to be heated at 350ºC for 15 minutes. After cooled in room temperature, the modified adsorbent was washed with distilled water until the pH of solution was around neutral, dried in oven for overnight and then crushed into powder form.

2.2 CHARACTERIZATION OF ADSORBENT

In order to obtain the surface area of adsorbent, Scanning Electron Microscopy/Energy Dispersive Spectroscopy (SEM/EDS, JEOL JSM-6360 LA, Japan) was employed. Furthermore, the elemental analysis was done using elemental instrument (Micro Corder JM10, Yanaco, Japan) in order to determine the amount of C, H, N, O, S and ash of adsorbent material. FT-IR Spectrometer (FT/IR-4100) and BET (BELSORP-mini, BEL Japan INC, Osaka Japan) were utilized in order to determine the functional groups, surface area and pore volume of adsorbent materials.

2.3 ADSORPTION PROCESS

Adsorption process in the present study was conducted by the batch system. Parameters such as mass of adsorbent, pH of the solution, stirring time and initial concentration of cadmium ion in the solution were investigated in order to know the ability and the optimum condition for adsorption using this adsorbent. In order to estimate the effect of mass of the adsorbent, 25 to 200 mg of adsorbent were added to 50 ml of cadmium solution and agitated at 1000 rpm for 2 hours using a shaker (EYELA CUTE MIXER CM-1000). The influence of pH on the adsorption of cadmium ion was investigated by using the solution of pH 2 to 8 and pH 2 to 5 for lead ion. Buffer solution, HNO_3 and NaOH were utilized to adjust the desired pHs of solution. Various stirring time from 15 to 1440 minutes was applied in order to know the influence of stirring time on the adsorption of cadmium ion. After equilibrium, the solution was centrifuged at 4000 rpm for 5 minutes using a centrifuge (IEC61010-2-020, KUBOTA, Japan) and then the concentration of cadmium ion in supernatant solution was determined using Flame Atomic Absorption Spectrophotometer (FAAS) (HITACHI A-2000, Japan).

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3. RESULTS AND DISCUSSION

3.1 PROPERTIES OF ADSORBENT

Based on the elemental analysis, the composition of main elements of paper sludge carbon were 19.4, 0.1, 16.3, 0.0, 0.0, and 64.2% for C, H, O, N, S, and ash, respectively. The IR spectra of the paper sludge carbon suggested the presence of some functional groups such as carboxyl and phenolic hydroxyl group. These functional groups might participate in the adsorption of cadmium ion.

According to the result of SEM/EDX, silicate, calcium oxide and carbon were main components of the paper sludge carbon and this adsorbent may have a good performance in adsorbing cadmium and lead ions in water. Fig. 3.1 shows the surface texture and porosity of this adsorbent before and after modification with phosphoric acid captured using Analytical Scanning Electron Microscope (SEM) (JEOL JSM-6360 LA, Japan). These high porosity and large surface are essential for the high efficiency of adsorbent.

It can be seen that the surface of adsorbent after modification with phosphoric acid appears to be physically more porous compared to the raw adsorbent. Treatment with phosphoric acid on the adsorbent material resulted more pore on the surface of adsorbent. Based on the data obtained by BET analysis, the surface area and volume of pore of adsorbents before and after modification with citric acid are 50 m2.g-1 and 84 m2.g-1, respectively. This data supports the SEM photograph that modification with phosphoric acid resulted more pore on the surface of adsorbent.

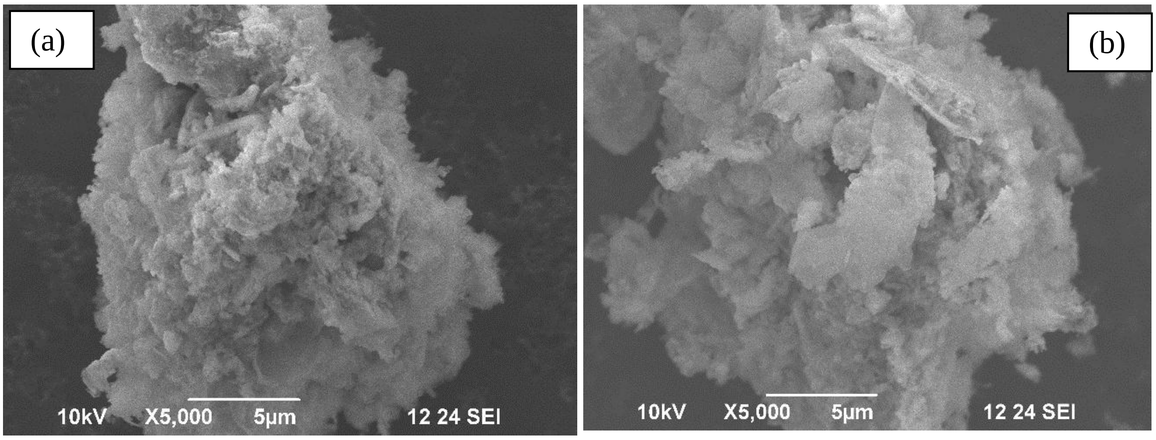

Figure 3. SEM photograph of adsorbent based on sludge of paper industry (a) raw adsorbent, (b) modification with phosphoric acid

Figure 3.2 the FTIR spectra of adsorbent before and after modification with phosphoric acid shows the new peak at 1080 and 1213 on modified adsorbent indicated the presence of phosphate functional group as an effect modification with phosphoric acid. The phosphate functional contributed in the binding of metal ions in water such as Cd(II) and Pb(II), therefore, the adsorption capacity of modified adsorbent increased significantly.

Figure 3.3 shows the effect of impregnation ratio on the adsorbent for removal of cadmium and lead ions. It was clear that impregnation ratio (R) 0.5 was the favorable condition for the adsorbent to remove cadmium and lead ions in water.

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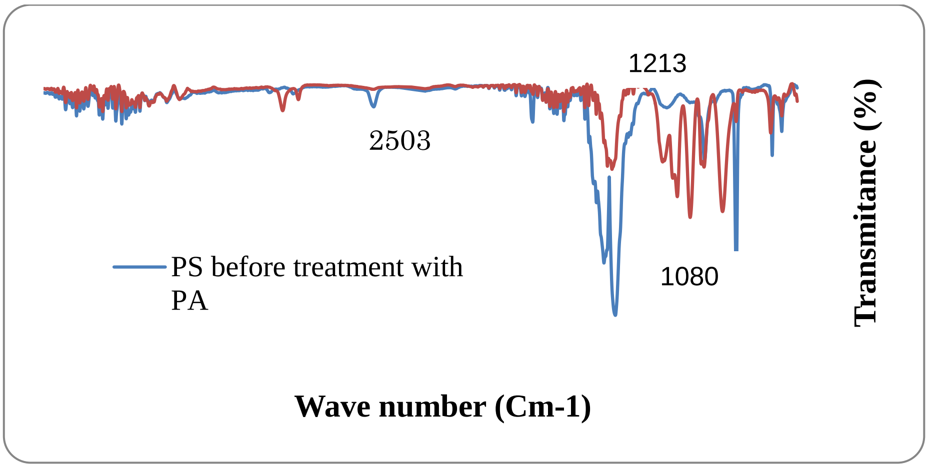

Figure 4. FTIR Spectra of adsorbent before and after modification with phosphoric acid

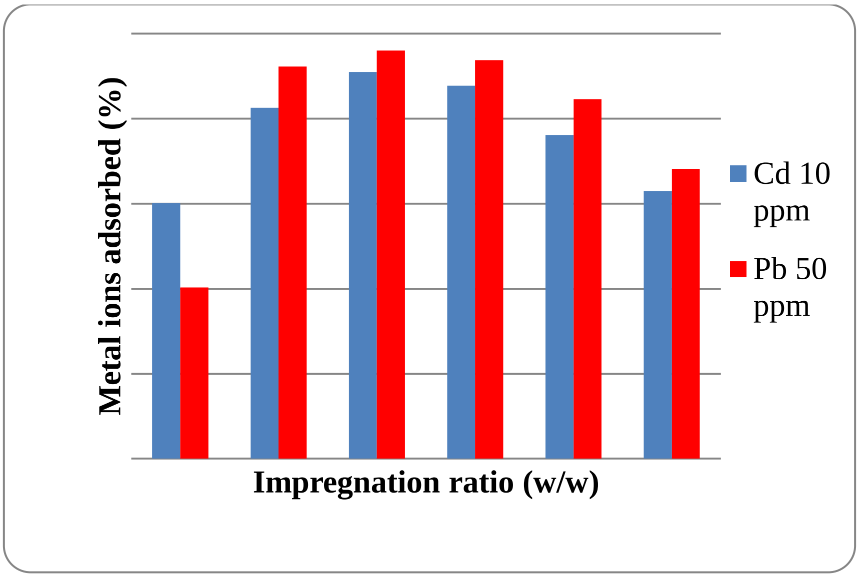

Figure 5. Effect of impregnation ratio of adsorbent on the adsorption of cadmium and lead

3.2 EFFECT OF PH OF SOLUTION

The removal efficiency of raw and modified adsorbents for cadmium and lead ions are shown in Figure. 3.4. The binding of Cd and Pb with surface functional groups strongly depended on the pH of solution. The percent removal of cadmium and lead ions increased with pH of the solution because cadmium and lead ions form complex with some functional groups in the adsorbent. The removal of metal cation at any pH was much greater than that by hydroxide precipitation. Adsorption of metal cation on adsorbent depends upon the nature of adsorbent surface and the distribution of metal species which distribution also depends on the pH of the solution. The removal efficiency of cadmium and lead decreased with the decrease of pH, because protons compete with metal ion for the adsorption sites on the adsorbent surface as well as the ion existing decrease of negative charge by association of the functional group with proton. The increase in the removal of metal ions as pH increase can be explained on the basis of the decrease in H+ on the surface, which results in less repulsion with adsorbing metal ions (C. Namasivayam and K. Ranganathan, 1995) and (Souag R., et al., 2011). Rao M. M, (2006) reported that the point of zero charge of adsorbent was 5.7, where under 5.7 of pH, the surface of adsorbent was positively charged and adsorption of metal ion was low due to the electrostatic repulsion. Another researcher mentioned that in the highly acidic medium, the dissolution of the adsorbent occurs to a consequent decrease in the active sites. In this condition, the adsorbent surface is highly protonated, which is not favorable for the uptake of cadmium and lead ions because of the electrostatic repulsion (Sing D. B., et al., 1998) and (Papandreou A., et al., 2007).

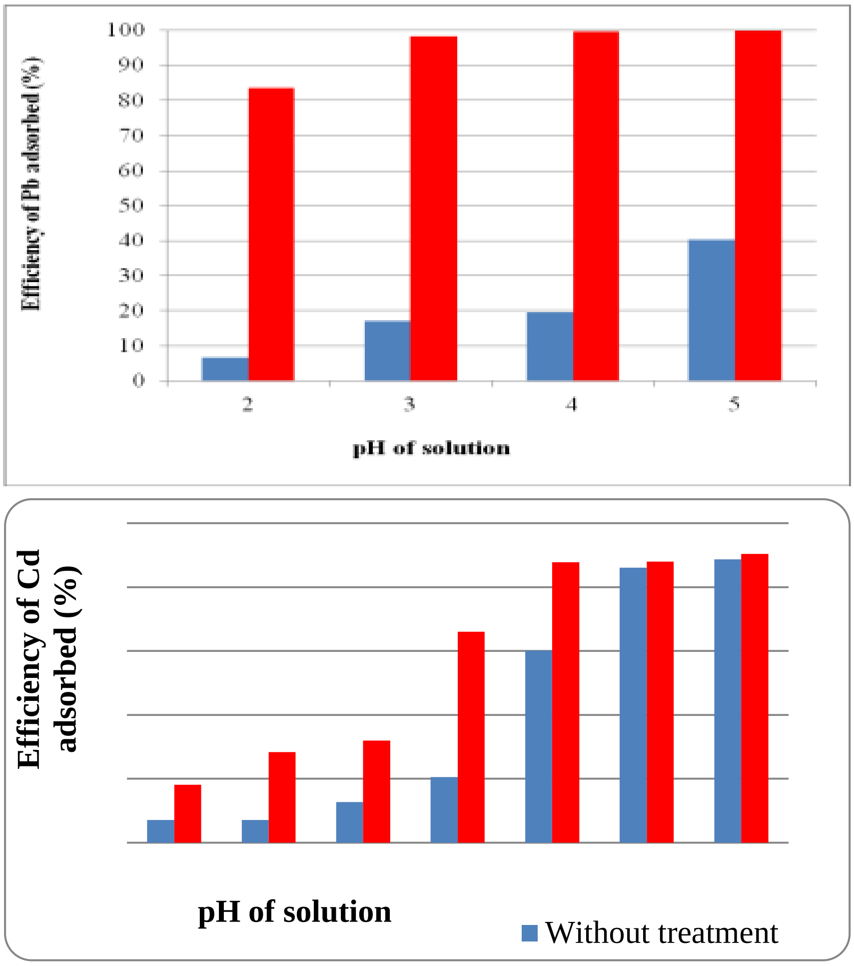

Figure 6. Effect of pH on the adsorption of Cd and Pb

3.3 EFFECT OF STIRRING TIME

The effect of shaking time on the adsorption of cadmium ion is shown in Figure 3.5. The equilibrium adsorption for 10 mg/l of cadmium and lead ions were achieved after around 15 minute, however, higher initial concentration needs longer stirring time. This result is important because the equilibrium time is one of the considerations for the application of economical wastewater treatment plant (Rao M. M., et al., 2006).

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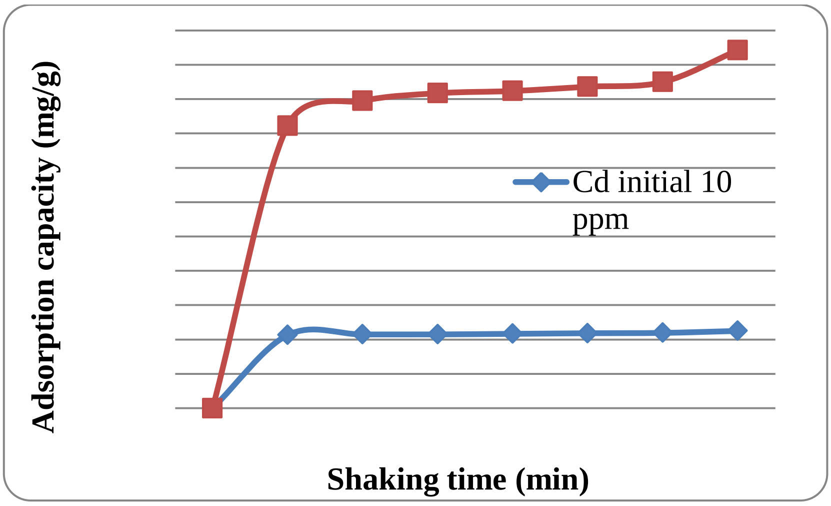

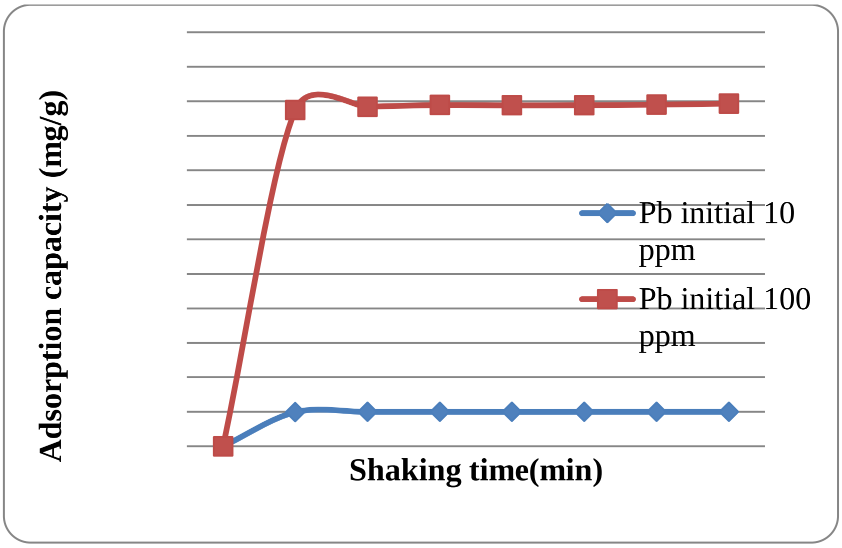

Figure 7. Effect of stirring time on the adsorption of Cd and Pb

3.4 ADSORPTION ISOTHERM

The Langmuir isotherm model was applied to obtain the equilibrium constant of adsorption by the following equation:

$$\frac{C_e}{q_e} = \frac{1}{q_m} C_e + \frac{1}{K_L . q_m} \quad (1)$$

where Ce is the equilibrium concentration (mg/l), qe is the adsorbed amount of cadmium at equilibrium (mg/g), qm and KL are the constants of Langmuir isotherm related to the adsorption capacity and energy of adsorption, respectively. From the equation, a plot of Ce/qe versus Ce will be used to determine the values of qm and KL as the tangent of approximate straight line and its intercept of the vertical axis.

The Freundlich isotherm model was also used to evaluate the isotherm process in this study. The equation of this model is:

qe = Kf Ce1/n (2)

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where qe is the amount of adsorbed (mg/g), Ce is the equilibrium concentration (mg/L) and Kf and n are constants. To determine the amount of Kf and n, plots between log Ce and log qe.

$$\text{Log (qe)} = \log (\text{Kf}) + 1/n \log (\text{Ce}) \tag{3}$$

The results of Langmuir and Freundlich adsorption isotherm models are shown Table 3.2. Based on the result of Langmuir and Freundlich isotherm models, it was clear that sludge of paper industry followed the Langmuir isotherm model rather than Freundlich isotherm model.

Table 3.2 Adsorption isotherm of the adsorbent based on Langmuir and Freundlich models.

Adsorbent	Langmuir model			Freundlich model		
	q_m (mg/g)	$K_{L\ (l/mg)}$	R^2	K_f	n	R^2
Cd adsorption	29.2	0.301	0.961	6.275	2.721	0.987
Pb adsorption	138.9	0.193	0.999	0.95	1.691	0.960

4. CONCLUSION

It was clear from the present study that sludge of paper industry had a good adsorption capacity to remove cadmium and lead ions in water. The increase of adsorption capacity after modification with phosphoric acid might be due to two possible reasons. First, after treatment with phosphoric acid, it was found from FTIR spectra that the adsorbent had phosphate functional group which contributed in the adsorption of Cd(II) and Pb(II) ions. Second, calcium in the paper sludge reacted with phosphoric acid performing calcium phosphate which also had a contribution in binding of some metal ions such as Cd(II) and Pb(II). Further study is needed to describe the detail mechanism of modification and also effect of some minerals in the solution which may influence the adsorption capacity of the adsorbent.

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THE ROLE OF THE INFORMAL SECTOR IN THE MANAGEMENT OF INORGANIC WASTE IN INDONESIA (A CASE STUDY IN SLEMAN REGENCY, YOGYAKARTA)

Hijrah Purnama PUTRA[1] and Bahar IBRAHIM[2]

ABSTRACT: Settlements contribute to produce larger quantity of waste than the other sources. In the past few years, the composition of household waste has changed, initially 75% of it was dominated by organic waste and the remaining 25% of it was dominated by inorganic waste, currently the amount of inorganic waste reaches 48.77% while the volume of organic waste decreases into 51.23%. The higher the family income, the higher the inorganic waste that the family produces. Organic waste has been extensively used as materials to produce compost, briquettes and biogas, still the management of inorganic waste has not been carried out optimally. It is completely difficult for inorganic waste to degrade even it cannot be degraded by nature any at all, therefore, intensive efforts are necessary to manage this type of waste in order not to pollute the environment. Inorganic waste can be managed into more useful items, one of which is known as recycling activities, which is a process of collecting, separating, processing, selling the materials that can be reused or changed into new materials. The main problem in the management of this waste is the lack in the availability of potential data.In so doing, data collection and analysis are required in order to reveal the potential of inorganic waste managed by the informal sector and the economic value addition of the waste in Sleman Regency, Yogyakarta. This research activity managed to collect data from 23 locations for the activities of the informal sector with the waste composition that consists of paper, plastic, iron and metal as the type of waste with a high selling value. Of all these locations, a number of 16.545,6 tons of inorganic waste per year can be managed. This informal sector is categorized into two, namely the large-sized informal sector and the small-sized informal sector. The addition in the economic value of the waste depends on the additional treatment given. The combination between waste sorting and slicing can increase the selling value up to 33.25% higher than its initial value, while the combination between waste sorting, cleaning and compacting can increase the selling value by 30.25% higher than its initial price.

KEYWORDS: *Solid waste management, inorganic waste, informal sector,*

1. INTRODUCTION

Solid waste management is one of the issues faced by many cities in Indonesia. Waste is one of the consequences of human activity and the volume is directly proportional with total population. It means the higher the total population in a location, the amount waste will produce also be higher. If not handled effectively and efficiently, the existence of waste in nature will destroy lives around it (Putra, 2010).

Waste management in landfill (TPA) is actually not an effective solution to develop in Indonesia. Generally, solid waste management is divided into two, i.e. prevention before waste is produced and processing after waste is produced. In practice, in Indonesia the processing activity is performed at the end of a system (end of pipe), so various problems potentially occur, such as technological issues and high cost.

Since law (Undang-undang) Number 18/2008 regarding Solid Waste Management was passed, nearly cities in Indonesia do competition to build landfills with sanitary and controlled landfill concepts. However, the developments aren't followed by adequate funding for operation and maintenance, so that landfills constructed with those concepts are operated in

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a simple method like landfills which still use open dumping concept. This condition in continuous waste management efforts is very worrying.

As a regency which continues to grow and whose population drastically increases, Sleman Regency also faces this issue. Generally, the population in the center of Sleman Regency is 37,2% of total population of Sleman Regency. In 2010 the total population was 1.090.567, while in 2012 it significantly increased to 1.137.365 (Kabupaten Sleman dalam Angka, 2011 & 2013).

Solid waste management in Sleman Regency is performed by Housing and Public Work Service according to Regional Regulation No 9 of year 2009 regarding Regional Organizations of Sleman Regency Government and Regional Regulation No 14 of Year 2007 regarding Solid Waste Management. Management is performed by transporting waste with service coverage only 30% of the entire territory of Sleman Regency. The waste which has been transported will be taken to landfill which is located in Piyungan Sub-District, Bantul Regency. Piyungan landfill is a regional landfill managed by 3 regencies/cities in DIY region. Total waste which entered Piyungan lanfdfill in 2010 was 413 m^3/day and increased to 428m^3/day in 2011 (Badan Lingkungan Hidup DIY, 2014).

Housing contributes in producing a large amount of waste compared with other sources. In the past several years, the composition of waste from housing has changed. Initially it's dominated by 75% organic waste and the remaining 25% was inorganic. Currently inorganic waste reaches 48,77% and organic decreases to 51,23% (Direktorat Pengembangan PLP, 2012). The higher the family income, the higher the inorganic waste will produced.

Organic waste has been extensively used for materials to make compost, briquettes, and biogas. However, inorganic waste hasn't been carried out optimally. Inorganic waste is vey difficult to degrade and event can't be degraded at all by nature. Therefore, intensive efforts are required to manage this waste so that it won't pollute the environment. Inorganic waste can be processed into more useful items, one of them is known as recycling activity, which is a process of collection, separating, or performing other process such as selling materials which can be reused or changed into new materials. The main problem in this waste management is the lack of available potential data. Therefore, data collection and analysis were required to discover the potential of inorganic waste managed by informal sector and increase of economic value of waste in Sleman Regency, Yogyakarta.

2. RESEARCH METHOD

Research was conducted for six months (September 2013 to February 2014) in 23 locations of informal sector in Sleman Regency, including Godean, Berbah, Kalasan, Ngaglik, Mlati, Ngemplak and Sleman Sub-districts. Data collection techniques were interview, questionnaire, observation, and documentation methods. The purpose of this study was to identify the number of informal sector and its participation in waste management in Sleman Regency.
After data was collected, qualitative analysis was performed on the amount of waste which can be managed by the informal sector and the increase of economic value which could be performed with various types of additional management performed in it. The following is the stages of the study:

Figure 1: Research stages

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3. RESULT AND DISCUSSION

3.1. INORGANIC WASTE MANAGEMENT

All discharges produced by human activities and animals in solid, sludge, liquid or gas forms which are discharged because it's needed or not wanted anymore. Although considered useless and unwanted, those materials can sometimes still be reused and made into raw materials (Tchobanoglous *et al*., 1993). In law No 18 of Year 2008 regarding Solid Waste Management, waste is divided into 3 parts which are household waste, household type waste and specific waste. In developed countries can be divided into several types, including:

- Perishable organic waste (garbage): kitchen leftovers, food leftovers, vegetable leftovers, fruit skins
- Nonperishable organic waste (rubbish): combustible such as papers, cardboards, plastics, etc. and non-combustible such as metal, tins, glasses
- Heater ash waste (ashes)
- Carcass waste (dead animals): dead rats, fishes, dogs, and cattle
- Street sweeping waste: wrappers and food leftovers, papers, leaves
- Construction waste (demolition waste), etc (Wilson, 1977).

Waste from settlements/housings and commercial areas consists of organic and inorganic waste as well as category hazardous waste. Organic waste is biodegradable is it decomposes easily, while inorganic waste is non-biodegradable so it's difficult to decompose (Damanhuri, 2010). Organic waste mostly consists of food leftovers, papers, cardboards, plastics, textiles, rubber, leather, wood, and garden waste. Inorganic waste mostly consists of glasses, potteries, metal, and dust. Waste which decomposes easily, especially in hot weather, usually creates strong smell and draws flies when decomposing.
Waste generation increases every year and this also happens in Sleman Regency. In 2010, waste generation in Sleman Regency was 1.101,54 m^3/day, while in 2013 it increased to 1.246,96 m^3/day. Meanwhile waste service coverage in 2013 was 30,71% (Badan Lingkungan Hidup DIY, 2014).
This low service coverage could be caused by various factors, including difficulty to reach the entire region, limited facilities and infrastructures and minimum waste management budget. The following is the comparison between operational cost and waste retribution revenue from 2004 to 2009 in Sleman Regency.

Table 1. Comparison of Operational Cost with Waste Retribution Revenue in Sleman Regency

Fiscal Year	Operational Cost	Revenue Realization	Percentage (%)
2004	1.164.299.016	535.920.150	46,03
2005	1.467.435.182	689.205.625	46,97
2006	2.426.881.480	763.810.650	31,47
2007	4.602.919.850	666.455.200	14.48
2008	4.020.000.000	835.000.000	20,77
2009	4.859.769.000	1.043.949.500	21,48

Source : BLH DIY, 2014

Along with population growth, the amount of waste which should be handled increases. Budget deficit in city waste management is common, so it's difficult for waste management to think far ahead to develop. The effectiveness of available infrastructures shrinks with time. Moreover, most regional governments to this day think that waste management isn't top priority, especially in difficult economic situation. To this day a city relies on landfill system in solving its waste problems. Usually city/regency governments tend to not give serious

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attention to the landfills, leading to cases of communities rejecting landfills, and even other alternatives of final disposal. It's certain that the system used in Indonesia isn't good landfill system because nearly all landfills in Indonesian cities only apply what's known as open-dumping, which actually can not be called waste management technology (Damanhuri, 2007).

With the problems above, regional government should consider the role of informal sector in waste management. The first step should at least be collecting data on existing activities and followed by calculating potentials which can be developed. Reduce, reuse and recycle activities are the keys to solve city waste problems, as well as the role of informal sector in managing inorganic waste. The following is the potential of inorganic waste managed by informal sector in Sleman Regency.

Table 2. Types of Waste Managed by Informal Sector in Sleman Regency

No	Category	Type (Other Term)	Description
1	Plastic	Water containers	
		Mineral water glasses	
		PP	Bottle caps
		Whites	White hard plastics
		Solid	Other hard plastics
		Colored plastics	Detergent/whitener bottles
2	Paper	Cardboards	
		Archives	
		Opaque	
		Newspapers	
		Colored papers	
		HVS	
3	Iron	Category A	High quality/not rusted
		Category B	Medium quality
		Category C	Low quality/rusted
4	Other metals	Aluminum	
		Copper	
		Brass	
		Lead	

3.2. INFORMAL SECTOR ACTIVITIES

In Sleman Regency there are 2 Waste Recycling Locations (LDUS) managed by the regional government, which are in Depok Sub-District LDUS Tambakboyo and in Sleman Sub-District LDUS Tridadi. Both waste recycling locations manage to reduce the quantity of waste which enters Piyungan landfill by 60,1 m^3/day. The main activity in both waste recycling locations is recycling organic waste into compost, and partly processing inorganic waste into marketable products. Both waste recycling locations shows that management activity by Sleman Regency Government is very low in managing inorganic waste.

Based on investigation in the field, there were 23 locations of waste management ran by informal sector in Sleman Regency. From 23 locations, only 1 location intensively managed organic and inorganic waste. While 22 other locations focused on managing inorganic waste produced around their working areas.
From the 23 locations, the authors managed to classify the activities. This classification was to make management activities in the future easier. The following is the summary of the classification parameters.

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Table 3. Parameters of Classification of Informal Sector in Sleman Regency

No	Parameters	Description	Informal Sector	
			Small Scale	Large Scale
1	Land	Size of land used by informal sector	5 - 10 m^2	11 - 20 m^2
2	Transportation/ vehicles	Types of vehicle used	Motor carts Wheelbarrows	Pick Up Truck
3	Waste volume	Amount of managed waste	50 - 1000 kg/day	1000-6000 kg/day
4	Number of employee	Number of employees involved	1 - 3 people	4 - 12 people
5	Total revenue	Total revenue from waste management	IDR. 100.000,- until 1.500.000,- per day	IDR. 1.500.000,- until 7.000.000,- per day
6	Performance/ activity level	Employees' daily activities	Low	High
7	Processing equipment	Waste processing equipments used	Manual	Choppers Compactors
8	Processing system	Processing flow from start to finish of waste management process	Not organized well	Organized well with clear order of work
9	Distribution of goods	Distribution of processing products to other places	Large scale informal sector Factory branches	Factory branches Large factories

Based on these parameters, from 23 locations of informal sector, 11 locations were small scale informal sector and 12 other locations were large scale.

Figure 2. Small Scale Informal Sector, (a). Collector Mr Gendol, Jalan Magelang, Beran, Sleman, (b) Collector Mrs Harni, Jetis, Wedomartani, Maguwoharjo

Figure 3. Large Scale Informal Sector, (a). Ade Sunarto, JalanBener No 59, (b). Mrs Supriyatmi, Pondok Raya, Condongcatur

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3.3. QUANTITY OF INORGANIC WASTE

Inorganic waste which can be recycled has 4 categories shown in table 2 above. From 23 locations of informal sector which managed inorganic waste in Sleman Regency, not all of them accepted all four categories. This was due to limited equipments and manpower because each category of inorganic waste required different management. On average, small scale informal sector could process 2.210 to 5.100 kg/week of various types of inorganic waste, while large scale informal sector could receive 14.020 to 24.050 kg/week.

Tabel 4. Quantity of Inorganic Waste Managed by Informal Sector in Sleman Regency

Types of Inorganic Waste	Volume of waste (Kg/week)	
	Small Scale	**Large Scale**
Plastic		
1. Mineral Bottles	300 - 500	900 – 1000
2. Mineral Glasses	150 - 400	700 – 1000
3. PP	100 - 250	700 - 1100
4. Whites	20 - 150	700 - 900
5. Hard	30 - 150	700 - 1000
6. Colored plastics	50 - 150	700 - 1000
Paper		
1. Cardboards	200 - 400	1000 - 1500
2. Archives	200 - 400	900 - 1000
3. Opaque	100 - 300	1000 - 1500
4. Newspapers	70 - 100	1000 - 1500
5. Colored papers	50 - 100	1000 - 1500
6. HVS	100 - 700	1000 - 2500
Iron		
1. Category A	300 - 400	1500 - 2000
2. Category B	200 - 550	1000 - 1500
3. Category C	250 - 400	900 - 1500
Other Metals		
1. Aluminum	20 - 30	100 - 500
2. Copper	30 - 50	100 - 900
3. Brass	30 - 50	70 - 150
4. Lead	20 - 30	50 - 2000
Average	**2.210 - 5100**	**14.020 - 24.050**

With that amount, small and big scale informal sectors could process significant amount of waste with the following details:

- Small scale = 5.100 kg/week : 6 days/week
  = 850 kg/day x 24 days/month
  = 20.400 kg/month ~ 20,4 tons/month

  One location of small scale informal sector could manage up to 20,4 tons month inorganic waste per month. Based on the survey, there were 11 locations of informal, including small scale. So, waste which could be managed reached 224,4 tons/month.

- Large Scale = 24.050 kg/week : 6 days/week
  = 4008,33 kg/day x 24 days/month
  = 96.200 kg/month ~ 96,2 tons/month

  One location of large scale informal sector can manage up to 96,2 tons of inorganic waste per month. If there were 12 locations which could manage waste with the same quantity, in one month large scale informal sector could manage 1.154,4 tons of inorganic waste.

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Note :
6 days/week = weekly effective working time with 1 day off/week
24 days/month = monthly effective working time, with the assumption of 4 days off/month

The involvement of informal sector in waste management in Sleman Regency managed to reduce inorganic waste by (224,4 ton/month + 1.154,4 ton/month) = 1.378,8 ton/month ~ 16.545,6 ton/year. Of course this activity helped the government of Sleman Regency in managing waste produced everyday. Most likely waste managed by informal sector came from areas outside the service coverage of waste management of the regional government. Based on existing data, waste management service coverage in Sleman Regency in 2013 was 30,71% (Bappeda Sleman, 2013).

3.4. ECONOMIC VALUE OF INORGANIC WASTE

Aside from helping the management of inorganic waste in Sleman Regency, informal sector could operate because of the economic value of the waste. This informal sector utilized price difference between purchase and sale after adding several processes in their activities. The processes were sorting (P1), slicing (P2), packaging (P3), pressing (P4) and cleaning (P5).
By just performing P1, the price of waste could increase by IDR. 700,- to 1.900,- per kg. Small scale informal sector usually only performed two stages of processing which were, P1 and P3, increasing price of waste by IDR. 1.500,- to 2.500,- per kg. While large scale informal sector usually performed nearly all processing activities from P1 to P5, average increase of waste price started from IDR. 1.500,- to 4.000,- per kg.

Table 5 below shows difference in purchasing and selling prices of waste in small and large scale informal sector. Price list in small scale informal sector was usually lower than big scale because the activities in small scale informal sector weren't very careful in accepting and managing goods. Sorting to packaging was done without care so the quality of waste produce was low. This made selling price not too high. The more careful the process of processing, slicing, packaging, pressing and cleaning, the higher the selling price of the waste. The order of the process was usually small scale informal sector released processed waste to large scale then the product reached processing factories. The following is the increase of selling price of waste in small and big scale informal sector in Sleman Regency.

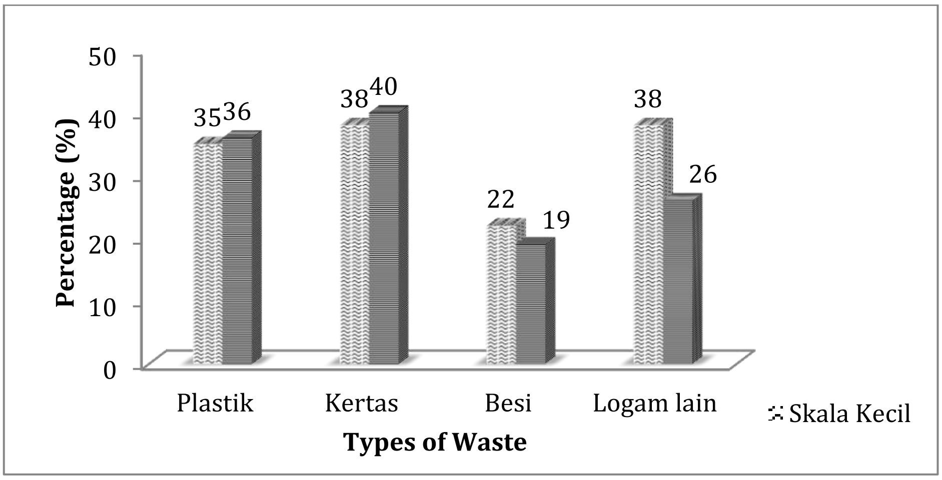

Figure 4. Percentage of Increase of Selling Price in Small and Large Scale Informal Sector in Sleman Regency

Table 5. List of Purchasing and Selling Prices In Small and Large Scale Informal Sector in Sleman Regency

Type of Inorganic Waste	Price in Small Scale (IDR/Kg) Purchasing	Selling	Price in Large Scale (IDR/Kg) Purchasing	Selling
		Plastics		
Mineral water bottles	700-1400	1500-2500	1500-3500	3000-4000
Mineral water glasses	700-2000	2900-3000	1200-4000	3500-4000
PP	600-2000	1900-3000	1000-3500	3000-4500
White	700-1900	1000-2500	1200-4000	3300-4000
Solids	650-1000	900-1200	700-1500	1000-2000
Colored plastics	800-1400	1000-2000	700-2500	1500-2500
		Papers		
Cardboards	700-1000	1000-2000	1300-2000	1700-2500
Archives	700-1700	1900-2200	800-1900	2000-2700
Opaque	800-1000	1000-1400	1000-1800	1500-2400
Newspapers	600-1000	1000-2000	1400-2000	1700-2500
Colored papers	500-700	700-1300	700-1200	800-1400
HVS	600-1000	900-2000	1000-2000	1700-2300
		Iron		
Category A	1800-2000	2000-2700	1400-2900	3000-4000
Category B	1700-2000	1900-2600	2500-3000	2800-3500
Category C	1000-1500	1800-2200	2200-2800	2500-3000
		Other metals		
Aluminum	5000-8800	9000-12000	10000-14000	12000-18000
Copper	20000-30000	30000-37000	30000-55000	46000-60000
Brass	2000-25000	24000-30000	16000-38000	30000-36000
Lead	5000-8000	9000-12000	5500-9000	10000-12000

Small scale informal sector in average performed only two stages of processing, i.e. sorting (P1) and slicing (P2), those activities could increase selling price by 33.25% in average, while large scale informal sector usually performed two to three processing stages, including sorting (P1), compacting (P4) and cleaning (P5). Mathematically it could be calculated that the increase of selling price of waste which had gone through the three processes reached 30.25% (Figure 3).

5. CONCLUSION

1. Data collection was performed in 23 locations of informal sector which manage inorganic waste in Sleman Regency, Yogyakarta.
2. Informal sector was classified by 9 parameters, i.e. size of land, transportation/vehicles used, volume of accepted waste, number of employees, revenue, level of activities, processing equipments owned, processing system used and distribution of processing products.
3. 23 locations could be classified into large scale informal sector which consisted of 12 locations and small scale informal sector which consisted of 11 locations.
4. Quantity of waste which could be managed by informal sector in Sleman Regency, whether small or large scale, reached 16.545,6 tons/year.
5. Small scale informal sector in average performed two processing stages, i.e. sorting (P1) and slicing (P2), able to increase selling price by 33.25% in average. Meanwhile large scale informal sector performed two to three processing stages, i.e. sorting (P1), compacting (P4) and cleaning (P5), and could increase selling price by 30.25%

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VACANT LAND UTILIZATION AGREEMENT MODEL TO STRENGTHEN THE FOOD SECURITY: CASE STUDY IN THE SLEMAN DISTRICT, YOGYAKARTA SPECIAL REGION, INDONESIA

SUPARWOKO[1]

ABSTRACT: This paper is to structure agreement model of the vacant land utilization to strengthen the food security in the Sleman District of the Yogyakarta Special Province in Indonesia. The government of Indonesian gives land rights or management rights to the holder of the right to cultivate, use, and maintain properly in addition to the income generation of the people, the nation and the state. However, there is still untapped land to maintain, increase soil fertility, and prevent damage to the land so that the empty land can be utilized by local community to strengthen economically agricultural activities. That issue is that a lot of people do not have land and a number of people mastered a lot of land that are not utilized in the Sleman District. The holder of the rights to the land that has not been optimally utilize their empty ground impacted on the delay achievement of the objectives of development programs, food insecurity and resilience of the national economy, and also close the access to socio-economic for the people. In the Article 3 Paragraph (6) of the Sleman Regency Regulation No. 8 of 2008 on government affairs, concerns on the use of vacant land and settlement issues, thus strengthening or supporting the regional food security. The research suggests that the vacant land utilization model can be developed by the government, local people, and land owner to use the land for seasonal crops. In this regard, the agreement of vacant land utilization was formulated by the local government, the farmers, and land owners. Therefore, the agreement model of vacant land utilization in Sleman would be implemented by the local farmers for seasonal crops with the support of working capital provided by the local government of the Sleman District and working together with the land owner.

KEYWORDS: agreement model, vacant land utilization, food security, people, government

1. INTRODUCTION

The poverty rate in Indonesia fell from year to year, however the speed was slow (Sinar Harapan, 10 Oktober 2014). In Sleman district, there were some 57.869 poor families or 17% of the total number of 391.106 people (Badan Pusat Statistik Kabupaten Sleman, 2010). In Sleman, a lot of vacant land had unknown owner (Republika, Februari 25, 2014). The research shows that 16% of vacant land in 7 sub-dsitricts in the Sleman District had not been utilized (Dinas Pengendalian Pertanahan Daerah, Kabupaten Sleman, 2011). However, the Regulation of the Agrarian Minister/Head of the National Land Autority Number 3, 1998 states that any person, corporation or institution duly authorized by law to have the land, they are required to use the land so that the land is more efficient and effective as well as beneficial to the public welfare. Land rights holders or parties obtaining control over land required to use the land in accordance with the nature and purpose of the right. While the land is not used in accordance with the nature of the goal rather than his right, then the land should not be left empty and must be used with planted crops with regard suitability and capability of the land as well as aspects of the protection and preservation of the environment.

Land has a very important role in the implementation of national development organized as a continuing effort to achieve a just and prosperous society based on Pancasila and the 1945 Constitution. The government gives land rights or management rights to the Right Holder for cultivating, using, and maintaining the land properly in addition to the well-being of the rights

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holder and also to be devoted to the welfare of the community, the nation, and the State (Dinas Pengendalian Pertanahan Daerah, Kabupaten Sleman, 2011). In Act No. 5 of 1960 on Basic Regulation of Agrarian mentions that the rights holder is obliged using the land to maintain, increase soil fertility, and prevent damage so that the land can support the welfare process of society. The Government and the Local Government must optimize the use of available resources by providing policy 11 (eleven) national priorities, where two of them are to reduce poverty in the hope of a decline in absolute poverty from 14.1% in 2009 to 8 -10% in 2014 and to increase food security (Alisjahbana, A.S, 2013). Due to the food security, the creation of self-reliance of food at the end of 2014 was marked by the increasing ability of self-sufficiency in rice and other major food commodities. Therefore, the food security programs which is the development of regional and spatial agricultural, regulatory arrangements to ensure legal certainty on agricultural land, the development of new agricultural areas of 2 million hectares, optimizing the use of vacant land and wastelands (Alisjahbana, A.S, 2013).

The purpose of this paper is to to analyze and to structure an agreement model for the vacant land utilization in the District of Sleman, Yogyakarta Special Region, Indonesia. The research area was conducted in seven of 16 sub-districts in the Sleman District including Seyegan, Godean, Sleman, Prambanan, Mlati, Ngaglik, and Gamping which are sub-districts having more vacant lands and more urbanized compared to others. The research included a series of activities with the following steps: 1) a pre-survey questionnaires, determining the number of respondents, 2) data inquiry from the public by distributing questionnaires and interviews and secondary data concerning on the geographic profile, the profile of economic, and socio-cultural profile, 3) analyzing the results of questionnaires and interviews, 4) This stage includes the inventory, determination of areas of land, the establishment parties, and cooperation agreements of vacant land utilization, and 5) Agreement formulation between the farmer, land owner, and the village staff.

The method of analysis using deductive way of reasoning is because it begins with the norms or rules or theories of a general nature which is then applied to the case or issue a special nature that would lead to the conclusion of a special nature or assessment using a systematic interpretation and functional interpretation. Systematic interpretation is the interpretation of the data by linking conditions or problems with the articles of the rules or norms or theories that exist in the rules or norms or the theory itself or with others in order to obtain a solid understanding. While the functional interpretation is done by taking into account the interpretation of the function / purpose to be fulfilled by the regulations / norms / particular theory (Jaya, 2013).

2. VACANT LAND UTILIZATION AND AGREEMENT

The state of the art of this paper is on Table 1 presenting several studies respecting on vacant land utilization agreement and food security. Mendez et al examin recent trends in agroecology wiewing the field as a transdisciplinary and participatory process and adessing actors and social processes at different geo-political scales to transform the global agrifood system. They highlight transdisciplinary research to integrate different academic disciplines as well as different forms of knowledge (e.g., experiential, cultural, and spiritual). The participatory action research (PAR) was conducted to engage all relevant actors, engendering an equitable process of research, reflection, and engagement on areas of desirable change (Méndez, VE et al, 2010)

The International Food Policy Research Institute (IFPRI) informs that hundreds of millions of people are food insecure because they cannot afford to buy all the food they need and do not have access to the resources to produce it for themselves. Due to the poverty issue, causes

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of food insecurity were including powerlessness, conflict, discrimination, demographic factors, and unsustainable natural resource management (Pinstrup-Anderson, 2002). Concepts to alleviating food insecurity vary based on some conditions, including the type of food insecurity (relating to food availability, access or utilization), its severity and the social, political and environmental considerations of a particular region. The intervention spectrum ranges from initiatives that address the symptoms to those targeting the causes, for example, seeking systemic change that confronts inequality in the access to resources and markets (Caswell, M., Méndez V. E., and Bacon, C. M., 2012).

Table 1. Some Studies Concerning on Vacant Land Utilization Agreement and Food Security

Study Area	Focused Activity	Community Aspiration Variables	Source
Surabaya	vacant land can be used for crops or cultivation Law No. Regulation 5 of 1960 on Basic Agrarian	Vacant land utilization for local community use and benefit based on agreement	Jaya, Monica Juliana, 2013
Asia and Africa	Food Security and Smallholder Coffee Production	Type of food insecurity (food availability, access, and utilization), its severity and the social, political and environmental conditions of a particular region.	Caswell, M., Méndez V. E., and Bacon, C. M., 2012)
Nicaragua, Guatemala, El Salvador, Mexico	Stratified survey, 2004-05	63% struggle to meet basic food needs	Méndez, VE et al, 2010
Asia and Africa	Achieving Sustainable Food Security for All	hundreds of millions of people are food insecure due to powerlessness, conflict, discrimination, demographic factors, and unsustainable natural resource management	Pinstrup-Anderson, 2002
Saginaw, Michigan	Managing Vacant and Abandoned Property in the Green Zone	A number of communities, are addressing for reusing vacant and abandoned property for parks, open space, community gardens, **urban agriculture**, and green infrastructure.	United Stated Environmental Protection Agency (USEPA), 2014
Sleman	Regulation and Optimization of Vacant Land Utilization in the Context of the Land Authority in the Implementation of the Sleman District	Vacant Land Utilization and Financing Implementation Model	Sarjita, 2012
Sleman	Academic Study of the Empty Utilization Policy and Troubleshooting of Vacant Land	acant land and its utilization for seasonal crops	Sarjita, 2010

Vacant land is land that is mastered by property rights, lease rights, land rights, the right to use, and management of land rights or land already acquired basic mastery but have not obtained the rights to the land in accordance with the provisions of the legislation in force, or only some of which have not been used in accordance with the nature and the purpose of the right or the spatial plans in force. Holders of land rights that are not optimally utilize the land, in addition to an act that is not wise, it is not economical (loss of opportunity to make real economic potential of the land), and not just, as well as a violation of the obligation to be performed or the rights holder has obtained basis of land tenure (Sarjita, 2010).

Dubbeling (2003) concerns that a process on the participatory consultation and action planning developed in the city of Rosario (Argentina) purposes to provide poor families with secure access to vacant lots for farming. The process, implemented in September 2002, has led to the formulation and institutionalization of an enabling regulatory and legal framework. It was promoted by the local government of Rosario, non-governmental institutions, universities and the community. In the project, 10,000 families were involved in the urban agriculture program, and occupied more than 60 ha of private, institutional and municipal land.

3. VACANT LAND UTILIZATION AND FOOD SECURITY

Borton and Shoham suggests that the availability of food at the national level does not automatically ensure food security at the household level (Borton, J. And J. Shoham, 1991). So it is very important to enhance the capacity of poor households to the level directly involved in the utilization of vacant land in their village. Due to Managing Vacant and Abandoned Property in the Green Zone, green reuse of vacant and abandoned property can help reduce stormwater runoff, clean up contaminated property, increase the value of adjacent property, reduce neighborhood blight, and provide community amenities, and is often provide essential services to existing residents. A small but growing number of communities, such as Youngstown, Ohio, and Philadelphia, Pennsylvania, are addressing this challenge by reusing vacant and abandoned property for parks, open space, community gardens, **urban agriculture**, and green infrastructure (Environmental Protection Agency, 2014)

Community participation is driven by 1) community development projects that are designed in a simple and easily managed by the community, 2) community organizations and institutions that are able to mobilize aspirations of the people, and 3) increasing community involvement in development (Whyte, 1991). According to the Government Regulation No. 38 of 2007 that the authority of the Government of District/ Regency/Municipality in the Implementation and Utilization of Vacant Land and Dispute Resolution, including stages (Sarjita, 2012) as follows:

1) Inventory and identification of vacant land for the use of seasonal crops
2) Determination of land parcels as vacant land that can be used for annual crops under an agreement
3) Determination of the parties who need land for seasonal crops with emphasis on the local community, especially farmers, and guarantee the sale of agricultural produce to the village cooperative.
4) Facility cooperation agreement between the holders of land rights to those who will be working on is known by the Head of the village and the local sub-district, with an agreement for two planting seasons.

4. VACANT LAND UTILIZATION AND AGREEMENT MODEL

Global, national, and local companies can leverage their resources to engage and strengthen local enterprises and partners with diverse stakeholders to deliver results at any scale. Civil society can mobilize the community to meet its unique social, environmental and economic needs. It can also demonstrate innovative programmes that can be scaled by governments and businesses, and provide risk mitigation tools that build market confidence. In fulfilling these roles, each sector should bolster the availability of affordable financing, the scope of research and the capacity of local leaders (McKinsey & Company, 2011)

Due to contract farming, according to Eaton and Shepherd (2001), contract farming is an agreement between farmers and processing and/or marketing companies for the production and supply of agricultural produce under forward agreements. The formulation or scheme also invariably includes the provision of a degree of production support by the purchasing corporation. The structure of agreement models is a commitment on the part of the farmer to provide a specific commodity in quantities and at quality standards decided by the company and a commitment on the part of the company to support the farmer's production and to purchase the commodity. Agreement farming models typically involve the provision of inputs (seeds, fertilizers and pesticides) on credit by the company, and possible with additional advice and services such as crop spraying (Mushobozi, 2010).

The success of any development initiative ultimately relies on delivering local results, so programmes must be implemented to empower individual decision-making and enable community ownership. Effective agreement models are often designed for a region, where programmes driven by regional leaders can achieve scale within the unique cultural context. It is crucial to recognize that the small-scale farmer is embodied within national, regional and global trade systems and markets. Targeting small-scale agricultural systems is important through new and innovative public-private partnerships, increased public investments and development-oriented local governance and institutions. Emphasis should be placed on developing cooperatives, farmer organizations, business associations supporting the needs of small-scale agricultural producers, and entrepreneurs to capture and add value to on-farm, post harvest and off-farm enterprises (Watson, ____).

Farmers as the main stakeholders in agriculture comprising men and women, small, medium and large farmers, indigenous people with varying cultural practices, livestock farmers, pastoralists, and fisher-folk. There are the most affected differently and to varying degrees if the sustainability of their enterprises is affected by Government Policy, Environment and Climate-change, Market conditions, genetic interferences without safeguards in their ecology, man-made or natural disasters (Gopalan, 2011). Around 99% of grain producing farms are family owned. Australia has a strong tradition of family owned and operated farms. However many family farms are constrained by a lack of capital (Price Water House Coopers, 2011).

5. VACANT LAND UTILIZATION IN THE SLEMAN DISTRICT

Geographically the districts of Sleman is located between between 110 ° 33 '00 "and 110 ° 13' 00" East Longitude, 7 ° 34 '51' and 7 ° 47 '30 "South latitude" with boundaries Magelang District in the north, Boyolali and Klaten District in the east, Bantul District and Yogyakarta Municipality in the south, and Kulon Progo District in the west. Sleman consists of 17 sub-districts and 86 villages. Based on the results of the 2010 Population Census enumeration, while the population of the district of Sleman is 1,090,567 inhabitants, consisting of 545 980 men and 544 587 women. Depok sub-district was the most densely area in the Sleman District and followed by Mlati, Gamping and Godean sub-districts. In most sub-districts in Sleman, agriculture activities was still dominated in sector employment (see Table 2) and this suggest that agriculture was important sector in the people existence in Sleman. Therefore, more agriculture program improvement is crucial to support employment issues in Sleman.

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Table 2. Research Respondents due to Vacant Land Utilization

Macam Responden	Sub-District Ngaglik	Mlati	Seyegan	Sleman	Prambanan	Godean	Gamping	Number of Respondents
Land Owner	8	5	3	12	1	5	0	**34**
Village Apparatus	3	4	4	3	2	5	3	**24**
Community	5	4	4	3	6	10	7	**39**
Total Participant	**16**	**13**	**11**	**18**	**9**	**20**	**10**	**97**

Source: Primary Data, 2011

Table 2 shows the research respondent of the community aspiration to the vacant land utilization in the district of Sleman involving land owners 34 people, village apparatus 24 people, and community (mostly farmers) 39 people. The research participant confirms with Slamet (2003) and Adisasmita (2006) that the participants of land owners, village apparatus, and local community were involved in the interview to have their aspiration due to the vacant land utilization in their villages. In this respect, interview stage could be viewed as the planning process of the agreement between land owner and the community to manage the purposed vacant land as part of a democratic atmosphere to realize unity and harmony among partisipans (Asngari, 2001); The aspiration process confirms with Whyte (1991) that the participation process was able to mobilize aspirations of the local farmers to increase community involvement in the vacant land utilization.

Table 3. Vacant Land Utilization in the Sleman District

ASPEK		Sub-District Ngaglik (%)	Mlati (%)	Sayegan (%)	Sleman (%)	Prambanan (%)	Godean (%)	Gamping (%)	Sleman (%)
Vacant Land Condition in 2011	Utilized	39.58	53.57	33.33	53.85	66.67	41.38	62.16	50.08
	Unutilized	8.33	17.86	22.22	0	0	51.72	13.51	16.23
	No info available	52.08	28.57	44.44	46.15	33.33	6.9	24.32	33.68

Source: Primary Data, 2011

Table 3 represents the vacant land utilization in the Sleman District. More than 50% of the vacant land in the Sleman District had been utilized and only 16,23 % of the empty land was not utilized. The information of the Table 3 is also potential for development process as oppotunities of knowledge, skills and attitude improvement (Rahayu, 2008).

Tabel 4. Type of Vacant Land Utilization

ASPECT		Sub District Ngaglik (%)	Mlati (%)	Sayegan (%)	Sleman (%)	Prambanan (%)	Godean (%)	Gamping (%)	Sleman District (%)
Vacant Land Utilization	Plantation/ Crops	18,18	17,39	28,57	42,31	66,67	57,14	6,25	33,79
	Building	22,73	39,13	14,29	7,69	0	21,43	65,63	24,42
	Social Activities	2,27	4,35	0	3.85	0	7.14	0	2,52
	Sold	0	4,35	0	0	0	0	0	0,62
	No info available	56,82	34,78	57,14	46,15	33,33	14,29	28,13	38,66

Source: Primary Data, 2011

Table 4 shows that about 33,79% of vacant land in the Sleman District was used for plantation or crops and some 24,42% h s been erected building. Some of the vacant land was also functioned as social and economic activities such as food ball, play ground, and building material stock. This vacant land utilization in line with the Comprehensive Plan represented by the key themes including (Westminster, 2013) including urban agriculture, recreation, housing, mixed uses, etc. However, based on the Government Regulation No. 38 of 2007, the Sleman Government stipulates the vacant land utilization for seasonal crops. Therefore, based on the regulation, only about 30% of vacant land in Sleman is potential for plantation or crops (see Table 5) such as such as rice, corn, soybeans, peanuts, sweet potatoes, seasonal vegetables (Dinas Pengendalian Pertanahan Daerah, Pemerintah Kabupaten Sleman, 2011).

The community aspiration of the vacant land in Sleman was also conduction to explore the community respond to the Government Program concerning on land utilization. Most local community agreed and support the government program regarding the utilization land for seasonal plantation and done by the community by using production sharing system (Dinas Pengendalian Pertanahan Daerah Kabupaten Sleman, 2012). However, the community aspiration has not given any formulation concerning financial capital due to the start up for the cultivation production to conduct seasonal crops for sharecroppers. This will strengthen the seasonal crops business for the sharecroppers as suggested by Kartasasmita (1997) that the availability of adequate land and credit will be able to develop capital for strengthening the community's business to increase production and income.

6. SIMULATION MODEL AGREEMENT

Early models were simulated agreement format to the public, especially the land owners, prospective tenants, and tenants. From the simulation results produce two types of agreements submitted by the community. The simulation process is carried out on January 11, 2012 with 3 respondents, 2 respondents from the Sayegan Sub-District and one respondent from the District Mlati. The third agreement is an agreement the model proposed by the respondent and is based on farming systems is usually done by the local community. The simulation results are as follows:

1. Agreement between Land owners and Cultivators
   The first model agreement contains agreements made by the land owners and prospective tenants of land. Based on the interviews conducted, it was more appropriate type of agreement for more than 500 m² of land, and should be managed by the local village youth clubs or the surrounding communities who are still unemployed.
2. Time Frame Agreement
   The Model Agreement contains an agreement between the landlord and tenants within the next few years, usually at least 2 years of the lease term. The content of the cooperation agreement was a contract to lease the land owners land to tenants. After signing the agreement, there is no bond between the obligations and rights of both parties, except in matters of payment. Also, it can be used for rental agreements based on the growing season, which is an agreement between the landlord and tenants within the next few seasons. Usually they cultivate with one type of crops, such as rice. For example, tenants renting land for 10 seasons for rice cultivation.
3. Agreement between the Land Owner and the Peasants.
   The Third Model Agreement was not yet defined as what was the content inside. In this case, the owners work on their own land with the help of laborers. It is a lot going on in the community, especially for retirees who return to cultivate their land. So it can

be concluded that they cooperate with such unwritten agreements as usually happens.

The stakeholders of the production sharing agreement tended to use deliberation in determining the agreement vacant land utilization and they will also be consultation or discussion to find the best solution when solving possible incoming problems. In the future, there needs to be cooperation and coordination with the Department of Agriculture associated with a program of seasonal crops in Sleman. To support this purpose, there should be a land utilization workshop including soil preparation, seeding, planting, fertilizing, harvesting, and marketing. There needs also for publications on vacant land uncultivated, and tenants or tenants who do not have any land for cultivation and it could be publicized through the village concerned.

7. CONCLUSIONS AND RECOMMENDATION

Based on the aspect of land conditions, there was currently vacant land untapped in Sleman. Candidates Cultivators vacant land prioritized for local people who will work as sharecroppers. Crops community expected seasonal rice, corn, soybeans, peanuts, cassava, vegetables annuals in accordance with the aspirations of the people Sleman. Utilization of Vacant Land Draft Agreement resulting from the practice of simulation obtained three types of agreement models which are:

1. Agreement between Land owners and Cultivators
2. Time Frame Agreement Land owners and Cultivators
3. Unwritten Agreement between the Land Owner and the Peasants.

Agreement pasticipants will use deliberation or familier discussion in determining the agreement and they will be consultation to solve possible incoming problems.

8. RECOMMENDATIONS

There are needs for socialization associated with vacant land utilization policy, because most people said not much aware of the policy. A number of respondents have a constraint on the initial capital, so the government is expected to provide credit assistance to poor community in particular. Some communities also suggested that counseling be held related to the problems of farming faced by the farming community. The agreement model needs to be discussed further with the community owners and tenants and other stakeholders to generate a model of cooperation as mutually agreement.

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GAS EMISSIONS INVENTORY OF METHANE (CH_4) WITH FIRST ORDER DECAY (FOD) METHOD IN TPA PIYUNGAN, BANTUL, DIY

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ABSTRACT: TPA Piyungan is an endpoint landfill disposal of waste that generated from three citizens (Yogyakarta , Sleman and Bantul). The amount volume of waste that goes on everyday and the volume of waste that has been buried in landfill, has huge potential of methane. The purpose of this paper is to inventory emissions of methane (CH_4) in TPA Piyungan with First Order Decay (FOD) method and analyze the alternative utilization technologies of methane (CH_4) in accordance with the conditions of TPA Piyungan. From the results obtained by the First Order Decay (FOD) method, emissions of methane (CH_4) is equal to 6.186 Gg or 6186 tons. The use of alternative methane (CH_4) utilization technologies are such as Landfill Gas (LFG) Flaring, Fuel Cell, and Convert Methane Gas to Methanol. From the three alternative technologies, Landfill Gas (LFG) Flaring is the technology that can be most applied in accordance with the TPA conditions.

KEYWORDS: Methane gas emissions, tpa piyungan, first order decay method, landfill gas (lfg) flaring

1. INTRODUCTION

TPA Piyungan is an endpoint landfill disposal of waste that generated from three citizens (Yogyakarta , Sleman and Bantul), which in a day can receive waste as much as 300 to 400 tons. TPA Piyungan is administered through the SEKBER KARTAMANTUL which facilitates city of Yogyakarta, Sleman and Bantul in coordinating and determining the policy to be taken in the management of waste in the TPA Piyungan. Moreover, the age of TPA Piyungan operations that have expired and the capacity of the waste that has narrowed.

One of waste management agenda in TPA Piyungan is methane (CH_4) gas management activities that has yet to be implemented properly. The amount volume of waste that goes on everyday and the volume of waste that had been buried in landfill has huge potential of methane gas, so we need a technology that can accommodate gas production that can be used either for TPA Piyungan or society around the landfill.

There are two methods for determination emissions of methane (CH_4) from landfill : Mass Balance Method and First Order Decay (FOD) Method. Based on the IPCC 2006 GL, the level of greenhouse gas emissions from the landfill are advised to be calculated using the first order decay (FOD) method, because FOD has more accurate on annual emissions calculation results.

Inventory of methane gas in TPA Piyungan with the FOD method also been done before, but was limited to the amount of potential methane results without any further management. Based on previous research, derived emissions of methane (CH_4) in TPA Piyungan reaches 1,13 Piyungan Gg (gigagram) on 1996 and reached its peak in 2010 of 6,39 Gg then decreased in 2011 with the emission 6,35 Gg. Therefore this paper aims to inventory the methane gas emissions with FOD method based on primary and secondary data in the field

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and proposes an alternative methane utilization technology in accordance with the conditions of TPA Piyungan, so it can be used as a reference for the formulation of policies related to waste management in the future.

2. METHODOLOGY

2.1. CLASSIFICATION OF WASTE COMPONENTS

Waste component is a parameter that indicates the fraction of wet or dry weight of waste components. In this paper, waste components expressed in fractions (percent) wet weight of waste components. Referring to the implementation of the standard waste composition survey, based on the IPCC 2006 GL, classified into 11 components: food waste, garden and park waste, wood, paper and cardboard, textiles, nappies, rubber and leather, plastic, metal, glass (ceramic and pottery) , and others (ash, dust, waste electronics, etc.)

2.2. DETERMINATION OF WASTE COMPOSITION

Determination of waste composition is based on 1m^3 of waste samples that represent the entire composition of waste dumped in TPA. Waste composition is determined on the weighing sample components which sorted from 1 m^3 of waste samples. This method refers to the IPCC 2006 GL.

2.3. IMPLEMENTATION OF WASTE SAMPLING

Waste sampling was conducted for 8 consecutive days beginning on Tuesday, April 8, 2014 until Tuesday, April 15, 2014 at 09.00 until 12.00 pm (rush hour operations in TPA Piyungan).

2.4. DETERMINATION OF THE DRY MATTER CONTENT

- Sampling Methods

  Samples were taken for determination of dry matter is samples that used in the determination of waste composition. Base the determination of dry matter content is per type of waste component where not all components have water content. Based on the IPCC 2006 GL, the determination of the dry matter content just applied for waste components that contribute to the formation of methane gas.

  Weight of samples for determination of dry matter content of a waste component is ± 5 kg samples were taken from the determination of waste composition by weight reduction of the sample. Reduction of the sample weight for each waste component is done with a 'quartering' procedures, such as those in Figure 1 below:

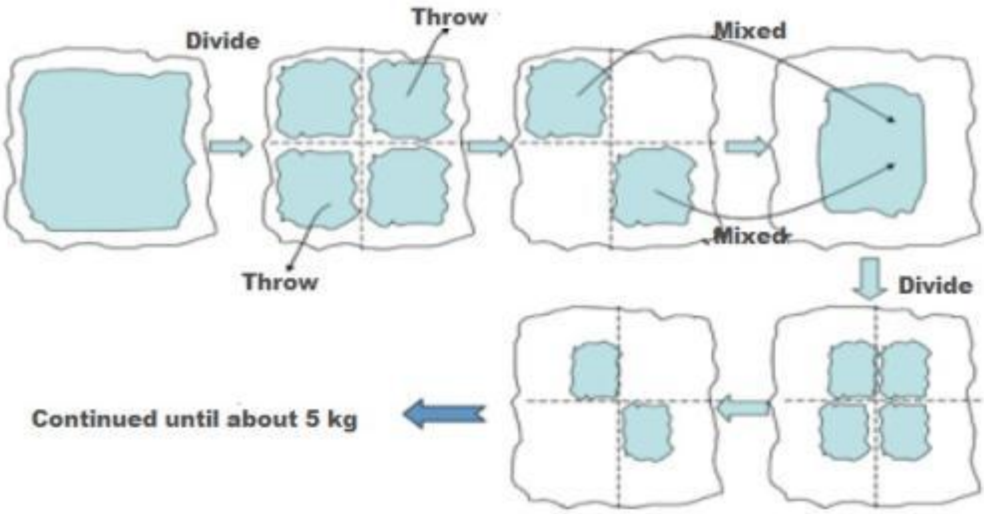

Figure 1. Quartering procedures in sample weight reduction

- Dry Matter Content Determination Method

  Determination of dry matter content (dry matter content) is done with a gravimetric approach, that is through the weighing of a representative sample.

  - The water content in waste component is calculated by the equation :

$$\textbf{\% water content} = (B - C) / (B - A) \times 100\ \% \qquad (1)$$

  Explanation :
  A **:** Weight empty tray
  B **:** Weight tray containing sample
  C **:** Weight tray containing sample which has been dried for 2 hours and cooled for ± 15 minutes in a desiccator

  - The dry matter content in waste component is calculated by the equation :

$$\textbf{dry matter content} = (100\ \% - \%\ \text{water content}) \qquad (2)$$

3. DATA ANALYSIS

The data obtained will be analyzed using the First Order Decay (FOD). The phases in the processing of FOD method is as follows:

- Calculation of DDOCm

At first order reaction, the amount of product is proportional to the amount of material that reacts. In the degradation process of waste organic material in the landfill, CH_4 formation reaction rate is proportional to the rate of reduction of mass organic carbon decomposes in anaerobic conditions (DDOCm). That means, the year in which the waste deposited / piled in a landfill is not relevant to the amount of CH_4 formed each year as there are only a total mass of material that decomposes in the landfill.

When the amount of material that decomposes in the landfill in the first year is known, then every year the number could be considered as the first year on the method of estimation of CH_4 formation. The calculation of the basic order can be done using two simple equations by

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decomposition reactions begin to occur on January 1 in the year after the deposition of waste.

FOD Simple Spreadsheet Model (using the Template or Software IPCC 2006)

To estimate CH_4 emissions from all landfills in the country / region, the emissions of waste dumped in landfill each year is modeled as a separate row in the spreadsheet. In the IPCC Waste Model, the formation of CH_4 is calculated separately for each year of waste disposal, and the total CH_4 formed is obtained by summing CH_4 formed at the end of each year.

- Calculation of DDOCm deposited on year T, Gg

Data input of dumped waste in landfill into a spreadsheet can be bulk data or based on composition. On the basis of composition, waste is separated into paper, cardboard, food, etc. (11 components). DOCf parameter is the fraction of the real DOCm degraded in landfill sites. DOCm decomposition process (DDOCm) entering the landfill is calculated with the following equation:

$$DDOCm = W \times DOC \times DOCf \times MCF \quad (3)$$

Explanation:

W = Amount deposited (Gg)

DOC = Degradable organic carbon

DOCf = Fraction of DOC decomposing under anaerobic conditions

MCF = Methane correction factor (based on the IPCC 2006 GL, TPA in Indonesia is categorized unmanaged - deep (>5m waste) and/or high water table by the value of MCF = 0,8) (IPCC, 2006)

- Calculation of DDOCm rem, DDOCm dec, DDOCm a, and DDOCm decomp

The method of calculating CH_4 emissions from landfill which has been described previously using the assumption that the anaerobic decomposition from DDOCm to CH_4 be starting to happen January 1 in the year after the waste accumulation (with an average delay of 6 months before the decomposition reaction starts). If anaerobic decomposition occurs earlier, that is in the year of accumulation, separate calculations must be made to the accumulation. DDOCm can be calculated with the following equation:

- Calculation of DDOCm rem

  Decomposable DOC (DDOCm rem) Not Reacted is mass of deposited DDOCm which not decomposed at the end of the year of sampling (2014). The calculation DDOCm rem are as follows:

$$DDOCm\ rem = DDOCm \times exp2 \quad (4)$$

Explanation :

DDOCm = Mass of organic components in the waste that degraded and decomposed (Gg)

k = Rate of reaction constants

M = Month of reaction starts (= delay time +7)

exp2 = $exp^{[(-k\ (13-M))/12]}$ (IPCC, 2006)

- Calculation of DDOCm dec

  Decomposable DOC (DDOCm dec) decomposed is mass of deposited DDOCm which decomposes in the year of sampling (2014). The calculation DDOCm dec are as follows:

$$DDOCm\ dec = DDOCm\ rem \times (1 - exp2) \quad (5)$$

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Explanation :

DDOCm rem = Mass of deposited DDOCm which not decomposed at the end of the year (Gg)

exp2 = $exp^{[(-k\ (13-M))/12]}$ (IPCC, 2006)

- Calculation of DDOCm a

  Decomposable DOC (DDOCm a) Accumulated in SWDS End of Year is mass of accumulated DDOCm in the landfill at the end of the year of sampling (2014). The calculation DDOCm a are as follows:

$$DDOCm\ a = DDOCm\ rem + [\ DDOCm\ a\ (T-1) \times exp1] \quad (6)$$

Explanation :

DDOCm rem = Mass of deposited DDOCm which not decomposed at the end of the year (Gg)

DDOCm a (T-1) = Mass of accumulated DDOCm in the landfill in the previous year

k = Rate of reaction constants

exp1 = $exp^{[-k]}$ (IPCC, 2006)

- Calculation of DDOCm decomp

  Decomposable DOC (DDOCm decomp) decomposed is mass of DDOCm in the landfill decomposes in the year of sampling (2014). The DDOCm decomp calculation is as follows:

$$DDOCm\ decomp = DDOCm\ dec + [DDOCm\ a\ (T-1)] \times (1- exp1) \quad (7)$$

Explanation :

DDOCm dec = mass of deposited DDOCm which decomposes in the deposit year (2014)

DDOCm a (T-1) = Mass of accumulated DDOCm in the landfill in the previous year`

k = Rate of reaction constants

exp1 = $exp^{[-k]}$ (IPCC, 2006)

- Calculation of Methane (CH_4) Generated from TPA

Methane generated is mass formed of methane in the year of sampling (2014) decomposition of organic components stored in the waste. The calculation of CH_4 generated is as follows :

$$CH_4\ generated = DDOCm\ decomp \times (16/12) \times F \quad (8)$$

Where :

DDOCm decomp (2014) = Mass of DDOCm in the landfill decomposes in the year of sampling

(16/12) = Molecular weight ratio of CH_4 / C

F = Fraction of CH4 by volume in generated landfill gas (0,5)

(IPCC, 2006)

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4. RESULTS AND DISCUSSION

4.1. DETERMINATION WEIGHT OF WET WASTE IN TPA PIYUNGAN

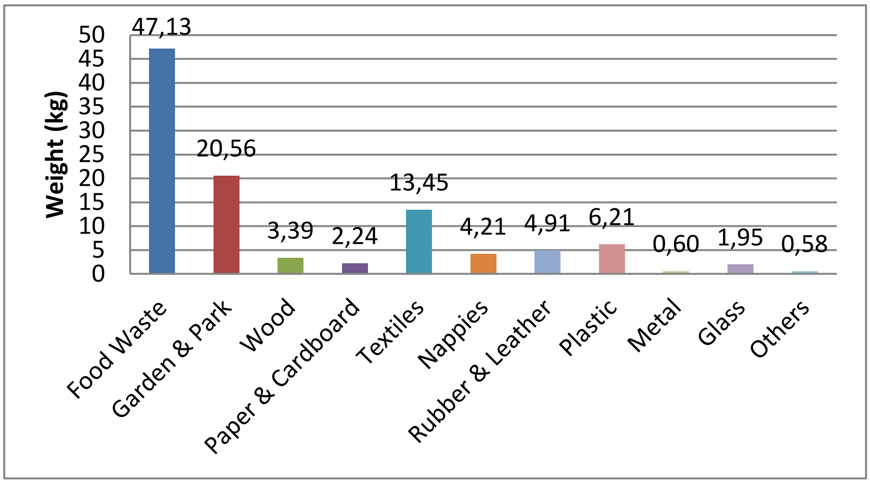

Figure 2. Wet weight per composition (kg)

It can be seen from Figure 2 above, earned the biggest weight of wet waste is derived from food waste which is equal to 47.13 kg equal to 44.82% wet weight. This suggests that the characteristics of the waste that went into TPA Piyungan everyday dominated by food waste so that the results of the weighing of wet waste, food waste is the most severe among other components.

4.2. CALCULATION OF DOC (DEGRADABLE ORGANIC COMPOUND)

DOC (Degradable Organic Compound) is one of the waste characteristics that determine the emission rate amount of formation methane gas. The calculation results are shown in Figure 3 below :

Table 1. The results of the calculation of DOC components trash

No.	Components	Wet Weight (%)	Dry Matter Content (%)	DOC i (% dry matter)	DOC
		A	B	C	D = A x B x C
1	Food waste	44,82	56,93	38	0,097
2	Garden & Park	19,59	70,56	49	0,068
3	Wood	3,24	40,45	50	0,007
4	Rubber & Leather	2,08	53,80	44	0,005
5	Textiles	12,72	51,55	30	0,020
6	Nappies	3,99	32,74	60	0,008

The result from Table 1 above, the highest DOC result is food waste component that is equal to 0.097. This suggests that food waste is a component that became the greatest contributor for the rate formation of methane emissions among other components.

4.3. CALCULATION ANALYSIS OF METHANE GAS EMISSIONS USING FIRST ORDER DECAY (FOD) METHOD

Based on the calculation of methane emissions with first order decay method, the results of CH_4 Generated are shown in Table 2 below :

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Table 2. Total emissions of methane

No.	Waste Components	CH_4 Generated	
		Gg	Ton
1	Food waste	4	4000
2	Garden & Park	2	2000
3	Wood	0,054	54
4	Rubber & Leather	0,053	53
5	Textiles	0,045	45
6	Nappies	0,034	34
	Total	6,186	6186

Table 2 shows the total CH_4 Generated by 6.186 Gg is equal to 6186 tons. From these results, it can be seen from the six waste components, food waste is the largest contributor to emissions of methane which is equal to 4 Gg or 4000 tons. This is consistent with the composition of waste that goes to TPA Piyungan which are mostly derived from food waste.

From previous research, decreased methane emissions in 2011 is equal to 6.35 Gg. The results of methane emissions that researchers gain is decreased from 2011 that is equal to 6.186 Gg. This is due to a decreasing the volume of waste that goes to TPA Piyungan since 2009. Indications decrease the volume of waste is evidenced by the many people who have succeeded in carrying out the management of organic waste by using communal composter. Waste management based on data from previous research, indicate that the number of composting reach until 0.3% in 2011.

4.4. SCALE ASSESSMENT OF ALTERNATIVE METHANE (CH_4) GAS UTILIZATION TECHNOLOGY

Scale assessment that used for the selection of alternative technology is ranking procedure method, where there are several factors that serve as parameters along with the scale in units of numbers. The assessment of these parameters can be seen in the Table 3 below :

Table 3. Scale assessment of alternative methane gas utilization technologies

No.	Aspect	Parameters	Scale*	Alternative Tecnologies		
				LFG	Fuel Cell	Methanol Conversion
1	Technical	▪ The installation compatibility with the environment conditions in TPA	10	8	6	7
		▪ The installation compatibility with the climatic conditions in TPA	5	5	5	5
		▪ The installation compatibility with the geographical conditions (region)	5	5	5	5
		▪ Availability of supporting infrastructures	6	6	4	6
		▪ Capability of human resources for operational technology	8	7	6	6
		▪ Health and Safety	9	8	8	8
2	Potential Utilization	▪ Potential absorptivity for the community around the landfill	6	3	4	4
		▪ Potential absorptivity for the landfill operations	5	5	5	5
		▪ The level of energy efficiency	3	3	2	3
		▪ Environmentally friendly	4	3	4	4

3	Economic **	▪ Investment cost ▪ Operational dan maintenance ▪ Payback duration	10 8 7	8 6 4	5 4 3	4 4 3

*) The scale value is 1-10, where the larger the number, the greater the importance of these parameters.
**) For the economic aspect (alternative technologies column), the smaller the number shows the more expensive its cost.

Having conducted an assessment of each alternative technology, the next step is to calculate the total value of each technology. Technology with the largest total value indicates that the technology is the most possible to be applied. The total value is multiply the scale of each parameter with the scale of each technology. Calculation of the total value can be seen in Table 4 below :

Table 4. The total value of alternative methane gas utilization technologies

Aspect	Scale / Paramaeters	Alternative Tecnologies		
		LFG	**Fuel Cell**	**Methanol Conversion**
Technical	▪ The installation compatibility with the environment conditions in TPA	80	60	70
	▪ The installation compatibility with the climatic conditions in TPA	25	25	25
	▪ The installation compatibility with the geographical conditions (region)	25	25	25
	▪ Availability of supporting infrastructures	36	24	36
	▪ Capability of human resources for operational technology	56	48	48
	▪ Health and Safety	72	72	72
Potential Utilization	▪ Potential absorptivity for the community around the landfill	18	24	24
	▪ Potential absorptivity for the landfill operations	25	25	25
	▪ The level of energy efficiency	9	6	9
	▪ Environmentally friendly	12	16	16
Economic **	▪ Investment cost	80	50	40
	▪ Operational dan maintenance	48	32	32
	▪ Payback duration	28	21	21
The Total Value		**514**	**428**	**443**

From the Table 4 calculation results, can be obtained the highest total value of alternative technologies is Landfill Gas (LFG) Flaring with 514. This suggests that landfill gas (LFG) flaring is the technology that can be most applied in accordance with the TPA Piyungan conditions compared to the fuel cell and the methanol conversion. Also required to consider the assessment of the social and political aspects that influence the decisions of technology selection. In this paper, social and political aspects are not discussed in detail (more into the technical, the potential utilization and the economic aspects) of each alternative technology.

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5. CONCLUSIONS AND RECOMMENDATIONS

5.1. CONCLUSIONS

Based on the research that has been conducted, was determined as follows:

1. Based on a waste sampling in TPA Piyungan, can be obtained by the composition of the waste wet weight (kg) and (%). From these data, the composition of the waste that has the greatest wet weight is food waste that is equal to 47,13 kg equal to 44,82% wet weight. This suggests that the characteristics of the waste that went into TPA Piyungan everyday dominated by food waste.
2. DOC calculations from each waste component can be obtained after analyzing the dry matter content. Based on these calculations, food waste is a component with the largest DOC value is 0,097. This suggests that food waste is a component that became the greatest contributor for the rate formation of methane emissions among other components.
3. From the analysis of methane (CH_4) emissions calculation using the first order decay (FOD) method, can be obtained the total emissions of methane (CH_4 generated) is 6,186 Gg or 6186 tons.
4. Decreasing of methane (CH_4) emissions since 2011 due to the decrease in the volume of waste that goes to TPA Piyungan since 2009. Indications decrease the volume of waste is evidenced by the many people who have succeeded in carrying out the management of organic waste by using communal composter.
5. According to the calculation results of the scale assessment, it can be concluded that the Landfill Gas (LFG) Flaring is a technology that can be most applied in accordance with the TPA Piyungan conditions.

5.2. RECOMMENDATIONS

1. Necessary infrastructure in the form of a layer or geomembrane landfill cover that aims to support the Landfill Gas (LFG) Flaring technology.
2. Supervise required to sterile the location of landfill from scavengers and all forms of activity that is not in accordance with the operational procedures of Landfill Gas (LFG) Flaring technology.
3. Central and local governments should provide clear regulations and procedures related to the procurement of installation and operation of Landfill Gas (LFG) Flaring technology.

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SPATIAL ANALYSIS OF WATER RESOURCES CARRYING CAPACITY IN YOGYAKARTA URBAN AREA

Eva HAPSARI[1], Widodo BRONTOWIYONO.[2] and Any JULIANI[3]

ABSTRACT: One very apparent impact of the keep increasing population especially in urban area is the decreasing of water carrying capacity. Water Carrying Capacity is the capacity of water resources to support human activities as well as other kind of life in one area. The problem of decreasing water carrying capacity also occurs in areas located in Yogyakarta Urban Agglomeration Area which covers Yogyakarta City and surrounding urban area in Bantul and Sleman District. Aim of this study is to determine the status of water carrying capacity of this area. The method applied in this study is by comparing water availability to water utilization by various activities in this particular area. Water availability potential is estimated based on analysis of hydrological data, while water utilization is estimated based on the quantity of various activities and water need of each particular activity. Estimation carried out for each Desa/Kelurahan in Yogyakarta Urban Agglomeration Area. Calculation result for each Desa/kelurahan (village) is then converted into 3 type of status: Overshoot, Sustain or Sustain with Condition. According to this study, 52 villages have the status of “Overshoot”, 19 villages have the status of “Sustain” and 1 village has “Sustain with Condition” status. This result can be a recommendation for policy maker to formulate better water resources management effort in this area.

KEYWORDS: water resources, water carrying capacity, Yogyakarta Urban Agglomeration Area

1. INTRODUCTION

Data from Central Bureau of Statistic showed that in 2012, urban population in Yogyakarta Special Region reached up to 68.02% of the total population of 3,514,762 people (BPS DIY, 2013). This number is likely to be increasing in the coming years due to urbanization. This especially happened in Yogyakarta City area and presently extends to its surrounding area of Bantul and Sleman Regency developed an urban region called Yogyakarta Urban Agglomeration Area (YUA). This region showed rapid physical development related to domestic, commercial, services and education activities. The increasing human activities in this area also means an increasing water demand. Meanwhile the capacity of nature to provide water for various purposes or water carrying capacity is limited. Without proper management, this condition would lead to water crisis where water extensive exploitation exceeds nature’s replenishment capacity. Furthermore, environmental problem such as depletion of aquifers, land subsidence or even drought would be expected threats. This study was aimed to determine the status of water carrying capacity condition in YUA Area as the basis and recommendation for proper water management in this area.

2. RESEARCH METHODS

Water carrying capacity status was determined by comparing the water availability to water demand/utilization by various activities in one particular area. Water availability potential is estimated based on analysis of hydrological data, while water utilization is estimated based on the quantity of various activities and water need of each particular activity. Estimation carried out for each Desa/Kelurahan (village) in Yogyakarta Urban Agglomeration Area.

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Calculation result for village is then converted into 3 type of status: Overshoot, Sustain or Sustain with Condition

2.1 CALCULATION OF WATER AVAILABILITY

Water availability was determined by calculating the potential of rainwater infiltration by using the modified method runoff coefficient of the rational equation. Runoff coefficient for each type of land use is presented in Table 1.

$$C = \frac{\sum(ci.Ai)}{\sum Ai} \tag{1}$$

$$R = \frac{\sum Ri}{m} \tag{2}$$

$$SA = 10 \times C \times R \times A \tag{3}$$

Note:
SA = water availability (m3/year)
C = coefficient of weighted runoff
Ci = coefficient of land use runoff i as shown on the following table 1
Ai = the extent of land use i (Ha)
R = average of annual rainfall of the area (mm/year)
Ri = annual of rainfall on I station
m = number of rainfall observation stations
A = extent of the area (Ha)
10 = conversion factor from mm.ha to m^3

2.2 Water Demand (DA)

Water demand/utilization was determined by calculating water usage for each type of activities mainly categorized into domestic and non domestic sector. Data of type of activities and its quantity was taken from secondary data mainly from Central Bureau of Statistic and Public Works Provincial Sub Project Management of Yogyakarta Special Region. Quantity of each sector of activity was then multiplied with relevant water consumption standard as presented in Table 2.

$$DA = DAD + DAND \tag{4}$$

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Table 1. Data of coefficient of land use runoff

No	Land Cover	Ci
1.	City, asphalted road, roof tile	0.7 – 0.9
2.	Industrial area	0.5 – 0.9
3.	Multi-unit settlement area, shopping centre	0.6 – 0.7
4.	Housing complex	0.4 – 0.6
5.	Villa	0.3 – 0.5
6.	Park, cemetery	0.1 – 0.3
7.	Yard of heavy land:	
	a. > 7 %	0.25 – 0.35
	b. 2 – 7 %	0.18 – 0.22
	c. < 2 %	0.13 – 0.17
8.	Yard of lightweight land:	
	a. > 7 %	0.15 – 0.2
	b. 2 – 7 %	0.10 – 0.15
	c. < 2 %	0.05 – 0.10
9.	Heavy land	0.40
10.	Meadow	0.35
11.	Land for agricultural cultivation	0.30
12.	Production forest	0.18

Source: Regulation of Environmental State Minister No 17, 2009

Table 2. Water consumption standard

No	Water sector	Unit	Water consumption
A	Domestic Sector		
1	Village (rural)	Liters/capita/day	80
2	Urban		
	Small city	Liters/capita/day	100
	Medium-big city	Liters/capita/day	150
B	Non Domestic Sector		
1	Livestock		
	Cow/buffalo/horse	Liters/head/day	40
	Goat/sheep	Liters/head/day	5
	Pig	Liters/head/day	6
	Chicken	Liters/head/day	0.6
2	Fishery in pond with depth < 70 cm	Liters/head/day	7
3	Agriculture		
	Paddy fields	Liters/second/hectare	1
	Dry crops	Liters/second/hectare	0.3
4	Industry	Liters/day/employee	500

2.3 Water Resources Carrying Capacity (DDA)

Water carrying capacity was calculated by using equation (5). The result then interpreted into either overshoot, sustain with condition or sustain.

$$DDA = SA / DA \tag{5}$$

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Note :
DDA = Water Resources Carrying Capacity
SA = Water Availability
DA = Water Demand

Output analysis:
DDA < 1 = The Water Resources Carrying Capacity is Overshoot
DDA 1-3 = The Water Resources Carrying Capacity is conditionally-Save
DDA >3 = The Water Resources Carrying Capacity is Save

3. RESULTS AND DISCUSSION

Calculation and determination of water carrying capacity status was done for 72 villages located in Yogyakarta Urban Agglomeration Area. The result is shown in Table 3. The table shows that 52 villages in this area have overshoot status which means that water demand in these areas has exceed water availability. There is one village having status of sustain with condition with DDA value 1.61. This value is very close to unsafe/overshoot condition that requires serious concern. Meanwhile, 19 villages are still in safe condition and should be well managed to prevent those from falling into unsafe condition.

Table 3. List of Water Carrying Capacity Status

No	Village	Water Demand (m^3/year)	Water Availability (m^3/year)	DDA	DDA Status
1	Gedongkiwo	639850558.4	89319299.4	0.14	Overshoot
2	Suryadiningratan	513864916.2	79433420.17	0.15	Overshoot
3	Mantrijeron	494199821.6	80990555.04	0.16	Overshoot
4	Patehan	297914490	17553600	0.06	Overshoot
5	Panembahan	436668208.4	47789676	0.11	Overshoot
6	Kadipaten	322899669	12682476	0.04	Overshoot
7	Brontokusuman	508561800	76828815.9	0.15	Overshoot
8	Keparakan	486267600	42446799	0.09	Overshoot
9	Wirogunan	620470800	72364716	0.12	Overshoot
10	Giwangan	314221200	150468362.1	0.48	Overshoot
11	Sorosutan	638910600	180626544	0.28	Overshoot
12	Pandean	534447600	181225560.6	0.34	Overshoot
13	Warungboto	418158600	92698367.4	0.22	Overshoot
14	Tahunan	400463400	99180034.2	0.25	Overshoot
15	Muja-muju	476587800	184641930	0.39	Overshoot
16	Semaki	251587200	77984062.2	0.31	Overshoot
17	Prenggan	492224400	107092319.4	0.22	Overshoot
18	Purbayan	424991400	88327521	0.21	Overshoot
19	Rejowinangun	523497600	137411775	0.26	Overshoot
20	Baciro	587577019.5	51144388.38	0.09	Overshoot
21	Demangan	429984631.2	35721576	0.08	Overshoot
22	Klitren	456527400	34705222.56	0.08	Overshoot

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No	Village	Water Demand (m^3/year)	Water Availability (m^3/year)	DDA	DDA Status
23	Kotabaru	167009420.8	34429192.2	0.21	Overshoot
24	Terban	442380010.4	40619030.4	0.09	Overshoot
25	Suryatmajan	302526600	8561329.56	0.03	Overshoot
26	Tegalpanggung	216985200	13462514.1	0.06	Overshoot
27	Bausasran	316893000	24430881.06	0.08	Overshoot
28	Purwokinanti	301650626	11223333	0.04	Overshoot
29	Gunungketur	213481200	10532160	0.05	Overshoot
30	Notoprajan	3845172059	27197109	0.01	Overshoot
31	Ngampilan	505262189.4	22216275	0.04	Overshoot
32	Patangpuluhan	348472800	28287626.4	0.08	Overshoot
33	Wirobrajan	441333180	43368363	0.10	Overshoot
34	Pakuncen	490925000	41503293	0.08	Overshoot
35	Pringgokusuman	586788610.4	19954493.64	0.03	Overshoot
36	Sosromenduran	380359200	14629828.5	0.04	Overshoot
37	Bumijo	474995124.8	37542762	0.08	Overshoot
38	Gowongan	403693660.4	23719302	0.06	Overshoot
39	Cokrodinatan	448218839.6	47789676	0.11	Overshoot
40	Tegalrejo	460452214.5	73472128.74	0.16	Overshoot
41	Bener	219986244.6	35969959.44	0.16	Overshoot
42	Kricak	607851433.1	73607072.04	0.12	Overshoot
43	Karangwaru	472739332.2	53704142.1	0.11	Overshoot
44	Prawirodirjan	439489200	22344635.7	0.05	Overshoot
45	Ngupasan	298102800	49278221.28	0.17	Overshoot
46	Jagalan	142919400	132981750	0.93	Overshoot
47	Banguntapan	2179787016	9113538126	4.18	Sustain
48	Singosaren	198327529.1	58958526	0.30	Overshoot
49	Baturetno	753364154.2	2038869624	2.71	Sustain
50	Wirokerten	604464703.2	1956913464	3.24	Sustain
51	TSavean	595160792.9	1846968750	3.10	Sustain
52	Potorono	566111792	1997681400	3.53	Sustain
53	Panggungharjo	1464314331	6643808814	4.54	Sustain
54	Bangunharjo	1294738141	8905652872	6.88	Sustain
55	Ngestiharjo	1606362139	3416153400	2.13	Sustain
56	TSavetirto	1177356284	5931104256	5.04	Sustain
57	Tirtonirmolo	1069274956	3456461646	3.23	Sustain
58	Wedomartani	308347453.6	1975533247	6.41	Sustain
59	Maguwoharjo	1284379739	535067652	0.42	Overshoot
60	Condongcatur	179751708.2	63541199.52	0.35	Overshoot

No	Village	Water Demand (m^3/year)	Water Availability (m^3/year)	DDA	DDA Status
61	Caturtunggal	2716808053	535067652	0.20	Overshoot
62	Sendangadi	158771029	1004961408	6.33	Sustain
63	Sinduadi	205279212	1900005162	9.26	Sustain
64	Ambarketawang	926926261.5	4818031574	5.20	Sustain
65	Banyuraden	83100250.8	1954656000	23.52	Sustain
66	Nogotirto	87837797.3	1487994097	16.94	Sustain
67	Trihanggo	778606695.5	3858539810	4.96	Sustain
68	Sidoarum	592098874	391512588.5	0.66	Overshoot
69	Sidomoyo	355289151.6	256100832	0.72	Overshoot
70	Sinduharjo	698445405	1122636588	1.61	Sustain with condition
71	Minomartani	628591525	209067372	0.33	Overshoot
72	Sariharjo	765044161	1596115968	2.09	Sustain

The result in Table 3 was then converted into map of carrying capacity status in YUA area as presented in Figure 1. With spatial approach or GIS (Geographical Information System) by employing other thematic maps, this map can be used to develop water management policy for this area. The ability of GIS to handle and process geographically referenced data established GIS as a technology which is important to a wide variety of application. (Yu, et.al., 2005)

Solutions to the problem are to be found in supply side and demand side measures (Prinz et.al., 2007). In supply side, the service coverage of piped water system should be increased, so that groundwater exploitation can be significantly reduced. Service coverage of piped water company (PDAM) in Bantul Regency, Sleman Regency and the City of Yogyakarta are still 42.2 %, 28.7 % and 40.1 respectively (Ministry of Public Works, 2012). Not only quantity, water quality is also of serious concern. According to the report on the performance of piped water company in Indonesia, the quality of piped water in Yoyakarta City and Sleman are still under requirement. Only 65.4 % samples in the service area of Yogyakarta City met the quality standard. In Sleman, it was even worst with only 50 % of samples met the standard (Ministry of Public Works, 2012). On the other side, water demand can be reduced through more efficient water use. A continuous campaign and initiative on less water use should be encouraged through technological innovation and although not popular is water pricing. Groundwater use especially for non domestic sector should be well managed through strict regulation. For both sides' measures, water conservation is of important aspect that should be continuously taken into action as it would maintain water availability.

Result of this study showed that "overshoot' status happened mostly in Yogyakarta City Area which is mostly developed and has highest population density of 12123 persons/km2 (BPS DIY, 2013). The increasing population and development would be in line with increasing water demand and land use changes. Land use change has deteriorated the rainwater infiltration capacity which would reduce water availability. Appropriate water conservation structures can be developed to allow rainwater infiltration in the built environment. Water retention facility could be one example of application. It can be divided into two types:

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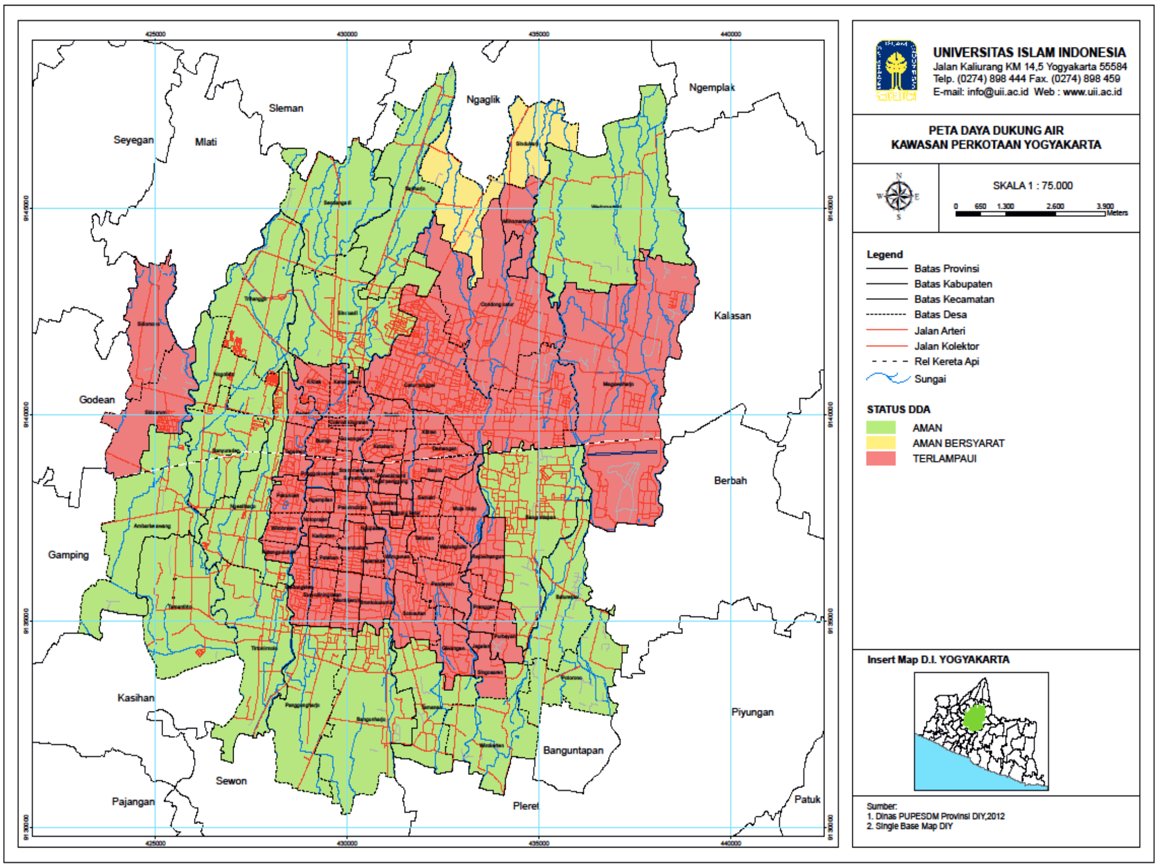

Figure 1. Map of Water Carrying Capacity Status

a. Storage facility to collect and store excess runoff to allow slow infiltration or simply as water source for various purposes
b. Lecharging facility which can be developed in areas that have a high degree of soil permeability and suitable aquifer for example recharge wells and biopores

Since 1988, through Regional Act no.5/1988 issued by Yogyakarta City Government, every new construction should be completed with an appropriate recharge well. The decree stated that for every construction, ratio of built area to total parcel must not exceed 80 % to maintain water recharge for water conservation. Through this regulation, construction of recharge well becomes one of requirements to acquire construction permit (Juliani, et.al. 2009). According to UNEP, it is estimated that if each house in Java and Madura had its own infiltration well, the water deficit of 53% by the year of 2000 would be reduced to 37%, which translates into a net savings of 16% through conservation. However, the regulation almost has no impact on conserving the rainwater due to lack of socialization, monitoring, awareness, and law enforcement (Brontowiyono, 2008). So, these aspects should be seriously addressed in the implementation.

4. CONCLUDING REMARKS

Water carrying capacity can be estimated by comparing water demand to water availability in one area. The study showed that 52 villages in Yogyakarta Urban Agglomeration Area have overshoot water carrying capacity status. Solutions at supply and demand side should be applied to answer the problem. Water conservation by building water retention structure can be an example of solution for both sides. However other supporting aspects such as raising awareness and law enforcement can be the key points of its successful implementation.

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STUDY ON THE PERCEPTION OF SETTLEMENT'S ENVIRONMENTAL INFRASTRUCTURE IN YOGYAKARTA URBAN AGGLOMERATION AREA

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ABSTRACT: The extensive development in Yogyakarta City has spread to its surrounding urban area of Bantul and Sleman District and established new area called Yogyakarta Urban Agglomeration Area. This area is of high attraction for investment as well as for people to come and stay. High population growth as well as vast housing construction is inevitable. This situation is not followed by provision of adequate supporting infrastructure including those related to sanitation and environment. This paper will discuss the assessment on the condition of settlement's environment insfrastructure in Yogyakarta Urban Agglomeration Area (YUA) according to the perception of its inhabitans. Settlement infrastructure assessed includes road, drainage system, solid waste handling, and water supply system. Field survey using proportional cluster random sampling was conducted. Settlement type was divided into 2 (two) categories; housing complex and non housing complex whilst the condition of environmental infrastructure was categorized into 3 (three) ; good, average and poor. This study showed that according to its inhabitans, the condition of environmental infrastructure in housing complex area is generally better than that in non housing complex area. The result of this research will be an input towards the development of green settlement.

KEYWORDS: Yogyakarta, environmental infrastructure, settlement, residential

1. INTRODUCTION

The extensive development in Yogyakarta City has spread to its surrounding area of Bantull and Sleman Regency established a highly populated urban region. Data from Daerah Istimewa Yogyakarta (DIY) dalam Angka (2013) recorded that the number of urban residents reached 68.02 % of the total population of DIY and is likely to be increasing in the coming years. This condition should be followed by provision of adequate housing as well as its supporting facilities. Otherwise, this region will suffer from slum settlement and illegal housing. Housing development should be in line with the affordability of the city to provide the necessary infrastructure.

In the term of green settlement, necessary infrastructure facilities should be provided includes road, drainage system, waste management and water supply system which accommodate environmental protection effort. One important element towards the implementation of green settlement is public perception which would affect the awareness on the need to build the necessary individual facility that meets certain standar or to maintain the available public facilities. This paper presents the evaluation of existing environmental infrastructure related to green settlement according to public perception.

2. RESEARCH METHODS

2.1 DATA COLLECTION

Primary data collection was conducted by field survey and interview with sample respondents. Population sample is household settled in Yogyakarta Urban Agglomeration

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Area. Respondent was determined by proportional cluster random sampling. There were 2 (two) cluster of housing area to be assessed i.e. housing complex and non housing complex. Housing complex cluster was divided into 3 groups based on property price i.e high class, medium class and low cost housing complex, while of non housing complex cluster was also divide into 3 groups based on number of population i.e. highly populated, moderate and less populated non housing complex area. Criteria for each groups is presented in Table 2.

Secondary data was taken from reports or other official sources of relevant agencies such as Central Statistics Agency of Yogyakarta and Department of Public Works of Yogyakarta.

Table 1. Criteria of Group Samples

Housing complex criteria		**Non housing complex criteria**	
Group	**Property price (rupiahs)**	**Group**	**Criteria (number of population)**
High class	800 million – 2 billion	High populated	> 30.000
Medium	400 – 800 million	Moderate	11.000-30.000
Low cost	80 – 400 million	Less populated	1000-11.000

Respondents for each group would be asked to assess whether the condition of each parameter of infrastructure evaluation in their housing area is good, medium/moderate or in bad condition. The parameter used for evaluation refers to the standard stated in Regulation of The State Ministry of Public Housing No : 22/Permen/M/2008 on The Standard of Public Housing Infrastructure for Province and District in Indonesia.

The condition of excisting related facilities in concern were also observed to assess the relation between people perception and the real condition.

2.2 DATA ANALYSIS

Data would be descriptively analyzed. Data was collected and processed by using percentage calculations and presented in a tabular format.

$$P = f/n \times 100\% \tag{1}$$

P = Percentage
f = frequency response
n = The number of samples

3. RESULTS AND DISCUSSION

The high population growth has led to the rapid conversion of land use into housing area. Initially the conversion occurs to brownfields, but presently it has already penetrated protected or water recharge area. This rapid change of land use is not followed by provision of necessary infrastructure such as road, sanitation, drainage system, solid waste handling and water supply system. The evaluation based on public perception for each particular infrastructure is as follows:

3.1. ROAD

The main function of road is to enable or support mobility of people as well as to maintain network in and among region. The condition of road infrastructure of housing area in Yogyakarta Urban Agglomeration Area based on the people perception is presented in Graph 1.

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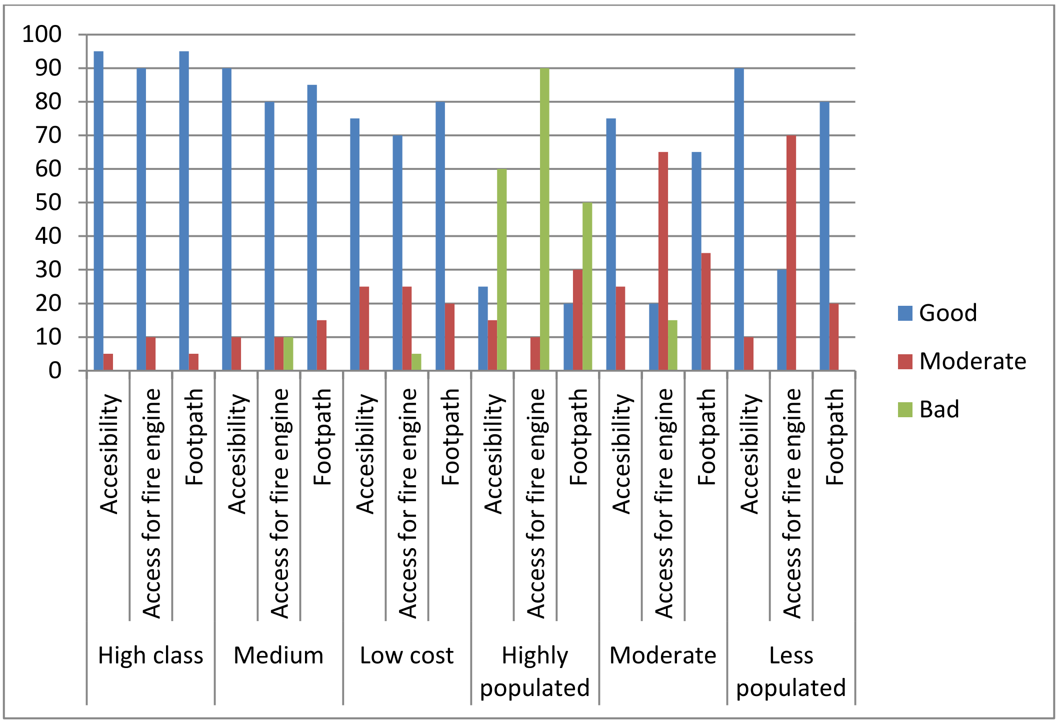

Figure 1. Condition of road

According to this regulation, road should be accessible for all connected settlement, save pedestrians way and disable friendly. The road should also be accessible for fire engine to penetrate or at least not more than 200 meters away from each house or building. The footpath should be accessible to all persil houses with the width of 0.8 to 2 meters.

According to public perception, condition of road based on accessibility to all connected settlement, accessibility to fire engine and footpath including its width, generally the condition are good in all types of housing cluster whether high class, middle or low cost housing. In the other side, the condition is generally bad in the high populated area especially in the aspect of the access to fire engine. In the moderate populated area this is also an issue, while in less populated area the condition is moderately better. Especially in non housing complex area, the accessibility of fire engine is rarely considered in the development of settlement.

3.2. SANITATION

According to the standar, a proper sanitation should meet following criteria:

1. Domestic wastewater should not pollute any water sources or soil and it should not emit odor to the environment.
2. Fecal sludge is disposed off every 2 years
3. In the absent of septic tank, a new housing should be connected to municipat sewerage system or by other option to enable wastewater treatment prior to disposal.

The condition of sanitation facilities in study area is presented in the following fugure:

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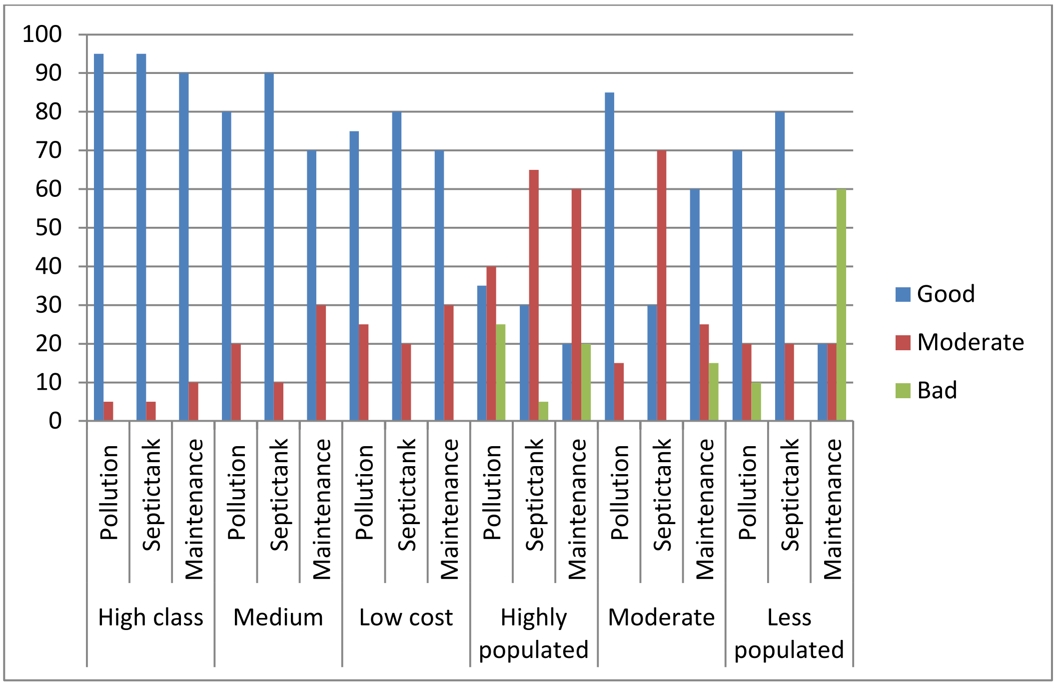

Figure 2. Condition of sanitation facility

It is showed in figure 2. that the condition of sanitation system in the aspect of its impact to pollution, the structure and physical condition of septictank as well as its maintenance in housing complex is better than that in non housing complex area. In the highly populated area, this facility 28.3 % is in bad condition.

- In high populated area, pollution occurs due to limited land area available for sanitation facilities. The distance of septic tank to water well is also less than 5`` meters.
- For houses connected to sewer system and Sewon wastewater treatment facility, the distance of system manhole to houses still allow odor problem as well as its high susceptibility to contamination in the case of leakage.
- Fecal sludge removal to maintain the quality of process in the septictank was rarely performed

To develop green settlement**,** service capacity of sewer system to Sewon wastewater treatment plant should be optimized for areas which already covered by the system. On the other hand, the provision of individual or communal wastewater treatment system should be enhance for areas not covered by municipal system.

3.3. DRAINAGE

The condition of drainage system according to public perception in study area is presented in the following figure.

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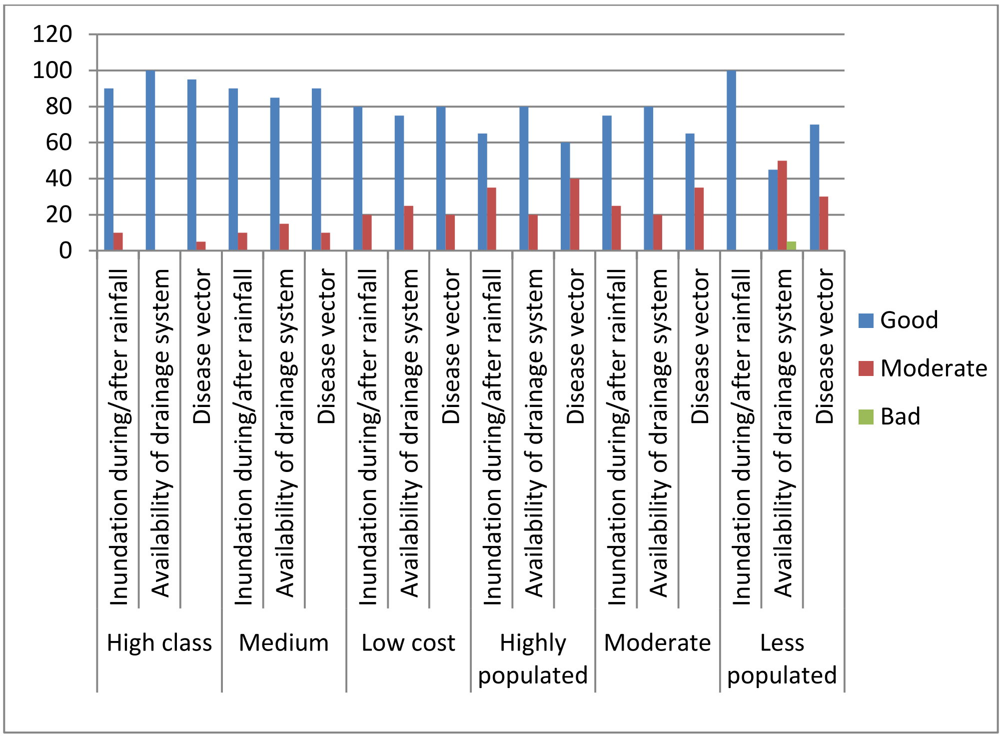

Figure 3. Condition of drainage system

According to the study, water inundation still occurs during or after rainfall event in low cost housing complex and in non housing complex area. According to the standard, a proper drainage system should meet following criteria:

1. Average height of water inundation/standing water should be less than 30 cm for less than 1 hour
2. Settlement should be Every neighborhood should have drainage system with sufficient capacity to prevent standing water after rainfall.
3. Drainage system should be connected to municipal drainage channel or water body with sufficient receiving capacity.
4. Drainage channel does not become vector breeding ground.

3.4. SOLID WASTE

Solid waste management is one of most prominent problem related to urban environment. The limited service coverage of municipal solid waste management worsened by people's lack of awareness and knowledge on the importance of proper waste management.

To assess the condition of waste management at residential level, criteria according to the standard were used. According to standard, solid waste management should cover following criteria:

1. All or 100 of solid waste generated are properly managed
2. Proper solid waste disposal that meet health standard.
3. Individual/communal waste management system

The existing condition of solid waste management in study area is presented in the following figure.

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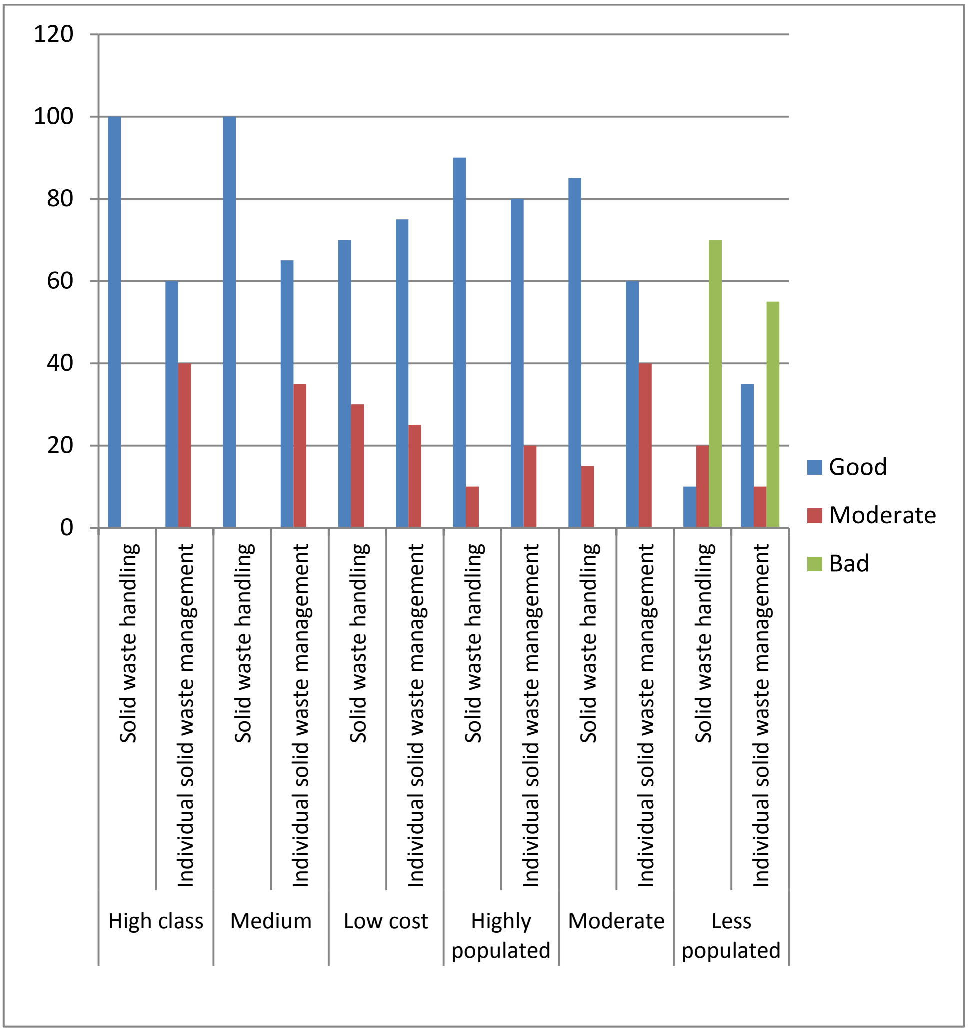

Figure 4. Condition of solid waste management

According to figure 4, solid waste management becomes major problem in less populated area which only 10% of solid waste generated were properly handled while only 35 % respondents have individual solid waste management. Solid waste management in other group of housing area is of better condition. Some solid waste management problem were identified during study i.e. lack of supporting equipment or facility such as local temporary waste collection site, solid waste burning or improper waste disposal.

3.5. WATER

Criteria for ideal water supply system according to the standard are as follows:

1. Service coverage is 100 % of total population
2. Provides 60-220 liters/person/day for urban area and 30-50 liters/person/day for non urban area
3. For public connection outlet, every tap serves for maximum 220 persons with maximum service radius 100 m and capacity of 30 liters/person/day
4. Provide good quality of water (met the standard)

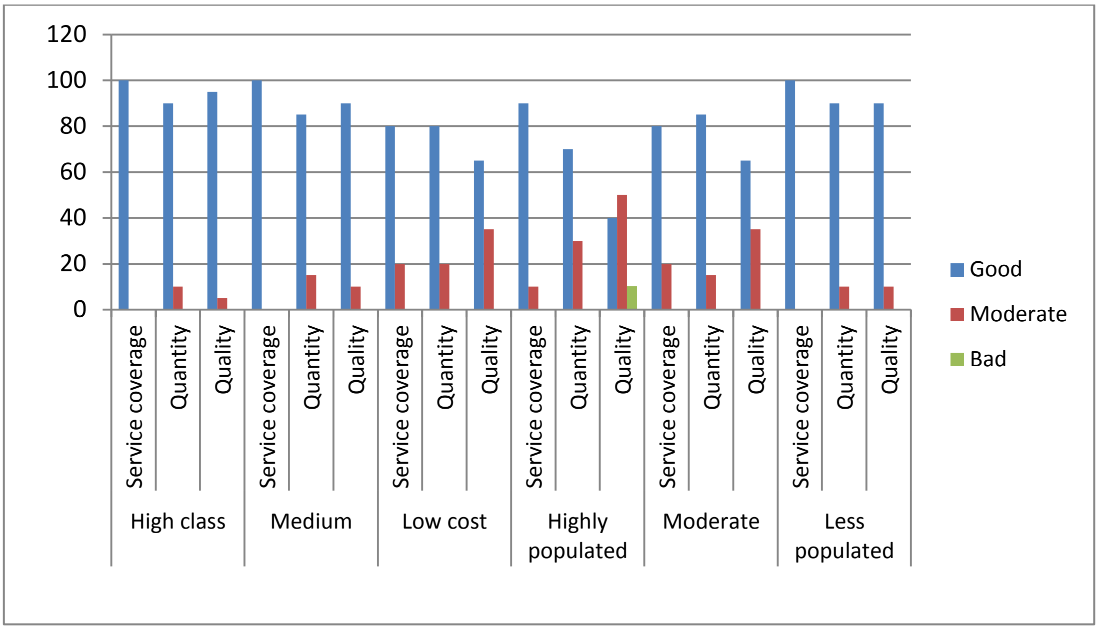

Figure 5. Condition of water supply system

Generally, all respondent have access to water through municipal piped water system or individual system especiallya groundwater well. The prominent issue is its quality. There is quality problem with piped water as well as groundwater well. Municipal piped water system can not maintain water quality so that most consumers are reluctant to use piped water for drinking water. They use bottled water instead. Quality of water from groundwater well is also a concern. Some *E.coli* contaminations of groundwater were identified which is an indication of fecal contamination due to low quality of sanitation system especially that is related to wastewater system.

3.6. ENVIRONMENTAL CONSERVATION

Environmental conservation efforts addressed in this study are rainwater harvesting and green space or open space reserve. Environmental conservation is closely relevant to the development of green settlement. The existing condition of environmental conservation efforts at household level is presented in figure 6.

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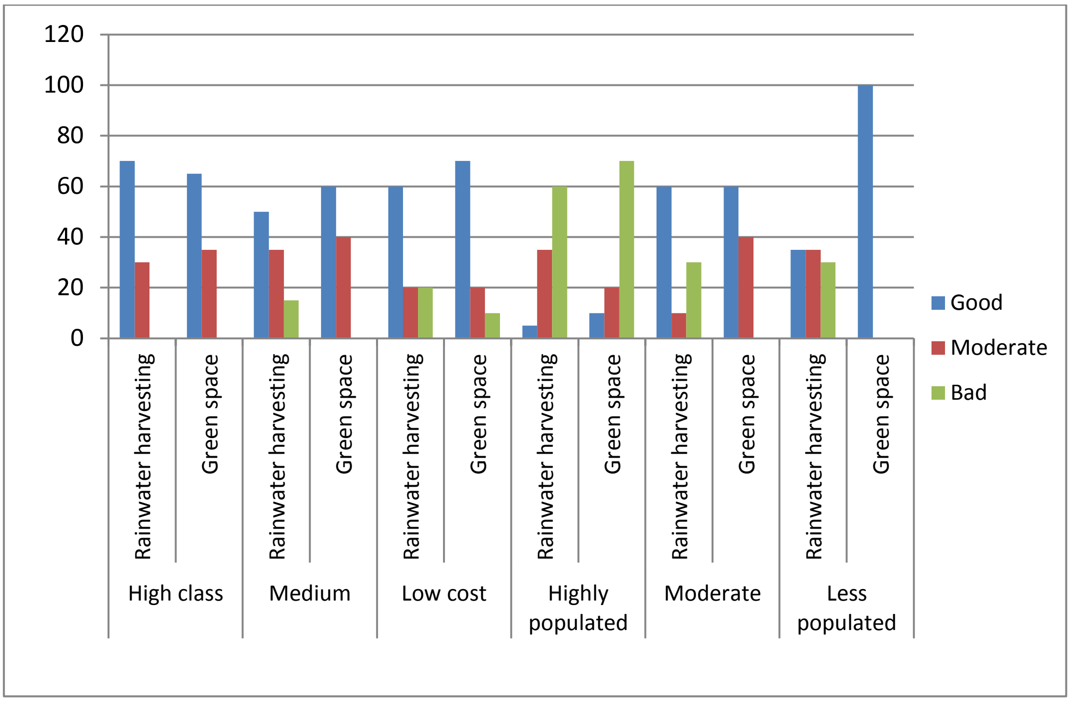

Figure 6. Condition of conservation facilities

The application of rainwater harvesting in Yogyakarta Urban Agglomeration Area is mainly to recharge the groundwater by using biopores or recharge well method or simply by providing open space with permeable surface or cover to enable rainwater infiltration. In highly populated housing area, limited space as well as cost requirement becomes the main issue to avoid such efforts. People awareness is another issue that actually biopore method for example is still applicable in limited space.

In term of green space, Regulation of State Ministry of Public Housing stated that urban area should manage area of minimum 30 % as green space. In highly populated area this is also a problem. Some innovative methods of making greenery in limited space should be introduced so that green space is also available in highly populated area.

4. CONCLUDING REMARKS

According to public perception, the condition of environmental infrastructure in housing complex is better than that in non housing complex. To develop green settlement, government should consistently improve the service coverage of municipal infrastructure as well as its quality. On the other hand, continuous public education to increase people knowledge and awareness is one complement element so that even in the area which is not reached by municipal service, the people can manage to build individual/communal system.Government can offer incentive or stimulus for every positive initiative towards the implementation of green settlement at every level.

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THERMAL ENVIRONMENT ON GREEN ROOF IN URBAN AREA OF WET TROPICAL CLIMATE

Yudi CHADIRIN[1] , Dila RAHMAYUDILA[2] , MAYASARI[3] and Hernadi ADHA[4]

ABSTRACT: As the impact of development activities in urban areas, many soil surfaces has been changed and turned into impermeable layers such as asphalt roads and concrete roof of the buildings. This condition affects urban environments by changing heat balance in urban areas and led to the phenomenon of rising air temperatures (heat island). One of the efforts to reduce the heat island effect is to extent permeable layers such as green roof on the rooftops of buildings. The purpose of this research is to study the thermal environmental conditions in a concrete roof and green roof. The result of measurements showed that the temperature on concrete roof surface varied in the range of 27 - 38.9 ^{o}C, while the temperature on green roof varied in the range of 20 - 34.9 °C. The presence of green roof on the rooftops of building can lower roof temperature up to 4 °C compared to bare concrete roof. Thus application of green roof is able to function as a heat insulator on the rooftop of buildings, and helpful to improve the thermal environmental conditions on the roof and thermal comfort in the room under the roof

.

KEYWORDS: Green roof, bare concrete roof, thermal environment, urban environment, heat insulator

1. INTRODUCTION

Green area tends to change and decrease as impact of development and construction activities, especially in big cities. Green areas in urban areas serve as a permeable layer that can absorb and retain water and then stored as groundwater. In addition green area serves as a permeable layers to evaporate water thus decreasing air temperature. However, construction activities as development demanding causes the green area turns into a impermeable layers such as asphalt roads, office buildings, settlement and industry. This condition causes the heat island phenomenon, the increasing of air temperature in the urban area that is higher than the air temperature in the sub-urban areas. Extention of green areas are usually constrained by limited space and the economic value of land is increasing. Green roof is an alternafive to create permeable layer in urban area that land is very limited.

Green roof is a roof that is partially or completely covered with vegetation and a growing medium that provides a general benefit to the city/community. Many studies has shown that green roofs built better environment in urban area, such as retain the run off (Mentens et al., 2006; Carter and Jackson, 2007; Getter et al., 2007); alleviate the urban heat island effect (Wong et al., 2003b; Takebayashi and Moriyama, 2007); improve urban biodiversity (Brenneisen, 2003); reduce building energy consumption and maintain buildings at lower temperature in summer (Wong et al., 2003a; Santamouris et al., 2007). Application of green roof for urban area in tropical region that characterized with high solar radiation and rainfall will provide benefit to conserve cooling energy and also improving air quality. The objective of this paper is to obtain thermal environment of green roof layers and compared to bare concrete roof from building in tropical climate.

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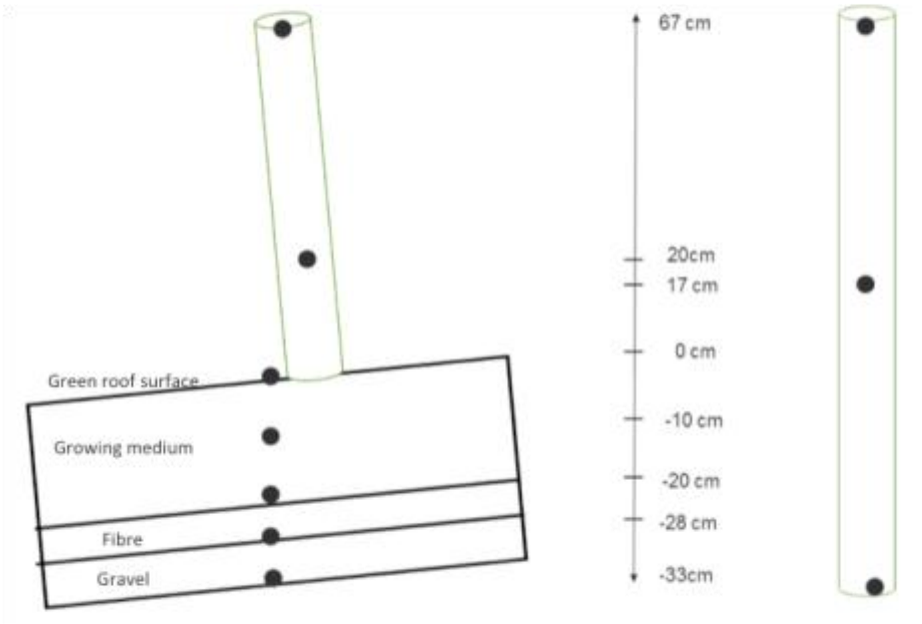
2. MATERIALS AND METHODS

The study was conducted from March to July 2014 on the rooftop of Agricultural Technology Information Centre (PITP) building, Faculty of Agricultural Engineering and Technology, Bogor Agricultural University at Darmaga, Bogor. A green roof models with size of 1 x 1 x 0:35 m and made of acrylic box was placed on the rooftop. The green roof model consits of 50 plants lilies paris (*Clorophytum comosum*) as vegetation layer, 20 cm thick layer of soil as a growing medium, 5 cm thick layer of fibers and 8 cm thick layer of gravels as a filter. Thermocouples (T type) was set up at every layer to measure temperature and recorded every 5 minutes by GL 820 midi data logger. Air temperature above green roof and bare roof top also measured and recorded with same method. The position of measurement points at rooftop are presented as Figure 1. Weather condition such as air temperature, relative humidity, solar radiation, precipitation and wind (speed and direction) were obtained from weather station that installed at Dept Civil and Environmental IPB, located at near PITP building. The weather station measured and recorded weather parameters using automatic weather station (Davis Vantage Pro2).



(a) Green roof (b) Bare concrete roof

Figure 1. The position of temperature measurent points at rooftop.

3. RESULTS AND DISCUSSIONS

Data from automatic weather station described environmental condition surround experimental area. Figure 2 shows ambient temperature and ambient relative humidity (RH) that obtained from weather station. The maximum ambient temperature occurred on 25 April 2014 at 15.00 h. It was 34.6 ° C. While the minimum ambient temperature occurred on May 23, 2014 at 07.00 h. It was 22.4 °C. Ambient relative humidity in range of 51% to 98%. Weather station was located at area that vegetated with grass.

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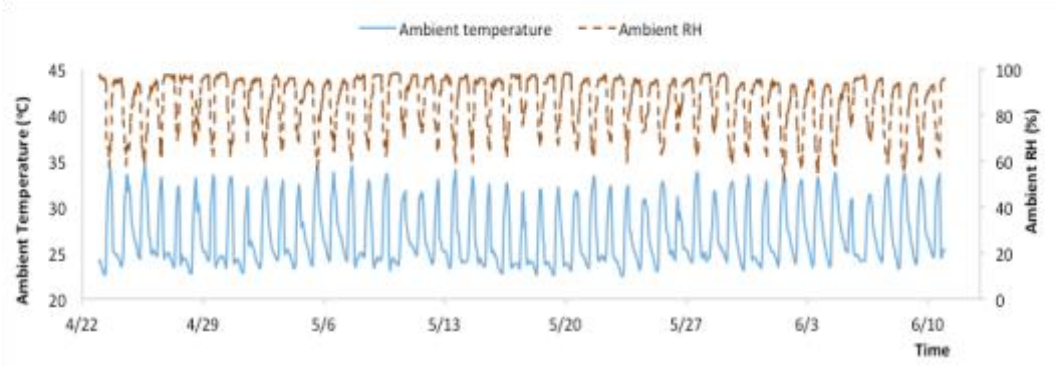
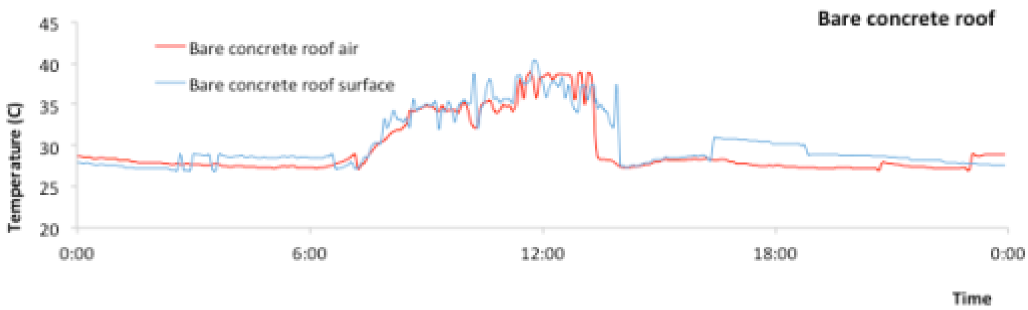


Figure 2. Ambient temperature and ambient relative humidity during experiment.

Below we present the diurnal temperature regime results of the comparison of the green roof and the bare concrete roof as Figure 3. These data were measured when solar radiation was high (sunny day). Comparing the green roof and the bare concrete roof on a typical sunny day with high solar radiation, the air temperature above the roof had similar pattern (Fig. 3). The air temperature above both of green roof and bare concrete roof rose along with the increase in the intensity of solar radiation and reached maximum at noon when radiation was maximum. The air temperature rose in same pattern but the level was different. The maximum air temperature of green roof was 34.9 ^{o}C occurred at 12.45 h. It was lower than air temperature of bare concrete roof that 38.8 ^{o}C,



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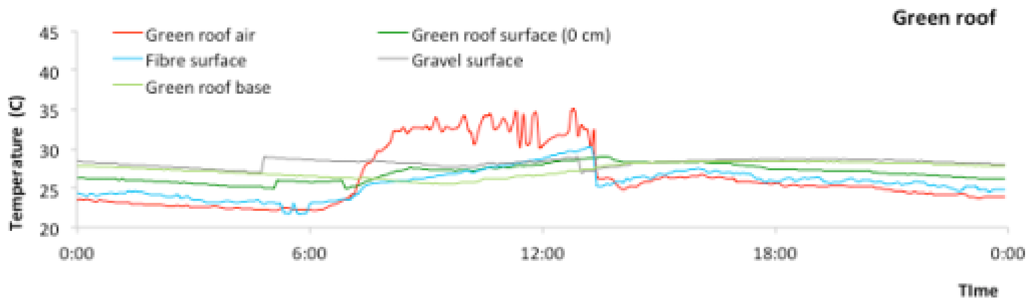

(b)

Figure 3. Diurnal temperature on fine day at (a) bare concrete roof and (b) green roof.

At bare concrete roof, the air temperature and surface roof temperature had same pattern, rose at morning, reached maximum at noon and felt at afternoon. This diurnal temperature was same as solar radiation intensity. Surface temperature of bare concrete roof was slightly higher than air temperature for both of daytime and nighttime. Diurnal temperature of green roof differs from bare concrete roof. The temperature under the 33 mm thick green roof is more stable than at surface layer. Temperatures at green roof layers were below 30 ^{o}C while air temperature daytime rose until 38.8 ^{o}C. These temperatures were lower than temperature at bare concrete roof. It shows green roof layer able to protect the base roof against higher temperatures at tropical climate.

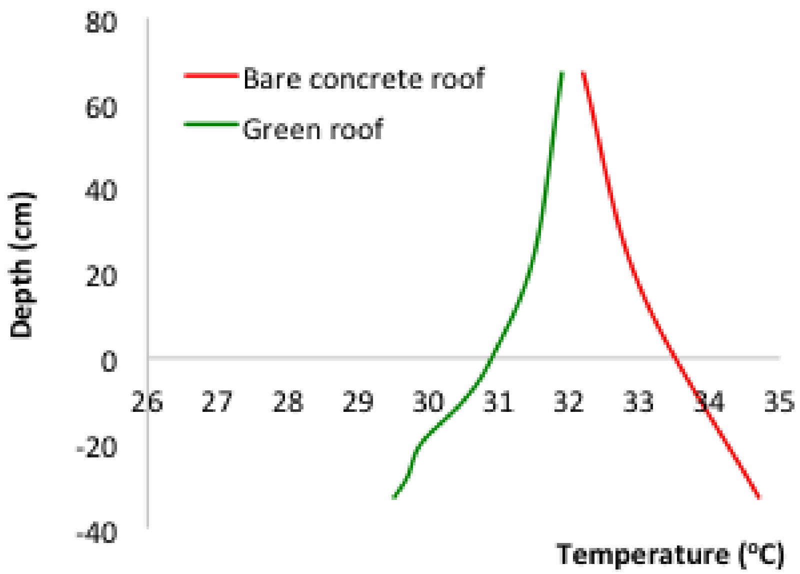

Figure 4. Temperature profile for both of bare concrete roof and green roof on sunny day

The amplitude of the diurnal temperature wave becomes smaller with increasing depth of green roof layers thus temperature decreased when it passed through green roof layers from air to roof base (Fig 3b). Opposite from green roof, temperature of bare concrete roof increased from air down to roof surface. It because of bare concrete roof functioned as exchange surface thus concrete received radiation and reflected back to the air and heated the air above the surface of bare concrete roof. For the soil such as growing medium in green roof layers, heat is stored in each succeeding layer so less heat is passed on to the next layer (Campbell and Norman, 1998). This Phenomenon can be illustrated at Figure 4 as temperature profile of bare concrete roof and green roof.

4. CONCLUSION

At tropical region such as Indonesia, characterized by hot weather and higher rainfall intensity. This encourages the development of technology to protect the building from weather and built better environment. The use of green roof is one solution. This paper articulated that application of green roof is able to function as a heat insulator on the rooftop of buildings in urban area. Application of green roof could protect base roof against higher temperature. Furthermore it could be expected air temperature inside the room below the roof being more comfortable. In addition, the air temperature in the upper layer of the roof can be lowered thus reducing the heat island effect in urban areas can be expected.

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THE OPEN SPACES ADDED VALUE OF THE EAST COAST OF SURABAYA RESIDENTIAL DEVELOPMENT

Timoticin KWANDA[1]

ABSTRACT: Surabaya is the second largest city in Indonesia, and half of the city at the eastern part has a coastline that extended from the north to the south. In 1990's, three developers have been granted to develop the area of 3,200 hectares, the so-called the East Coast of Surabaya. The East Coast of Surabaya is inherently vulnerable to climate change impacts such as rising sea level, changes in rainfall. These impacts would put this coastal area at greater risk of flooding, land subsidence, and sinking land. Therefore, before the area can be developed for residential area, some studies have to be done, namely environmental study, transportation study, hidrology study, and soil investigation to cope with issues, such as accessibility, flooding, soil settlement, and land reclamation. This article aims to show that these environmental issues of the East Coast of Surabaya is not a constraint for development, and it argues that coping these environmental issues with open space namely retention ponds, canals, green open space such as mangrove coastline zone and parks are indeed added value for residential development namely economic benefits. The economic benefit of the residential area is the increasing of land price.

KEYWORDS: East Coast, Surabaya, Residential, Open Space, Added Value

1. INTRODUCTION

Surabaya is the capital of East Java that most of the municipal territory at the north-south corridor has already urbanized, and new residential development can only be done at the open land areas at the western, and the eastern part of the city with a long coastline, the so-called the East Coast of Surabaya. The situation of the East Coast of Surabaya is though highly potential as it is very close from the city centre that can be enhanced to develop a new residential area. In 1990s, the East Coast of Surabaya with 3,190 hectares was granted to three developers for residential development.[2] This coastal area is a lowland area occupied by fish and shrimp pond activities with the presence of seven rivers flowing toward the sea that is inherently vulnerable to climate change impacts such as rising sea level, extreme weather events, and changes in rainfall. These impacts would put this coastal area at greater risk of flooding, land subsidence, and sinking land.

As a lowland coastal area, to develop the East Coast of Surabaya as a livable residential area, some studies have to be conducted, namely a district spatial planning, an environmental study, a transportation study, a hydrology study, and a soil investigation to cope with issues such as accessibility, flooding, soil settlement, the impact of land reclamation. Based on these studies of environmental issue, the area can only be developed with 31 per cent of the land for open space, and only 47 per cent for housing, public facilities (6%), industries (3%), and roads (13%). For the developers, this land composition with large open space is not worth to be quantified, as the revenue (return) on investment of open spaces is often not paid back to the developers, but to other parties namely communities benefiting from the green-space. The subdivided lots only are worth to be quantified as revenue for return on investment allocated for land filling, facilities provision and roads construction.

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[2] *The three developers were Dharmala group, Sac Nusantara group, and Pakuwon group.*

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Current reality reveals that the environment is often sacrificed in order to benefit residential development, mainly because in the East Coast of Surabaya open space such as retention ponds, canals, and green-spaces are seen as a luxury, a visual attribute of the area, and not a necessity. Open spaces on the other hand are believed to be more valuable, due to their direct benefit which can be determined in monetary value, thus the financial value of green-spaces needs to be quantified. In short, this article aims to show that environmental issues are not a constraint in residential development, and instead it has economic benefits.

2. OPEN SPACES AS ADDED VALUE

The literature study will explain the environmental issues as added value that affects the context of planning, they be used as a base for innovative approaches and processes. Environment is no longer approached as a constraint but as an added value that will have a transversal impact on all future residential developments. Some studies show that environmental issues such as green open spaces have direct and indirect benefits. These indirect benefits of green-spaces are hard to quantify in monetary terms (Harnik, 2009:6), and therefore classified as an indirect benefit of green-spaces.

These indirect benefits include social benefit that is the aesthetic value it offers, creating a qualitative living environment for all residents. Ahmed & Hassan (2003:9) concluded that the lack of green-space and the exponential increase of the population enhance physical, social, psychological and environmental hazards. Community cohesion is built through the use of green-spaces, as users are bound by location and common interest. Alongside the social benefits, open space especially green-spaces also have direct economic benefits such as increase of house or land prices (Perman et al., 2003). Direct benefits of green-spaces can be measured in monetary terms, but it is this value that is neglected within current planning procedures. Green-spaces needs to be expressed in monetary terms in order to become comparable to economic factors and consequently have more weight in the decision-making processes (Luttik, 2000:161-162). Numerous studies have also shown that housing and land value, which are adjacent to green spaces, may increase by 8% to 20% (Circea & Pîrlogea, 2011). It is known that most people are willing to pay more if they close a park, a school, a police station and any other facility of its kind. Therefore, urban green space can help increase revenue in real estate as a result of high property prices.

In this environmental issues, the East Coast of Surabaya has a map of constraints, such as flooding, and therefore the concept of a large portion of open space of residential development is selected with 31 per cent of the land for green open space, and only 47 per cent for housing. The 31 per cent of open space comprises mangrove coastline zone, green open space such as parks, canals and retention ponds. This study will focus how this land use composition is applied to the residential development and its economic benefits such as increase of property prices.

3. METHODOLOGY

It is important to note that this study was done within a specific reference framework, from a green planning perspective, evaluating green space planning concepts and the added value and benefits thereof. Other impacting forces also contribute to the green planning concept, but were not the main focus of this study. The case study of the East Coast of Surabaya is evaluated and described accordingly. Most of the data are collected from available documents, such as drawings (district plan, master plan, site plan), brochures, transportation study by the experts of Bandung Institute of Technology, the hydrology study by Prof. Lee Seng Lip, an expert from National University of Singapore, the Environmental Impact study (AMDAL), and the District Spatial Plan of the East Coast of Surabaya (Rencana Detil Tata

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Ruang Kota Pantai Timur Surabaya). Analysis and interpretation are based on the author personal experiences as part of the residential development team during the process of development from 1990 to 1996.

4. COPING WITH ENVIRONMENTAL ISSUES

Planning guides and ensures the orderly development of settlements. In the planning stage, in 1990 the East Coast of Surabaya as a lowland coastal area was planned to deal with the environmental issues through some studies as follows:

4.1 HYDROLOGY AND GEOTECHNICAL STUDIES

As a lowland coastal area that used for fish and shrimp ponds, it is inherently vulnerable to greater risk of flooding due to tidal seas and rains. In addition, there are seven rivers, also function as the rain water system, flowing from the eastern part of the city to the sea or the strait of Madura. Aware of this condition, the developers agreed to do various studies to develope the area as a livable residential area, such as hydrology and geotechnical studies.

The hydrology studies was carried out aim to set an efficient flood control and drainage systems, and the geotechnical studies was done to look for the most efficient land reclamation methods, such as whether to use the maximum level of land reclamation, the polder system, or the combination of the both systems. As a result of the studies, it is decided to use the combination system as the most efficient system, which is the area has to be filled at a level of 4 meter above the sea level (+1 meter of the existing level)) and equipped with some retention ponds that equals to 7 per cent of the total area, and barrages along the coast and rivers at a level of 5 meter above the sea level (+2 meter of the existing level) to block flooding due to high tides and heavy rains.

For the land filling, a conventional way of land filling through the city’s roads was not possible due to its huge volume, for it will destroy the roads and disturb the nearby community with noise and dusts. Hence, the existing fishponds were filled with sands that obtained by dredging sand from the bottom of the sea and pumped them to the site for at least 20,000 m3 per day.

4.2 THE ENVIRONMENTAL IMPACT STUDY

According to the Master Plan of Surabaya Year 2000, the area was planned for open space with mangrove forests, and limited used for fish and shrimp ponds. In order to sustain this condition, the municipal government asked the developers to do the Environmental Impact Study (AMDAL). As a result, the recommendation is 100 to 200 meter of coastal setback line to conserve the mangrove plant, 50-meter river setback line for Wonokromo river and 25-meter for the other smaller rivers (Figure 1). Another study such as transportation study was also carried out. This study tries to look for some access to the area from the western part of the city in order to connect the main road system of the two areas, and to accommodate the eastern outer ring road that passes from the north to the south in the area.

4.3 THE DISTRICT SPATIAL PLAN OF THE EAST COAST OF SURABAYA

Based on these previous studies, a district spatial plan of the East Coast of Surabaya or Rencana Detil Tata Ruang Kota (RDTRK) Pantai Timur Surabaya was done as the legal document that guide developers to develop the area. The area was permitted to be developed for residential uses with some restrictions, namely (Figure 1):

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- Coastal setback line from 100 to 200 meter, and 50-meter river setback line for Wonokromo river and 25-meter for the other smaller rivers,
- Providing a flood control system with north-south canal to hold flood from the west side of the area, and 7 percent of the area for retention pond
- 31 percent of the land for green open space, land use composition for the rest are housing (47%), public facilities (6%), industries (3%), and roads (13%).

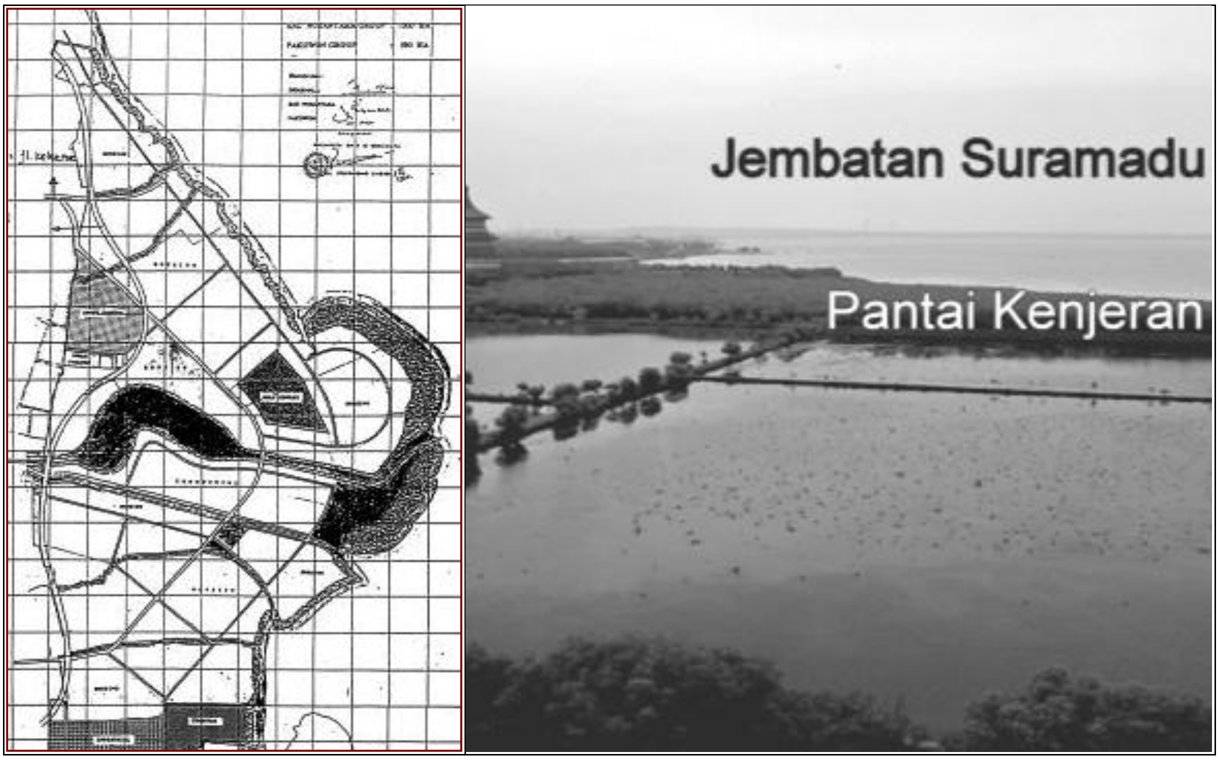

Figure 1. The co-production between the Municipal government and the developers for the District Spatial Plan of the East coast of Surabaya (left), and the mangrove of the East coast of Surabaya (right). Source: The Municipality Government of Surabaya (left), and author (right)

4.4 THE MASTER PLAN: THE ELEMENT OF OPEN SPACE

Based on the recommendation of the District Plan (Figure 1), a conceptual master plan of the residential area was developed by a well-known American architect, Paul Rudolph (figure 2). In the master plan, open space in the residential area is the main element as seen in the Conceptual Plan and the Master Plan. The open space is namely retention ponds located in between the residential blocks (the round shape or the irregular shape), rivers, and green open space such as mangrove (coastal line zone) and parks (Figure 2). In the two master plans, the main roads system is also appeared, especially the main accessed roads to area and the Eastern Outer Ring Road in the area, the collector and local roads pattern is also shown especially in the master plan (Figure 2).

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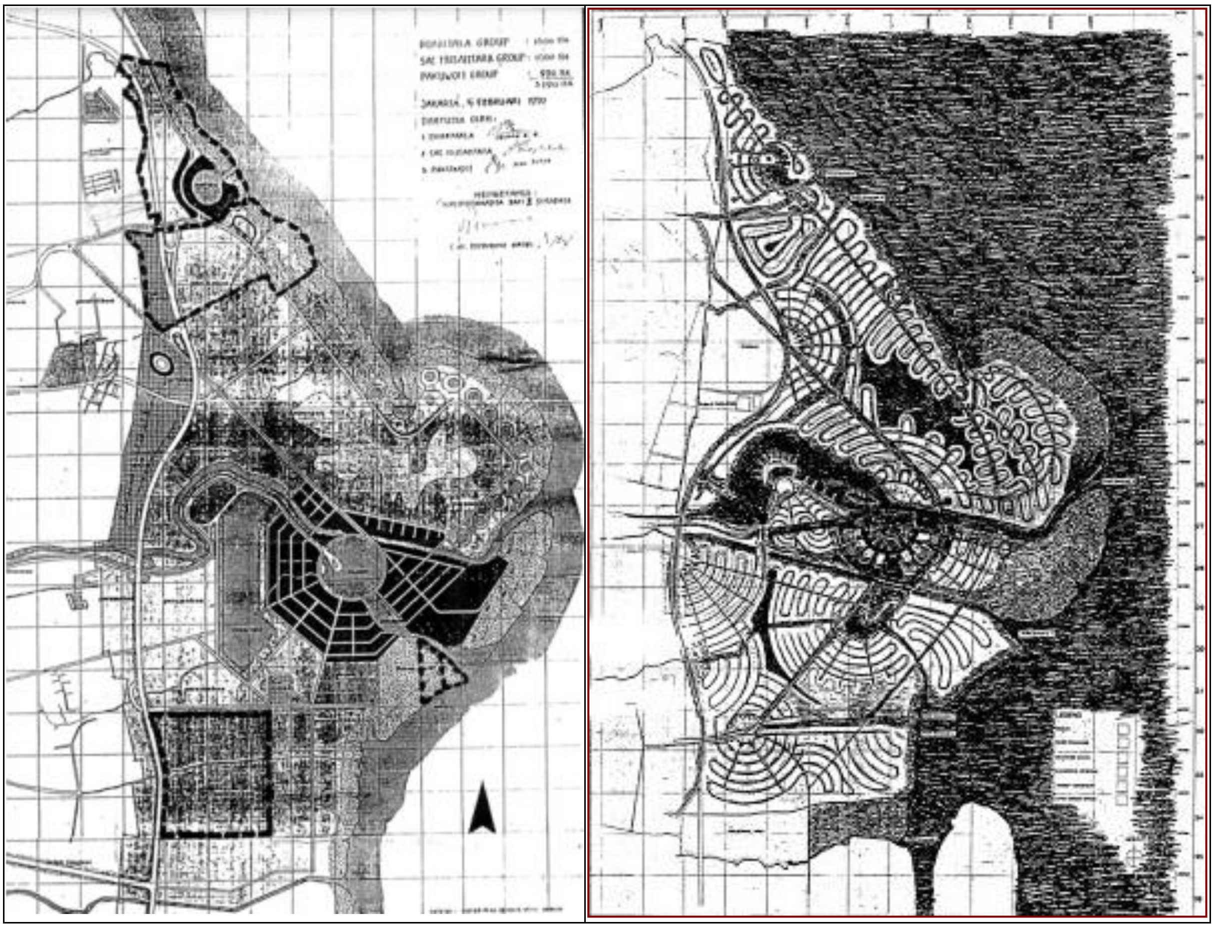

Figure 2. The conceptual Master Plan of the East Coast of Surabaya designed by Paul M. Rudolph (1918-1997) in 1990 (left), and the final Master Plan designed in 1991 (right). Sources: author.

5. THE BENEFITS OF OPEN SPACE

After six year of development through various stages such as land acquisition, planning, and marketing, in 1996, Pakuwon group developed the first zone of the area at the northern part with an area of 590 hectares. The rest of the area belongs to the two developers can not be fully acquired by them before 2009, consequently they cannot develop it as according to the Surabaya Spatial Plan 2009–2029, the area was planned for natural retention pond. The residential area was developed based a site plan designed by an American consultant that was totally different with the Rudolph's master plan due to the market demands. In the Rudolph's master plan, inefficient curved and circular road pattern will create irregular shape of lots, and it is difficult to sell irregular shape of lots, as most consumers of high-income groups and Chinese ethnics are unwilling to buy this kind of lots for geomancy reasons (Figure 3). The site plan still has to be confirmed with the District Spatial Plan such as the land use composition, the main streets pattern, and the most important elements of the area the open spaces (31 per cent of open space), such as mangrove coastline of 100 meter wide, parks, the retention ponds and the canals.

Today, the residential area, the so-called Pakuwon City is livable residential area with various developed residential clusters (Westwood, Virginia Regency, Palm Beach), a shopping mall, some schools, one campus, and two complexes of 19 tower apartments, and Town Square of a 9,2 hectare commercial center that is conveniently accessed by two main

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boulevards and an outer ring road (Figure 3). The commercial center consists of East Coast Center, an 8-storey retail mall with area of 23,372 square meters with anchored shops, specialty shops and alfresco dining and Soho (shop and home office). The mall was opened in October 22, 2010 (Figure 4).

As mentioned previously, direct benefits of green-space increases property value as many empirical studies have shown that parks have a positive impact (8% to 20%) on nearby residential property values (Harnik, 2009; Circea & Pîrlogea, 2011). Most people are willing to pay more for a home close to a green-area, this being reason for an increase in the market value. This was proven in Windsor, Canada where homes of 30 feet from a green-space were valued $6,995 more than those at a mean distance of 1,035 feet (Environment Canada, 1991). In four British Columbia urban communities it was found that a 10% to 15% increase in property value could be attributed to the land's proximity to a riparian greenway system (Evergreen, 2009:1).

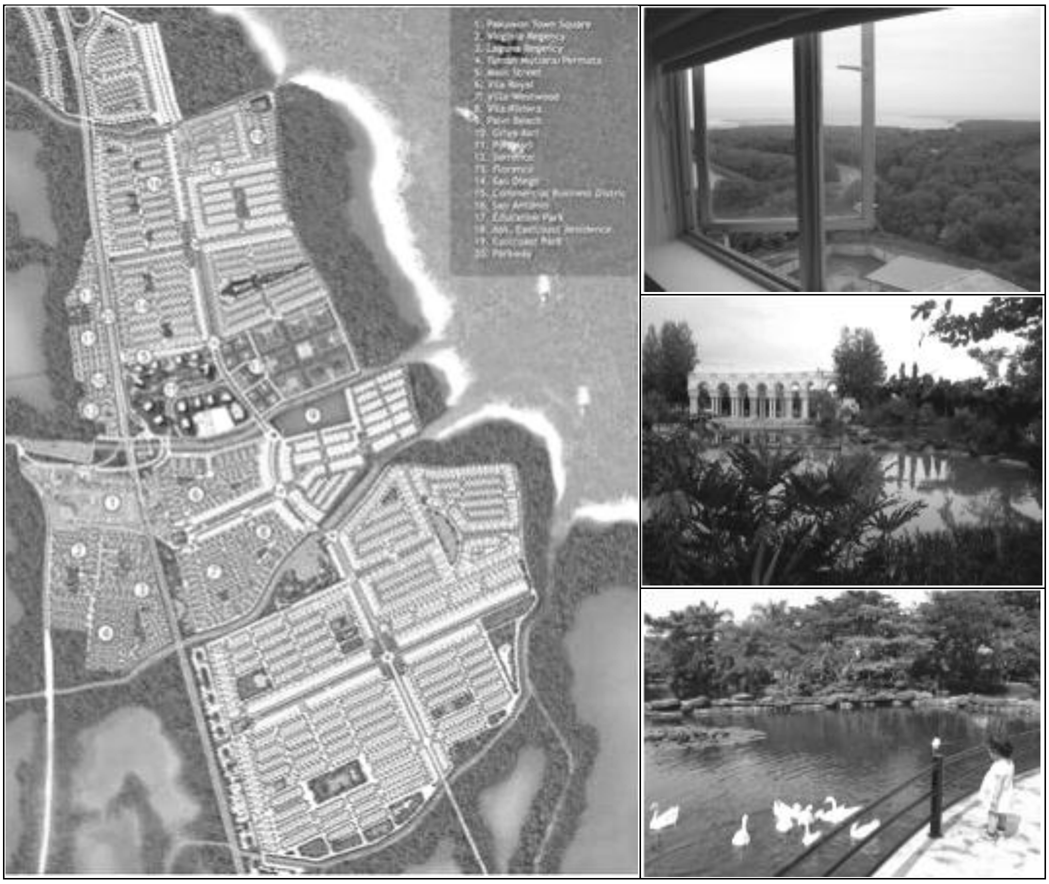

Figure 3. The current site plan showing the developed area coded with numbers (left), and one of the park with retention pond, the Goose Park (top and middle right), and the mangrove along the coastal line as seen from the window of the East Coast apartment (bottom left). Sources: PT. Pakuwon Jati.

In the case of the Pakuwon City of the East Coast of Surabaya, as the area develop the land price of the area has been increased drastically, since its first launching in 1994, the land price of a lot was only Rp. 400,000 per m2, and today the price of land has increased to Rp. 12,500,000 per m2, thus it has increased more than 3,000 percent for 20 yeas or 150

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percent per year.[3] This current land price is not only influenced by the open space, but also the provision of amenities in the residential complex, however as shown in the price list of lots, a certain lot close to a park is valued 10 to 20 percent higher than those far from the parks. One popular park with retention pond is Taman Angsa or Goose Park (Figure 3). In 2014, a new residential area has been developed related to the 'open space as added value' such as the Grand Island cluster is developed as a canal resort, a residential complex with water recreation and sports, and the land price of a lot is 21,500,000 per m2 (Figure 4).[4]

The Town Square | The East Coast Center | The East Coast Apartments

Palm Beach residential complex

The Educity apartments | A high school building | A university complex

The gate to the Grand Island cluster | The canal concept of the Grand Island cluster

Figure 4. The livable residential areas with public facilities at the Pakuwon City. Source: PT. Pakuwon Jati

[3] *The land price of the first cluster, Westwood, launced in 1994, and in 2014 the land price of the Palm Beach Cluster at Pakuwon City as offered by broker, http://rumahdijual.com/surabaya/128227-dijual-tanah-di-palm-beach-malibu-pakuwon-city-surabaya (downloaded on September 14, 2014).*

[4] *See http://rumahdijual.com/surabaya/487158-grand-island-pakuwon-city ((downloaded on September 14, 2014).*

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6. CONCLUSION

Residential planning is constantly faced with conflicts between pro-development approaches and pro-environment approaches. In the case of the East Coast of Surabaya, especially the Pakuwon City, it can be concluded that the development of the residential area has been developed in line with the environment approach. Following the environment approach, the master plan of the East Coast area was designed based on the various studies such as a hydrology study, a geotechnical study, and an Environmental Impact Study. Subsequently, the residential area was planned with a large open space or 31 percent of the land area for open space namely retention ponds, and green open space (parks and mangrove).

This environment approach is no longer as a constraint but as added value as in this residential area, the green-spaces have economic benefits that increase house or lots prices when green space is present. It is proven that the land price has been increased for more than 30 times since its first launching of the residential area in 1994. Thus, open space has been seen as added value for residential development. Unfortunately, this green space of the high-end residential development in Surabaya is used only for the people who live in the residential complex, except for the Goose Park that located outside the residential cluster.

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CONCEPT OF SUSTAINABLE CITY IN DEVELOPING COUNTRIES

Munichy Bachron EDREES[1]

ABSTRACT: Generally, most of cities in developing countries as though sporadic and without planning. So it's likely if the pleasant predicate of the cities and towns is always best achieved by the cities in developed countries. The face of city are influenced by both of environmental and residential patterns of upperclass people, middle class, as well as community grassroots level. Lack of planning on the environment will result in damage, both in social and environmental order as well as the natural environment. Good planning is thinking long-term planning and sustainable. With the concept of sustainable planning, the pattern of community life will be planned and patterned so well that minimize impacts caused by urban development (urban development is more controlled and designed).

The concept of sustainable planning and designing of urban space, we must pay attention to community characteristics. In this globalization era, we should not turn a blind eye to the occurrence of mixing indigenous culture with the outside culture, which in turn will shape the characteristics of communities to form local wisdom. Local wisdom is that we must dig and utilized to form urban spatial. Local genius is local ideas that is characterized such as: wise, full of wisdom, good values, that planted and followed by society. Local genius is also a local wisdom.

Keywords: patterns of occupancy and the environment, sustainable cities, characteristics of local wisdom

1. INTRODUCTION

The existence of a wide range of cultural patterns affect people's lives, including in terms of social and psychological, which ultimately helped shape the face of the city. Growing city became sporadic, and the lack of shelter arrangement that makes the city fragmented and not humanist. Culture and customs of the society and its inherent character before, 'forced' to change according to the demands of the city that is often 'not friendly'. This is exacerbated by the business arrangement that does not care about the needs of society, and without any approach to cultural and community character of its inhabitants.

For that we need a cultural approach and explore the character of the community, so that planners and urban designers capable of managing a city with empathetic approach, so as to create a more humane city.

2. RESULT AND DISCUSSION

2.1. PATTERNS OF OCCUPANCY AND THE CITY ENVIRONMENT

In this discussion we shall use a rather different interpretation, which is both more pragmatic and behavioral, and social. At the other side, social objectives can not be separated from the economic power. Levels of economic power affect social life, while the level of community social also influence what kind of their environment. Of course, buildings can be seen in many different ways, for example, be viewed as works of art, as technical achievements, as the wallpaper of urban space, and as behavioral and cultural phenomena. It will treat architectural and urban spaces as containers to accommodate, separate, structure and organize, facilitate, heighten and even celebrate human spatial behavior. In so much as they do that, they will also be viewed as psychological, social, and partly cultural phenomena.

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Space, and consequently that which encloses it, are much more central to all of us in our everyday lives than purely technical, aesthetic or even semiotic interpretation would suggest. Space is both that which brings us together and simultaneously that which separates us from each other. It is thus crucial to the way our relationships work. Space is the essential stuff of a very fundamental and universal form of communication.

Building will form space, and space will form face of the city. But most city in Indonesia have no arrangement which cause cultural friction and lack of quality of the environment. Community 'forced' accept and change the pattern of their life to be 'acceptable' in the city living. This cause environment raises new characteristic of the people who lives in city, although their origin culture often still underlie behavior.

Clearly, than, one of the role of space is to create settings that facilitate the acting out of range of identities we use in our lives. Much of this must be done not by architects but by the actors themselves, since the space is effectively and extension of their own behavioral mask. In turn, the challange for architects is how to create space that invites and facilitates taking possession and personalization. In passing, it is worth noting that this is a rather different view of the task of architects to that which seems to dominate in many contemporary schools of architecture. Here it seems the task is to create space that is a monument to the originality of the architect.

Perhaps we tend only to notice this language when it is in some way abused. Buildings (and also public space) can fail to speak the language of the space properly just as much as people can. For example:

- One of the important features of the family territory is that it must be easily distinguished in some way from all the others. Its separate location gives it a uniqueness, of course, but this is not enough. Its shape and general appearance must make it stand out as an easily identifiable entity, so that it can become the 'personalized' property of the family that lives there. This is something which seems obvious enough, but which has frequently been overlooked or ignored, either as a result of economic pressures, or the lack of biological awareness of architects. It can be seen in slum, and many government project about public housing (perumnas and rumah susun). Slum and public housing have a lack of quality of the environmental. Their environment create daily life that 'over-social', so that cause friction among residents who have different cultural. For the opposide, in the upper class of community, their environment make an expression 'anti-social'. Their lives tend to be individualistic.
- Government buildings which should be open because its fuction are public service, but what happens is the government buildings that does not seem friendly, the buildings appears secretive and forbidding. That buildings may have an interesting architectural form, but it seems consistenly to send out the wrong signals.
- Characteristic of the people of Indonesia are social interaction to gather around. So people need some of open public space. But cities in Indonesia have less open public space.

We are interested in the space created in and around architecture. Architecture organized and structures space for us, and its interiors and the objects enclosing and inhabiting its rooms can fasilitate or inhibit our activities by the way they use this language. Because this language is not heard or seen directly, and certainly not written down, it gets little attention in a formal sense. However, we all make use of it throughout all of our lives as we move about in space and relate ourselves to others.

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2.2. COMMUNITY PSYCHOLOGY APPROACH

Since these two dimentions of conciousness and control are independent, we can usefully think of human behavior in four major sectors.

Our behaviour is influenced and even constrained by space form that comprise both the physical and the social environment. This succinctly points out that a space form really consists of the space, its surroundings and contents, and the people and their activities. Space form, whether they are parts of special territories or not, are important to us as ways of generating security.

Figure 1.

- Stimulation is perhaps the most obvious and simplest of the three to understand; however, it turns out to be rather fundamental and less of a luxury than at first we might think. By contrast, an environment in which we are bombarded with sensation seem equally disturbing, and sadly this is exploited in many forms of torture. Actually, of course, the level of stimulation we require varies-some people simply like the quite life, while others prefer more action-but even then our needs change as our moods change and indeed as we age. If we just see this, of course impossible to produce an environment that all would feel ideal. So we also had to approach the culture and characteristics of the local community (by the group).
- Security have a very deep and fundamental need for a degree of stability, continuity, and predictability in our lives. It might sound exciting not to have this, but just imagine how stressful it would be to lead a life of constant flux and unpredictability. We depend for our sanity upon knowing the rules, as it were. Every social group that has any degree of cohesion also has norms. These norms regulate behaviour, dress, and forms of language and even in some cases define entirely local aspects of spoken language. Social norms then are extremely powerful in that they give security to people in the group, allowing them to behave in a regulated way without fear of their behavior being thought to be inappropriate by their neighbours, colleagues, and friends. Security and secure is one of psychological needs and physiological needs. Those needs can be solved with the architectural design.
- Identity is one of the most fundamental forces at work in our psychological make up is the need to create and maintain our own identity. One of the role of space is to create settings that facilitate the acting out of range of identities we use in our lives. Much of this must be done not by architects but by the actors themselves, since the space is effectively and extension of their own behavioral mask. In turn the challenge for architects is how to create space that invites and facilitates taking possession and personalization.

Spaces, as we shall see, can always contribute to all these three requirements of stimulation, security, and identity.

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Other than those already mentioned above, motivation undoubtedly plays a central role in our behaviour, and any analysis of how we behave in relation to space must recognize this powerful force. Motivations are many and varied, and not only depend on personality and culture but also change with time and situation. However, we do seem to be driven by fundamental internal needs, or so a great deal of psychological theory would have it. Certainly, those needs that architectural space can help to satisfy.

Territority is important. We have by now seen some crucial distances in human relationships. We have seen that these distances are not absolutely precise, but we have also learned that neither are they entirely abitrary. In fact they are closely linked to how we sense and than perceive other people. How we choose to allow others to relate to us depends on a number of factors: these sensory factors, our own personality, and the occasion and our wider culture. The consequence of distance for us humans is far more complex than all other species, largerly due to our sophisticated culture. It is now time to define these distance more carefully.

Figure 2.

In addition to these things, which must be considered also by the planners is a matter of psychology towards a common space, such as: noise problems (will affect the work activity), phobia of space, such as claustrophobia (fear of enclosed spaces), or Nyctophobia Achluophobia (afraid of the dark room).

In shape space, we will classify based on linkage with the user, namely:

1. As the Configuration Space.

   In breaking down the problem space, the required definition of the form of space and this raises two meanings, namely the composition of human beings in space and relationships between people in the room (Hiller and Hanson, 1984: 26). Interpretation of the behavior: people and buildings, where the relationship between design and use of domestic space tested, many studies in the field of environmental psychology, sociology houses, and architectural model adopts the interpretation of form or function behavior model space.

   With regard to the principle that expected on the relationship between humans and space we will find at the level of the configuration of the space instead of the individual activities. It is situated on the relationship between humans and the configuration of the configuration space (Hiller 1996: 29-31).

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2. Space As Social Object.

   The fundamental problems of the theory of space in terms of sociology is to show how a group going, into as individuals, came out as the behavior and thinking. Sociology defines the behavior at the individual level should be described with the terminology of the broader group (Hiller and Hanson, 1984: 201).

   Here there are two aspects of the problem. First, the idea of building compiled by social ideas. Secondly, the idea of social institutions with the idea of the building. Each show problems for the theory of architecture. First discuss the question form - function. Both talked about the question of building a social object. (Hiller 1996: 372 and Hiller and Hanson, 1984: 176).

Sustainable cities can be achieved if the space form can provide a sense of secure, security, and comfort.

2.3. CONCEPT OF SUSTAINABLE CITIES

In this discussion we shall certainly consider the purely physical charateristics of space, the objects they contain and the envelopes that devine them, there is something far more important to us than that. Of course we are all different, but in general ultimately it is our relationship not directly with spaces or buildings that matters most to us, but our relationship with other people.

To create sustainable city, we must to see in advance the need of community:

- ‘Personalized’ property of the family that lives there.
- A place to socialize
- Secure and safety
- Place identity of the community that lives there

In connection with the theory of space in architecture, environmental psychology has a discussion of human behavior towards the relationship with their physical environment.

There are strong relationships in the environmental psychology of human-environment relationships studies on contextual architecture. By answering this question, it will form a sustanable cities.

Architects / planners in designing should pay attention and adhere to the following five principles, to answer the questions above, namely:

- **Function.** Building functions are influenced by human activity, whereas humans are influenced by biological, psychological, social, and also influenced by reason and culture. These aspects form the pattern of human behavior, which ultimately will affect the form of space. So the form of space must consider the pattern / configuration of human behavior, which in the context of the environmental pattern is formed not by individuals, but the group trend.
- **Form.** Form a building or space is influenced by the behavior of human users, which in turn form shaped by function. For example, suppose that we will design a living room, would have been different with the design of the dining room, bedroom, kitchen, etc. So also, when we design buildings with commercial functions, of course, will also vary with the building that serves private.

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- When we design, between function and form are intimately associated with one another, but in shaping the form must also consider the **technics, safety,** and **comfortability**. Safety and comfortability is a basic human need during activity. Safety and comfortability is influenced by human needs of both the psychology and physiology. All of these design principles (function, form, technics, safety, comfortability) must be efficient, which should always pay attention to the context in which the building / environment will be established / planned, because everything is back to his character and behavior of humans who will use it. Architect shall be deemed to fail if the building design / space / environment planned / establishment are not able to accommodate the needs of users, not able to regulate the negative behavior of users. For example, although a beautiful building, but that does not give comfort to its users, does not give users a sense of security, does not fit the character / culture of its users will be called a failure. Architecture is a container which contain human activities in it, so the architect should be able to design not only beautiful in form, but also able to reflect the character of its users, so it needs psychology and physiology needs can be met.

Figure 3.

3. RECOMMENDATIONS

From discussion above, we see that in order to establish sustainable cities in developing countries must go through psychological approaches to meet the physical needs of space. Psychological needs are fundamental and the most important in human lives. The differences of psychological needs of every human being (group) are often also influenced by culture. So that the fulfillment of psychological needs as a basic for designing space and environment will create a sustainable city, while the influence of culture in psychological needs will create an environment characterized by community appropriate.

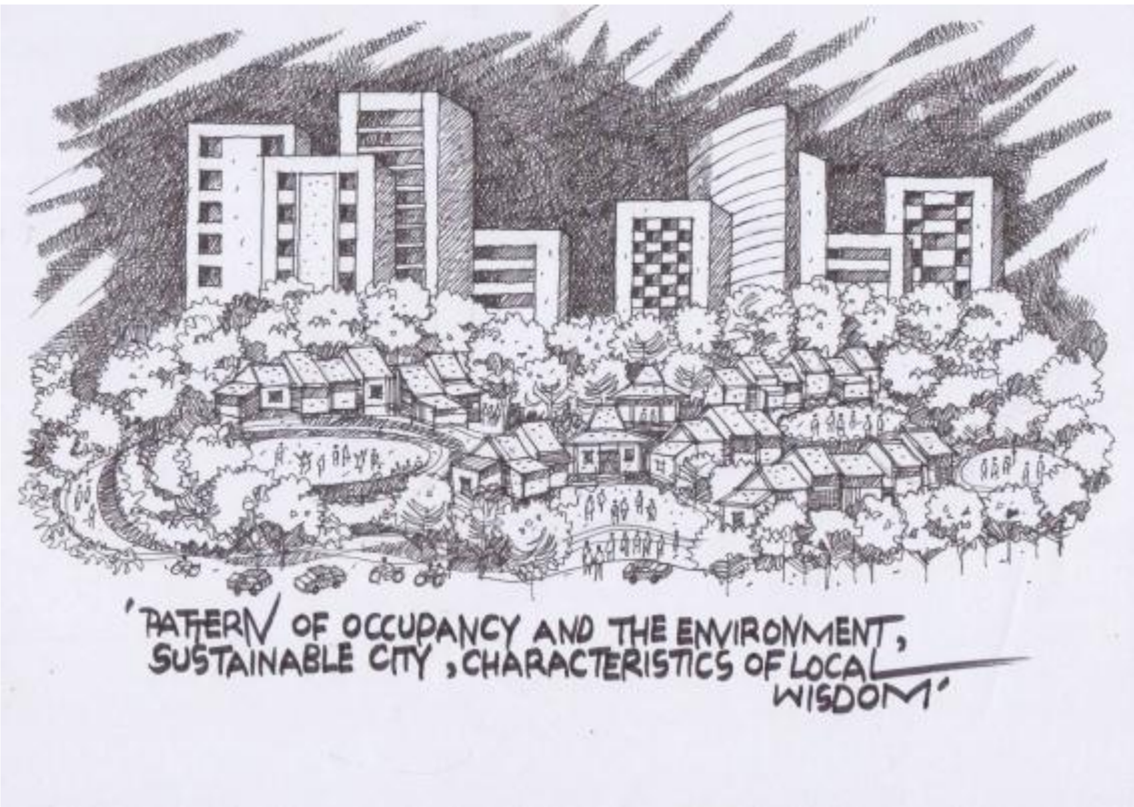

Figure 4.

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DECREASE OF CARBON MONOXIDE USINGA WATERFALL GLASS COMBINED WITH WETSCRUBBER IN A SMOKING ROOM

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ABSTRACT: Cigarette smoke is one of the air pollutants. Wet scrubbing is the process of removing toxic gases, namely by reacting water with other chemicals. In this study, the researcher creates a tool that reduces carbon monoxide levels in a smoking room. The purpose of this research is to determine the decrease of carbon monoxide (CO) in the smoking room due to discharge waterfall flow treated rateon wet scrubber tool. This research was conducted in a room measuring of 2.70m x2.6m x2.5m with one wall mounted with wet scrubber tool measuring of 0.4m x 2.1m x 2.63m. The independent variable in this study is waterfall discharge of 0.1 liters / second and 0.2 liters per second. The dependent variable is the CO level. The researcher conducted measurement every 30 minutes during 8 hours period for each treatment. One person was asked to smoke 5 cigarretes then send the burning cigarretes to a smoking room through a tool called cigarrete train. The CO level was measured before and after the operating tool running. The CO level was measured using the Monoxor Gas Analyser tool. The result shows that after being treated with the water falls flow of 0.1liter / second, the average CO level went up by 13.6 ppm. The discharge of 0.2 liter / second brought the average up by 9.5 ppm. After the wet scrubber discharge of 0.1 liter / second filled with activated charcoal, it showed the average of CO level falling by 21.1 ppm. The discharge of 0.2 liter / second showed the decrease of the average CO level by 28.1 ppm.

KEYWORDS: wet scrubber,discharge,CO

1. INTRODUCTION

According to NIOSH (ASHRAE,2001), one ofthe five sources of indoorpollutants is pollution of the building such as cigarette smoke, pesticides, and cleaning materials room.

Smoking is proven to be harmful to human health, both for passive and active smokers. Even in Indonesia, the National Commission for Child Protection says that there are 121 millions smokers that could harm the family includingtoddlers and kids (Marieska, 2013).

Smoking is a habit that is difficult to stop by the smoker. Within a day, a smoker can spend up to 1 pack of cigarettes. Many passive smokers feeldisturbed when they are adjacent to the active smokers who are smoking. It is one of the things that interfere the breathing problem.

Cigarettes smoke contain more than 4,000 ingredients of organic substances in the form of gases and particles that have been identified coming from tobacco leaves and cigarette smoke. The general characteristic of the cigarrete material is toxic and carsiogenic, as well as radioactive and addictive. The components of cigerattes can be divided into two phases, namely the gas phase and the tar phase (particulate phase).The gas phase is a harmful gas produced by cigeratte smoke. Itconsists ofnitrosopirolidin, hydrazine, vinyl chloride, urethane, formaldehyde, hydrogen cyanide, acrolein, acetaldehyde, nitrogen oxides, ammonia, pyridine, and carbon monoxide (Mu’tadin, 2009 in Dimas, 2009).

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Carbon monoxide(CO) is a toxic gas which is colorless, odorless, and tasteless. Since it is odorless, CO is usually mixed with other gases.So CO can be inhaled unconsciously along with other gases that have odor. CO is produced from industrial waste andincomplete combustion of natural gas and other materials containing carbon (Psychologymania, 2002).

CO gas that enters the body can lead to heart diseases because it can bind the oxygen gas in the blood so the body deprives oxygen and inhibits the blood circulation. Effects of CO exposure depend on the concentration and duration of the exposure, andthey can lead to negative effects including light headaches, nausea and even death.

Cigarette smoke is very dangerous, especially for passive smokers. Besides the nicotine, it also contains carbon monoxide (CO). People who smoke will release smoke containing CO gas in concentration of up to 20,000 ppm which then become diluted approximately 400-500 ppm when it is inhaled by active smokers.

CO gas level in the blood of non-smokers is less than 1%, while CO level in the blood of smokers is 4% up to15 % (Psychologymania, 2012).

A Wet Scrubber is an air pollutant control equipment which serves to collect the fine particles carried in gas by using water droplets (Panji, 2008). Wet scrubbers have the ability to resolve high temperature and humidity. In a wet scrubber, the gas is cooled down, resulting in smaller levelof particlein overall. Wet scrubbers can remove both types of gaseous pollutants and solid particles. It can also neutralize corrosive gases.

This research is aimed to reduce carbonmonoxide using wet scrubber in two variations of discharges treated. There were 0.1 lt/ second and 0.2 lt/ secondplaced in a smoking room.

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2. METHODOLOGY

Flow diagram / sketch of the principal theoriesis described as bellow;

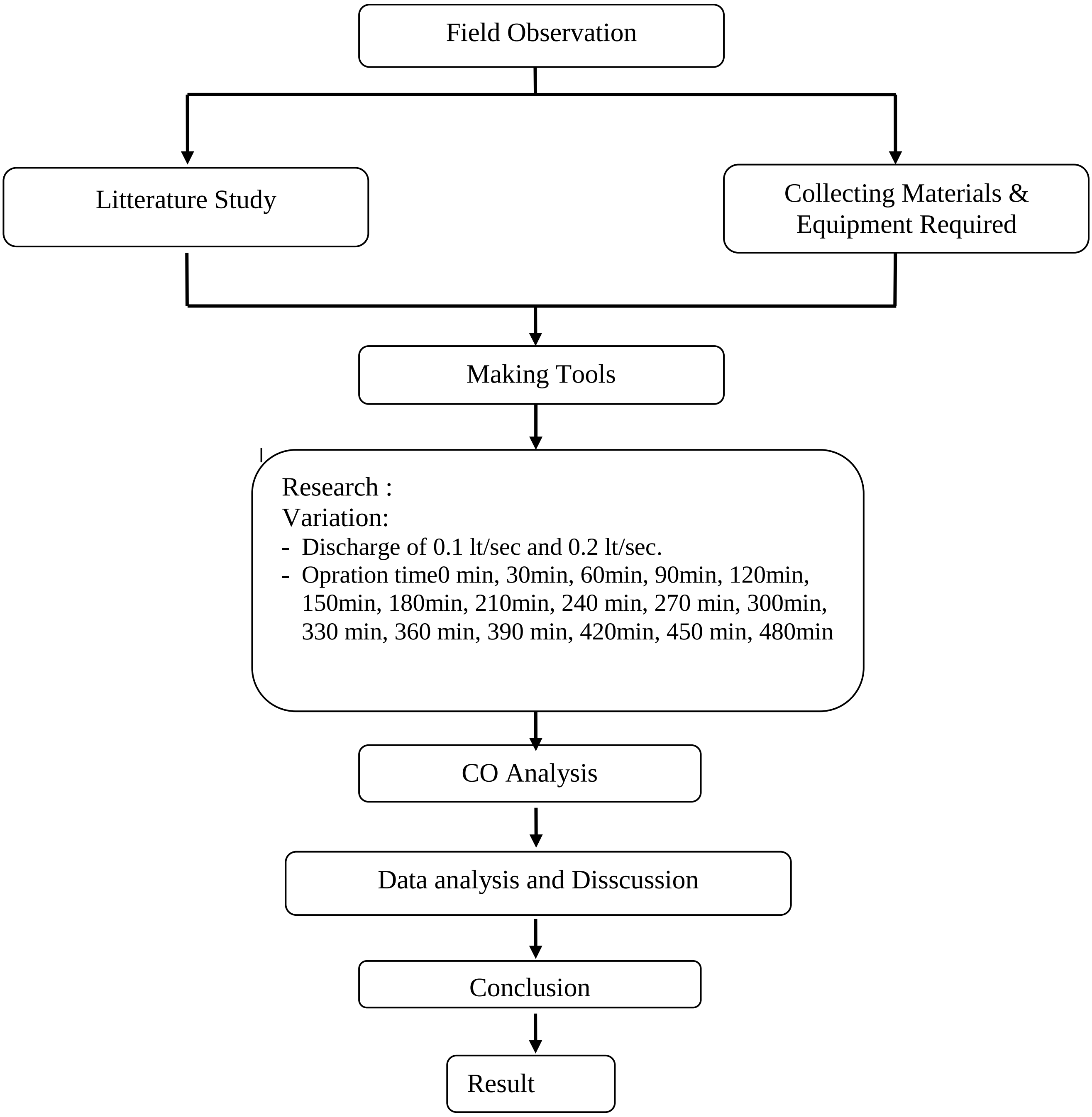

Figure 1. Schema of step by step research to reduce CO content using a wet scrubber.

The location ofthis research was in*Harjoko* Laboratory,located at Campus 2 of STTL "YLH" Yogyakarta. The object ofthis research wascontent of CO (Carbon Monoxide) air pollution in the smoking room.

The independent variable is a variable that can cause changes to the dependent variable;they are a disharge variation of 0.1 lt/sec, 0.2 lt/sec, 0.1 lt/sec with activated

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charcoal and 0.2 lt/sec with activated charcoal. In this research the dependent variable is the content of CO (Carbon Monoxide).

2.1. PROCESS OF IMPLEMENTATION

This research used a simulation method with no smokers in the smoking room. This process use burn cigarettes and 5 blowers to circulate the air.

a. In the first step, the researcher prepare the material and check the instrument before starting the experiment. Water and air in this process is circulated as a circulation system.
b. The researcher measured water discharge of 0.1lt/sec and 0.2 lt/sec.This process of was doneby opening the valve to calculate the water discharge by using baker glass for 5 seconds. After finding out the exact needed water discharge, the researcher marked the valve to helpthe researcher to operate the water discharge.
c. Before starting the experiment, the researcher switch on the *Monoxor,* then put the sample of airfrominside the smoking room.
d. Researchers prepare cigarettes (brand of Djarum Super) that will burntand putin the roomone by one and then put in a cigarrete train with a clampthat serves to hold the cigarette not to fall off.
e. The reseacher put the burnt5 cigerattes throught a hole at the cigarette train, while the wet scrubber tools and blowers are on.
f. Every 30 minutes, the researcher measured the content of CO inside the smoking room. The experiments were carried out every 30 minutes for 8 hours (480 minutes) with discharge variations of 0.1 lt/sec, 0.2 lt/sec, 0.1 lt/sec with activated charcoal and 0.2 lt/sec with activated charcoal.
g. Before the treatment of g, the cigarrete was burnt without operating tools as a control except blowers.
h. This process usedrepetition do in 2 trial error for each discharge.Each this treatment was repeated twice.
i. The content of CO in the room was measured using *COMonoxor digital*through special window to put the tool and see the number in the CO Monoxor digital.
j. The researcher replaced the water in every 8 hours or before a new treatment.

2.2. PROCESS OF USING MONOXOR DIGITAL TO MEASURETHE CO IN THE AIR

a. Switch on *Monoxor*, wait for 60 seconds until the number of CO was shown 0 ppm.
b. Put the Monoxor inside the smoking room through the special window and see the number on the Monoxor Digital.
c. Record the data every 30 minute for8hours treatment.

2.3. DATA ANALYSIS

Research data collected will be presented in the form of quantitative descriptive, tables, and graphs then analyzeduse regressionanalysed.

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2.4. DESIGN OF THE INSTRUMENT

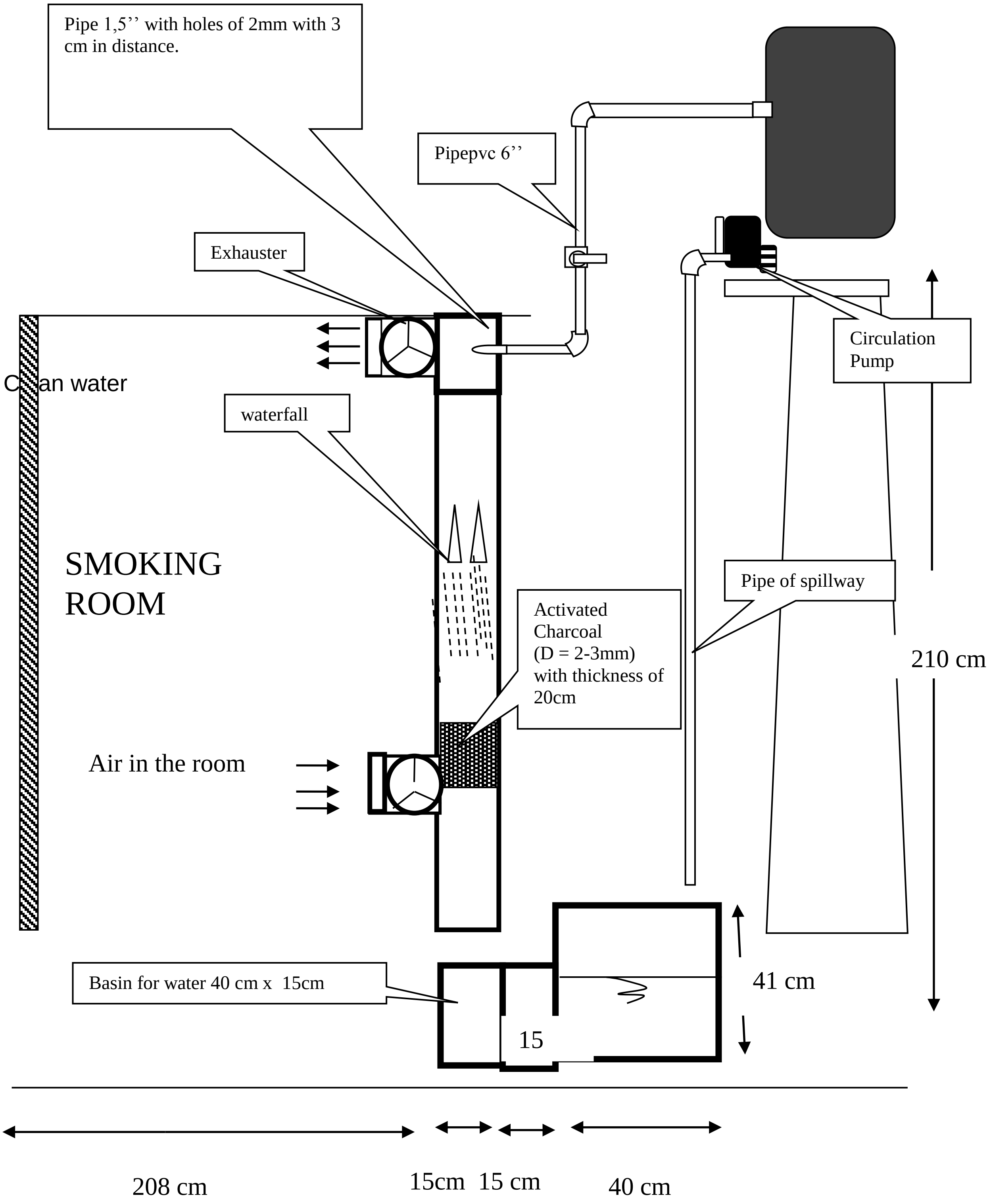

Figure 2. Combination of waterfall glass and Wet Scrubber Section

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3. RESULT AND DISCUSSION

The result of the Carbonmonoxide (CO) levels were indicated on the tabel below.

Tabel 1. The results of the study with treatment discharge variations

No	**Time (Minute)**	**Unit**	**Control**	**Treatment with Discharge Only**					
				0.1 lt/sc			0.2 lt/sc		
				Repetition 1	Repetition 2	Average	Repetition 1	Repetition 2	Average
1	0	ppm	0	0	0	0	0	0	0
2	30	ppm	45	4	16	10	4	22	13
3	60	ppm	65	4	10	7	10	14	12
4	90	ppm	84	89	95	92	101	43	72
5	120	ppm	98	116	144	130	126	116	121
6	150	ppm	105	141	166	153,5	159	151	155
7	180	ppm	127	170	195	182,5	186	146	166
8	210	ppm	128	156	187	171,5	176	165	170,5
9	240	ppm	158	154	206	180	188	113	150,5
10	270	ppm	128	153	192	172,5	177	118	147,5
11	300	ppm	114	148	195	171,5	205	166	185,5
12	330	ppm	141	160	170	165	197	177	187
13	360	ppm	162	189	157	173	210	175	192,5
14	390	ppm	166	168	166	167	209	113	161
15	420	ppm	180	168	194	181	220	152	186
16	450	ppm	187	164	200	182	187	152	169,5
17	480	ppm	189	162	206	184	189	140	164,5
	TOTAL	ppm	2091			2322,5			2.253,5
	Average	ppm	123			136,62			132,56

These results indicate, if cigarets burn longer, CO level in the room will increase. The average CO level becomes 123 ppm in the room. This number is very far from the quality standard levels of carbon monoxide in the room according to the Regulation of the Minister of Health of the Republic of Indonesia Number: 1077/Menkes/V/2011 on guide lines for home air sanitation, which is 9 ppm CO level for 8 hours. The Increased levels of CO caused by smoke accumulated from time to time so that the CO level was increased from time to time too.

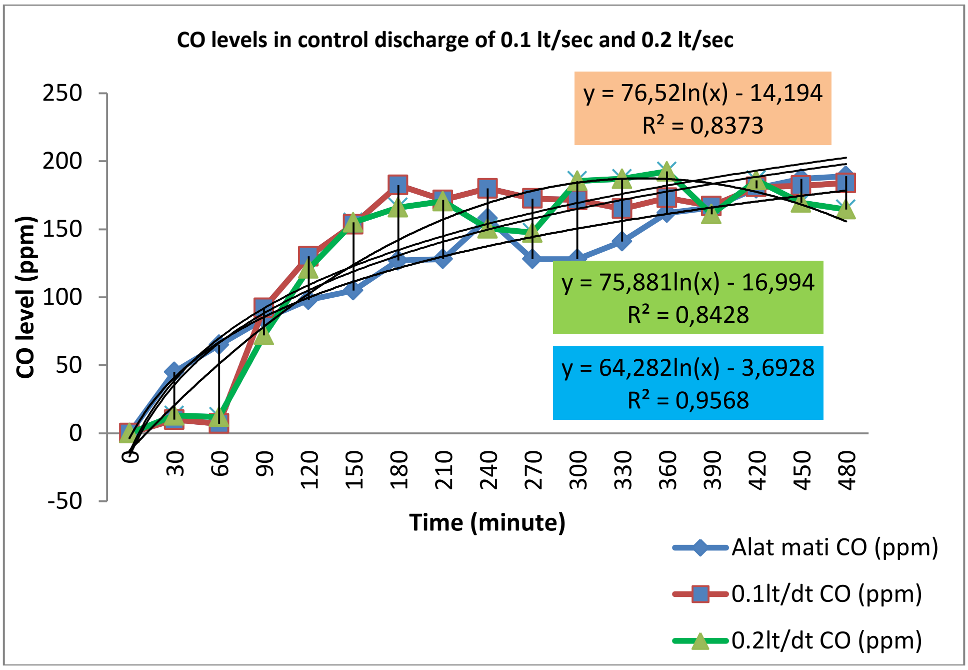

Figure 3. CO levels in control discharge of 0.1 lt/sec and 0.2 lt/sec.

The figure shows that there is no significant influence resulted from treatment of discharge 0.1 lt/secondand 0.2 lt/second. It is affected by CO that can not reacted with water. The decrease of CO in minute of 390 was affected by the increasing heat of the room that affect on the CO reduction. According to http://id.wikipedia.org/wiki/, carbon monoxida (CO) is gas, and the reduction could be faster through heating process. As for example, carbon monoxida, even though considered as a pollutant, it stays long in atmosphere as a product of volcano activity. It dissolves in the volcanic lava under a high pressure in deep earth.

The CO level after the treatment used combination discharge and activated charcoal can be shown as below:

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Tabel 2. Results of studies using variations of discharges and activated charcoal.

No	Time (Minute)	Unit	Control	Treatment with Discharge and Activated Carcoal					
				0.1 lt/sc			0.2 lt/sc		
				Repetition 1	Repetition 2	Average	Repetition 1	Repetition 2	Average
1	0	ppm	0	0	0	0	0	0	0
2	30	ppm	45	49	39	44	59	45	52
3	60	ppm	65	43	86	64,5	98	66	82
4	90	ppm	84	69	123	96	114	75	94.5
5	120	ppm	98	88	137	112,5	137	88	112.5
6	150	ppm	105	74	135	104,5	133	94	113.5
7	180	ppm	127	115	109	112	137	123	130
8	210	ppm	128	84	120	102	146	98	122
9	240	ppm	158	159	101	130	140	109	124.5
10	270	ppm	128	146	93	119,5	113	82	97.5
11	300	ppm	114	132	122	127	116	113	114.5
12	330	ppm	141	120	110	115	111	76	93.5
13	360	ppm	162	95	115	105	113	87	100
14	390	ppm	166	93	114	103,5	110	90	100
15	420	ppm	180	134	108	121	85	86	85.5
16	450	ppm	187	146	119	132,5	82	85	83.5
17	480	ppm	189	164	119	141,5	103	111	107
	TOTAL	ppm	2091			1589			1612.5
	Average	ppm	123			93,47			94,85

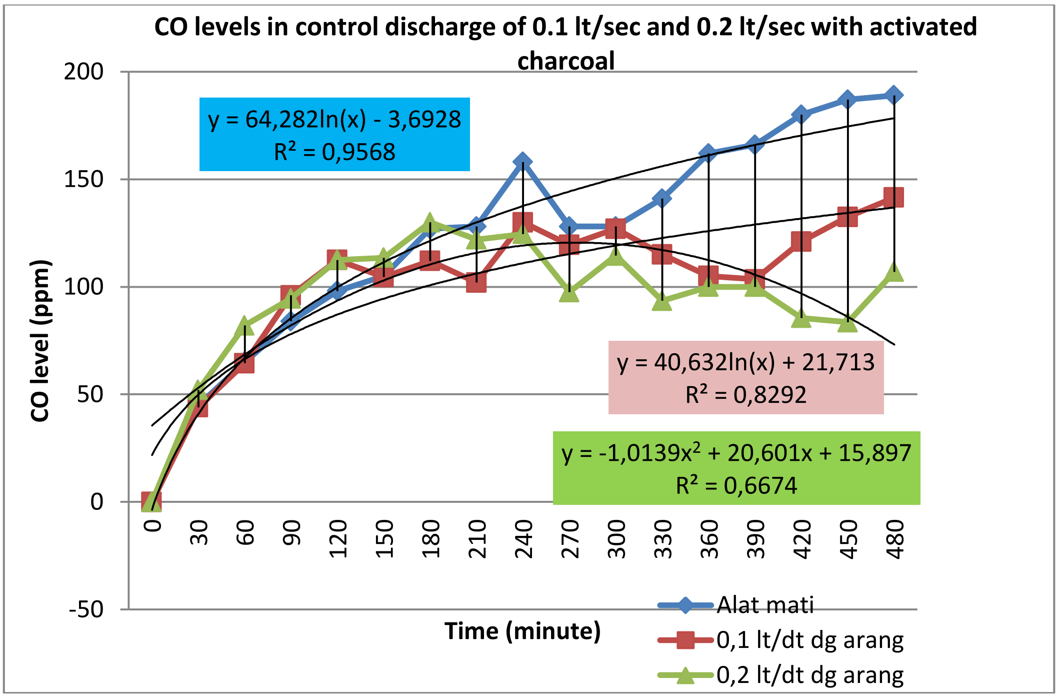

Figure 4. CO levels in control discharge of 0.1 lt/sec and 0.2 lt/sec with activated charcoal

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This result shows that by using activated charcoal under the waterfall, the content of CO in the room decreases. It occured in minute of 240.

The line agreement after treatment using waterfall of 0.1 lt/secondwith the activated charcoal shows positive inclination which means the longer the smoke exposure, the higher the content of CO in the room. Treatment using waterfall of 0.2 lt/secondusing activated charcoal compared to another treatment showed lower CO content. It is resulted by the air absorbtion done bythe activated charcoal that placed close to the exhouter where the air went through out and in. Adsorbtion is an effect of the magnetism on the surface of the adsorben that attract the gas and liquid molecules. According toReynold (1982), adsorbtion is a process of a particle attached to a surface as a result of weak current difference between two objects, that eventually form a thin layer of fine particles on the surface. The active carbon in unite group has wide porous surface area, so it can do absorbtion to adsorbat. The number of the adsorbed gas will depend on the partial pressure, the higher is the pressure, the more gas will be absorbed. In this study, the exhauster is very helpful to give pressure for the gas to go through the active carbon.

According to aryafatta.wordpress.com/.../meningkatkan-nilai-arang-tempurung-ja..., downloaded, at 18 august, 2014. at 10.36 am, in one gram of active carbon, generally has surface areaof 500-1500 m2, which is very effective to catch the very fine particles sized of 0.01-0.0000001 mm. Active carbon is characteristically very active. It will absorb any particles contacted with the carbon. During 60 hours period, active carbon will usually become saturatedand inactive. In this study, the smoke was exposed for 8 hours, so the activated charcoal remained active during the process.

The cigarrete smoke is divided into mainstream andsidestreamwhich are different in their characteristics of physiochemical. The mainstreamsmoke is cigarrete smoke that directly inhaled by the smoker, while the sidestream smokeis the smoke that goes to the air and remained uninhaled. Compared to the mainstreamsmoke, thesidestreamsmoke has more carsinogen content. We have also the term ofenvironmental tobacco smoke; it is a dynamic mixture betweensidestreamsmoke and the exhalation of the mainstream. In the air, environmental tobacco smokehas a potential to be absorbed by the surface of things inside the room. The vent factors, room size, room surface character, the wide of room surface, temperature, relative humidity, and another particles and gas in the atmosphere influence the composition of environmental tobaccosmokein that particular room. (Witorsch,1991) in the chairman ofHimpunanAhliKesehatanLingkungan (HAKLI) Yogyakarta Special Provinceand the Chairman of Environmental HealthPoltekkesDepkes Yogyakarta as cited from http://www.dinkes.jogjaprov.go.id/index.php/clingksehat/read/104.html, dated onJanuary 17th 2012, at 13.38 pm.

4. CONCLUSION

In this research, we come to our conclusionas below:

1. The influence of discharge shows positive trend toward the increase of carbon monoxida content. Treatment using discharge of 0,2 lt/secondhas more capability to decrease carbon monoxida content.
2. Activated charcoal has a high influence on decreasing the CO content in the room.
3. Treatment of discharge 0.2 lt/secondusing activated charcoal has more capability to decrease the CO content.

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BUILDINGS AND CONSTRUCTIONS

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RE-USE FAILURE REINFORCED CONCRETE BEAM REPAIRED WITH EXTERNAL PRESTRESS

HAZAIRIN[1], Bernardinus HERBUDIMAN[2], Dida KHRISNA[3]

ABSTRACT: Reinforced concrete is the most popular construction material used in Indonesia. Beam is the structure element which supports flexure and shear under working loads. During long service, the reinforced concrete beam will tend to crack and then failure. This failure beam then could not support the given loads. Construction rework will generate waste and build new construction need expensive process. This research was proposed to study re-use failure beam after repairing with external pre-stress method. This repairing method was chose due to its simple installation, user-friendly tools, and low cost. Specimen used in this research is four 15cmx25cmx100cm reinforced concrete beams with concrete characteristic compressive strength of 25 MPa. Each beam uses three 13mm-diameter deformed tensile bar with yield strength of 400 MPa and two 8mm-diameter plain compressive bar with yield strength of 240 MPa. Beam was tested under flexural loading with third point loading method until crack and then failure. The failure beam then was repaired with external pre-stress method by adding longitudinal bars at left and right outer sides of beam at mid-height elevation which supported by steel plates at beam ends. Pre-stress was applied by twist bolts at end plates which were controlled by torque meter. After being repaired, the failure beam with its external pre-stress then being tested again under flexural loading. This research also observes beam failure modes and crack paths. The maximum loads which caused failure on initial beams were 109.5 kN, 116.8 kN, 146.6 kN, and 148.4 kN, respectively. After being repaired, failure beams could support maximum loads 89.1 kN, 89.6, kN, 132 kN, and 115.4 kN, respectively. This experiment show the failure beam after repaired with external pre-stress could bring the flexural capacity until 76.7%-90% with average of 81.5% compared with the initial beam.

KEYWORDS: beam, repair, external pre-stress.

1. INTRODUCTION

Reinforced concrete is the most popular construction material used in Indonesia. Beam is the structure element which supports flexure and shear under working loads. Due to natural disaster, over loading, lack of material quality, and lack of construction process controlling, the reinforced concrete beam will tend to crack and then failure. This failure beam then could not support the given loads. Construction rework will generate waste and build new construction need expensive process.

Several methods could be used to repair the failure structure, such as crack grouting, using Kevlar at tensile side, adding steel plate connection, and using external pre-stress. This research was proposed to study re-use failure beam after repairing with external pre-stress method. This repairing method was chose due to its simple installation, user-friendly and availability tools, and low cost. Torque-meter is used to measure prestress force.

The purposes of this research are giving input to national standardization agency about structural repairing using external pre-stressing method; to project owner for choosing lower cost method in reinforced concrete structural repairing; and to constructor for constructing structural repairing with simple and available tools.

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2. LITERATURE STUDY

2.1. REINFORCED CONCRETE BEAM

Reinforced concrete beam is designed to resist flexure. Nominal flexure strength is maximum beam capacity. This capacity is generated from inner compression forces resultant (C_c and C_s) and inner tension force resultant (T_s) which build resistant coupled moment with moment arm of z. Flexure mechanism on cross section of reinforced concrete beam with its strain diagram and its force diagram are shown on Figure 1.

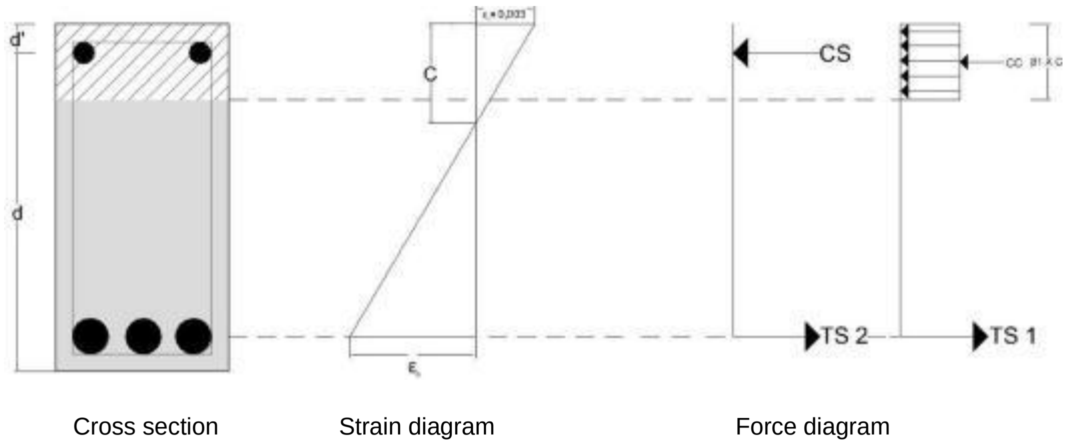

Figure 1. Flexure mechanism of reinforced concrete beam

2.2. FAILURE ON REINFORCED CONCRETE

Failure on reinforced concrete structure generally could be classified in three categories as follow:

Crack is concrete brake in lines which is relatively long length and small width. This crack is caused by: 1) quick water evaporation in concrete mix due to hot and dry weather, usually known as plastic crack; 2) over bleeding in concrete, and imperfect curing; crack is short and connected each other over slab surface, usually known as crazing; 3) structure deformation, lack in beam-column or slab-column connection, or unstable soil; crack is deep and wide, usually known as random crack; 4) reaction between alkali and aggregate; crack is generated after about 10 years after pouring then become more deep and wide and connected each other.

Void is relatively deep and wide holes in concrete. Void in concrete caused by: lack in vibrating due to slim concrete dimension and dense reinforcement then mortar could not well fill the void between coarse aggregate. Void happened is staggered holes, usually known as honey combing. Lack on molding generates water or cement paste out. Void also caused by high water content in concrete mix or poor aggregates gradation, usually known as sand streaking;

Scaling/spalling/erosion is small surface loss caused by expose to repeat freezing and thawing which known as scaling; bonding between concrete with mould surface which known as spalling; and loss due to small abrasion, known as dusting. Organic material in concrete mix could generate reactive contamination or corrosion in reinforcement, usually known as

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pop outs, and also caused by porous aggregate expansion depend on concrete permeability and instability aggregate volume.

2.3. FAILURE MODES IN REINFORCED CONCRETE BEAM

Failure modes in reinforced concrete beam could be classified as two categories, flexure failure and shear failure. Flexure failure is signed by vertical cracks start from beam mid-span. Shear failure is signed by diagonal cracks start from area near supports. Failure and shear failure sketches are shown on Figure 2.

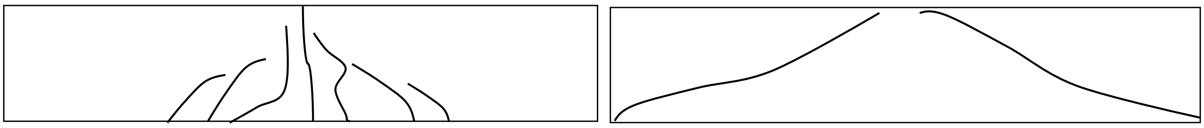

Figure 2. Failure and shear failure sketches

2.4. PRESTRESS CONCRETE

Prestress concrete is reinforced concrete with inner stress added to reduce potential tensile stress in concrete under working load. Main purpose of prestress concrete is reducing tensile force by adding compressive stress in concrete section. This compressive stress is got by tensile tendon, hold at support anchorages, then being released. The steel part will react compressively, including to its concretes.

2.5. REPARATION USING EXTERNAL PRESTRESS

External prestressing has been important and popular method in construction industry, major to strengthen and to repair several types of reinforced structure (Foure and Hoang, 1993; Mutsuyoshi et al., 1995; Miyamoto and Nakamura, 1997; Abdunur and Godart, 1998; Lebet and Utz, 2005; Nordin, 2005; Fernandez Ruiz et al., 2006). Since its uses, this method gives much benefit. This method give several benefit, such as: beam still on elastic stage at higher loading and incremental maximum beam capacity. Sketch of repaired the beam crack with external prestress is shown on Figure 3.

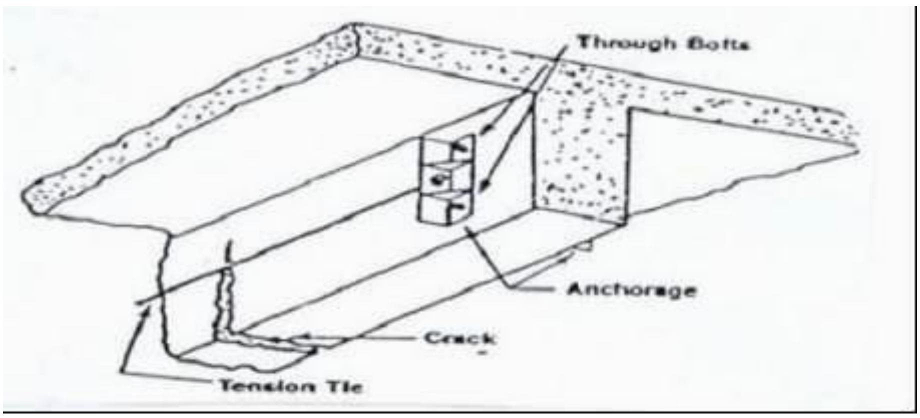

Figure 3. Repair the beam crack with external prestress

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3. RESEARCH METHODOLOGY

3.1. MATERIAL AND TEST PREPARATIONS

Materials used in this research are pozzolanic portland cement, Lagadar split coarse aggregate with maximum dimension of 20 mm, and fine aggregate from Galunggung. Mix design uses SNI 03-2834-2000.

Compressive strength test uses three 100-mm-diameter, 200-mm-height, concrete cylinder. Flexural strength test uses four 100-mm-width, 250-mm height, and 1-m-length beam specimens with three 13-mm-diameter deformed steel for tensile bar and two 8-mm-diameter plain steel for compressive bar with yield strength of 380 MPa. The concrete cylinders and the beam specimen after molding are shown on Figure 4.

Figure 4. Specimen molding

3.2. BEAM FLEXURAL TEST

Flexural test on beam specimen use third point loading method and uses universal testing machine with load control.

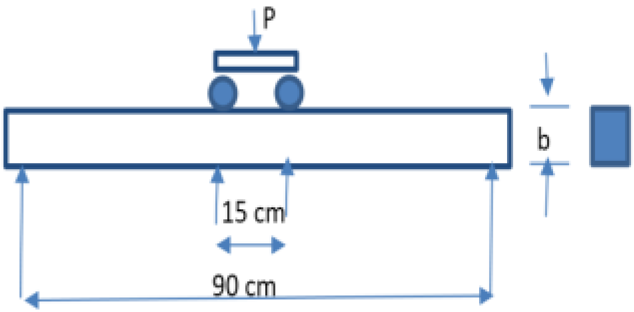

Figure 5. Sketch of third point loading test

3.3. EXTERNAL PRESTRESSING

Prestress force is given on failure beam through tightening two 13-mm-diameter steel bars placed left and right sides beam specimen, supported by end-steel plates. Torque-meter is used to measure prestress force. Required prestress force on designed beam is 6.16 ton.

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Actually, prestress force given on beam only 4 ton due to manual tightening which has limit capacity.

4. TEST RESULTS AND DISCUSSION

Compressive strength of concrete cylinders are 25.95 MPa, 27.62 MPa, and 28.79 MPa, all strength beyond designed compressive strength. Steel for tensile bar has actual diameter of 11.75 mm and has yield stress of 380 MPa. Steel for compressive bar has actual diameter of 7.56 mm and has yield stress of 260 MPa.

Beam specimen is prepared for third point loading, then is observed to predict the beam flexure capacity and compared with the actual capacity. The capacities of section before and after flexure loading are shown on Table 1.

Table 1. Capacity of section before and after flexure loading

No	Concrete Strength MPa	Theoretically Section Capacity		Max Loading [kN]	Moment and Shear at Max Loading		Failure Modes
		M [kNm]	V [kN]		M [kNm]	V [kN]	
1	25.9	25.674	180.32	109.5	20.531	54.75	Flexure
2	27.62	27.139	182.40	116.9	21.919	58.45	Flexure
3	28.79	28.136	183.78	146.6	27.488	73.30	Flexure
4	28.79	28.136	183.78	148.4	27.825	74.20	Flexure

After failure, beam specimen is repaired by external prestressing. After repairing, beam specimen then prepared again for third point loading, then is observed again to predict the beam flexure capacity after prestressing and compared with the actual one. The capacities of beam repair section before and after flexure loading are shown on Table 2.

Table 2. Capacity of beam repair section before and after flexure loading

No	Theoretical Section capacity due to external prestressing		Max Loading	Moment and Shear at Max Loading		Failure Modes
	M [kNm]	V [kN]	[kN]	M [kNm]	V [kN]	
1	16.670	132.61	89.1	16.706	44.55	Flexure
2	16.670	116.71	89.6	16.800	44.80	Flexure
3	16.670	116.71	132.0	24.750	66.00	Shear
4	16.670	116.71	115.4	21.638	57.70	Flexure and shear

Actual section capacity of all beam specimens are lower than theoretically due to lower quality concrete poured in beams specimen compared with poured in cylinders. All beams have failure modes (Table 1). Actual beam shear is far below the theoretically beam.

Similarly, the actual section capacity of beams after repairing by external prestressing are also lower than the theoretically beam. Failure modes on the beams after repairing are vary, flexure mode as shown on Figure 6, shear mode as shown on Figure 7, and combining failure-shear mode. Base on observation, this variation on failure modes are caused by different crack depth. This difference generates different shear capacity. From Table 2, the first and second beams has flexure modes with actual flexure capacity lied nearly the theoretically flexure resistance. The third beam has flexure capacity far below the theoretically flexure resistance, but the actual shear strength is nearly reach the theoretically shear resistance. For fourth beam, beam has combination of flexure and shear failure. The actual flexure and shear strength are rather similar than the flexure and shear resistances.

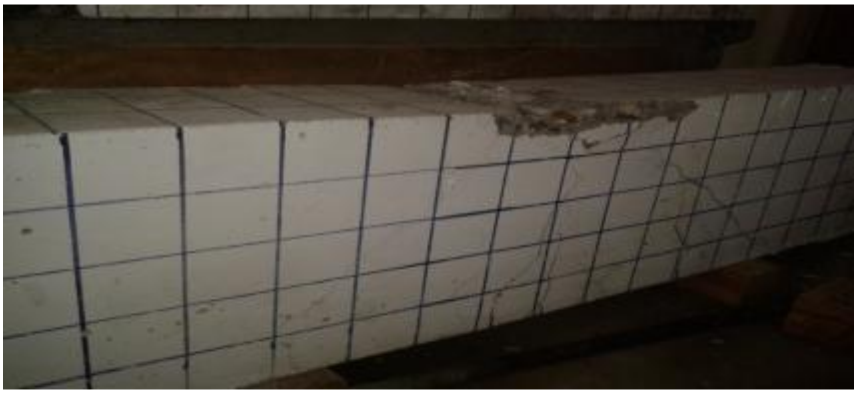

Figure 6. Flexure failure at specimen

Figure 7. Shear failure at specimen

Test results are giving actual beam capacity which is nearly similar with small difference than the designed resistance. The small difference is appeared due to lack of working quality control from concrete mixing until reinforcement placing which could reduce moment arm and moment capacity.

The failure modes of repaired beam show the external prestressing method will be effective if the repaired beam still has sufficient shear capacity. If the beam crack path reaches compression part, external prestressing method could not be used.

5. SUMMARY

Test results show that beam flexural strength nearly reaches flexural resistance based on design calculation. Beam repairing with external prestressing is suitable as an option for structural repairing as long as the repaired beam still has sufficient shear capacity. External prestressing is a simple and economical method for beam repairing, but still has limitation due to limit of manpower to initiate required prestress force.

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SEISMIC PERFORMANCE OF PRECAST SOFT STOREY BUILDING

Ari WIBOWO[1], John WILSON[2], Nelson LAM[3], Emad GAD[4]

ABSTRACT: Studies undertaken in recent years have indicated that the existing building stock at most risk of damage and collapse from earthquake excitation in low-to-moderate seismic regions such as Australia and developing countries such as Indonesia are unreinforced masonry buildings and soft storey structures. Soft storey buildings possess storeys that are significantly weaker or more flexible than adjacent storeys and where deformations and damage tend to be concentrated. Soft storeys commonly occur at the ground floor where the functional requirements dictate a higher clearance level or a more open configuration, such as for car parking or retail space, resulting in an inherently weaker and more flexible level. In high seismic regions soft storey structures are banned, yet in Indonesia such building types and configurations are common and are often used as office buildings, malls and shopping complex. A unique experimental field testing of a precast soft storey building in Melbourne was then undertaken. Four pull-over tests were conducted to measure the drift capacity and load-deflection behaviour of such buildings. Detailed theoretical models were developed that considered rocking behaviour, connection behaviour, P-Delta effects and ground slab interaction effects. The experimental results together with a comparison with theoretical model predictions showed that the precast columns with weak connection had significant displacement capacity controlled by column whilst maintaining the gravity load carrying capacity. Interestingly, the lateral strength capacity would have increased significantly if the column end connections were as strong as the members, but the drift capacity would have reduced substantially since the rocking mechanism would have been prevented forcing the columns to deform inelastically in shear and flexure. Hence, the precast soft storey construction resulted in a weaker structure with far greater drift capacity compared with a more traditional insitu reinforced concrete structure.

1. INTRODUCTION

1.1. BACKGROUND

Many of multi-storey buildings do not have structural walls at ground floor level for the purpose of recreational use, parking or for retail or commercial use. The buildings that are called as soft storey building has a discontinuity in the stiffness of the building, which have at least one of the following characteristics: (a) one storey is significantly more flexible than adjacent storeys, (b) have vertical discontinuity (e.g. posses fewer columns in one storey than that of storey above), (c) have a heavy superstructure.

ASCE 7-05 Reference Section Table 12.6-1 defines that the lateral stiffness of soft storey is less than 70% of that in the storey immediately above, or less than 80% of average stiffness of the three stories above. Under substantial ground shaking, these structures behave like an inverted pendulum (Figure 1) with the ductility demand concentrated at the soft storey elements. These structures as a result tend to have limited stability and vulnerable to severe ground shaking when the displacement demand can be very significant. Without structural walls to act as bracing elements, the columns that must resist the full axial gravity loading are

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forced to drift excessively which in turn leads to the collapse of the building as gravity loading takes over.

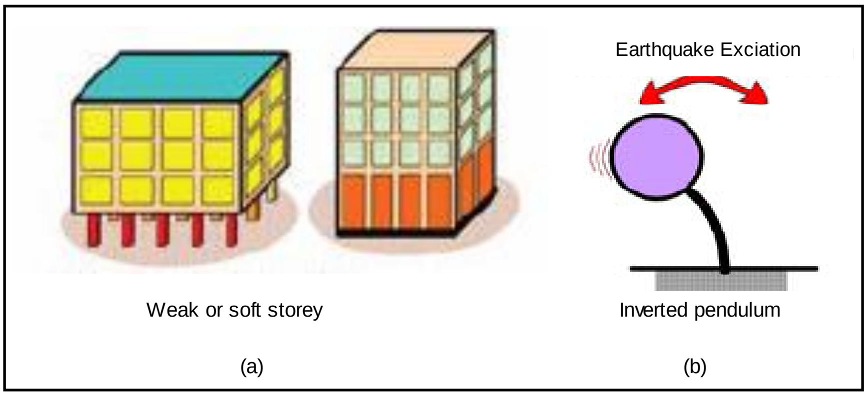

Figure 1. Idealization of Soft Storey Structures

1.2. SCOPE AND OBJECTIVE

A research project has been undertaken which involves experimental field testing of a four-storey soft storey building in Melbourne. The major aim of this unique project is to study the load deflection behaviour of soft storey buildings when subjected to lateral loading. The results from the field test will be used to develop a representative seismic performance assessment procedure for soft storey buildings subject to different levels of ground shaking.

This paper provides an overview of the experimental field-testing of the soft storey building. Details of the building configuration and experimental test set-up, instrumentation and test results are provided in Sections 2, 3, 4 respectively.

2. BUILDING CONFIGURATION AND TEST SET-UP

2.1. BUILDING CONFIGURATION

The configuration of the buildings are shown in Figures 2 and consisted of four levels above the open plan ground storey. The upper levels consisted of precast walls and slabs creating a rigid box whilst the ground floor was constructed from reinforced concrete columns and beams founded on individual pad footings. The building is significantly stronger in the short portal direction compared with the long spandrel direction. Observations from the pre-trial test of adjacent buildings indicated that the building to be used for the experimental testing had a precast ground floor storey (Figure 3) with connections significantly weaker than the members they connect. Consequently, the ground floor columns tended to rock when subject to a horizontal load. Several material samples were also collected from the site to investigate the properties of the building elements, and were tested to determine the load-deflection behaviour of each element. Importantly, with the help of this information it was possible to estimate the horizontal capacity of each bay. The horizontal capacity was calculated from both the connection capacity of the top and base of the column combined with the gravity load rocking mechanism. The modelling relationships for rigid-body rocking were developed from first principles by taking moments about the pivot point at the edge of the column.

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2.2. TEST SET-UP

Four push-over field tests were undertaken on a ground floor bay consisting of four columns pre-loaded with kentledge. It was decided for safety reasons to demolish the upper levels of the building to first floor level to create the test bay without damaging the portal frame (Figure 4). Four test bays were selected for testing and were separated from each other by sawing cutting the floor slab between adjacent bays. A steel frame was constructed at first floor level and positively secured to the slab and beams to provide support for the kentledge and to provide anchorage for the lateral load to be applied to the soft storey bay. Horizontal loads were applied in both the strong and weak directions via steel tension ties and hydraulic jacks secured to a piled tie back system some distance from the frames as shown schematically in Figure 5. The four columns in a typical bay would typically support around 200 tonnes of dead load plus a proportion of live load from the upper storeys. However, it was not deemed practical to load the frame with the full gravity load and consequently 50 tonnes of kentledge in the form of precast 'jersy barriers' was added to provide a reasonable loading as shown in Figure 5.

Figure 2. Configuration of the buildings

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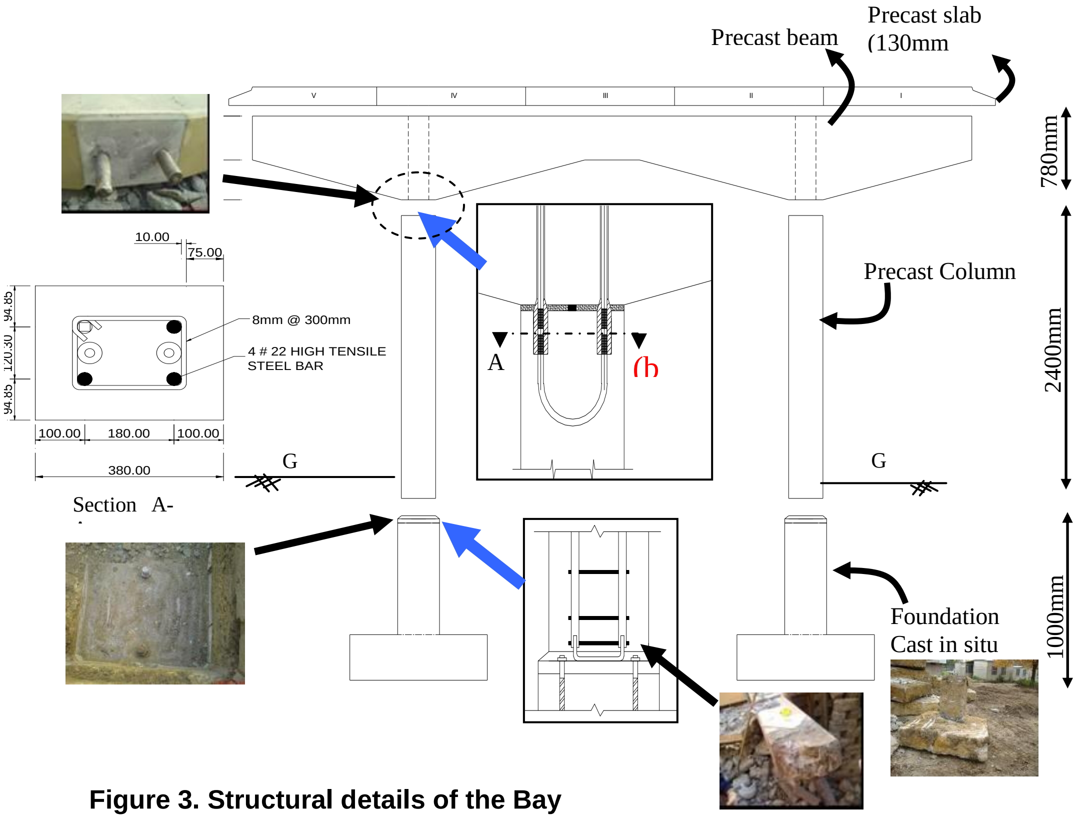

Figure 3. Structural details of the Bay

Figure 4. Demolition process of the buildings.

Interestingly, the slab on ground provided significant restraint to the columns at ground floor level and consequently two tests were conducted with the ground slab intact and the other two tests with the slab cut away to prevent restraint. The subsequent four field tests consisted of:

a. Test 1: Strong direction with ground slab
b. Test 2: Weak direction with ground slab
c. Test 3: Strong direction without ground slab
d. Test 4: Weak direction without ground slab

Due to space constraints, this paper will focus on the results from Test 1 and 3 only.

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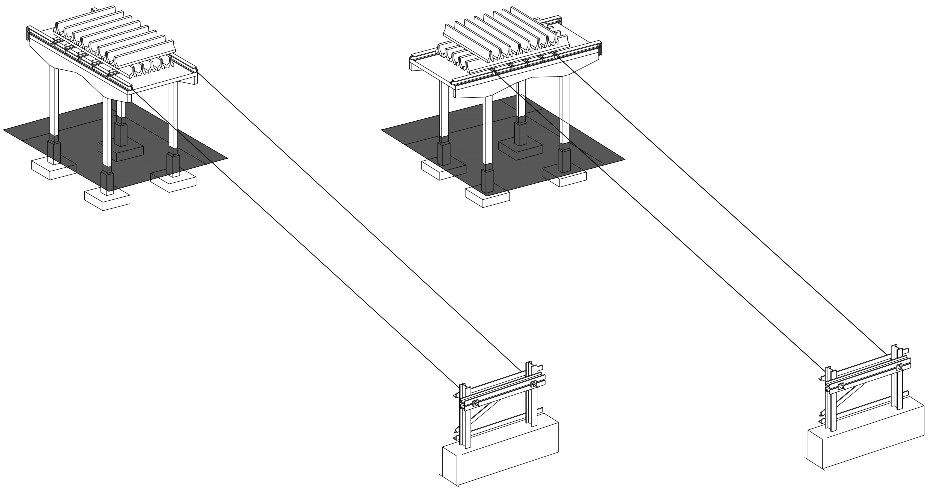

Figure 5. Test set-up configuration

3. INSTRUMENTATION

Various measurement techniques were utilised to obtain the overall load deflection behaviour of each test specimen as well as curvature of the column and crack width. The applied horizontal loads were measured using load cells, whilst the displacement measurement techniques included global positioning system (GPS), total point station (TPS), laser scanner, photogrammetry, visual measurement using a theodolite and ruler, and LVDT transducers. A degree of redundancy was built into the measuring systems to ensure that if one system failed, results could be obtained from other sources. The theodolite was particularly important for directly measuring the incremental displacements when the testing was in 'displacement' control. In addition, some systems provided real time readings such as visual measurement and LVDT whilst other methods such as photogrammetry and laser scanner required some post processing. The overall measurement setup for each of the four tests showing pulling direction of the test bay, position of GPS antennas, total point station, laser scanner, and theodolite for Test 1 is shown in Figure 6.

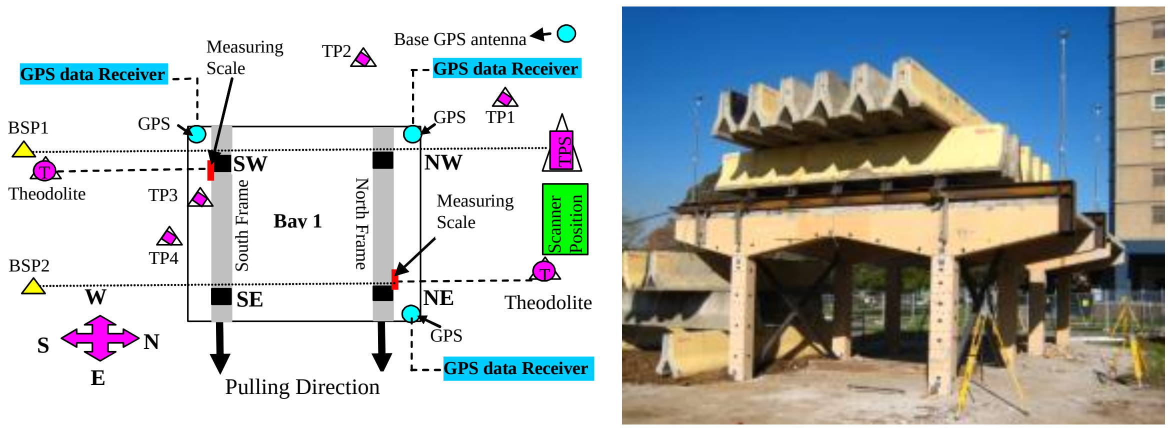

Figure 6. Measurement setup for Test 1

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4. TEST PROCEDURE AND EXPERIMENTAL RESULTS

4.1. TEST PROCEDURE

A hydraulic jacking system with tension ties and a temporary piled tie back anchorage system were used to apply the lateral loads to the frame as shown in Figure 5. The test specimens were laterally loaded under 'force' control in increments of 10 KN until the ultimate load was reached. The loading was then applied in 'displacement' control with displacement increments of 25 mm up to around 250 mm in both directions.

4.2. EXPERIMENTAL RESULTS

A comprehensive set of results have been obtained from the experimental testing and a sample load displacement curve for all test are shown in Table 1 and Figure 7 and 8. The displacement shown corresponds to the lateral displacement at the slab level and the load is the total lateral force imposed on the structure. In the strong direction, the majority of the deformations were concentrated at the end connections, with gaps opening at the foundation and beam interfaces. This was a clear indication that the columns were significantly stronger than the connections. In the weaker direction, deformations were concentrated at the foundation interface and at the interface of the portal beams and the first floor slab. It can be shown analytically that the load-deflection behaviour of the strong direction is mostly affected by the connection strength at the top of the column, whereas the gravity load rocking mechanism dominates the load-deflection behaviour in the weak direction.

Table 1. Summary of maximum load, displacement and drift of all tests

Orientation	Test	Maximum Load	Maximum Displacement	Maximum Drift
Strong Direction	Test 1	310 kN	200 mm	5.9 %
	Test 3	250 kN	255 mm	7.5 %
Weak Direction	Test 2	125 kN	225 mm	6.6 %
	Test 4	75 kN	260 mm	7.6 %

The soft storey column was found to have significant displacement capacity irrespective of strength degradation. An important outcome of this work is that the columns maintained their gravity load carrying capacity at a lateral displacement of about 260mm or a drift capacity of about 8% under these quasi-static conditions. Interestingly, the weak column/foundation and column/beam precast connections allowed the columns to rock about their ends, greatly enhancing the displacement capacity of the soft storey system compared with rigid end column connections more typical of in-situ construction.

Interestingly, the ground slab provides significant restraint to the frame, especially in the weak direction. The increase of load capacity due to the existence of ground slab is about 25 percent in the strong direction and about 67 percent in the weak direction.

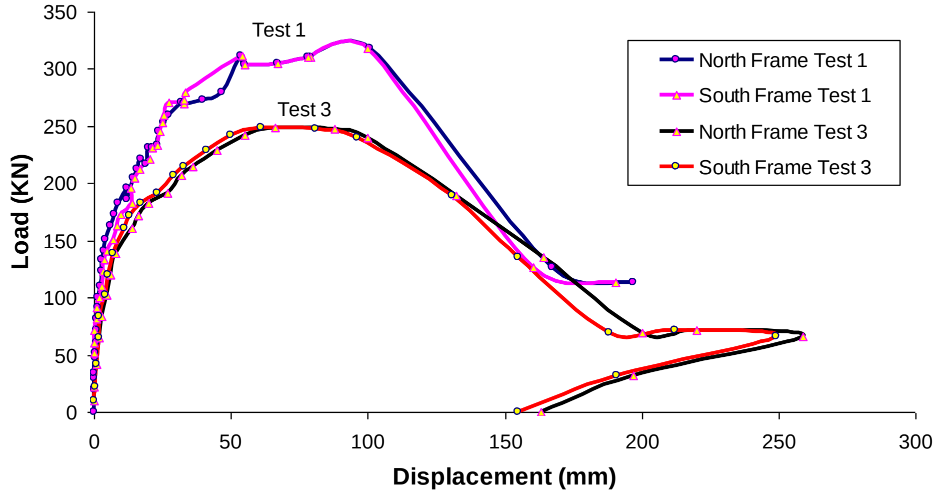

Figure 7. Experimental result for Test 1 and 3

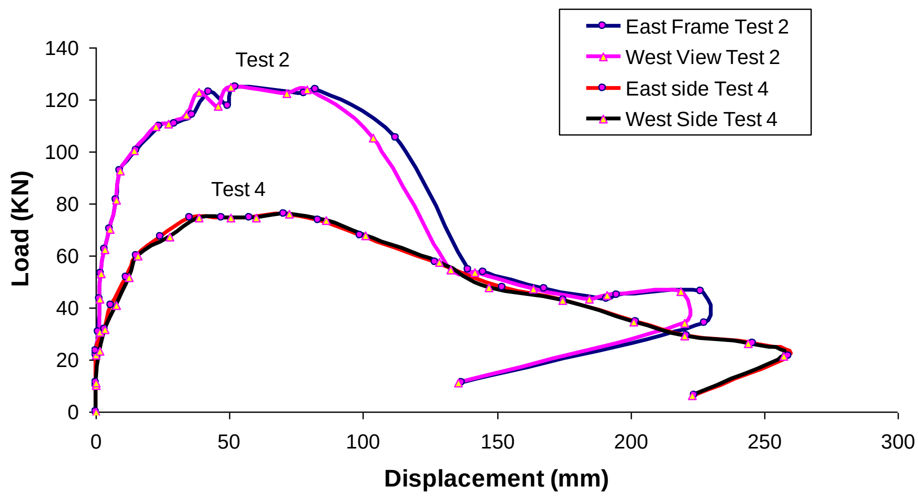

Figure 8. Experimental result for Test 2 and 4

5. ANALYSIS

This section develops a theoretical model to predict the load–deflection behaviour of the soft storey test bays and to compare the behaviour with the experimental results. The load-deflection behaviour is influenced by the three components; a) connection strengths at the column ends, b) the rocking mechanism of the precast columns and c) the additional restraint provided by the slab on ground as can be seen in Table 2.

The characteristics of precast concrete ductile connections have been conducted over the last two decades. Several approaches for predicting the behaviour of this mechanism consist of trilinear idealisation of moment-rotation behaviour (Priestley and Tao, 1993), calibration of the hysteresis parameter of hybrid connections (Cheok *et al*., 1998) and finite element modelling (El-Sheikh et al., 1999). The analysis in this paper was developed based on the moment-rotation principle proposed by Pampanin *et.al* (2001).

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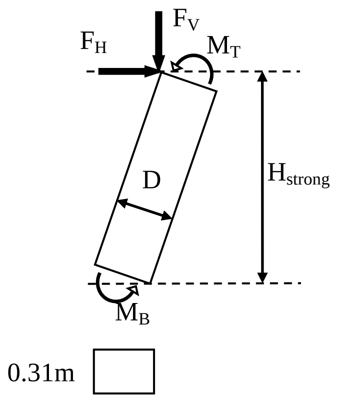
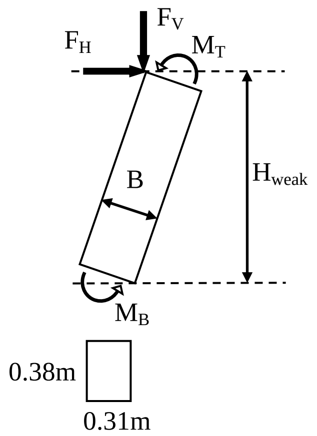
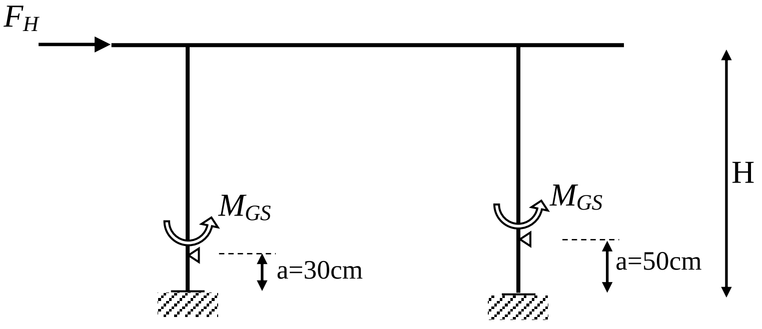
For the case of the top precast connection, the strain incompatibility in the section between the concrete and the unbonded steel tensile bar becomes the prominent problem in determining the neutral axis position, due to the unavailability of a closed-form equilibrium equation. In addition, the linear strain distribution and resulting local section curvature is directly related to the connection rotation and the global displacement of the structure. A trial and error procedure has been used to satisfy both the equilibrium and compatibility conditions.

Table 2. Horizontal Strength Prediction Analysis

<table>
<tr><td colspan="3">Horizontal capacity</td></tr>
<tr><td rowspan="2"></td><td>Strong direction</td><td>Weak Direction</td></tr>
<tr><td></td><td></td></tr>
<tr><td rowspan="2">Per column</td><td>$F_{H-STRONG} = F_K + F_R + F_{GS}$
Where :
$F_K = \dfrac{M_k}{H_{strong}} = \dfrac{M_T + M_B}{H_{strong}}$
$F_R = \dfrac{F_V D}{H_{strong}}$
$H_{strong} = H_{column}$</td><td>$F_{H-WEAK} = F_K + F_R + F_{GS}$
Where :
$F_K = \dfrac{M_k}{H_{weak}} = \dfrac{M_T + M_B}{H_{weak}}$
$F_R = \dfrac{F_V B}{H_{weak}}$
$H_{weak} = H_{column} + H_{beam}$</td></tr>
<tr><td colspan="2">The ground slab functioned as a reaction support to column; hence, the increase of horizontal load can be determined by calculating its cross section moment capacity.</td></tr>
<tr><td>Per Bay</td><td>$4(F_{H-STRONG})$</td><td>$4(F_{H-WEAK})$</td></tr>
<tr><td colspan="3">* F_k is the force at connection, F_v total vertical force (i.e. kentledge + self weight) ,
F_{GS} is reaction force of ground slab</td></tr>
</table>

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6. COMPARISON OF THE RECORDED WITH THE MODELLED FORCE-DISPLACEMENT RELATIONSHIP.

The load-deflection curves for the strong direction test without ground slab (Test 3) and with ground slab (Test 1) resulting from the theoretical analysis are in excellent agreement with that from the experimental test as presented in Figure 9 and 11 respectively. The components of total horizontal load for Test 3 and 1 are shown in Figure 10 and 12 respectively.

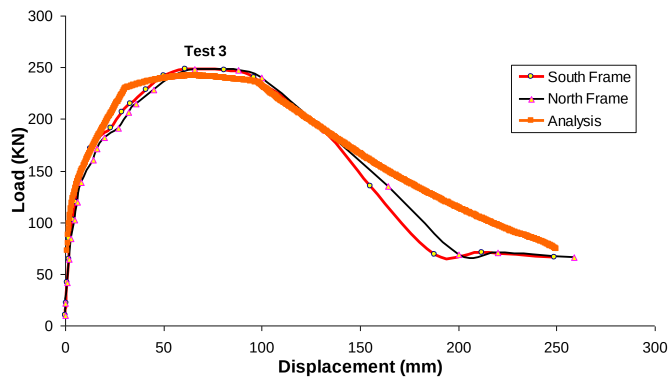

Figure 9. Comparison between load-displacement pushover test curve and analysis result for Test 3

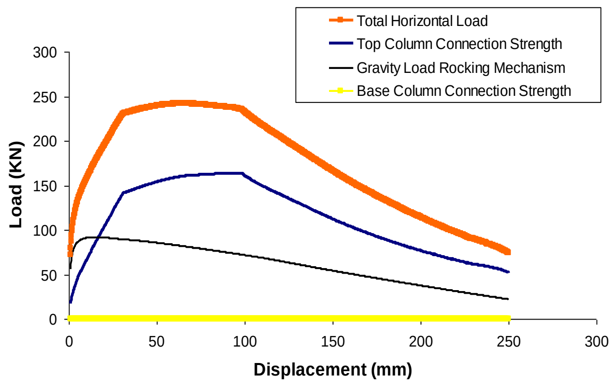

Figure 10. Detail of horizontal load resulted from the analysis for Test 3 (without ground slab)

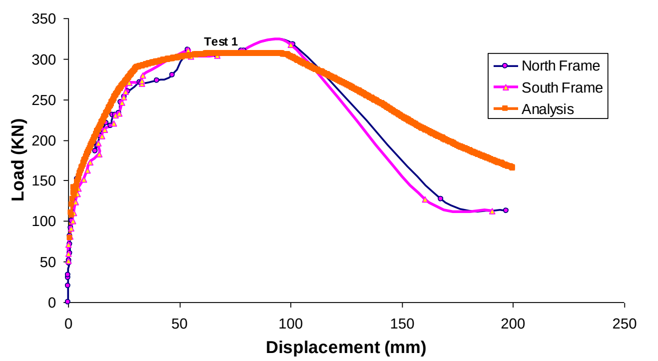

Figure 11. Comparison between load-displacement pushover test curve and analysis result for Test 1 (with ground slab)

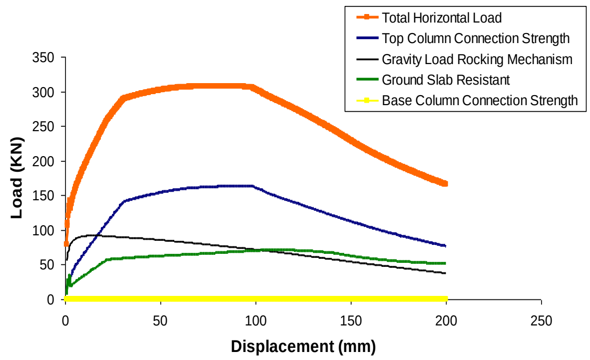

Figure 12. Detail of horizontal load resulted from the analysis for Test 1 (with ground slab)

The complete force-displacement relationship for the test bay can be idealised into the following four stages as illustrated in Figure 13.

(i) The resisting force increases steeply as a combination of the increase in both the connection and rocking mechanism strength until the rocking mechanism reaches its peak at a displacement of about 10 mm.

(ii) The resisting force increases more gradually as the rocking strength component decreases.

(iii) The resisting force plateaus as the unbonded high-strength steel yields and the concrete stress reaches ultimate strength.

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(iv) The resisting force then decreases significantly, as the connection loses strength, high strength steel fractures, compression mild steel yields, concrete cover commences to spall and the rocking mechanism dominates.

The lateral resistance from the top connection (163 KN) is markedly higher than that from the rocking mechanism (92 KN). The base column connection provides negligible strength for both tests (ie. around 0.1KN or about 0.1% of the total horizontal capacity), whilst the ground slab in Test 1 provides an additional 20% strength capacity, compared with Test 3.

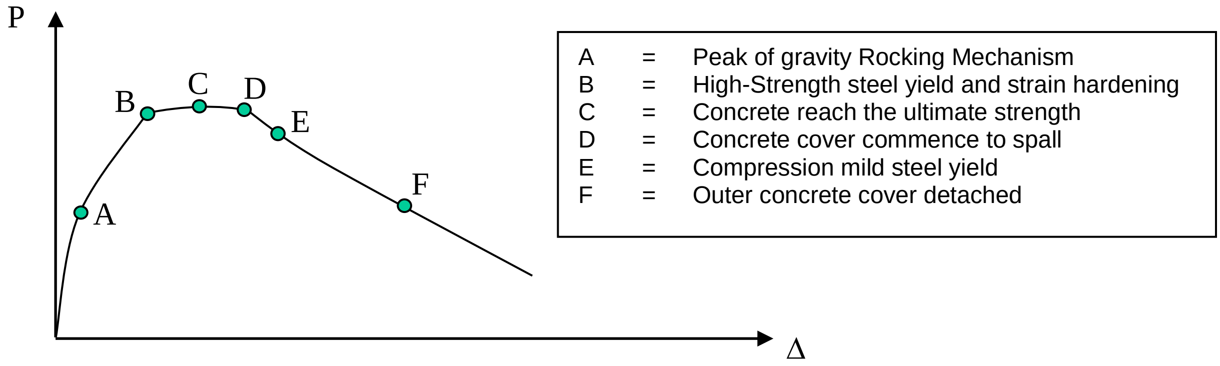

Figure 13. Idealisation of Push Over Behaviour.

7. CLOSING REMARK

A collaborative research project involving experimental field testing of a four-storey high soft storey building in Melbourne has been undertaken by the Office of Housing, Swinburne University of Technology and the University of Melbourne. Four test bays were tested in the strong and weak directions to obtain an actual push-over force-displacement curve. Comprehensive deformation measurements were collected using GPS, laser scanner, total station, theodolite, LVDT, and photogrammetry techniques. The preliminary results showed that the soft storey columns could sustain large drifts in the order of 6-8% whilst maintaining the gravity axial loads despite the reduced lateral strength capacity due to P-delta effects. The horizontal strength and drift capacity predicted by a rocking model was in excellent agreement with the lateral capacity obtained from the experimental tests.

The large drift capacity of the precast soft storey structure was attributed to the weak connections which allowed the columns to rock at each end. Interestingly, the lateral strength capacity would have increased significantly if the column end connections were as strong as the members, but the drift capacity would have reduced substantially since the rocking mechanism would have been prevented forcing the columns to deform inelastically in shear and flexure. Hence, the precast soft storey construction resulted in a weaker structure with far greater drift capacity compared with a more traditional insitu reinforced concrete structure.

Another important result from the experimental testing was the influence of the ground floor slab in providing restraint to the base of the columns and increasing the lateral capacity, particularly in the weaker spandrel direction.

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URBAN CLIMATE MODIFICATION IN COMMERCIAL AREAS IN MEDAN SHOP HOUSE CASE STUDY

Wahyuni ZAHRAH[1] and Achmad Delianur NASUTION[2]

ABSTRACT: Urban heat island is always concentrated in the area of high density building and high human activity. In the developed country, this area is characterized by high-rise building, but in Medan, Indonesia, it is characterized by shop houses. By the low quality of environment and building design, shop houses can be the centre of urban heat island. The aim of the study is to identify the effect of some building and environment design factors in modifying urban climate, particularly micro temperature, such as building density, green cover, roof material and ground treatment. The study measures micro temperature in three shop houses area with various building density, green cover and roof material and ground treatment. The study shows that the shop house area with the highest building density, the lowest green cover, and the widest roof and ground material becomes the area of highest temperature. The temperature different with the city's average is up to 1.9^{o}C. The fact indicates that the shop house tends to spread out to all city regions, until the sub urban area, even the new "urbanized" are that was formerly rural. The study recommends the controlling of the shop houses development and growth. The policy aims to prevent the spreads of high temperature to all area of the city. The study proposes a solution in modifying temperature by maximizing green area, both in ground level and roof top. The access to the parking lot has to be controlled in a "gated' lot so that distraction to the main road can be avoided. The high albedo material is recommended to be roof and ground level treatment.

KEYWORDS: shop house, urban climate modification, micro temperature, commercial area

1. INTRODUCTION

In the last 30 years, temperature of Medan city has been increasing up to 1.2^{o}C. The effect of global warming may causes the increasing, but beside that, it is a fact that the built area becomes increase day by day in the city. The buildings, the roads, the pavements can be the heat source that make urban temperature higher than the rural area (Griffith, 1978; Heat Island Group, 2005). The increasing of urban micro temperature caused by the physical elements create an urban heat island - UHI (Landsberg, 1981). The UHI gives impact to the increasing of energy for building interior cooling (Carlo and Lamberts, 2001; Watkins *et al*, 2002; Akasaka *et al*, 2002; Priyadarsini, 2009), the increasing of CO2 emission (Akbari *et al*, 1988) and the decreasing of citizens health quality by the heat and endangered gas emission (US EPA, 1992).

Some studies about UHI conclude that the urban heat is concentrated in the urban centre that is characterized by (1) high density buildings, mostly high-rise building (2) high rate of anthropogenic activity (Akasaka, 2002; Watkins *et al* , 2002). Not like many cities in developed country, in Medan the urban centre is filled by shop houses. The typology becomes growing fast and spreading out over the entire city, from a wide arterial road to a narrow neighbourhood street. The phenomenon endangers the spare for green area and discards the urban space character. The presence of such 'concrete forest' becomes heat source, and may make the urban micro temperature higher.

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The objective of this study is to analyse the influence of some urban design elements in modifying urban micro temperature. The result can be the consideration in formulating design guideline for shop houses, both to revise the existing buildings and to build the new ones.

2. URBAN PHYSICAL ELEMENTS AND MICRO CLIMATE MODIFICATION

The study concerning on urban climate started when Luke Howard observed London temperature performance in 1820, but the more intensive research have been just begun in the last twenty years (Arnfield, 2003). The distinction of the urban climate generates a new standard in the climate observation and complements the other standards provided by World Meteorological Organization –WMO (Oke, 1984). There are three types of observation scale of the urban climate, e.g. micro scale; local scale and meso scale.The micro scale is the type of climate observation to investigate the physical elements of urban space in 100 meters radius (Oke, 2004)

The physical urban structure becomes the heat-source when exposed by sun-heat, and together with greenhouse gas the structure compose an urban temperature (Akbari *et al*, 1988; Watkins *et al*, 2002). The condition create a part of urban space as an urban heat-island (UHI), that has a higher temperature than the outer part of the urban space.

Urban climate modification relates to some factors in urban design, such as land use and building function, open space and vegetation, and building design. The center of urban heat island usually occurs in the city center and Central Business District (CBD) where there is a concentration of human activity, mostly the commercial area. In London, for example, the UHI is centered in CBD and has a concentric pattern. The temperature becomes decrease as a place farther from the city center (Watkins *et al*, 2002). The similar patterns also found in New York (Gedzelman *et al*, 2003) and Athena (Mihalakakou *et al*, 2002).

The roof material and pavement surface can modify urban climate depends on the albedo value. The higher albedo will reflect much more heat and preventing the surface to be the source of heat of the surroundings. Asphalt, the material mostly used as road pavement, is one of the lowest albedo materials (Pomerantz *et al*, 1997). When the sunshine exposes the asphalt surface, the temperature can be 120^{o}F, higher than concrete with 110^{o}F, and grass field with 100^{o}F (Watson *et al*, 2003).

The building mass design can create a shadow to the other surface and preventing it exposed by sunshine and decrease micro temperature (Watson *et al*, 2003). The wider surface of building roof and envelope can receive more heat intensity (Marsh, 1984). The UHI always takes place in an area of many high rise buildings which relates to the wider heat-absorber building envelope (Akasaka *et al*, 2002; Watkins *et al*, 2002). The roof design can modify micro temperature. The flat roof collects much more heat than the gable roof does (Marsh, 1984).

The wind blow can decrease micro temperature by spread out the heat to the broader area (Watkins *et al*, 2002; Gedzelman *et al*, 2003; Kim and Baik, 2003). The building height, formation and orientation can modify the wind direction by blocking or channeling it, and indirectly modify the micro temperature.

The vegetation can decrease micro temperature by evapotranspiration and shadow (Akbari *et al*, 1992; Estes *et al*, 1996; Purnomo, 2002; Wark dan Wark, 2003). The shadowed surface can be up to 5.5 - 11 ^{o}C cooler than the open-exposed surface (Robinette, 1983). The cooling effect is significant, so the cool community movement in some cities in United States requires at least three trees for one building (Rosenfeld *et al*, 1996). However, the

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quantity of trees does not always decrease the temperature when the trees blocking the wind, preventing it to spread out the heat, and then, decreasing the temperature (Purnomo, 2002).

The increasing of urban micro temperature causes the increasing of the need of energy and cost for interior cooling (Carlo and Lamberts, 2001; Watkins *et al*, 2002; Akasaka *et al*, 2002), the increasing of CO2 emission (Akbari *et al*, 1988) and decreasing of citizens' health quality (US EPA, 1992). The increasing of 3^0C is equal with the increasing of 0.6 GW energy need, and it means 71 USD per year (Rosenfeld *et al*, 1996). The high temperature can also decrease thermal comfort, reduces the intensity of citizens' outdoor activity and the opportunity to engage in a social interaction (Harris, 2004). Moreover, the high temperature can increase the risk of many kinds of disease, such as skin cancer and asthma (US EPA, 2003)

Figure 1. Stevenson screen situated in the node of shop house district (left) and the thermohygrograph inside it (right)

3. METHODOLOGY

The study was situated in three shop houses districts in Medan. The locations were chosen based on some criteria, such as the variation of building density, green coverage, ground treatment and roof material. The chosen case study was Thamrin, Setiabudi and Katamso.

There were two kinds of data collected e.g.: physical data (plan) of buildings and the environment of the shop houses and the temperature data. The physical data was collected through a visual recording by redrawing site plan that based on digital map of Medan City. Some thematic map was drawn up, such as the green coverage, the building typology, the height of the building, the building function, the roof material and the ground treatment. The map was drafted both in two dimensions (site plan) and three dimensions (isometric map). The proportion of the elements of urban design that relate to the climate modification was calculated by AutoCAD program.

The climate factors measured were temperature and relative humidity for 4 months, from August to November 2013 that measured *in situ* simultaneously. The measuring device was thermo hygrograph that put in the Stevenson Screen, situated in the centre of the shop house district (Fig. 1). The daily and monthly temperature average was recorded by the device automatically.

The one way analysis of variance (anova) is used to look up the significance difference of temperature among the three study area, and between the shop houses districts and the city climate station. The analysis of micro temperature modification is done by comparing the

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character difference of building and environment of the three shop houses with the difference of the micro temperature. The analysis based on the relevant theory about the relationship between urban micro climate and building and environment's elements.

Table 1. The Ratio of Micro Temperature and Urban Physical Elements of Shop House

Variables	Thamrin	Setiabudi	Katamso
Temperature average (^oC)	28	27.2	27.5
Temperature Maximum (^oC)	36.6	36	36
Temperature minimum (^oC)	23.2	22.8	23.0
Shop house typology	27%	12%	14%
Green cover	10%	24%	19%

Source: Survey, 2013

Table 2. The temperature difference between Thamrin shophouses districts and the other shop house district and BMKG Climate Station (Sampali and Balai)

The temperature difference between Thamrin and The Other Climate Station				
Week	**Katamso**	**Balai**	**Setia Budi**	**Sampali**
1	0,3	0,9	0,6	1,7
2	0,3	0,9	0,5	1,1
3	0,2	1,0	0,5	1,2
4	0,5	0,8	0,8	1,1
5	0,4	0,9	0,8	0,8
6	0,4	0,9	0,9	1,0
7	0,7	0,6	0,7	0,8
8	0,6	0,9	0,6	1,1
9	0,5	1,2	0,7	1,2
10	0,7	1,3	1,0	1,3
11	0,7	1,0	1,0	1,3
12	0,4	1,0	0,9	1,2
13	0,3	0,8	0,3	0,8
14	0,4	1,1	0,8	1,5

4. MICRO TEMPERATURE MODIFICATION IN SHOP HOUSES AREA

4.1. BUILDING DENSITY, BUILDING FUNCTION AND MICRO TEMPERATURE MODIFICATION

The Katamso shop houses district is one of new shop houses area. It was built in the last 5 years in a inner ring road network. In this area, there is 14 % shop house typology in 100 meters radius of the temperature measuring device (Fig.2). Not like The Thamrin, The Katamso shop house is situated at 6 meters setbeck from the main road, but the frontyrad is not used optimally to be parking lot and or green area. Some shop house unit is expanded over the setback and reduce space for parking. With the three storey building height average and most of them are retails, the micro temperature of the area is 0.2 – 0.7 lower than The Thamrin.

The Setiabudi shop houses district is the area of lowest density of shop houses typology. There is 12 % shop house in the 100 meters radius of the temperature measuring device (Fig.2). Similar with The Katamso and the Thamrin, the shop houses has a flat concrete-roof, but there is many more of buildings has a concrete-tile and zinc -gable roof. This area has the lowest micro temperture compare the two other shop houses district, but is still higher than the two city climate station.

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Figure 2. The map of building typhology and building function

The one way anova indicates that there is a significant difference (p-value (0.000) < α (0,05)) of micro temperature amongs the five location (three shop houses area and two city climate station). The fact shows that the physical character of building and environment relates to the micro temperature modification.The Setiabudi shop houses district is the area of lowest density of shop houses typology. There is 12 % shop house in the 100 meters radius of the temperature measuring device (Fig.2). Similar with Katamso and Thamrin, the shop houses has a flat concrete-roof, but there is many more of buildings has a concrete-tile and zinc -gable roof. This area has the lowest micro temperture cmpare the two other shop houses district, but is still higher than the two city climate station.

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The research shows that the highest density shop house in Thamrin Road is the area of the highest temperature (Table 1). In 100 meters radius of measuring devices, there is 27 % shop houses typology in the area, and almost all buildings have flat concrete roof (Fig. 3). The most buildings' function is commercial use, such as retails and private office, with little portion of house and education facility (Fig 2). Although two other locations are also commercial corridors, Thamrin Road is the busiest and the densest. Some buildings of four to eight stories take place in the district, many more than the two other case study locations. The fact indicates that the area of the highest building density and height is the place of the highest temperature (Watkins *et a*l, 2002; Gedzelman *et al*, 2003; Mihalakakou *et al*, 2002). Furthermore, with the busy commercial function, Thamrin Road becomes a concentration of vehicle circulation that release greenhouse gas and increase temperature. The zero-finish demarcation line of the buildings causes no enough space for parking, so that the visitors use the road area as on-street parking and, as the consequence, reducing the capacity of the road to accommodate vehicle circulation. Traffic jam always occurs in the place and makes emission becomes higher, concentrated in one spot and increase micro temperature.

Figure 3. The map of roof material and ground treatment

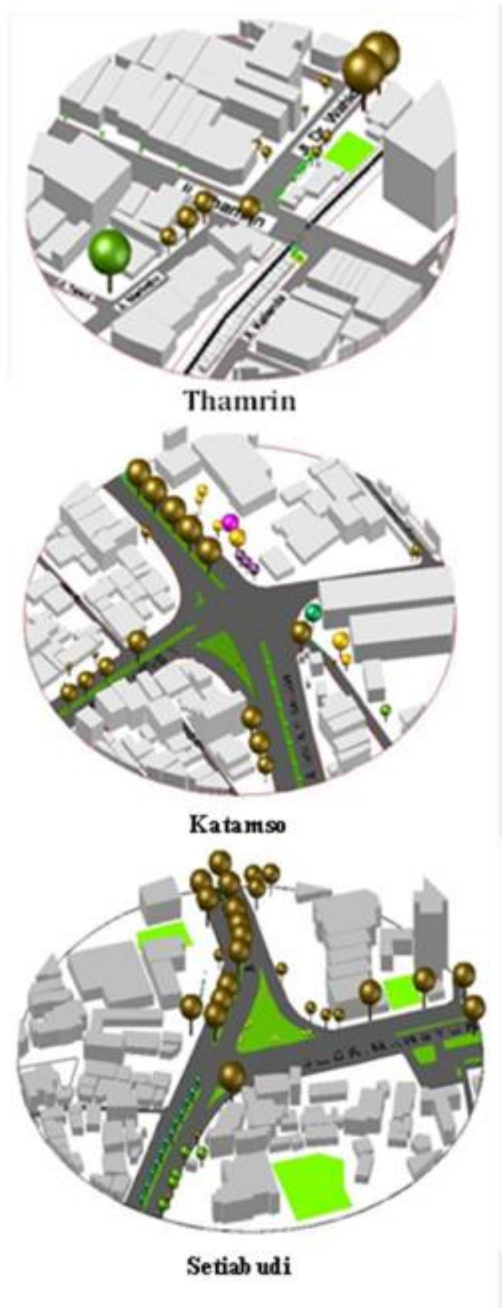

Figure 4. The map of trees distribution and green surface

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4.2. ROOF MATERIAL, GROUND TREATMENT AND MICRO TEMPERATURE MODIFICATION

The temperature measurement shows that Thamrin Road is the area of highest temperature. The temperature average was 28 ^{0}C, while maximum temperatur was up 36.6 ^{0}C and minimum temperature 23.2 ^{0}C. The area has a highest portion of flat-concrete roof material (23%), compare to Katamso (13 %) and Setiabudi (9%). Thamrin is also an area of fully paved. Almost all ground surface (99%) is paved, mostly with asphalt (22%), concrete-paving block (18%) and sand-stone (8%). The other material that has a potency to increase temperature is asphalt, and Katamso has the highest proportion of asphalt. The ratio of this material between Thamrin, Katamso and Setiabudi is 22 : 27: 25. In this condition, the temperature is 28 : 27.5 : 27.5. It shows Thamrin has the highest temperature. The average temperature difference between Thamrin and Katamso is 0.5 ^{o}C.

The study indicates that micro temperature modification by roof and pavement material relates to the heat-exposed, particularly the low albedo material. Most of the study area is filled by the buildings of flat concrete roof. However, the increasing of low albedo material is not always parallel to the increasing of temperature. Setiabudi Street has the highest surface of asphalt, the lowest albedo material, but the micro temperature average is the lowest, because the trees canopy shades the surface below, and decreases temperature significantly. The high albedo material with intensive heat-exposed contributes to increasing temperature significantly. On the contrary, the low albedo material but covered by trees canopy has a significant temperature decreasing.

4.3. VEGETATION AND MICRO TEMPERATURE MODIFICATION

In 100 meters radius of measuring device, Setibudi Road is the widest trees cover (7577, 43 m^2), then Katamso (6046, 86 m^2) and Thamrin (3227,71 m^2). It shows that Setiabudi Road is the area of highest green coverage and the lowest micro temperature. In contrast, Thamrin Road is a district of lowest green coverage and highest temperature. The zero-setback causes there is no space enough for trees along the road.

The wider trees' canopy is equal with the lower temperature. The study confirms some study before that the vegetation decrease micro temperature, though the width difference is not so extensive. Different with Thamrin Road, the trees in Setiabudi and Katamso Road take place both in the median and the edge of the road, so that the shadow is more effective in covering pavement below, whereas the pavement is a low albedo material. The fact shows that the vegetation is not always significant in decreasing micro temperature, depends on the positions to the shadow effect, the wind direction and the heat absorber surface (Purnomo, 2002; Emmanuel, 1997).

Figure 5. The elevation of shop house shows the implementation of the basic concept in maximizing green area in ground level, green wall and green roof

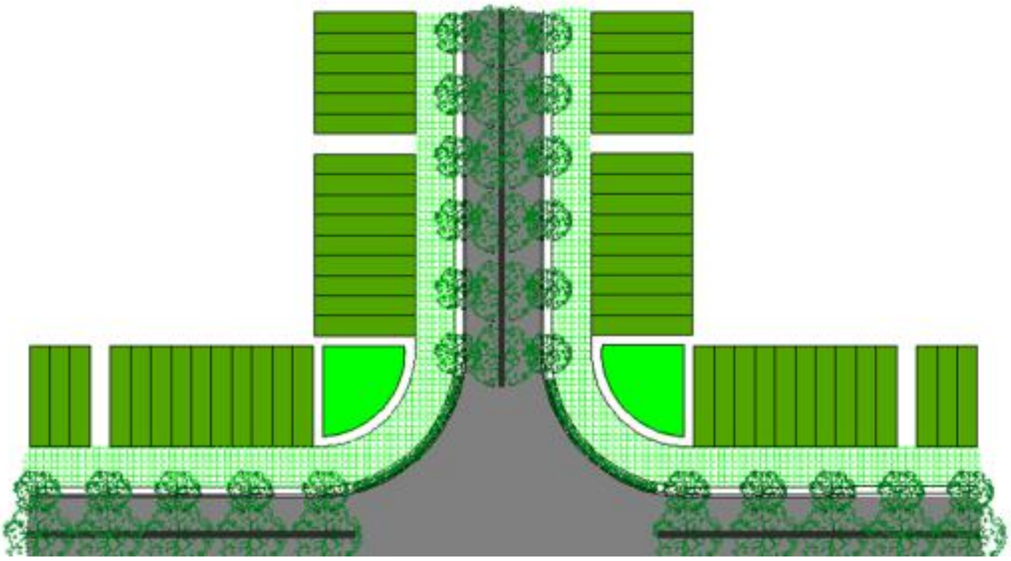

Figure 6. The site plan of shop house shows the implementation of the basic concept in maximizing green area in ground level, green wall and green roof

5. THE CONCEPT PROPOSED FOR SHOP HOUSES URBAN DESIGN GUIDELINES

5.1. BASIC CONCEPT

Concerning the endeavour in modifying urban micro climate by urban design guidelines, the basic concept for the shop houses is based on the environment and climate-responsive design, specifically in a humid tropical context. The primary objective is to prevent the increasing of micro temperature and to provide the decreasing of micro temperature. The basic concept for this is the optimizing green area, minimizing heat-exposed surface and minimizing anthropogenic-heat effects (Fig 5 &6). All the design guidelines factors should consider the basic concept. In this case, there are two types shop houses to be developed, first, the guidelines for improving the existing shop houses, and, the second, the guidelines for the new shop houses development.

5.2. GUIDELINES FOR IMPROVING THE EXISTING SHOP HOUSE

There are two types of the existing shop houses to be improved, the first, the zero-finish line shop houses with no front yard and, the second, the shop house with front yard.

For the first type shop houses, the main problem is the limitation of space to be improved in an ideal climate-responsive way, so there is less green area and high anthropogenic heat due to the absence of good parking. The guidelines are as follow:

1. In the first phase, there should be pedestrian path improvement to optimize the function of pedestrian. The improvement includes the clear segregation between pedestrian and vehicle circulation path. Thus, the pedestrian becomes more convenience and more utilized.
2. In the next phase, there should be a sharing car park building instead on street parking that potentially gives contribution to traffic jam. Furthermore, the adequate trees should be planted in the two edge of the road. The green roof should be installed in the shop houses rooftop.

For the second type shop houses, the main problem is the using of the front yard with no optimization function to be parking and green area. The condition makes the on-street parking that potentially causes traffic jam, increase emission and temperature. The research shows that the area of less vegetation cover becomes the highest temperature place. Thus, the guidelines are as follow:

1. The shop houses' front yard should be utilized as sharing parking, as well as green open space with adequate trees. Therefore, it is not allowed to extend the private area to the front yard.
2. There should be limited access to the parking lot, so the road becomes free from the parking-circulation distraction. It is not allowed making a free access along the edge of the road to the parking area.

5.3. BUILDING FUNCTION AND ACTIVITY FOR FUTURE SHOP HOUSE DEVELOPMENT

The fact shows that the growth of shop houses is not controllable when the development spread out to the part of low-density zones in the city. From the climate point of view, it seems like 'planting concrete forests' in a large scale that can endanger the spare for green space and also urban climate. The research indicates that the busy activity, such as commercial activity, which attracts high volume of vehicle circulation to the shop house area, causes the increasing of anthropogenic heat sources. Therefore, the activity and function guidelines for shop houses are as follow:

1. The development of shop houses should be restricted only in a zone of neighborhood or urban scale public service
2. The primary function for shop houses should be a short-duration visitor activity, such as retails or small-scale office
3. The secondary function with long-duration activities, such as education or health facility, can be attached in a little portion and required an adequate parking facilities, such as basement or car park building

5.4. HORIZONTAL LANDSCAPING

The research shows that the shop houses with least green area become the highest temperature space. In modifying the micro temperature the guidelines are as follow:

1. The shop houses area should be optimized as green space and green surface
2. The horizontal landscaping should be optimized by making the front yard as 'parking-garden' with a large proportion of trees and vegetation.
3. The ground should be covered by the wide-canopy trees and or the pergolas to protect it from heat-exposed.
4. The pathway-space should be optimized to be a greenway. There should be adequate trees to shade the ground pavement surface. The trees should be planted in the median and the edge of the road to give optimal shading for pedestrian path.

5.5. VERTICAL LANDSCAPING

The research indicates that the area of 'naked' concrete roof and wall becomes the highest temperature area. In modifying micro temperature, the guidelines are as follow:

1. The vertical landscaping applied as vegetation integration in envelope building design, both wall and roof, to prevent heat-exposed surface

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2. Green roof or roof garden should be installed in an intensive or extensive way. Therefore, the building structure should be prepared to provide the static or dynamic load of the garden. The planting medium can be permanent or moveable. The fix roof garden or green roof makes a more design prospect.
3. The 'movable' green roof or roof garden is more suitable for the existing shop house that never planned to be a green roof or roof garden. As the consequence, there should be adequate drainage equipment.

5.6. VEHICLE ACCESS, CIRCULATION AND PARKING

The research indicates that the shop house which attracts highest volume of vehicle has a highest micro temperature. The main problem is the absence of an adequate car park facility that causes traffic jam. In preventing the increasing of such anthropogenic heat sources, the guidelines are as follow:

1. There should be a separate access for shop house that placed in an arterial road to prevent a mix-line between the neighborhood and the urban scale vehicle
2. The shop houses should have an adequate demarcation line and front yard to be a space for parking and green area. The existing shop houses with no front yard have to be equipped with car park facility, such as basement or car park building. The on-street parking should be avoided.
3. The parking area should have limited access. The free-access parking of any point along the road should be avoided.
4. In the area where there is trishaw as transportation mode should provide the space for trishaw-line. The using road space to be trishaw-park should be avoided
5. There should be a bus stop with a "loop" shape – bus line
6. The shop houses of long-duration activities, such as education or health facility, should be equipped with parking facilities, such as basement or car park building.
7. The ground level parking lot should be functionalized as green area with adequate trees and water-permeable ground treatment

6. CONCLUSION

The study found that there is a significance temperature difference in the three study area and between the study area and the city climate station (BMKG Sampali and Padang Bulan Selayang). The difference temperature relates to the difference proportion of green coverage, shop house density, roof materials and ground treatment. The study identified that the highest temperature was in Thamrin shop houses district. The district is the busiest retail function with highest volume of vehicle circulation. The condition makes Thamrin becomes the place of highest rate of antropogenic heat-source.

The micro temperature modification also relates to flat roof-shape, high proportion of low albedo roof material and ground treatment. The increasing of micro temperature was equal with the higher proportion of concrete flat-roof as one main character of shop houses. The micro temperature decreases as shop house density decreases.

The most ground treatment found in void area of shop houses district is asphalt – a low albedo material, but the proportion of the material was not always equal with the increasing of micro temperature. It depends on the heat-exposed of the material. The condition relates to the position of shading elements, such as trees and building shading. The study indicates that the low albedo material is not significance in making micro temperature higher while it is covered by trees. In contrast, the high albedo material may give a higher contribution to a higher micro temperature, because of the high rate of heat-exposed.

The decreasing of micro temperature is equal with the increasing of green coverage. The place of highest proportion of green coverage becomes the place of lowest micro temperature.

The study recommends that the building envelope and void area of shop house district should be optimized as a green surface to modify the micro temperature to be lower. Besides that, the anthropogenic heat-source should be re-designed, such as the access and position of parking lot, the public transportation stop and the function of the buildings.

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STABILITY ANALYSIS OF SLOPE PROTECTION FOR THE RETAINING WALL OF ABUTMENT A2 AT LEMAH IRENG BRIGDE, SEMARANG- SOLO TOLL ROAD

Edy PURWANTO[1]

ABSTRACT: Lemah Ireng Bridge, section VI, Semarang – Bawen toll road is a monumental structure of PT. Trans Marga Jateng, Publics Work Departement, Province of Central Java. The bridge has span of : 85 m – 130 m – 85 m and 25 m width, more than 35 m height above the land surface. The upper structure of the bridge is box girder and the sub structure is bored piles foundation. The Construction staging of Lemah Ireng Bridge is a balanced cantilever method. The abutment A2 structure is laid on the valey so to get the final grade of the highway surface needs a fills works more than 8 m height at the back side of the abutment A2. To maintain this soils fill is needed a Retaining wall structure where this structure stands also at the valey. To stabilize the abutment A2 and the retaining wall along service time due to water rainfall, it is covered by earth fill on the front and the right sides of the two structures by as a slope protection. The analysis of the slope protection uses Plaxis version 8.50.The result of the study gets the Safety Factor (SF) = 1,43. This value is bigger than SF = 1,30 approved at the proyect, so the slope protection is stable.

KEYWORDS: Lemah Ireng Bridge, Slope stability, Abutment, Retaining wall and Plaxis 8.5.

1. INTRODUCTION

Toll road construction is verry important activity to provide a good transportation public and to solve the traffics in the national road from Semarang to Solo and the surrounding cities in the Central Java province. Toll road Semarang – Solo is constructed in two phases.

Phase I is Semarang - Bawen section and the second phase is Bawen - Solo section. The main road alinnement passes at the villages, hilleys, forresters and agricultures areas. Based on the topography, the bridge should be bulit along from station 22+125 to station 22+840, that is Lemah Ireng Bridge . The structure of the bridge consists of two piers (Piers P1 and P2) and two abutments (Abutment A1 and A2). The Lemah Ireng Bridge II has tree spans of 85 m – 130 m – 85 m and 25 m witdh. The upper structure of the bridge is box girder and the sub structure is bored piles foundation. (see Figure 1.). Abutment A2 structure laids on the at valley, so to get a final grade of the toll road surface needed an embankment soil more than 8 m height and 150 m length from the back of the abutment A2 structure (Wing walls structure). To prevent the movement of the soil fill a Retaining Wall should be constructed which paralelly with the wing wall. (PT. Global Perfex Synergi & ASS. 2012).This article presents the result of the study of the slope protection stability at the retaining wall structure abutment A2, Semarang – Solo toll road using the Plaxis version 8,50.

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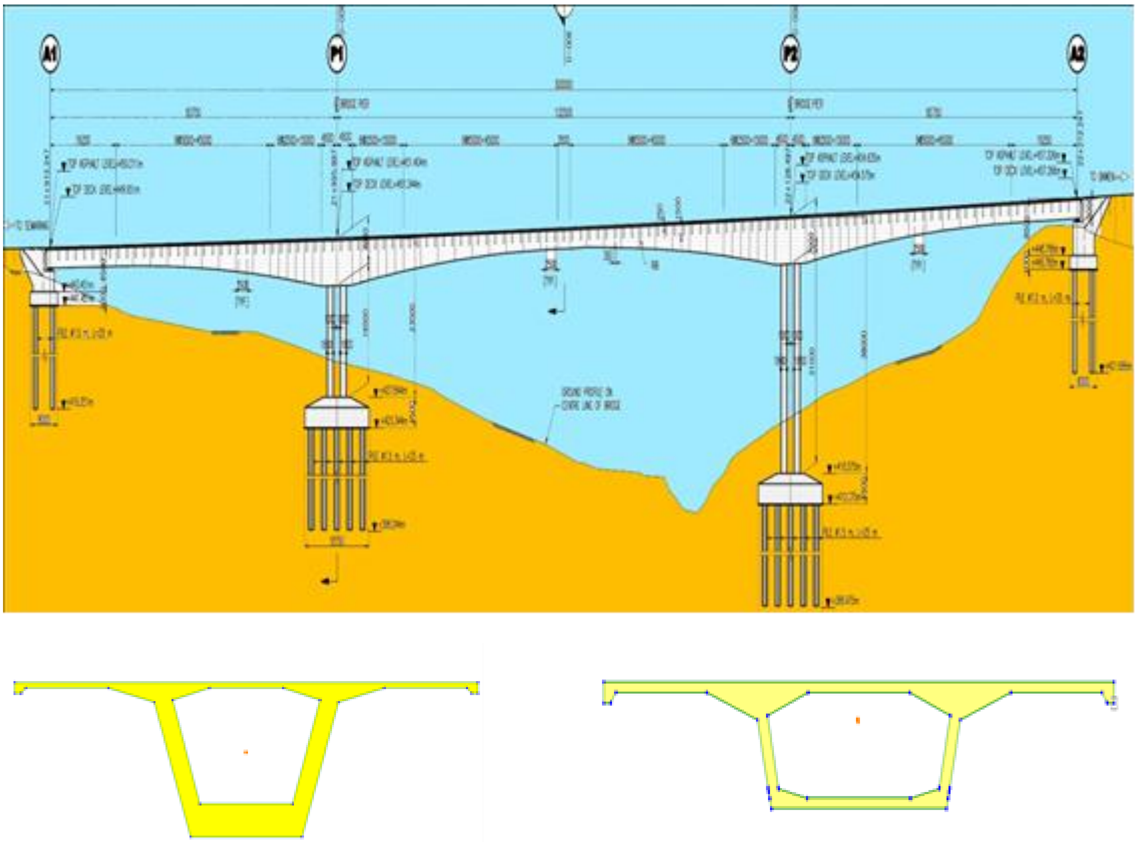

Box Girder Sec. at Support (Pier)

Box Girder Sec. At Mid Feld

Figure 1. Structure of Lemah Ireng Bridge

2. SLOPE STABILITY

The principles of slope stability have been developed over the past seventy years and provide a set of soil mechanics principles from which to approach practical problems. Although the mechanism of slope failure in heap leaching may be difficult to predict, the principles used in a standard of practice examination are relatively straightforward. There are many forms of slope failures. Slope stability analysis is an analytical tool for assessing the stability of a slope by using a simple failure model in analysis. There are two methods to slope stability analyzis, the first method is a limiting equilibrium method (LEM) and the second metod is a finit element method (FEM).

The limit equilibrium method by assuming the failure happened at the points a long the surface failure. The Shear strength is needed to maintain the limit equilibrium conditions compare with the shear strength at the soil and will give the average safety factors a long the failure line.

PLAXIS is a finite element package that has been developed specifically for the analysis of deformation and stability in geotechnical engineering projects. The simple graphical input procedures enable a quick generation of complex finite element models, and the enhanced output facilities provide a detailed presentation of computational results. The calculation itself is fully automated and based on robust numerical procedures. It is equipped with features to deal with various aspects of geotechnical structures and construction processes using robust and theoretically sound computational procedures (Brinkgreve, R.B.J et al. (2007).

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In PLAXIS version 8,50, the geometry of the model can be easily defined in the soil and structures modes, after which independent solid models can automatically be intersected and meshed. The staged construction mode allows for simulation of construction and excavation processes by activating and deactivating soil clusters and structural objects. The calculation kernel enables a realistic simulation of the non linear, time dependent and anisotropic behaviour of soils and/or rock. Since soil is a multi phase material, special procedures allows for calculations dealing with hydrostatic and non hydrostatic pore pressures in the soil. The output consists of a full suite of visualization tools to check the details of the 2D underground soil-structure model (Brinkgreve, R.B.J et al. (2007).

Typical PLAXIS applications include: assessing street level displacements during the tunnel construction, consolidation analysis of embankments, soil displacements around an excavation pit, dam stability during different water levels, and much more.

PLAXIS version 8,50 is a user friendly geotechnical program offering flexible and interoperable geometry, realistic simulation of construction stages, a robust and reliable calculation kernel, and comprehensive and detailed post-processing, making it a complete solution for your daily geotechnical design and analysis.

3. RETAINING WALL STRUCTURE

Retaining walls are structures designed to restrain soil to unnatural slopes. They are used to bound soils between two different elevations often in areas of terrain possessing undesirable slopes.

In the field, the abutment A2 structure laids on the valey, to get the final grade of the toll road surface is needed a soil embankment works more than 8 m height and 150 m length from the back side of the abutment A2. To prevent the horizontal movement of the soil embankments is needed a Retaining wall structure placed at the left side and became continuous structure with the abutment A2. Type of the retaining wall structure is a cantilevered wall made from the concrete materials. Type of soils used is sandy clay where the soils is taken from the Sta. 0 + 225. To stabilize the abutment A2 along service time due to water rainfall, it is covered by earth fill on the front and right of Abutment A2 by as a slope protection. The retaining wall structure is presented at Figure 2 and Figure 3.The stability of structure consists of the external stability and internal stability.

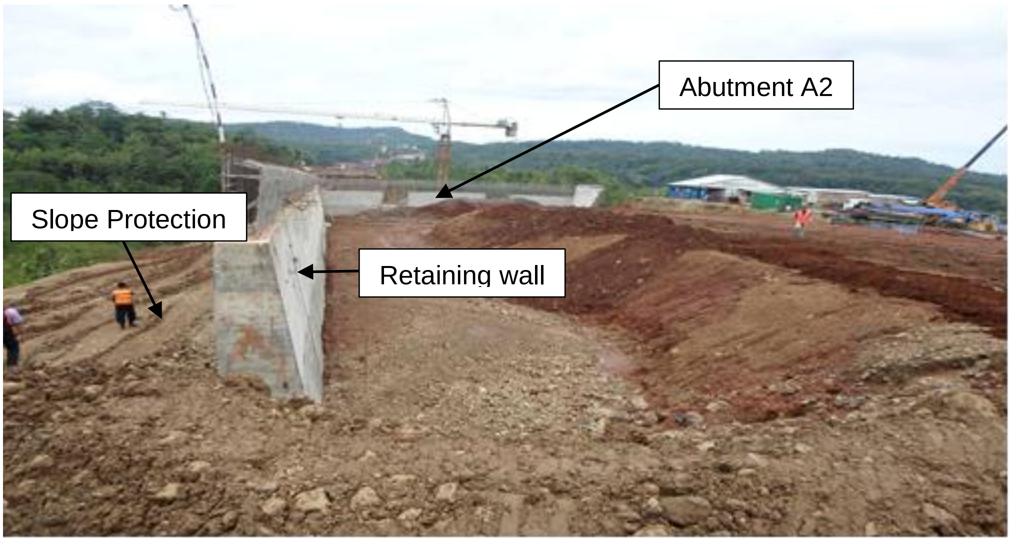

Figure 2. Structure of Reatining Wall at Sta. 22 + 840

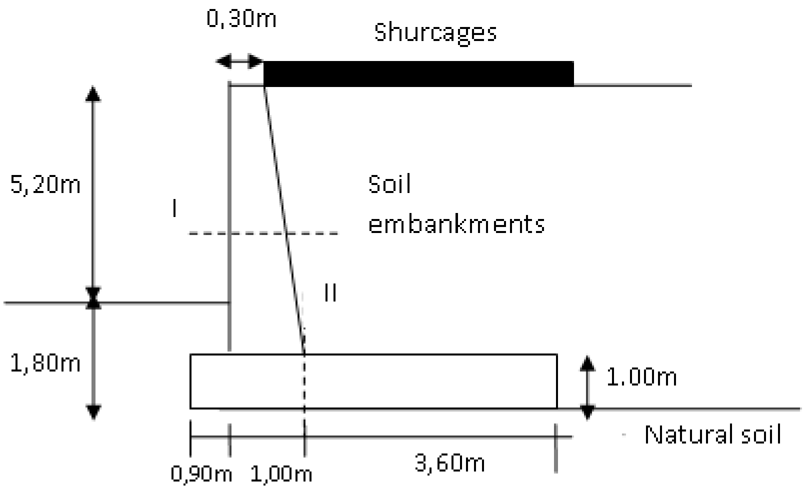

Figure 3. Design of Concrete Cantilever Structure

3.1. DESIGN ANALYSIS OF THE RETAINING WALL STRUCTURE

The materials of the retaining wall structure are the Concrete with f'c = 25 Mpa., γc = 25 kN/m3 , Steel ; f'y = 40 MPa. and the soil properties used is presented at Table 1.

Table 1 : Soil properties for the embankments work

No.	Type of soil	C (kN/m^2)	Φ (^{0})	γs (kN/m^3)
1.	Sandy clay	12	30	18

Source : PT. Waskita Karya Tbk. (2012)

3.2. EXTERNAL STABILITIES

1. Tourning stability.

   SF = ∑Mp / ∑Ma = 4,48 > 1,50 (ok)

2. Horizontal Stability

   SF = F / ∑Pa = 2,11 >1,50 (ok)

3. Bearing capacity Stability

   e = x – b/2

   = - 1,492 m > 1/6.b = 0,92m

Bearing capacity of soil (Terzaghi) :

σ ult = c. Nc + H.γ. Nq + 0,50. B. γ. Nγ.

σ ult = 1673,716 kN/m2. SF = 3

σ all = σ ult / SF = 557,90 kN/m2.

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Check of the Strength at the foundation :

$$\sigma_{maks} = \frac{V}{b.1}(1+\frac{6.e}{b})$$
$$= 314{,}368\, kN/m2 < \sigma_{ijin} \quad (ok)$$

$$\sigma_{\min} = \frac{V}{b.1}(1-\frac{6.e}{b}) = 75{,}10\, kN/m2 > 0 \quad (ok)$$

3.3. INTERNAL STABILITIES

1. At the cross section I-I :

$$\sigma = \frac{V}{b.1} + \frac{\sum M}{W} = 945{,}25 kN/m^2 < \sigma concrete$$

$$\tau = \frac{2}{3}.\frac{D}{b.h} = 60{,}314 kN/m^2 < \tau\, concrete$$

2. At the cross section B :

$$\sigma^- = \frac{V}{b.1} + \frac{\sum M_p - \sum M_a}{W} = 1060{,}11\, kN/m^2 < \sigma\, concrete$$

$$\sigma^+ = \frac{V}{b.1} - \frac{\sum M_p - \sum M_a}{W} = 799{,}05\, kN/m^2 < \sigma\, concrete$$

$$\tau = \frac{2}{3}.\frac{D}{b.h} = 77{,}8724\, kN/m^2 < \tau\, concrete$$

3. At the cross section II :

$$\sigma^- = \pm \frac{\sum M}{W}$$
$$= 328.06 kN/m^2 < \sigma\, concrete \quad OK.$$

$$\tau = \frac{2}{3}.\frac{D}{b.h}$$
$$= 92{,}78 kN/m^2 < \tau\, concrete \quad OK$$

From the analysis above, so the dimension of the retaining wall is stable and it Can aplicated in the field. After the dimension of the retaining wall structure is determined/defined, the calculation of the slope protection stability is calculating.

4. ANALYSIS OF THE SLOPE PROTECTION STABILITY

The topography model of the slope protection to Plaxis analysis is presented in Figure 4 bellow.

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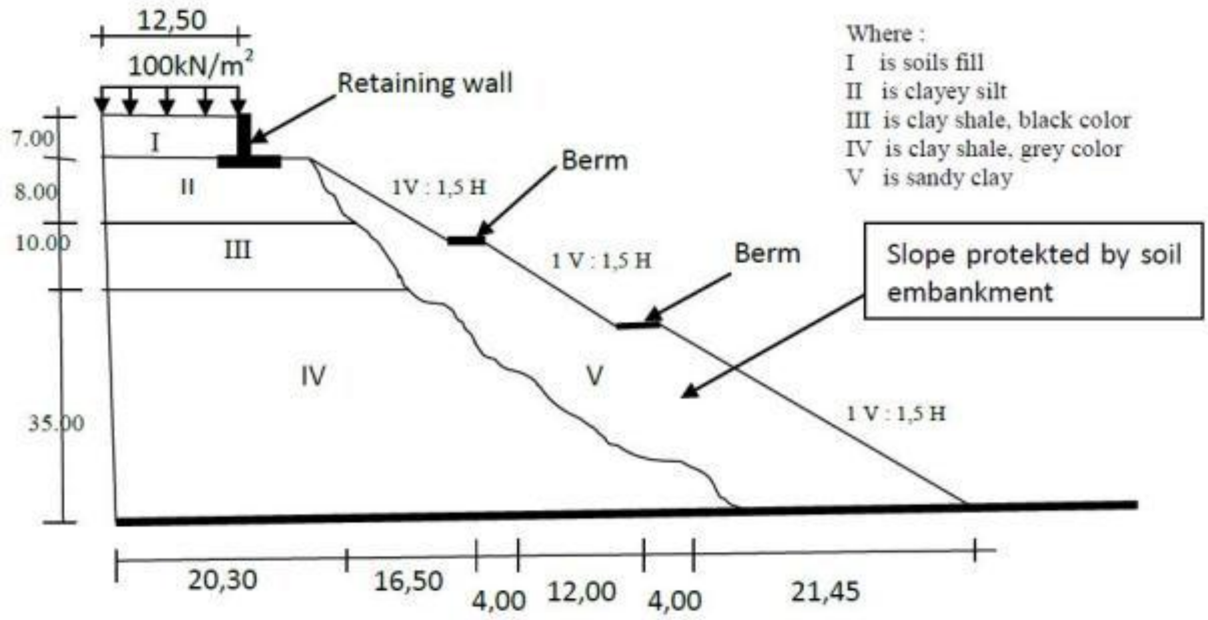

Figure 4. Topography Model of the Slope Protection at Sta 22+125

The soil properties for simulation in Plaxis version 8.5 is presented at Table 2. The Figure 5 shows the result of the bor log at station 22+125.

Table 2. Soil properties for slope protection

Parameter	Soil Embankment	Clayey silt	Clay shale I	Clay Shale II	
	MC	MC	MC	MC	-
γ_{unsat}	17,80	18,00	17,50	17,00	kN/m^3
γ_{sat}	21,00	22,00	18,00	19,00	kN/m^3
E	10235	10350	10062,5	9775	kN/m^2
v	0,33	0,33	0,33	0,33	-
c	25	60	55	40	kN/m^2
∅	30	35	30	25	°

Source : PT. Global Perfex Synergi (2012)

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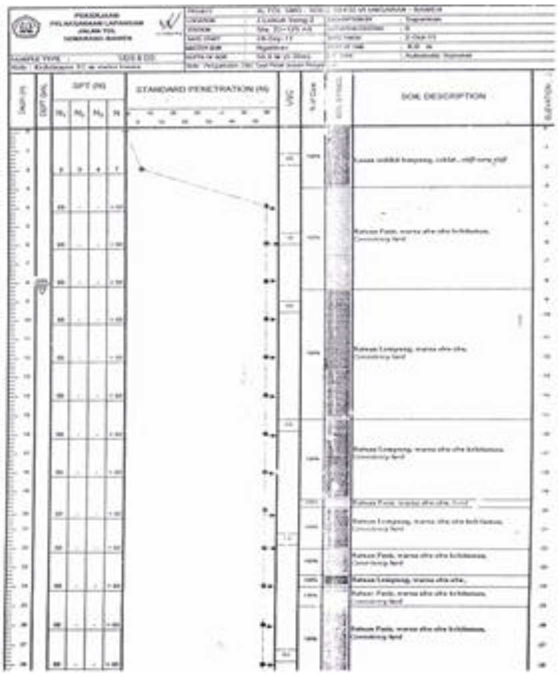

Figure 5. Bor Log at Sta. 22+125
(Source : PT. Waskita Karya, 2011)

The soil embankment is worked and compacted layer by layer with 20 cm thichness with the following a guide for soils compaction for soil fine agregates.The results of the Plaxis are presented at Figure 6, 7 and 8.

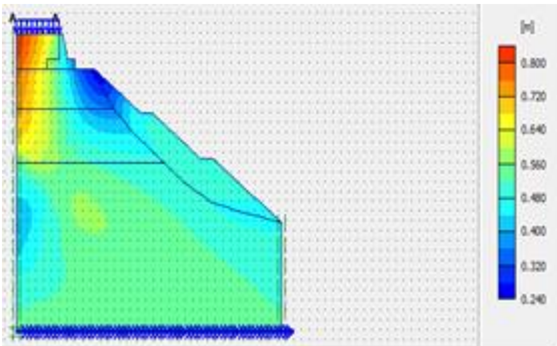

Figure 6. Total Displacement

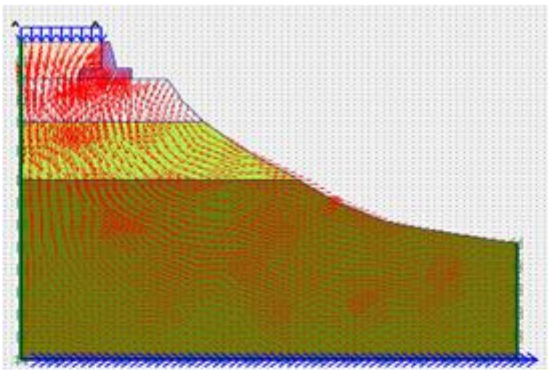

Figure 7. Direction of the Soil displacements

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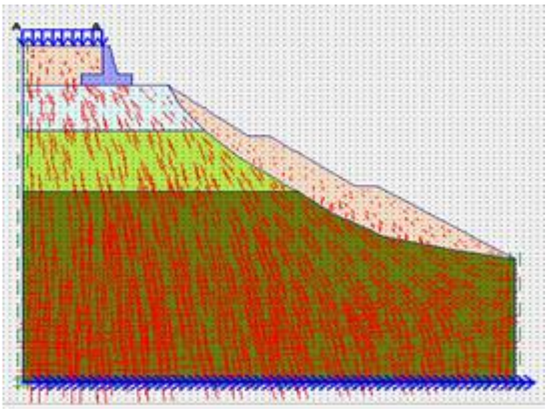

Figure 8. Efektif Stress

The figure 6 and 7 shows the direction of the soil displacements and the maximum total displacement. The Maximum total displacement is 837,70 10-3m. The figure 8 presents the effectif stress at the Slope. The effectif stress value is - 993,20kN/m2. The figure 9 at bellow presents the safety factor curves.

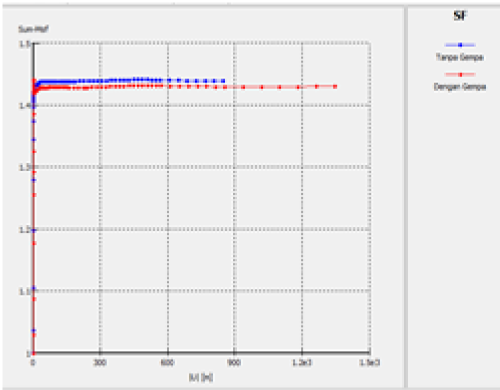

Figure 9. Safety factors

From the Figure 9, we gets the safety factor,SF= 1,430 and this value is bigger than safety factor recommended in filed, SF = 1,30. So the slope protection analyzed is stable.

5. CONCLUSIONS

The results of the study gets the safety factors, SF = 1,43, this value is bigger than SF = 1,30 recommended in field, so the slope protection for the retaining wall structure at Abutment A2 is stable and recommended.

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CHARACTERIZING FUEL USE AND EMISSIONS RATES OF HEAVY-DUTY DIESEL EQUIPMENT: A CASE STUDY FOR WHEEL LOADER

Heni FITRIANI[1], Phil LEWIS[2]

ABSTRACT: Heavy duty diesel construction equipment consumes large quantities of fuel and subsequently emits significant quantities of air pollutants. This paper presents a methodology for characterizing fuel use and emissions rates of construction equipment in order to better estimate air pollution emission rates. The research is based on real-world data collected from the equipment as it performed construction activities in the field. This study examined five wheel loaders by estimating the weighted-average fuel use and emissions rates via an engine load modal analysis. For each wheel loader, the engine load data was classified into 10 modes, ranging from the minimum to the maximum engine load, and an average fuel use and emissions rates were determined for each mode. The overall weighted-average fuel use rate was determined by multiplying the modal average fuel use and emissions rates by the percentage of time spent in that particular engine mode and then summing the results for each of the 10 modes. Monte Carlo simulation was used to model the distributions of the weighted-average fuel use rate for each wheel loader by randomly selecting values (within specified ranges) for the percentage of time spent in each engine mode and the modal average fuel use rate. The results indicate that there is inter-vehicle variability in the weighted-average fuel use rates of the five wheel loaders. A sensitivity analysis was also performed in order to determine which variables have the greatest impact on the weighted-average fuel use and emissions rates.

KEYWORDS: *Heavy-duty diesel construction equipment, fuel use, emissions rates*

1. INTRODUCTION

Human health and environmental problems have been in serious concerns due to the effect of air pollution. Construction activities consume a substantial amount of fuel and contribute a significant amount of pollutants emitted to the environment. EPA (2005) mentioned that approximately more than two million items of construction and mining equipment in the United States spend about six billions gallons of diesel fuel annually. Furthermore, in most construction activities, heavy-duty diesel (HDD) construction equipment is the primary source of emissions. It was estimated that in 2005 HDD construction vehicles produced U.S. national annual totals of 657,000 tons of NO_x, 1,100,000 tons of CO, 63,000 tons of PM_{10} and 94,000 tons of SO_2 (EPA, 2005). HDD construction equipment is typically a larger contributor of PM and NOx accounting for 65% and 30%, respectively (EPA, 2006).

HDD plays a significant role in contributing emissions to the environment which also affect human health problems. Diesel exhaust (DE) emissions are comprised of many constituents of pollutants such as oxides of nitrogen (NO_x), oxides of sulfur (SO_x), particulate matter (PM), and carbon monoxide (CO), Hydrocarbons (HC) and carbon dioxide (CO_2). According to EPA (2002), DE exposure may cause both long term and short term effects. Long term or chronic exposure to DE is potentially to trigger a lung cancer and lung damage risk to human. Meanwhile, short term or acute exposure to DE may pose irritation of the eyes and throat,

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neurophysiological symptoms (lightheadedness, nausea) and respiratory symptoms (cough, phlegm).

In order to address the issue with respect to the significant influence of DE from HDD to environment and human health, there is a need to measure the level of emission productions and fuel consumptions from HDD construction equipment. However, there is lack of research related to estimating fuel use and emission rates for HDD construction equipment based on the real-world data. Therefore, a thorough and reliable study on fuel use and emission rates quantification based on real-world data is essentially required.

This paper presents a methodology for characterizing fuel use rates and emission rates of construction equipment in order to better estimate air pollution impact. It is based on real-world data collected from the equipment as it performed construction activities in the field. This case study examined five wheel loaders by estimating the weighted-average fuel use rate via an engine load modal analysis.

2. PREVIOUS WORKS

Some of the most prominent real-world emissions measurements from HDD construction equipment were completed by the researchers at North Carolina State University (Abolhasani *et al*., 2008; Lewis, 2009; Rasdorf *et al*., 2010; Frey *et al*., 2008; Kim, 2007). Other researchers from West Virginia University and the University of California – Riverside also directed their studies on the use of on-board emission measurement for particular construction equipment.

Lewis *et al*. (2012) studied the influence of engine idling with respect to fuel use and emission rates of CO_2 for HDD construction equipment. Similar to the prior study, this study also investigated 34 items of construction equipment which comprised of 8 backhoes, 6 bulldozers, 3 excavators, 6 motor graders, 3 off-road trucks, 3 truck loaders, and 5 wheel loaders. Moreover, this study determined the operational efficiency of each item of equipment indicated by the ratio of nonidle time to total equipment use time. The results showed that nonidle fuel use and emission rates were significantly higher than those in idle condition. In addition, results also showed that as idle time increased, the fuel use and emissions rates of CO_2 increased significantly.

Abolhasani *et al*. (2008) mainly focused on measuring fuel use and emission rates of NO_x, CO, HC, CO_2 and PM for hydraulic excavators using real-world measurement. This study showed that nearly 90% of measurement was valid and approximately 50% of nitric oxides emissions were produced during 30% of the time of operation. Moreover, mass per time emission rates for nonidle activity modes were significantly higher; seven times compared to those of idle modes. Frey *et al*. (2008a) compared petroleum diesel and B20 emissions from backhoes, motor graders, and wheel loaders while performing typical duty-cycles. Furthermore, Frey *et al*. (2008b) highlighted the field activity, fuel use, and emissions of motor graders in terms of using petroleum diesel and B20 biodiesel.

3. METHODOLOGY

This paper presents a methodology for characterizing fuel use and emissions rates of heavy-duty diesel construction equipment specifically for five wheel loaders. However, only the calculations for fuel use rates are presented. Engine load was determined by measuring the MAP, which was used as a surrogate for engine load. Since most of the equipment has various ranges of MAP values, normalization of the MAP was conducted as explained by the following equation.

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$$MAP\ nor = \frac{\mathrm{MAP} - \mathrm{MAP\ min}}{\mathrm{MAP\ max} - MAP\ min} \quad (1)$$

where:

MAP_{nor} = Normalized MAP for a measured MAP for a specific item of equipment
MAP_{max} = Maximum MAP for a specific item of equipment
MAP_{min} = Minimum MAP for a specific item of equipment
MAP = Measured MAP for a specific item of equipment

For each wheel loader, engine load data was classified into 10 modes, ranging from the minimum to the maximum engine load, and an average fuel use rate was determined for each mode. The overall weighted-average fuel use rate was determined by multiplying the modal average fuel use rate by the percentage of time spent in that particular engine mode and then summing the results for each of the 10 modes.

Monte Carlo simulation was used to model the distributions of the weighted-average fuel use rate for each wheel loader by randomly selecting values (within specified ranges) for the percentage of time spent in each engine mode and the modal average fuel use rate.

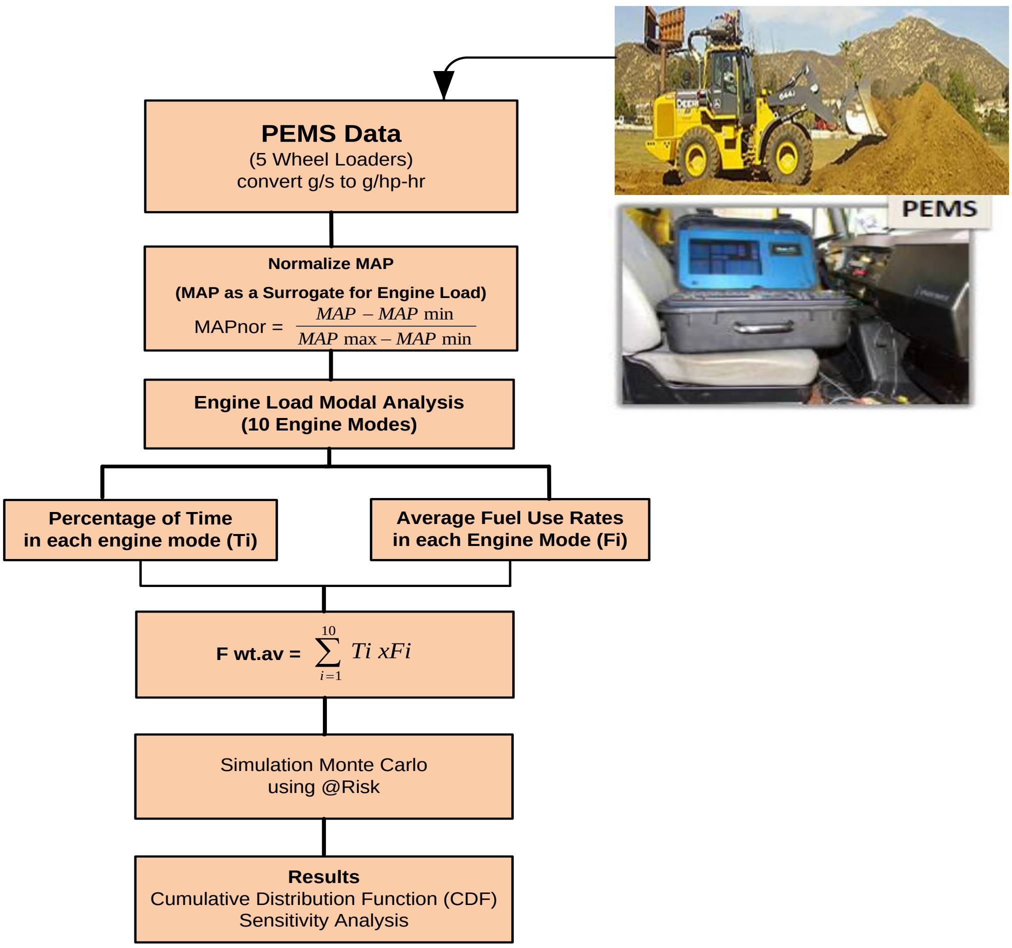

Figure 1. Procedure for Monte Carlo Simulation

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Two scenarios were developed for analysis:

- **Scenario 1**

Assume distribution % of time and fuel use rates for each mode in each wheel loader as lognormal function where the parameters are mean and standard deviation (10% of mean value).

- **Scenario 2**

Assume distribution % of time as lognormal function where the parameters are mean and standard deviation (10% of mean value) and fuel use rates for each mode in each wheel loader using fitted distribution.

4. RESULTS

This section presents the results of the weighted average of fuel use and emissions rates for five wheel loaders. The weighted-average fuel use as a function of percentage of time and fuel use rate is explained. Data from wheel loader 1 is provided as a baseline for analyzing further results.

Table 1 presents the summary of average percentage of time for each engine mode in 5 wheel loaders including the total average of all wheel loaders. Meanwhile, Figure 2 shows the distribution of engine modes and average percentage of time for 5 wheel loaders.

As seen in the table, it was found that the higher the engine load (shown by the minimum to maximum orders of engine modes), the lower the percentage of time spent in each engine mode. As indicated from the Table 1 and Figure 2, approximately 40% of time was spent in engine mode 1, 20% in engine mode 2, and 13% in engine mode 3, and less than 2% of time in engine mode 10. The average percentages of time are used to calculate the weighted average fuel use and emission rates.

Table 1. Percentage of Time in each Engine Mode

Modes	WL1	WL2	WL3	WL4	WL5	Average
1	46.99%	20.73%	48.44%	28.99%	54.71%	39.97%
2	18.98%	18.07%	17.22%	23.09%	22.49%	19.97%
3	9.83%	19.52%	8.74%	17.99%	5.84%	12.38%
4	6.78%	15.49%	6.96%	7.51%	4.61%	8.27%
5	4.85%	11.83%	4.65%	3.54%	2.80%	5.53%
6	3.89%	6.53%	3.94%	3.69%	2.26%	4.06%
7	2.37%	4.04%	3.27%	4.82%	1.55%	3.21%
8	2.36%	2.10%	2.83%	6.21%	1.72%	3.04%
9	2.33%	0.94%	2.31%	3.74%	2.09%	2.28%
10	1.63%	0.75%	1.64%	0.42%	1.93%	1.27%
			Total			**100.00%**

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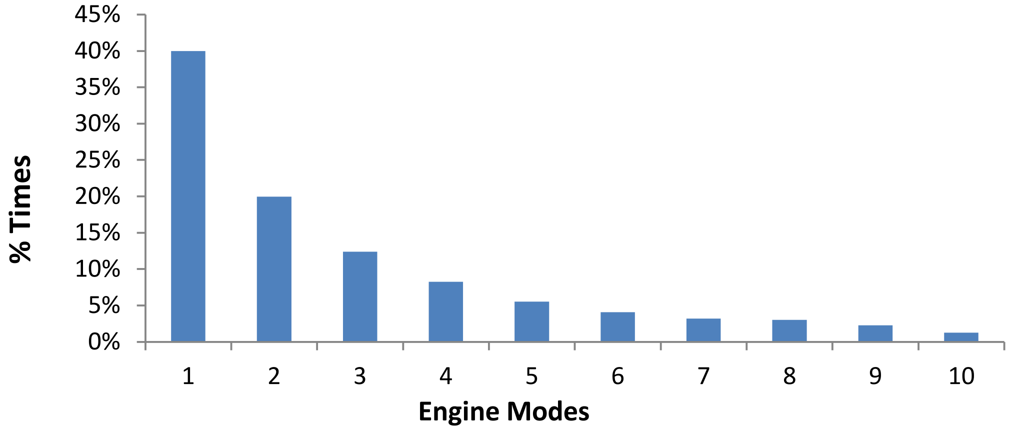

Figure 2. Average Engine Mode Distribution

Table 3 presents summary statistics and distribution graphs of weighted average fuel use rates for each wheel loader using Scenario 1 and 2. The graphs indicate there is variability in each wheel loader.

Table 2. Results using Deterministic Approach for Wheel Loader 1 (Baseline)

Modes	Times (%)	Fuel Use (g/hp-hr)	Wt. average Fuel use (g/hp-hr)
1	46.99%	0.00674	0.00317
2	18.98%	0.01102	0.00209
3	9.83%	0.01432	0.00141
4	6.78%	0.01806	0.00122
5	4.85%	0.02078	0.00101
6	3.89%	0.02355	0.00092
7	2.37%	0.02635	0.00062
8	2.36%	0.03007	0.00071
9	2.33%	0.03397	0.00079
10	1.63%	0.04117	0.00067
Total			**0.01261**

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Table 3. Summary Statistics and Distribution Graphs for 5 Wheel Loaders Using Scenario 1 and 2

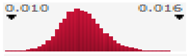
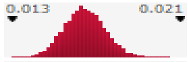
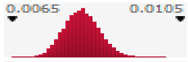
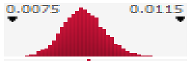
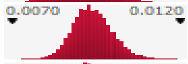
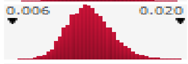
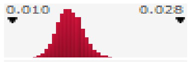
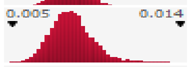
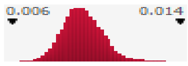
Scenario	WL	Weighted Average Fuel Use Rate (g/hp-hr)					Graph
		Min	Mean	Max	5%	95%	
1	WL 1	0.0101	0.0126	0.0155	0.0115	0.0137	
	WL 2	0.0133	0.0166	0.0203	0.0152	0.0180	
	WL 3	0.0067	0.0082	0.0101	0.0076	0.0089	
	WL 4	0.0077	0.0093	0.0111	0.0085	0.0100	
	WL 5	0.0075	0.0094	0.0118	0.0086	0.0103	
2	WL 1	0.0070	0.0126	0.0196	0.0101	0.0155	
	WL 2	0.0118	0.0166	0.0272	0.0146	0.0187	
	WL 3	0.0053	0.0083	0.0133	0.0069	0.0100	
	WL 4	0.0065	0.0093	0.0209	0.0078	0.0110	
	WL 5	0.0066	0.0095	0.0132	0.0082	0.0109	

Figure 3 and 4 illustrate detail comparison of CDF for weighted average fuel use rates of wheel loader 1 using scenario 1 and 2.

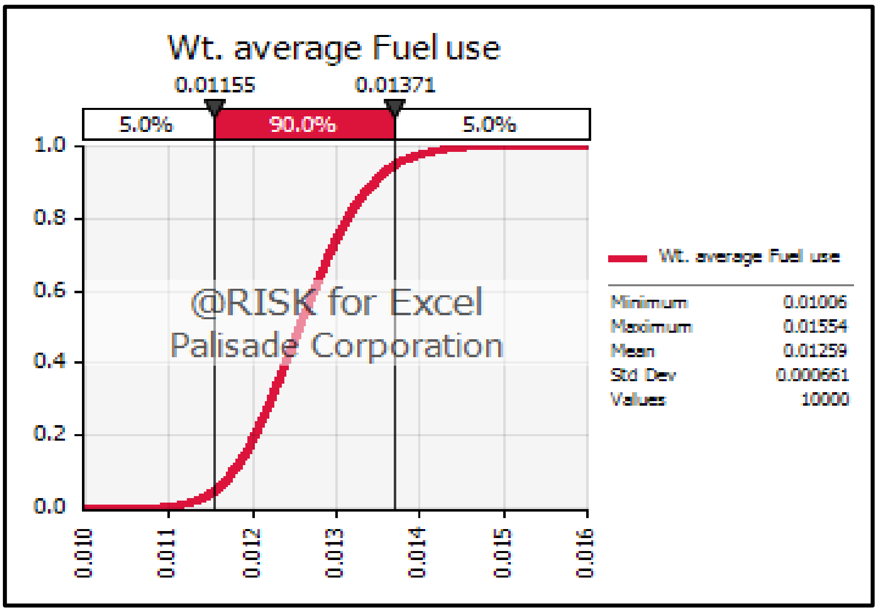


Figure 3. CDF for Weighted Average of Fuel Use Rate of Wheel Loader 1 using Scenario 1

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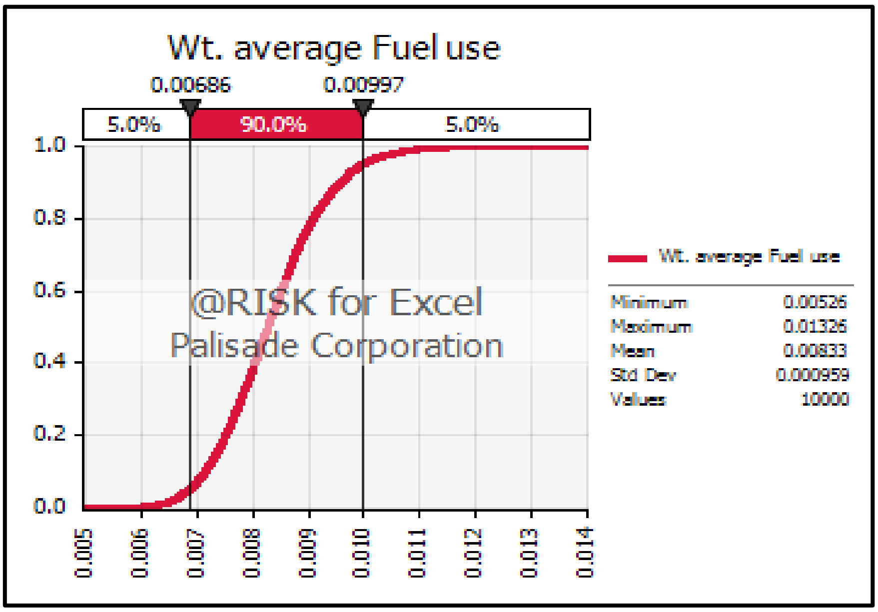

Figure 4. CDF for Weighted Average of Fuel Use Rate of Wheel Loader 1 using Scenario 2

A sensitivity analysis was also performed in order to determine which variables have the greatest impact on the weighted-average fuel use factors. Table 3 shows higher variability in Scenario 2 compared to Scenario 1; thus, a sensitivity analysis was completed for Scenario 2 as shown in Figure 5. Datasets illustrate that fuel use rate in mode 1 has the highest impact to the total weighted average fuel use rate. This is followed by mode 2 as the second most important variable.

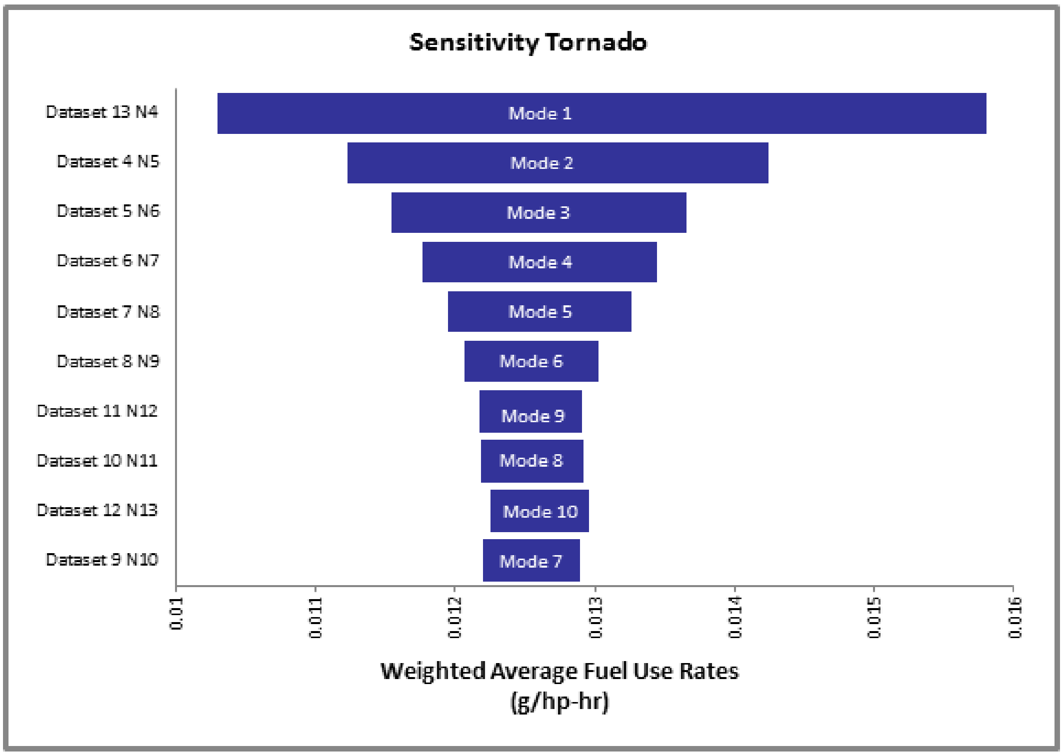

Figure 5. Sensitivity Analysis for Wheel Loader 1 in Scenario 2

5. CONCLUSIONS

The purpose of this paper was to demonstrate a methodology for characterizing fuel use rates and emission rates of construction equipment in order to better estimate air pollution impact. It is based on real-world data collected from the equipment as it performed construction activities in the field. This case study examined five wheel loaders by estimating the weighted-average fuel use rate via an engine load modal analysis.

It can be concluded that the fuel use rates increase as engine modes increase. The results for emissions rates for each pollutant actually followed the same results. It was found that fuel use and emission rates (g/hp-hr) increase significantly when engine modes reach to maximum values. This simply means that there are linear relationships between the fuel use and emission rates and engine modes. Therefore, the weighted average fuel use and emission rates were obtained by the multiplication of the average percentages of time and fuel use and emissions rates for each engine mode.

Monte Carlo simulation was used to model the distributions of the weighted-average fuel use rate for each wheel loader by randomly selecting values (within specified ranges) for the percentage of time spent in each engine mode and the modal average fuel use rate. The results indicate that there is inter-vehicle variability in the weighted-average fuel use rates of the five wheel loaders. The mean value for weighted average fuel use rates for scenario 1 and 2 are not significantly different. However, there is variability in the minimum and maximum values for weighted average fuel use rates including the values using 5% and 95% percentile.

Sensitivity analysis indicates that mode 1 has the highest impact to the total weighted average fuel use rate. This is then followed by mode 2 and mode 3 that gave the second and third highest impacts to the total weighted average fuel use rate.

Overall, the results of this study help quantify and characterize the air pollution problems from HDD equipment used in construction. The methodologies presented may certainly be used to develop fuel use and emissions prediction for other types of equipment.

6. ACKNOWLEDGEMENT

The authors acknowledge the use of the real-world nonroad equipment and emission database that was developed at North Carolina State University by Dr. H. Christopher Frey and Dr. William Rasdorf.

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COMPARISON OF STRUCTURAL PERFORMANCE LEVEL OF IRREGULAR BUILDINGS USING REINFORCED-CONCRETE OPENED FRAMES TO THE TYPE OF U AND H IN YOGYAKARTA BY USING SNI 1726-2012 AND PUSHOVER ANALYSIS METHOD

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ABSTRACT: Irregular building is a complex building that has lower structural performance level compared to regular building. Engineers do not recommend irregular building because of that factor. In the other side, irregular building is needed to provide the demand of space and design. There are many popular irregular building types such as U and H. The decision of which type should be used is depend on the demand of space and design. As engineer, we have to follow the demand and collaborate with architect. It becomes challenging for engineers to provide the proper structure design for irregular building. The irregular building should give the performance level that meets the need of the use of the building. There are many popular irregular building types that lead to a question, “which one does provide better performance level?” The purpose of the research is to find out the performance level of irregular high rise building with the type of U and H with the same height and mass of building in Yogyakarta seismic zone for stiff soil. The method of the research is pushover analysis which can determine the performance level of the building. The pushover analysis uses SAP2000 software and it refers to Federal Emergency Management Agency (FEMA) 356, and Applied Technology Council (ATC)-40. The design procedure for earthquake refers to SNI 1726-2012. Based on FEMA 356, the building performance level is categorized to three performance levels, i.e. Immediate Occupancy level, Life Safety level, and Collapse Prevention level. The building performance level is targeted depend on the use of the building. The result of the research is expected to give the difference of the performance level of irregular building with the type of U and H. Further, the evacuation plan for the type of building will also provide. Thus, it can be a consideration factor for constructors in using those irregular building types.

KEYWORDS: Irregular building, space and design, structural performance level, pushover.

1. INTRODUCTION

In the last couple years, the number of earthquake events was increased in some regions in Indonesia, i.e. Nabire, Aceh, Nias, Yogyakarta, Bengkulu, Tasikmalaya, Padang, and some other regions. Indonesia Data and Information for Disaster (DIBI) released data, 114 earthquake events had been occurred from 1998 to 2008, 3 of them were followed by tsunami events. DIBI reported that between those years at least 136.799 people died, 474.171 houses, 10.519 schools, and 1.336 hospitals were totally damaged and collapsed. The total cost caused by those events was approximately IDR 43,356 Trillion (DIBI, 2009)

Hotel is actually classified as engineered building. What was happened in Padang earthquake, on September 30, 2009 had shown that there were engineered buildings which were collapsed such as hotels, offices, hospitals, and schools. As the result, there is an emerged question, “do the other engineered buildings will have enough performance to face the same earthquake events in the future?” (Satyarno, 2010).

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Satyarno (2007) stated, “From the field observation, engineered buildings which were collapsed at the moment have high vulnerability level”. We can get a conclusion from big earthquake events occurred in the last couple years that the vulnerability to earthquake was increased. We can reduce the risk by increasing the capacity. It can be realized by providing a better design in buildings construction. Learning from the historical data of earthquakes, The Indonesia Standardization Agency (BSN) was working for the new earthquake zone map. BSN periodically released the revised code for the older earthquake code (SNI 1726-2002). Finally, in 2012 the full version of the new code was released, namely SNI 1726-2012. The code is revised the older code SNI 03-1726-2002.

We have found some increase and decrease level of the new design spectra in the new code. It has been found on 15 big cities and some other regions. Those big cities are Yogyakarta, Bandung, Jakarta, Surabaya, Semarang, Surakarta, Denpasar, Medan, Banda Aceh, Padang, Makassar, Palu, Manado, Palembang and Jayapura (Arfiadi and Satyarno, 2013). The comparison graph of the decreased and increased level of the new design spectra in short period for stiff soil in Yogyakarta is shown in Figure 1

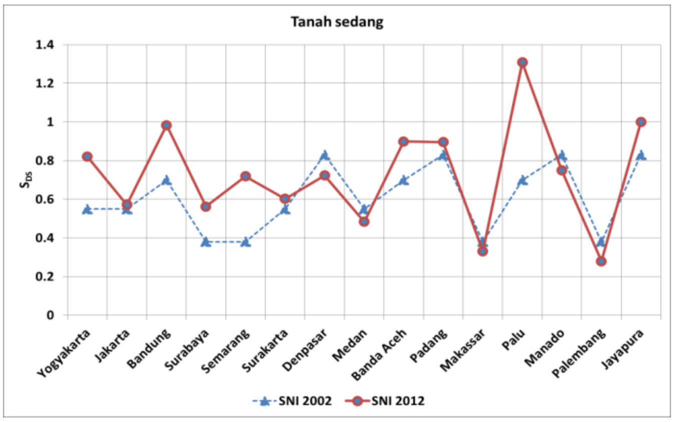

Figure 1. The comparison graph of the decreased and increased level of the new design spectra in short period for stiff soil (Arfiadi and Satyarno, 2013).

2. PERFORMANCE BASED SEISMIC DESIGN

Buildings are designed based on the building code to ensure the safety to the earthquakes. Nevertheless, the procedure used in the building code does not describe directly the building performance to the actual earthquake. The performance has correlation to the risk in terms of infestation spent by the owner.

Performance based seismic design is a procedure that can be used to designing new building and strengthening existing building. It has better understanding of the risk of life, occupancy, and economic loss that might be affected by future earthquake. The process of the procedure starts with creating building model and then simulating the model with some earthquake cases. Every simulation has different level of damage and structure tenacity, with the result that we can estimate the risk of life, occupancy, and economic loss. Thereupon, engineers can re-design the risk that allowed to the building accord with the building cost. Refer to FEMA-356 (2000); the classic reference to performance based seismic design, the performance level of the structure is classified to the following:

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- O = Operational
- IO = Immediate Occupancy
- LS = Life Safety
- CP = Collapse Prevention

The building has to meet one of the performance levels; it depends on the building use.

3. REGULAR AND IRREGULAR BUILDING

Building has classified into regular and irregular due to its shape. The regular building has symmetrical shape in terms of plan and vertical view, and then it has better distribution of mass. On the other hand, the irregular building has asymmetrical shape in terms of plan and vertical view. We have to use irregular building because the need of space and design. The irregular buildings need more attention due to the potential impact to the earthquake. There are many type of irregular building, this research focused on the irregular building to the type of U and H. Those types were evaluated with the pushover analysis to determine each characteristic to the earthquake.

4. STATIC NONLINIER ANALYSIS

Static nonlinear analysis, mostly known as Pushover analysis is a procedure analysis to understand the building performance to the earthquake. This analysis needs computer programs to analyze, the most popular computer programs are SAP2000, ETABS, GTStrudl, and Adina. Analysis done by push the structure with the static lateral load, and then increase the load periodically until one of the displacement target reached.

The objective of pushover analysis is to estimate the maximum force and displacement, also to get information where the critical points located. Thus, we can identify the critical point to give a better attention for the detailing and stability.

5. MODELING OF STRUCTURE

The structure data of the building with the type of U and H are in the following Table 1.

Table 1. Structure data for all type of building

Property of Building	
Function	Office
Building Area	Total 1200 m^2
Height	5-Story
System structure	Reinforced-Concrete Opened Frames
Concrete quality	25 Mpa
Rebar quality	240 MPa (□ < 12 mm, plain), and 400 MPa (□ > 12 mm, deform)
Beam	400 x 300 mm^2
Column	450 x 450 mm^2
Slab	100 mm (roof), and 120 mm (floor)
Dead Load	2.942 kN/m2 (roof), and 4.9253 kN/m2 (floor)
Live Load	0.9807 kN/m2 (roof), and 2.4517 kN/m2 (floor)
Earthquake Load	Yogyakarta Earthquake Zone

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The geometry of the U and H structures has shown by Figure 2.

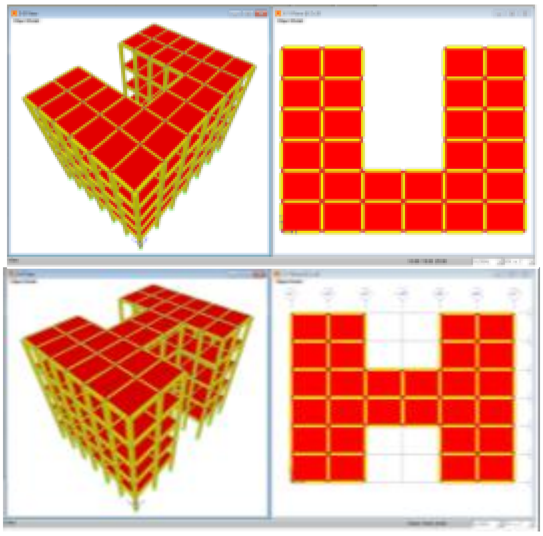

Figure 2. The geometry of structure.

6. MODAL ANALYSIS

The result of modal analysis (Eigen value) used to get the structural dynamic behavior and the natural vibration periods of the structure. The method used to determine the modal analysis for irregular structure is Complete Quadratic Combination (CQC). The analysis has to be done to determine the natural periods and mode of vibration to get modal participating mass ratio not less than 90% from the actual mass of each direction. We can see from the Table 2 that the modal participating mass ratios and load participation ratios have reached more than 90% at mode 4 for x-direction, and mode 5 for y-direction.

Step Type	Step Num	TYPE - U			TYPE - H		
		U-Period	SumUX	SumUY	H-Period	SumUX	SumUY
Text	Unitless	Sec	Unitless	Unitless	Sec	Unitless	Unitless
Mode	1	0.7898	0.8391	0.0000	0.7896	0.8402	0.0000
Mode	2	0.6911	0.8391	0.8519	0.6911	0.8402	0.8520
Mode	3	0.6786	0.8402	0.8519	0.6767	0.8402	0.8520
Mode	4	0.2520	0.9434	0.8519	0.2520	0.9434	0.8520
Mode	5	0.2250	0.9434	0.9519	0.2250	0.9434	0.9519
Mode	6	0.2199	0.9435	0.9519	0.2191	0.9434	0.9519
Mode	7	0.1415	0.9800	0.9519	0.1415	0.9800	0.9519
Mode	8	0.1301	0.9800	0.9842	0.1302	0.9800	0.9842
Mode	9	0.1266	0.9800	0.9842	0.1259	0.9800	0.9842
Mode	10	0.0965	0.9954	0.9842	0.0964	0.9956	0.9842
Mode	11	0.0921	0.9954	0.9968	0.0921	0.9956	0.9968
Mode	12	0.0885	0.9956	0.9968	0.0880	0.9956	0.9968
Mode	13	0.0756	0.9998	0.9968	0.0754	1.0000	0.9968
Mode	14	0.0744	0.9998	1.0000	0.0744	1.0000	1.0000
Mode	15	0.0707	1.0000	1.0000	0.0703	1.0000	1.0000

Figure 2. Modal Participating Mass Ratios

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Table 2 shows the fundamental period of structure on mode 1 (T_1 X-direction) and mode 2 (T_2 Y-direction). According to SNI 1726-2012, sec 7.8.2. the fundamental period of structure is not allowed to reach more than the upper limit on calculation period (Cu) from Table 14 and approximate fundamental period (Ta). The value of Ta (approximate period) is calculated by the following equation (SNI 1726-2012, eq. 26). According to Table 15, SNI 1726-2012, the value of Ct and x are refer to concrete moment resisting frames. The result of each T period is shown by Table 4.

Table 3. The fundamental period of structure for each structure

TYPE	Mode	Ta	T	Req.*)
Text	Text	Sec	Sec	Text
U	1	0.7898	0.967032	OK
	2	0.6911	0.967032	OK
H	1	0.7896	0.967032	OK
	2	0.6911	0.967032	OK

*) The Requirement is Ta < T

7. STRUCTURE ANALYSIS

Analysis structure for irregular building have to use dynamic load case and uses the Spectrum response of Yogyakarta zone map in SNI 1726-2012. The analysis uses SAP2000 computer software. The spectrum response for all structures (U and H) is shown by Figure 3.

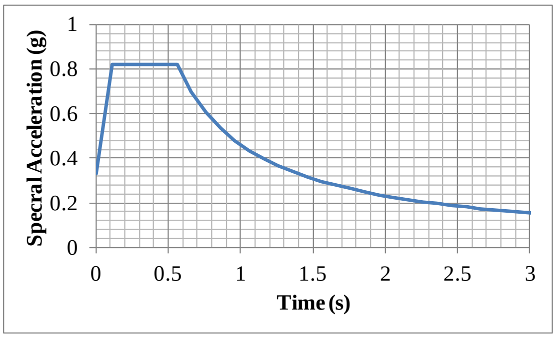

Figure 3. Spectrum response for Yogyakarta

According to SNI 1726-2012, sec 7.9.4.1. response combination for base shear variance (Vd) is smaller than 85% of the base shear is calculated (Vs) as using the equivalent lateral force procedure. Then, we calculate the base shear reaction of each structure, and resulting with the following Table 4.

Table 4. Base shear reaction of each structure.

TABLE: Base Reactions		
CaseType	U	H
Text	KN	KN
Vsx	1449.644	1449.644
Vsy	1449.644	1449.644
Vdx	1243.85	1245.26
Vdy	1436.686	1436.885
80%.Vsx	1159.715	1159.715
80%.Vsy	1159.715	1159.715
Vdx > 85%.Vsx	OK	OK
Vdy > 85%.Vsy	OK	OK

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Reinforcement beam and column resulted by SAP2000 is shown by Table 5.

Table 5. Reinforcement of beam and column

BEAM NO.	MOMENT	D	N-USE	
		(mm)	Type-U	Type-H
B5	NEGATIVE	13	2	2
	POSITIVE	13	2	2
B4	NEGATIVE	13	3	3
	POSITIVE	13	2	2
B3	NEGATIVE	13	3	3
	POSITIVE	13	3	3
B2	NEGATIVE	13	3	3
	POSITIVE	13	3	3
B1	NEGATIVE	13	3	3
	POSITIVE	13	3	3

COLUMN NO.	D	N-USE
	(mm)	
K5	16	12
K4	16	12
K3	16	12
K2	16	12
K1	16	12

Then, the rebar for beam and column inputted to do the next analysis. The next analysis is Pushover, which is the main analysis to determine the performance point of structure and location of weak joints.

8. PUSHOVER ANALYSIS

Pushover analysis is done by give the lateral load per story and push until the structure reach yield. The lateral load for each structure must be inputted and has the same value, and then it will be fair to analyze and compare each structure for Pushover analysis. The lateral load per story for each structure is shown by Table 6.

Stiffness of the cross section has been yield in the structure, will be modified to anticipate the post-yield behavior, in this case the modifications made is put on the plastic hinge bending elements that achieve bending strength, which is given at the end of the beams and columns. Defining the plastic hinges in the beams and columns will be auto assigned by SAP2000. The results of pushover analysis is the capacity curve, which curves to form a relationship between the displacement and the base shear force shown by Figure 4.

Table 6. Lateral load per story for each structure type

Floor	U (Fi)	H (Fi)
	(kN)	(kN)
SC0	0	0
SC1	100.687	100.687
SC2	201.373	201.373
SC3	302.06	302.06
SC4	402.748	402.748
SC5	442.776	442.776
TOTAL	1449.644	1449.644

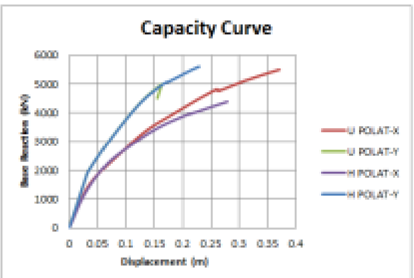

Figure 4. Capacity curve for each structure.

Figure 4. shows the maximum deformation capacity of the structure, and then each structure has different capacity. The performance point at the end step for each structure is shown in Table 7. Each structure has different number of end step.

Table 7. End step for each type of structure

NO.	TYPE	DIR.	End Step	Disp.	Base Force	AtoB	BtoIO	IOtoLS	LStoCP	CPtoC	CtoD	DtoE	BeyondE	Total
1	U	(X)	20	0.371	5497	610	236	237	72	9	6	0	0	1170
2	U	(Y)	8	0.155	4509.16	675	465	30	0	0	0	0	0	1170
3	H	(X)	14	0.229	5602.25	577	425	161	7	0	0	0	0	1170
4	H	(Y)	14	0.229	5602.25	577	425	161	7	0	0	0	0	1170

9. PERFOMANCE LEVEL

Evaluation of performance level on the existing building is based on the force and deformation that occurs when the displacement of control points is equal to the target displacement δt. The method used in the determination of the transfer point to the FEMA 356 which has a built-in in SAP2000. The results of the target displacement on the structure of type U, this can be seen in Figure 5, and to know the size of the target displacement on other structures, it can be seen in Table 8.

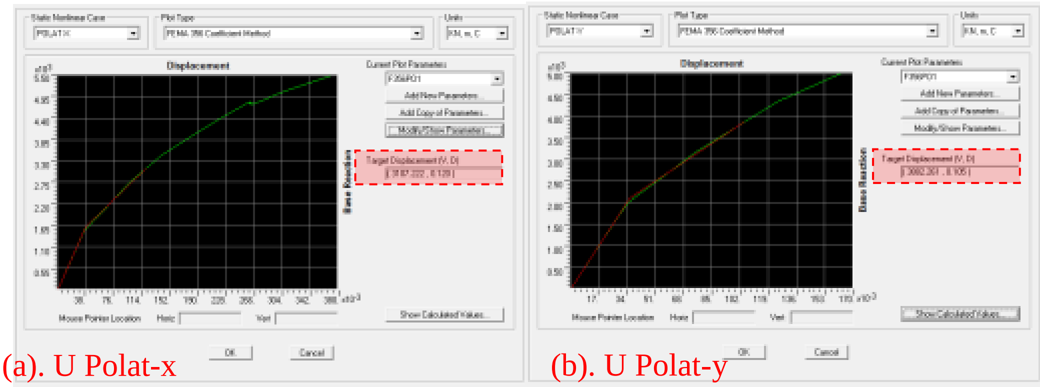

Figure 5. Pushover curve and performance point with coeficient displacement method (FEMA 356) of Type-U structure

Table 8. The target displacement of each structure type.

NO.	TYPE	DIR.	δt (FEMA 356)	Vt (FEMA 356)	δcontrol (SNI 2012)	V1	CONDITION	SAFETY
			(m)	(kN)	(m)	(kN)	Vt ~ V1	δt ~ δallow
1	U	X	0.120	3107.222	0.4	1449.644	INELASTIC	SAFE DEFORMATION
		Y	0.105	3882.261	0.4	1449.644	INELASTIC	SAFE DEFORMATION
2	H	X	0.123	3065.474	0.4	1449.644	INELASTIC	SAFE DEFORMATION
		Y	0.105	3872.196	0.4	1449.644	INELASTIC	SAFE DEFORMATION

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From Table 8, we can see that when the performance point reached, all of the structures are in inelastic condition. It caused by the value of base shear from the lateral load (V_t) is less than the nominal value of base shear (V_1) is equal to 1449,644 kN. According SNI 1726-2012 that limit of maximum displacement is no more than 2% from height of story is equal to 0.4 meter. The structures shows good state of deformation, it because the pushover lateral load still smaller than the maximum limit of deflection. When the performance point reached, the structure type-H in x direction shows the highest deformation: 0,123m, it means that the structure has the best capability than other structures.

Table 9. Performance level of each structure type.

NO.	TYPE	DIR.	ELEVATION NODE OF CONTROLLED	δt	STRUC TURAL DRIFT	LEVEL FEMA 356
			(m)	(m)		
1	U	X	20	0.120	0.60%	IO
2	U	Y	20	0.105	0.53%	IO
2	H	X	20	0.123	0.62%	IO
4	H	Y	20	0.105	0.53%	IO

Based on FEMA 356, Table 9 shown that all structures have reached Immediate Occupancy (IO) as the expectation of Office building is equal to less than 1%. On the other side, we can see appendix 1 to determine the performance level, and there showed that the target displacement is not more than BtoIO level. The plastic hinge points for each structure are shown by Figure 6-7.

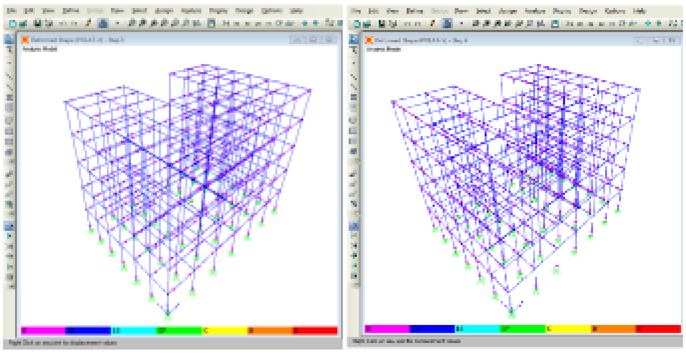

Figure 6. The plastic hinge points for U-structure (x and y direction)

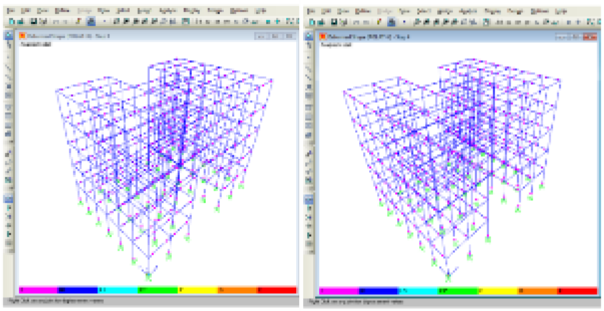

Figure 7. The plastic hinge points for H-structure (x and y direction)

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10. CONCLUSION

a. The type-U structure has better deformation capability compared to type-H structure. The deformation result of type-U structure for each direction are the following:

  - X-direction shown maximum displacement up to 0,371 meter
  - Y-direction shown maximum shear up to 5497 KN

b. Based on FEMA 356, the displacement target shown that type-H structure has better deformation compared to type-U structure. The deformation result of type-H structure for each direction are the following:

  - X-direction shown target displacement up to 0,123 meter
  - Y-direction shown target shear up to 3872,196 KN

c. Based on FEMA 356, the performance level point is Immediate Occupancy for U and H structure.

d. Type-U structure has lower percentage of damage compared to type-H structure. It has 360 damaged element of total 1170 element for x-direction, and then for y-direction it has 427 damaged element of total 1170 element. The comparison of damaged of each structure is shown by Figure 8.

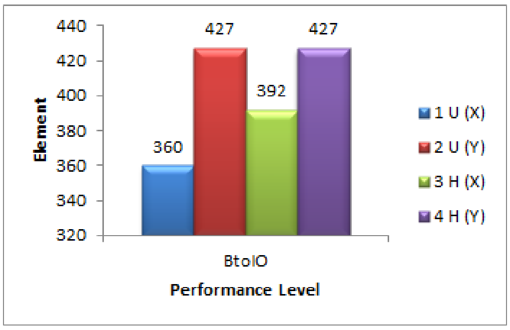

Figure 8. Performance level point of each type of structure

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Appendix 1

Table Of Plastic Hinge Distribution

TABLE: Pushover Curve - U POLAT-X											
Step	isplaceme	BaseForce	AtoB	BtoIO	IOtoLS	LStoCP	CPtoC	CtoD	DtoE	BeyondE	Total
	m	KN									
0	-1.73E-17	0	1170	0	0	0	0	0	0	0	1170
1	0.0124	523.463	1170	0	0	0	0	0	0	0	1170
2	0.0248	1046.926	1170	0	0	0	0	0	0	0	1170
3	0.035803	1511.4	1166	4	0	0	0	0	0	0	1170
4	0.048395	1828.77	869	301	0	0	0	0	0	0	1170
5	0.071039	2248.473	830	340	0	0	0	0	0	0	1170
6	0.083439	2475.274	830	340	0	0	0	0	0	0	1170
7	0.095839	2702.076	830	340	0	0	0	0	0	0	1170
8	0.120614	3145.973	817	353	0	0	0	0	0	0	1170
9	0.124	3204.684	810	360	0	0	0	0	0	0	1170

TABLE: Pushover Curve - U POLAT-Y											
Step	isplaceme	BaseForce	AtoB	BtoIO	IOtoLS	LStoCP	CPtoC	CtoD	DtoE	BeyondE	Total
	m	KN									
0	-5.8E-05	0	1170	0	0	0	0	0	0	0	1170
1	0.012342	737.576	1170	0	0	0	0	0	0	0	1170
2	0.024742	1475.152	1170	0	0	0	0	0	0	0	1170
3	0.027944	1665.607	1166	4	0	0	0	0	0	0	1170
4	0.034773	2004.378	872	298	0	0	0	0	0	0	1170
5	0.058103	2677.714	790	380	0	0	0	0	0	0	1170
6	0.070503	3030.137	790	380	0	0	0	0	0	0	1170
7	0.089706	3568.261	783	387	0	0	0	0	0	0	1170
8	0.10356	3922.072	752	418	0	0	0	0	0	0	1170
9	0.123942	4338.461	743	427	0	0	0	0	0	0	1170

TABLE: Pushover Curve - H POLAT-X											
Step	isplaceme	BaseForce	AtoB	BtoIO	IOtoLS	LStoCP	CPtoC	CtoD	DtoE	BeyondE	Total
	m	KN									
0	0	0	1170	0	0	0	0	0	0	0	1170
1	0.0124	534.654	1170	0	0	0	0	0	0	0	1170
2	0.0248	1069.309	1170	0	0	0	0	0	0	0	1170
3	0.027542	1187.534	1167	3	0	0	0	0	0	0	1170
4	0.041446	1678.992	994	176	0	0	0	0	0	0	1170
5	0.054608	1984.843	873	297	0	0	0	0	0	0	1170
6	0.06772	2246.541	839	331	0	0	0	0	0	0	1170
7	0.081477	2497.966	798	372	0	0	0	0	0	0	1170
8	0.096812	2739.657	796	374	0	0	0	0	0	0	1170
9	0.110795	2920.546	785	385	0	0	0	0	0	0	1170
10	0.123195	3076.536	778	392	0	0	0	0	0	0	1170
11	0.124	3086.594	778	392	0	0	0	0	0	0	1170

TABLE: Pushover Curve - H POLAT-Y											
Step	isplaceme	BaseForce	AtoB	BtoIO	IOtoLS	LStoCP	CPtoC	CtoD	DtoE	BeyondE	Total
	m	KN									
0	3.14E-18	0	1170	0	0	0	0	0	0	0	1170
1	0.0124	737.294	1170	0	0	0	0	0	0	0	1170
2	0.0248	1474.589	1170	0	0	0	0	0	0	0	1170
3	0.027944	1661.504	1166	4	0	0	0	0	0	0	1170
4	0.034946	2004.491	862	308	0	0	0	0	0	0	1170
5	0.057615	2657.976	790	380	0	0	0	0	0	0	1170
6	0.070015	3010.22	790	380	0	0	0	0	0	0	1170
7	0.089575	3558.853	783	387	0	0	0	0	0	0	1170
8	0.103554	3915.405	752	418	0	0	0	0	0	0	1170
9	0.124	4321.631	743	427	0	0	0	0	0	0	1170

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RESEARCH ON STANDARD COMPONENTS IN ARCHITECTURE FOR FLAT AND LANDED HOUSE ASSOCIATED WITH THE CONCEPT OF ECO HOUSE AND GREEN BUILDING

Doddy Friestya ASHARSINYO[1], Ully Irma Maulina HANAFIAH[2]

ABSTRACT: Needed a solution based on planning and ecological (sustainable) to solve the common problems of development and housing settlements in Indonesia. Sustainable building is where in the planning, development, operation and maintenance in the aspect - the aspect of protecting, saving, reducing the use of natural resources, maintaining a good quality buildings and the quality of indoor air quality, and attention to the health of the occupants of which are based principles of sustainable development. A building can be called already implementing green building concept if managed through an evaluation process to gain recognition as a green building. In the evaluation benchmark assessments used are appropriate to the local conditions and the situation in Indonesia and establishing techniques that is implemented in Indonesia. Some of the principles used to base the preparation of the benchmark are: Simple (simplicity), and can be easy to implement (applicable), available technology (available technology), and using the assessment criteria based on local standards wherever possible.

KEYWORDS: Sustainable, simplicity, applicable, available technology

1. INTRODUCTION

Standard components in architecture of the landed house and flats, can be defined as a minimum requirement in the establishment of reference concerning building architectural aspects of the building, use of materials, user physiological and environmental sustainability. While the purpose of the creation of standard architectural components of the landed house flats and houses can be formulated:

- As a reference in all phases of the development process, either by the government, private entities and individuals.
- Provide security, comfort, health and the environment associated with the construction is done.
- Achieve efficiency in the process of development, so that the costs are strictly controlled, optimum quality can be obtained.

Today there are so many standard architectural components of the building are made by experts in the architecture of all parts of the world. The construction standards may vary in each region in which the standard is being developed, to accommodate the interests and circumstances specific to each region. In addition, the architecture of standard components are independent of the main goals of these standards in the pipeline, as a minimum requirement to protect the health aspects such as the user, building resilience, safety against fire hazards, earthquakes, floods and environmental aspects of sustainability. Therefore, the purpose of making the formulation of standard components becomes very crucial.

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In examining these factors is expected that standardization can bridge the world of manufacturing with the architectural design world. A product has on standard criteria set by a body designated by the authorized institutions in the field of construction and building and home environment. Standardization is expected also a blend of the world's civil engineering with architectural techniques combined with the world of manufacturing and quality materials that are eco housing and green building.

Planning and construction of residential flats good to be able to translate the understanding of eco housing and green building in each component of the architecture.

Some of the components that can be used as standards set out in the plan that is like the lay out of the building, use of materials and building materials and fabrication, parts of the building such as the roof, doors / windows, floor coverings, walls, and others.

2. ECO HOUSING CONCEPT & GREEN BUILDING CONCEPT FOR FLATS HOUSING

The concept of green building is a building which in the planning, construction, operation and maintenance in the aspect - the aspect of protecting, saving, reducing the use of natural resources, maintain the good quality of the building and the quality of indoor air quality, and attention to the health of its inhabitants who all based on the principles of sustainable development.

A building can be called already implementing green building concept when managed through an evaluation process to obtain green building certification. In the evaluation benchmark assessment system used is Rating System.

For example:

- Green building material utilizing the principle of "life cycle" (reuse), "recycling" (recycle) and is made from renewable materials (renewable resources);
- Create an environment in buildings with minimal pollutants (reducing materials that produce emissions) and
- Landscape reducing water use (using local herbs)

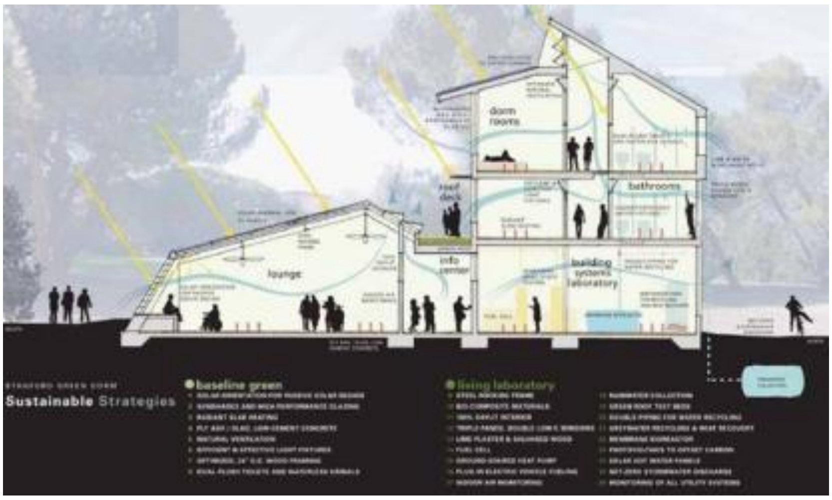

Figure 1. Conceptual drawing of the Green Dorm adapted from the project’s Feasibility Study (available from: http://www.stanford.edu/group/greendorm/greendorm/feasibility_study.html)

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3. ECO HOUSING & GREEN BUILDING CONCEPT FOR LANDED HOUSE

Eco housing is environmentally friendly home which is energy efficiency with regarding to the environmental always exist in an area where the house was built. The concept of eco-housing or often called the green house has several main objectives, among others, to reduce excessive energy usage in an effort to reduce the environmental issues such as global warming while growing, protecting occupant health, reduce environmental damage and fairly economical than building to be used as occupancy.

By applying the concept of eco-housing in residential buildings or residential areas we will be able to save the use of electrical energy, and comfort that is obtained will be better. In addition, the concept of eco housing the arrangement of an area will be neat, beautiful and beautiful.

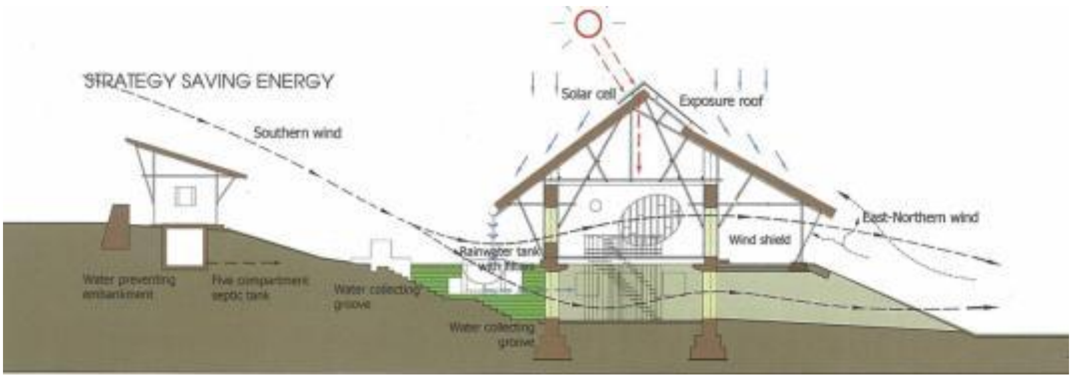

Figure 2. Conceptual drawing of the Green House adapted from the Green House Project (available from: FutureArc Magazine Green Issue 2012)

Along with increasingly concerned for the many environmental issues today will make us need to ponder a bit back on the fact that our ancestors (as the east) has long been thought of what was mentioned (west) as Ecohousing. Ecohousing, is essentially a residential home that adhered to the principle that a house will apply the Plan-considerations-Tech Materials 'environmentally friendly'.

A little look at how diverse archipelago that kara has such a long tradition applying the basic principles of the ecohousing.

- PLANNING: Java community has recognized the principle of architectural planning and Kawruh Griya Kawruh Kalang governing the orientation of the building footprint (Site Orientation) to the construction and application. Madurese people familiar with the philosophy or 'mojur are' that set the direction of the building to synergize with the direct path of the sun so it will physically obtain optimal natural lighting and accent on comfort inhabit tropical environment. In the aspect of Building Configuration, environmental architecture 'Taneyan naked' (Madura) or 'Natar' (Sasak, Nusa Tenggara), explains the importance of local knowledge structuring and formation of functional building mass. Both start from the facade plan, pendenahan and system utilities.
- MATERIAL: Building custom archipelago utilizing direct relative of the natural availability. But of course the exploitation of these natural ingredients have gone through the process of philosophical reflection. One thing in simple way of thinking, each timber will be used, must be selected from the tree really old. In addition due to the nature and strength needed constructively, it is the application of 'selective logging'

in order to maintain the ecological functions of the forest. Even the customary, enforced in some areas (tribal) that every tree cut down the number of required planting new trees as part of an effort sustainbilitas the tree vegetation. Selection of environmentally friendly natural material is clearly above the material biodegradable organic. Safe for human use and do not pollute the environment, eg the process of finishing the coloring of the building which so far has not used synthetic materials.

- TECHNOLOGY: Many things related to this aspect. Wood construction techniques that use systems pegs in each gusset construction gives reliability 'swinging portal' which is adaptable to the earthquake. The building houses on stilts (eg: Tower House or Tongkonan) though may have been intended as a security initiative for habitation, but obviously with this pattern will give room for a plot of land as a leach field. It is actually very important for soil water availability for humans.

Air circulation at Joglo House (Javanese) is designed to adapt to the surrounding environment. Joglo, which usually has the form of a terraced roof, getting to the middle, the distance between the floor with the higher roof is designed not without purpose, but each of the height of the roof into a relationship stages in human movement toward joglo with air that felt by the man himself. When humans are at the very edge joglo, as the boundary between outer space with space inside, humans still sense the air from outside, but when people move more to the middle, the air felt cool, this is due to the volume of space under the roof, the to the middle of the greater.

As the existing theory on the physics building, the volume effect is actually utilizing the principle that the greater the volume of air will be hot for longer when compared with a small volume of air. When the man returned wants out, the air was again changed, from the air feels cool to the air outdoors. It can be seen that penghawaan on joglo, pay attention to the human body adjustments on the weather around it. It is a simple thing that turns out will save electrical energy.

4. EXAMPLE OF STANDARD COMPONENT ARCHITECTURE CONCEPT FOR FLATS AND LANDED HOUSES ASSOCIATED THE ECO HOUSING AND APPLYING PRINCIPLES OF GREEN BUILDING

There are various principles of the application of the principles of eco housing and Green Building around the world. Obtained from the various examples used in the definition of the concept of applying the principles of eco housing is that eco-building minimizes resource use (in construction and life cycle) while also providing a comfortable environment in which to live.

There are many simple concepts to apply the principles of eco housing eco-housing common, as follows:

- Reduce the size (Reducing the size)
- Simple in design and to avoid unnecessary use of technology (Simple design and avoiding the use of unnecessary technology)
- Designing affordability in awalperencanaan / early stage (Designing affordability in at the start)
- Designing a modular unit so that the building can be extended at a later stage (Designing in modular units so that a building can be extended at a later stage)
- Plan for the design of the open space to allow for maximum flexibility (Internal open plan design to enable maximum flexibility)
- Using the space between buildings (Using the space between buildings)
- Building Systems is a collective (Building Collectively)

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- Share of public facilities and infrastructure (sharing common facilities and infrastructure)
- Be careful and meticulous in the choice of materials (Careful choice of materials)
- Using pre-fabricated elements or structures that exist (Using pre-fabricated elements or existing structures)

Figure 3. The Pettaway Pocket Neighborhood features nine homes that share a community lawn and playground, community gardens, and a low-impact development stormwater management system.

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5. ANALYSIS COMPONENT ARCHITECTURE STANDARDS FOR LANDED HOUSE

Analysis of a standard preparation of architectural components is done by compiling from source standard norms generally accepted architectural components used in building applications maupaun scope of academics and basic technical standard reference architecture components.

Basic norms and standards of reference, namely the technical components of the architecture:

- Architecture Data - Ernst Neufert; Issue Airlangga, Jakarta
- Permen.PU 29 / PRT / M / 2006 on Guidelines for Building Requirements
- Kimpraswil Decree No. 403 / Kpts / M / 2002 of the Simple Healthy House

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Based on the literature, the standard component architecture for the landed house can be seen in the following table.

Figure 3. The example of landed house (source Doddy Friestya A. ST., MT. Architect 2014)

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1. LAYOUT dan PERENCANAAN MATRA RUANG BGN

NOTE :
CHECKLIST TABEL

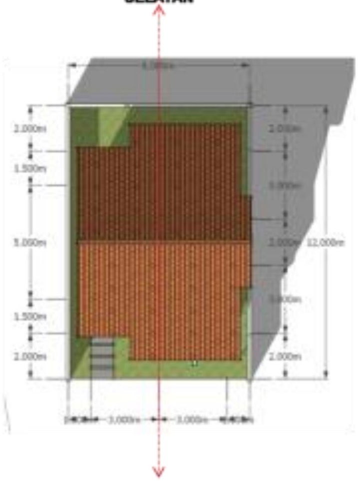
ILUSTRASI	JENIS KOMPONEN	PRINSIP PENERAPAN ECO HOUSE – GREEN BUILDING						KETERANGAN
		EFISIENSI LISTRIK	EFISIENSI AIR	PENERAPAN TEKNOLOGI	PENGELOLAAN BGN & LINGK.	LOKALITAS	KENYAMANAN, KESEHATAN	
SELATAN  UTARA	1. Orientasi thd sinar matahari (bangunan *RUPAK* diharapkan berorientasi Utara-Selatan) 2. Ruang Terbuka Hijau min. 20% 3. Sirkulasi silang udara (penghawaan alami – *cross ventilation*) dan bukaan di *RUPAK* 4. Zonasi publik-privat pada bangunan.							Penentuan orientasi thd sinar matahari langsung, bangunan menghadap Utara-Selatan diharapkan ruangan tidak terpapar langsung sinar matahari

Figure 4. The example of checklist table used to identify the standard component being used in landed house (source Doddy Friestya A. ST., MT. Architect 2014)

Standard components of the architecture for the application of flats and houses in the preparation footprint also refers to the application of the principle indicators of eco housing and green building.

Based on the literature that has been collected, the application of the principle indicators of housing and green eco building adapted from sources collected from;

- Ministry of Environment Regulation No. 8/2010 on Green Building
- Green Building Council (GBC) Indonesia; on Green Building Provisions
- Provisions Eco Housing and Green Building from existing experience (various sources)

Based on the literature of the application of the principle indicators of housing and green eco buildingdiatas that has been collected and analyzed bagiindikator application of the principles of eco housing and green buildingdalam its application to architectural components for flats and houses can be summed up some scope tread base indicator.

Conclusion The application of the principle indicators of housing and green eco building application on component architecture for the sole houses;

- Electrical Energy Efficiency
- Efficiency
- Application of Technology
- Locality
- Materials
- Leisure & Health Occupants

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10. SISTEM PENGHAWAAN / PENGUDARAAN

NOTE :
CHECKLIST TABEL

ILUSTRASI	JENIS KOMPONEN	PRINSIP PENERAPAN ECO HOUSE – GREEN BUILDING						KETERANGAN
		EFISIENSI LISTRIK	EFISIENSI AIR	PENERAPAN TEKNOLOGI	PENGELOLAAN BGN & LINGK	LOKALITAS	KENYAMANAN, KESEHATAN	
	Alami : Bukaan lebar dengan dimensi yang sudah menjadi standar dalam bangunan rumah, dan ventilasi tambahan pada bagian atas jendela dengan dimensi maksimal sehingga udara mampu masuk dan bertukar di dalam bangunan							Sistem penghawaan alami dan buatan yang disinergikan, dengan membuat bukaan yang standard dalam bangunan sehingga mampu memberikan aliran udara yang baik dalam bangunan tanpa menggunakan AC
	Buatan : Menggunakan AC hemat energi (ex. LG Inverter) Harga : Rp. 2.500.000 / Unit							

Figure 5. The example of checklist table used to identify the standard component being used in landed house context (source Doddy Friestya A. ST., MT. Architect 2014)

The concept of eco-housing and green building concepts can be said that the building has a system (planning-development-management) that is responsive to the environment and pay attention to the comfort and health of the occupants.

Analysis of the standard component architecture for the tread which apply the principle of housing & Eco Green building can be seen in the following table.

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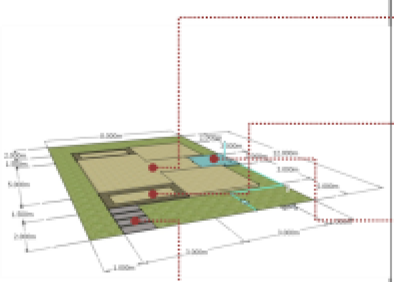
2. LANTAI

NOTE :
■ CHECKLIST TABEL



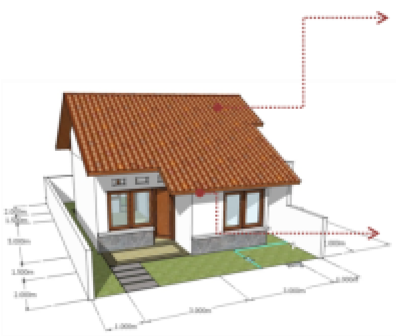
ILUSTRASI	JENIS KOMPONEN	PRINSIP PENERAPAN ECO HOUSE – GREEN BUILDING: EFISIEN SI LISTRIK	EFISIEN SI AIR	PENERA PAN TEKNOL OGI	PENGEL OLAAN BGN & LINGK	LOKALIT AS	KENYA MANAN, KESEHA TAN	KETERANGAN
	1. Ruang utama dlm bangunan *RUPAK* Keramik (ex. IKAD) 30cm X 30cm	■	■	■		■	■	Jenis penutup lantai keramik (ex. Merk IKAD) merupakan jenis keramik yang sangat mudah didapat / aspek lokalitas. Ukuran yang telah disesuaikan dengan luasan RUPAK merupakan salah satu poin dalam efisiensi energi listrik karena tidak banyak menggunakan pemotong keramik
	2. Teras Keramik exterior (Tekstur kasar) 30cm X 30cm	■	■	■		■	■	
	3. Kamar mandi / WC Keramik (ex. IKAD) 20cm X 20cm	■	■	■		■	■	
	4. Perkerasan jalan setapak Rabat cor beton camp. 1:3:5	■	■	■		■	■	

Figure 6. The example of checklist table used to identify the standard component being used in landed house context (source Doddy Friestya A. ST., MT. Architect 2014)

ATAP / PENUTUP BANGUNAN

LANJUTAN

NOTE :
■ CHECKLIST TABEL



ILUSTRASI	JENIS KOMPONEN	PRINSIP PENERAPAN ECO HOUSE – GREEN BUILDING: EFISIEN SI LISTRIK	EFISIEN SI AIR	PENERA PAN TEKNOL OGI	PENGEL OLAAN BGN & LINGK	LOKALIT AS	KENYA MANAN, KESEHA TAN	KETERANGAN
	Penutup atap : Genteng keramik (ex. KIA). Harga : Rp. 4000 / buah	■	■	■	■		■	
	Genteng tanah liat Harga : Rp. 1500 / buah	■	■	■	■	■	■	
	Papan lisplank Harga : Rp. 150.000 / lembar							

Figure 7. The example of checklist table used to identify the standard component being used in landed house context (source Doddy Friestya A. ST., MT. Architect 2014)

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6. CONCLUDING REMARKS

Today there are so many standard architectural components of the building are made by experts in the architecture of all parts of the world. Those standards vary in each region in which the standard is being developed, to accommodate the interests and circumstances specific to each region. In addition, the architecture of standard components are independent of the main goals of these standards in the pipeline, as a minimum requirement to protect the health aspects such as the user, building resilience, safety against fire hazards, earthquakes, floods and environmental aspects of sustainability. Therefore, the creation of standard components becomes very crucial.

Standardization is expected to bridge the world of manufacturing with the architectural design world. A product has on standard criteria set by a body designated by the authorized agency.

Some of the components that can be used as standards set forth in the plan such as the lay-out of buildings, use of materials and building materials and fabrication, parts of the building such as the roof, doors / windows, floor coverings, walls, and others.

Standardization is expected also a blend of the world's civil engineering with architecture engineering combined with quality materials and manufacturing world. In the conditions of the construction and development of flats and houses that are currently important footprint for harmony and synergy with the environment and sustainable development of the standardization of these components need to also apply the principles of eco housing and green building.

Eco housing is environmentally sound home that is energy efficient with regard to the potential environmental always exist in an area where the house was built. The concept of eco-housing or often called the green house has several main objectives, among others, to reduce excessive energy usage in an effort to reduce the environmental issues such as global warming while growing, protecting occupant health, reduce environmental damage and economic calculated from start of development to be used as residential. While Green building is an attempt to produce a building using processes that are environmentally friendly, efficient use of resources during the building's life cycle from planning, construction, operation, maintenance, renovation and even to demolition.

From the analysis and study, which has been presented, it can be concluded that in general the application of the principle of Eco Housing & Green Building design in the urban environment is as follows:

- Application of Green Building Eco Housing & Urban was constantly campaigned with different ways, either in the form of houses or flats tread, in order to maximize the performance of the building by applying the concept of Eco Housing & Green Building.
- Cooperation Public-Private Government-established synergistic expected to get the order of the built environment in harmony with nature.
- Sustainability of eco-friendly home should come with environmentally friendly behavior by occupants.
- Passive design factor is significant in planning environmentally friendly affordable homes.

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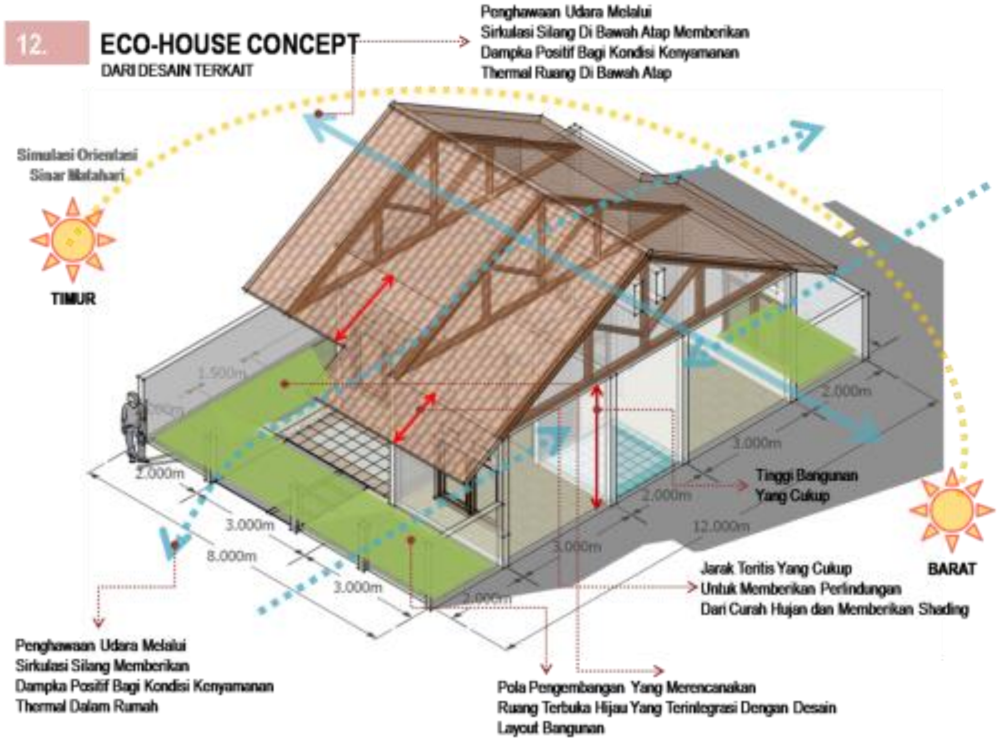

Figure 8. The example of application of green building concept witch aplly the standard component being used in landed house context (source Doddy Friestya A. ST., MT. Architect 2014)

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PERFORMANCE LEVEL EVALUATION OF TELECOMUNICATION TOWER USING PUSHOVER ANALYSIS

Nadya Nor AZILA[1], Atika Ulfah JAMAL [2], Rr Nur Ratri Purnama DEWI [3]

ABSTRACT: Nowadays, telecommunication become an important part in human life. According to Indonesia National Standard (SNI) 03-1726-2012, telecommunication tower include as vital building. Telecommunication tower has a functions as a place for antenna in order to provide telecommunication signal for customers around the tower area. As we know, Indonesia is one of the country that is prone to earthquakes, so it necessary to evaluate the performance level of the tower structure when the earthquake occurred. As a vital building, telecommunication tower not allowed to be damaged, because telecommunication plays an important role in a process of emergency response. This evaluation also include as mitigation process because it is done in order to identify the risks that possibly arise in the event of disaster. Therefore, telecommunication tower buildings in Indonesia can be planned well to serve the needs of community well although disasters occur. The telecommunication tower that analyzed in this study is a tower with a height of 42 m. The analysis of performance level evaluation of the telecommunication tower structure using coefficient displacement methode according to FEMA 356 and pushover analysis done using software SAP2000. This reasearch is aimed to determine the location of the plastic hinge on tower structure so it can know the location of the damage if affected from the earthquake loads. Moreover, this study also to know the performance level of telecommunication tower structure when the earthquake occured. The result shown that structure still on elastic condition when affected by earthquake loads. in addition, the location of plastic hinges occured on the bottom part of the tower, while from the analysis it known that performance level of tower structure is Immediate Occupancy level.

KEYWORDS: Performance evaluation, performance level, telecomunication tower, pushover analysis

1. INTRODUCTION

Telecommunication tower is one of the public facilities that need to design safely. Telecommunication tower has different seismic design philosophy if compare with common building, which should be remain completely elstic to against earthquake loads. This is because of the antenna that installed on the tower is very sensitive to rotation and displacement. In other hand, according to building codes, common building allow the element to having non-linier behaviour during strong ground motion.

Beside that, the different between telecommunication tower and common building is on the performance level of the structure. Telecommunication tower should be on the fully operation level because it plays important roles in handling post disaster management. The smoothness of telecommunications networks becomeone of the important points in disaster risk reduction. Therefore, it is very important to have safe telecommunications tower so it does not interfere with the performance of public service although disasters occurs.

The purpose of this research is to determine the performance level of a telecommunication tower also to know the location of the plastic hinge that occurs so that the location of the

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possible damage can be predicted. It can also be used to check the design of the telecommunication tower, whether it has been designed to be completely elastic or not.

2. BACKGROUND

As we know that Indonesia is one of the country in the world which has a high rate of earthquake occurrence. This is because the geographical location of Indonesia which became the confluence site of three plates and have a lot of active volcanoes spread across almost the entire island in Indonesia. Based on these facts, it is very important to have a secure building in order to reduce the risks caused by the earthquakes, tellecommunication tower is one of them.

Research on tower is still not popular in Indonesia, whereas according to Indonesia National Standard (SNI) 03-1726-2012, tower include as a vital building so it must be designed safely. However, there are many overseas studies that have been discuss about telecommunications tower, one of the first studies conducted by Kimura and Konno. Their study was discussed about the effects on steel tower caused by Tokachi Earthquake on 1968. The result was full scale measurements and earthquake response analysis on actually existing steel tower for microwave antennas that erected on the roof of buildings by Nippon Telegraph and Telephone Public Corp. It shown that resonant phenomenon between steel tower and building has wide range of frequency. It also proved that seismic forces that occurred in the tower due to strong earthquake might be exceed the wind force.

Another example is a research from Soltanzadeh which discuss the seismic performance of self supporting telecommunication towers. In this study, they using ten existing 4-legged telecommunication towers with heights ranging from 18 to 67 meter and have been designed and installed in Iran. At first, nonlinear static analysis has been applied to all towers. For this purpose, three different vertical distributions of lateral load have been utilized. Then, both target displacement approach and capacity spectrum approach have been considered to calculate the seismic performance point of towers. At last, three equations have been presented to estimate towers yield base shear and base shear that corresponds to immediate occupancy level for 4-legged self-supporting telecommunication towers.

In other hand, Amiri investigated about earthquake amplification of telecommunication tower using eight sample of towers with ranging from 18 to 67. The entire samples are telecommunication towers located in iran. The objective of the research was to estimate the base shear and vertical response of the telecommunication tower. Strong motion earthquake are applied to these towers in both vertical and horizontal direction by using linier dynamic analysis. In other research, Amiri also investigate the seismic response of telecommunication tower using ten existing samples of towers in iran. The purpose of this study was to know the dynamic response of tower under seismic loading. These towers are under the effects of wind and earthquake loading. Wind effects treated as static load according to TIA/EIA code, while for the earthquake effect based on iranian seismic code of practice and normalized spectra of Manjil, Tabas, and Naghan.

3. RESEARCH OBJECT

There are two types of tower mainly known as greenfield and roof top. Greenfield tower also known as self-supporting tower, it categorized in to two groups of 4-legged and 3-legged. This research used 4-legged self supporting tower with height of 42 meter. This paper focuses on the performance level of existing telecommunications tower in Indonesia. The illustration of the tower can be shown on Figure 1.

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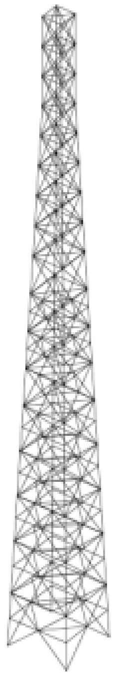

Figure 1. 4-Legged Self Support Tower height 42 m

Tower as shown in figure 1 is the telecommunication tower that analyzed in this study. All connections ,materials, and sections were assumed to be in good working order and data provided by assumed to be correct. This tower has 42 m height and 4m for the bottom width. It consisted of four legs and 17 panels. Each member of the structural model is from Equal Angle Steel (EA) which has 245 Mpa yield strength (fy 245).

4. MODELING PARAMETERS AND ACCEPTANCE CRITERIA FOR NONLINEAR PROCEDURES

This research using SAP2000 as software for analysis purposes. All element selections are steel. In modeling the towers, all the members including the legs, the horizontal and diagonal members have been considered. Foundations of the tower are assumed perfectly rigid. Loads that used in this analysis are dead load which from the member weight, antenna and wind. In this research, all structures used nonlinier static procedure for pushover analysis according to the parameter of displacement coefficient FEMA 356.

According to FEMA 356 (2000), steel braced frames shall be defined as those frames that develop seismic resistance primarily through axial forces in the components. Steel braced frames act as vertical trusses where the columns are the chords and the beams and braces are the web members. In order to model nonlinear behavior in any structural element, a corresponding nonlinear hinge must be assigned in the structure model. Nonlinear hinges were assigned to the following structural elements expected to undergo inelastic deformation. The nonlinear load-deformation behavior of member of tower structures shall be modeled as shown in Figure 2, with parameters a, b, c, as defined in Tables 5-6 and 5-7 at FEMA 356.

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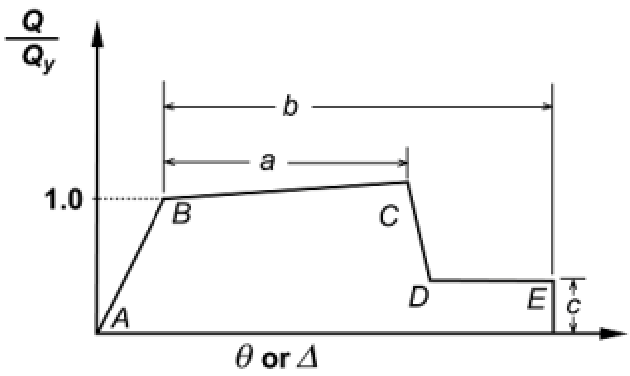

Figure 2. Generalized Force-Deformation Relation for Steel Elements or Components

Tabel 1. Modeling Parameters and Acceptance Criteria for Nonlinear Procedures

Component/ Action	Modeling Parameters			Acceptance Criteria		
	Plastic Deformation		Residual Strength Ratio	Plastic Deformation		
	a	b	c	IO	LS	CP
Braces in Compression	$0{,}5\Delta_C$	$9\Delta_C$	0,2	$0{,}25\Delta_C$	$5\Delta_C$	$7\Delta_C$
Braces in Tension	$11\Delta_T$	$14\Delta_T$	0,8	$0{,}25\Delta_T$	$7\Delta_T$	$9\Delta_T$

Δ_C is the axial deformation at expected buckling load.

Δ_T is the axial deformation at expected tensile yielding load.

Parameters in displacement coefficient methode (FEMA 356) can be modified according to the field condition. In this analysis, as input data parameters for displacement method on SAP2000, using Response Spectra region Yogyakarta, Indonesia as demand spectrum definition with moderate soil type. This data was obtained from website of Public Works (http://puskim.pu.go.id/Aplikasi/desain_spektra_indonesia_2011/) and can be seen on Figure 3.

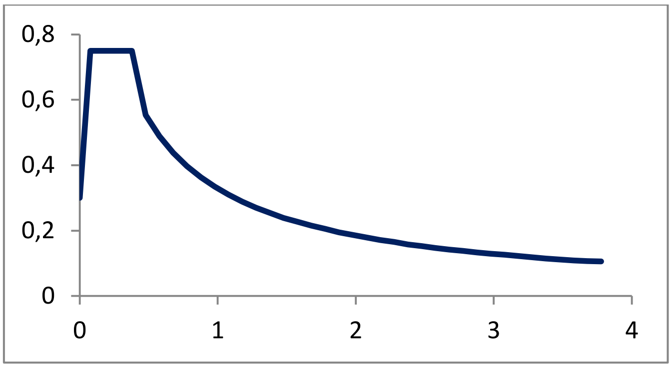

Figure 3. Spectrum response Yogyakarta, Indonesia with moderate type soil

Coefficient of seicmic reduction factor (R) and structure importance factor (I) that used in correction of spectra ordinate are $\frac{I}{R}g = \frac{1{,}5}{1}9{,}81 = 14{,}75$ and characteristic period of respon spectrum (Ts) at 0.2 sec, where Ts is the value of T at short period. Based on Table 3-1

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FEMA 356, obtained a value of Cm = 0.9 for SBF (Steel Braced Frame) buildings type. Table 3-3 FEMA 356 shows that the value of C2 = 1,0 for buildings performance level on immediate occupancy (IO) and value of C3= 1,0 taken from engineering judgement based on base shear-deflection relationship on post-melting condition that shows increase curve (positive stiffness).

There are two steps of Loading type in pushover analysis, first is analysis which have not consider the nonlinear condition where the structure given the gravity loads, and the second steps was the analysis followed by providing lateral load pattern which given monotonic gradual with the lateral load pattern. Lateral load pattern is a seismic forces that occur at each level and have been calculated from static loading equivalent to the following equation:

$$f_i = \frac{w_i \cdot h_i^k}{\sum w_i \cdot h_i^k} V \tag{1}$$

With the value of the exponent k is related to the period of the structure. For a structure with a period of ≤ 0.5 seconds, the value of k = 1.

5. ANALYSIS RESULT AND DISCUSSION

From the structure analysis, obtained the value of of Ti of the first mode (range of vibration) on the y-axis of building and second mode of x-axis of building was 0.4563 seconds. Natural vibration period which take into inelastic condition or effective vibration period (Te), can be obtained by the curve of pushover analysis result using displacement methode FEMA 356. The value of Natural vibration period early elastic (Ti) and the early stiffness of buildings on direction of interest (Ki), lateral stiffness of buildings (ke), efective vibration period (Te) and ratio of post-melt stiffness against effective elastic stiffness (α) from the analysis using displacement coefficient FEMA 356 shown on Table 2.

Table 2. The value of effective natural vibration period used displacement coefficient method (FEMA356)

T_i (sec)	K_i (KN/m)	K_e (KN/m)	T_e (sec)	α
0,4075	437,9474	437,9474	0,4075	1

Pushover analysis result shown that the X-direction loading analysis stops in step (step) 12th, at the time of displacement of the control points according to determined value at 0.5 m and a base shear force of 161.630 kN. While the pushover analysis of the Y-direction, stops in step (step) 10th, which is when the control point displacement at 0.5 m and a base shear force of 161.093 kN.

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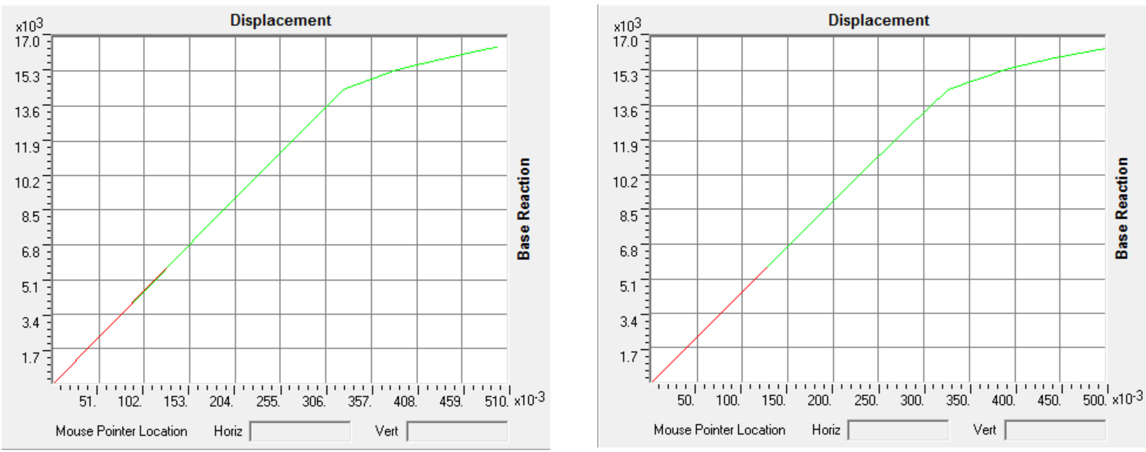

(a). X- direction (b). Y- direction

Figure 4. Pushover Curve and performance point using displacement coefficient method (FEMA 356)

Figure 4, show that the base shear force and displacement occurs when displacement target is reached on pushover loading at X-direction and Y-direction, the value shown on Table 3.

Tabel 3. Displacement target by FEMA 356

Pushover Loading Direction	**Base Shear Force (V_1) (kN)**	**Displacement Target (FEMA 356)**	
		Vt (kN)	**δ_t (m)**
X-direction	161,630	55,858	0,128
Y-direction	161,093	55,858	0,128

From Table 3 can be seen the value of base shear force caused of lateral loads x-direction and y-direction were Vtx= 55,858 kN < V1x = 161,630 kN and Vty= 55,858 kN < V1y = 161,093 kN so based on displacement coefficient method (FEMA 356,2000) structure behaviour of X-direction and y-direction earthquake design still on elastic condition.

Indonesian National Standard 03-1726-2012 clause 10.2.6 states that the displacement requirement does not apply to non-building structures if a rational analysis proves that the allowed displacement can be exceeded without reducing the stability of the structure or the connecting object.

From pushover analysis, can be known the location of plastic hinges that occured in the tower building. The analysis result shown that the point of the performance of the structure in the X-direction pushover loading is reached at step 5th, there are three elements that have been intemperate IO (Immediate Occupancy) and the Y-direction pushover loading is reached at step 5th, there are five elements that have been intemperate IO (Immediate Occupancy). The position of the damaged structural elements (plastic joints) when the performance point is reached can be seen in Figure 5 for the loading of X-direction and Figure 6 for the Y-direction loading. From Figure 5 and 6 it can be seen that the first plastic hinge occurred on bottom part (panel 17th).

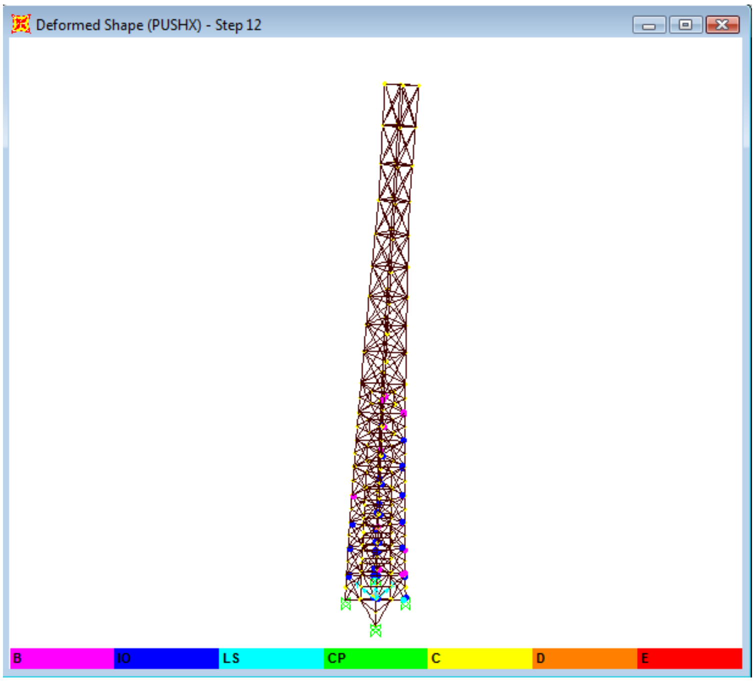

Figure 5. Plastic hinge position at pushover loading X-direction

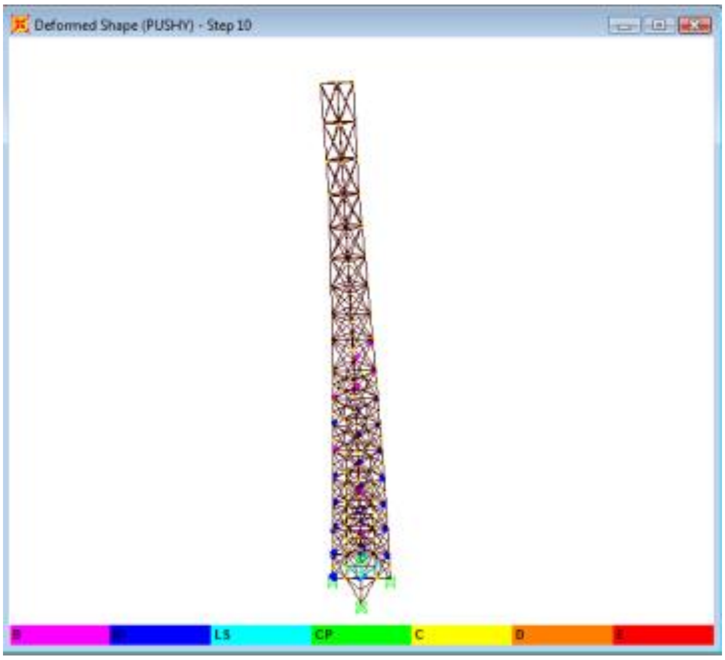

Figure 6. Plastic hinge position at pushover loading Y-direction

According to FEMA 356 (2000), determination of the level of performance of the structure (structural performance levels) based on structural drift ratio criteria obtained when the performance point is reached. Structural drift ratio obtained by the displacement that occurs at displacement control point, which on joint number 71.

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Table 4. The value of *structural drift ratio* acording to displacement control point when the structural performance level reached

Pushover loading direction	Elevation of control point (m)	FEMA 356	
		δ_t (m)	*Structural drift* (%)
X- Direction	42,00	0,128	0,305
Y-Direction	42,00	0,128	0,305

Table 4 shows that the value of structural drift ratio was smaller than 1%, so can be concluded that structural performance level according to FEMA 356 was Immediate Occupancy (IO). This is because the required drift-ratio limit from FEMA 356 (2000) for Immediate Occupancy (IO) performance level is 1%.

6. CONCLUSION

The results obtained from this study can be summarized as follows :

1. Structure behaviour of X-direction and y-direction earthquake design still on elastic condition when affected by earthquake loads.
2. The first plastic hinge occurred on bottom part (panel 17th)
3. Performance level of tower structure is Immediate Occupancy (IO)

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COMPRESSIVE AND FLEXURAL STRENGTHS OF GLULAM BETUNG BAMBOO BEAMS

Bernardinus HERBUDIMAN[1], Yosafat A. PRANATA[2] and Moch. G. SUMARJA[3]

ABSTRACT: Indonesia has a large bamboo source. Bamboo is renewable material and could replace wood which has limited sources. Bamboo reaches its maturity strength after 4–5 years old. Glued laminated (glulam) of bamboo is a fabricated due to a construction requirement on a large dimension of structural beam. Glulam bamboo is made from a bamboo bar. The bar is cut and split to generate several pieces of bamboo lamina. The bamboo laminas then were naturally dried, manually smoothed, and compressively glued to build beam width and beam depth. On this research, betung bamboo (dendrocalamus asper) from Majalengka, West Java is used. A bamboo lamina is glued by strong epoxy. Compressive and flexural performances of the horizontal and vertical lamina configurations of the beam are compared in this research. Specimen for parallel-to-the-grain compressive test is 6-cm-width, 8-cm-depth, and 20- cm-length beam. A specimen for one-point-loading flexural test is 6-cm-width, 8-cm-depth, and 100-cm-length beam. The bamboo density varies on range 0.5-0.8. Average compressive strength of glulam bamboo with horizontal and vertical lamina configurations are 63 MPa and 74 MPa, respectively. Average modulus of elasticity of glulam bamboo with horizontal and vertical lamina configurations are 6890 MPa and 10742 MPa, respectively. Average modulus of rupture of glulam bamboo with horizontal and vertical lamina configurations are 42 MPa and 64 MPa, respectively. Average flexural strength of glulam bamboo with horizontal and vertical lamina configurations are 21 MPa and 32 MPa, respectively.

KEYWORDS: betung bamboo, glulam bamboo, compressive strength, flexural strength.

1. INTRODUCTION

Recently, incremental demand in pulp and paper, furniture, and building material industries are could not supplied by wood production. Then, woods become expensive material. Bamboo could be use as alternative material due to its benefits such as its resistance in all seasons and all places, have relative short maturity of 4-5 years, easy to be plant, have high strength, cheap, and easy to be used (Misdarti, 2004). Indonesia has potential bamboo resources. Bamboo is very useful plant. Bamboo could be use for *rebung* food, building component, decorative features, kitchen set, lightweight bridges, paper material, and music tools.

According Ediningtyas, et al (2012), Indonesia has several economical-value bamboo such as *apus* or *tali* bamboo (Gigantochloa apus), *ater* bamboo (Gigantochloa atte), *andong* bamboo (Gigantochloa verticillata), *betung* bamboo (Dendrocalamus asper), black bamboo (Gigantochloa atroviolacea), and *talang* bamboo (Schizostachyum brachycladum).

Wood for structural element uses specific width and thickness dimensions. A larger dimension of a structural element with longer span needs larger wood dimension. A larger wood dimensions has difficulties in supply caused by less source, then the wood will be more expensive. Bamboo with its natural hollow-pipe cross section could be transformed to rectangular section, then could replace a wood beam with specific width and thickness

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requirements after several process glued laminated (glulam) production. Glulam bamboo is made from a bamboo lamina which paralelly glued in horizontal or vertical directions.

Scope of this research is limited as follow: 1) only betung bamboo is used in this research, 2) physical and mechanical characteristics observed are water content, specific gravity, compressive strength on parallel to the grain direction, 3) modulus of elasticity (MoE), and modulus of rupture (MoR), 3) laminas are glued in horizontal or vertical directions, 4) strong epoxy is used as glue material, and 5) flexural test uses one point loading method.

2. BAMBOO

Bamboo includes in Gramineae family, Bambusoideae subfamily, has same characteristics with wood. Major uses of bamboo in South East Asia are building material, buckets, food, raw material for paper, music tools, and handy craft. Indonesia has 143 types bamboos and only 40 types in Java.

A bamboo tree has anatomy characteristics such as fast primary growth without secondary growth. On normal condition, bamboo growth vertically with top end bar is rather curved due to gravity. Bamboo tree height is 0.3 m up to 30 m, bamboo diameter is 2.5 mm up to 250 mm, and thickness up to 25 mm. Betung bamboo is well known as dendrocalamus asper, and has a traditional name such as *awi bitung*, *pring petung*, and *pereng petong*. This bamboo grow with a dense configuration. This bamboos has yellowy green. The dimension is larger then other bamboo types. Bar height reach 20 m with bar diameter 200 mm. The bamboo could be found at place up to 2000 m above sea level. According to Morisco (1999) in Sarikusuma (2010), average tensile strength of betung bamboo could reach steel yield strength. Density of betung bamboo is getting larger correspond to the higher bar. Flexural properties (MoE and MoR) of betung bamboo on the bar without a diaphragm is larger then on the bar with a diaphragm. The MoE value is bigger correspond to higher bar position, but the MoR decreases on the end bar. According to Jansen (1981) in Sarikusuma (2010), tensile strength parallel to the grain reaches 2000-3000 kg/cm^2, average flexure strength is 840 kg/cm^2, and average shear strength is 22.5 kg/cm^2.

Water content in bamboo influences its mechanical properties. Water content in maturity bamboo is between 50-90%, in growing bamboo is between 80-150%, and in dried bamboo is between 12-15%. Water content in bamboo bar increase from 1–3 years, and decrease after 3 year. Water content is higher at rainy season compare with at a dry season. Specific gravity of bamboo varies from 0.5 up to 0.8. Outter part of a bamboo bar has bigger specific gravity than the inner part. Specific gravity increase from the lower bar to the higher.

Modulus of elasticity is defined as capability to resist moments with low curvature in elastic condition. Modulus of rupture is defined as capability to resist moments until failure. Failure strength is the highest stress at outer bamboo grain when beam crack. On Commonwealth Scientific and Industrial Research Organization (CSIRO) method, a proportional limit is calculated by multiplying the deflection value of 40% maximum load with 1.25. Intersection line from deflection value is a load at a proportional limit.

Other important thing in a bamboo flexure test is failure modes, as shown on Figure 1. These failure modes could detect a bamboo defect and could recommend several treatment needed to improve bamboo strength.

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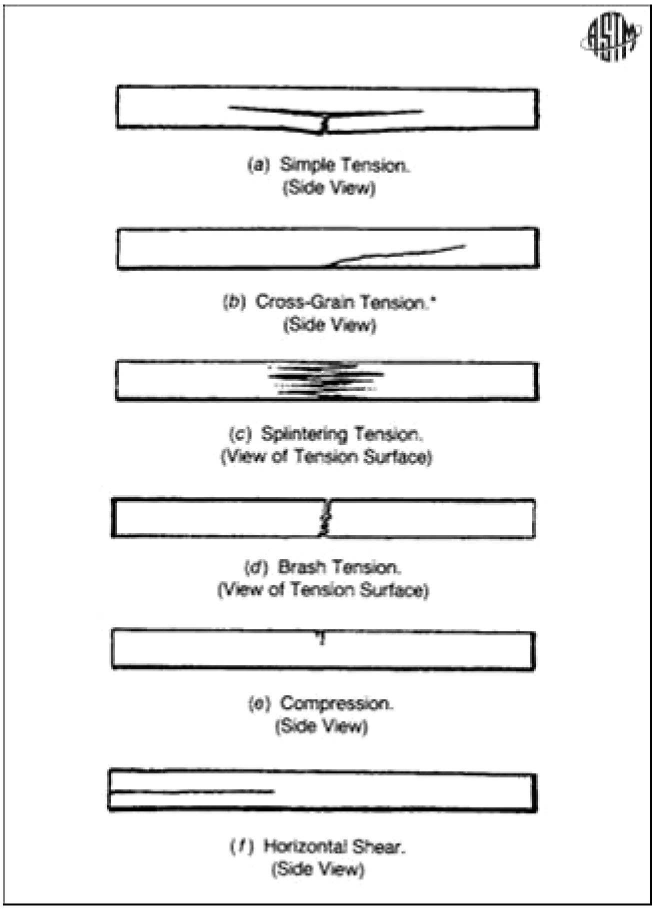

Figure 1. Failure modes in flexure (ASTM, 2005)

3. GLULAM BAMBOO

Glulam bamboo is a product made from several laminas glued parallel to the grain. Gluing is arranged in the horizontal and vertical directions. The result is plank or beam depend on its width and thickness (Sulastiningsih, 2005). Several benefits of glulam bamboo is dimension which could reach wood dimension, longer span, cross section could be arranged to be curved, and a slim configuration could be simply fabricated.

Glue is material which has capability to bond two surfaces. From the glue reaction at hot condition, glue could be classified as thermosetting and thermoplastic glues. Thermosetting glue could be hardened when expose to heat or chemical reaction with catalisator or hardener and has irreversible characteristic. After hardening, this glue type could not be soft again, such as phenol formaldehyde, urea formaldehyde, melamine formaldehyde, isocyanate, resorcinol formaldehyde. Thermoplastic glue could be soft if expose to heat and back to hardening in low temperature, such as polyvynil adhesive, cellulose adhesive, dan acrylic resin adhesive.

Epoxy glue is used at specific or special application compare with for a general purpose. Base on high strength bamboo could be reached and also relatively expensive, epoxy usually used for structural element production with same type material or glued metal. Epoxy has several benefits such as time development which could be controlled, higher bonding strength compare with material which is glued, such as wood which has high oil content with suitable mix, also epoxy could be used to glew wood with metal.

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Glue which is used in this research is named strong epoxy. Base on shear strength test, the shear strength of the strong epoxy is ranged between 5.6 – 7.0 MPa (Tjondro and Dewi, 2009).

4. RESEARCH METHODOLOGY

Betung bamboo that used in this research comes from Majalengka, West Java province, Indonesia, as shown on Figure 2. The bamboo length is ranged from 3 m to 5 m. The bamboo bar which is chosed has ± 2 years old, and picked from bottom, middle, and top parts. A bamboo diameter vary at 100-170 mm with inner thickness vary at 8-30 mm. Bamboo is dried naturally under sunlight in several days to improve simply glued processes. Lamina width and thickness are 20 mm and 5 mm, respectively.


Figure 2. Bamboo betung

A bamboo lamina with 5-mm-thick and 20-mm-width dimension is fabricated by cutting, surface finishing, and drying, as shown on Figure 3. The bamboo laminas are glued and manually pressed horizontally, as shown on Figure 4, and then, prepared for vertically pressed, as shown on Figure 5. Glue material used in this research is strong epoxy due to its strength and its availability (Tjondro and Dewi, 2009). After pressed horizontally and vertically, glulam bamboo is ready to be used as beam specimen with 60-mm-width and 80-mm-height dimension, as shown on Figure 6.

Figure 3. Lamina fabrication

Figure 4. Pressing Lamina Horizontal

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Figure 5. Preliminary Fabrication

Figure 6. Post-Pressing

Figure 7. Horizontal Lamina

Figure 8. Vertical Lamina

In this research, glulam bamboo is created with two different lamina arrangements, a horizontal lamina as shown on Figure 7, and vertical lamina as shown on Figure 8.

Specimen for test of parallel to the grain compressive strength is 60-mm-width, 80-mm-thick, and 200-mm-height column, according to ASTM D 143 (ASTM, 2005), as shown Figure 9. Specimen for flexural test is 60-mm-width, 80-mm-thick, and 1000-mm-length beam, as shown Figure 10. To increase statistically confidence level, there were 5 specimens for each test method with two types of lamina arrangements.

Flexural strength of glulam bamboo is shown by MoE and MoR parameters. The MoR is influenced by beam moment and moment of inertia, and the MoE is influenced by deflection, load, span, distance between load and support, and moment of inertia.

Figure 9. Compressive test

Figure 10. Flexure test

5. DISCUSSION

Average water contents of several betung bamboo bars are varying as follow: 32.79%, 48.24%, 37.47%, 40.37%, 25.54%, 32.60%, 39.72%, and 41.46%.

Average specific gravity of several betung bamboo bars are varying as follow: 0.73, 0.51, 0.68, 0.67, 0.78 0.71, 0.69, and 0.58.

Test results of glulam bamboo compressive strength parallel to the grain for a horizontal laminas are 60.67 MPa; 55.35 MPa; 66.43 MPa; 66.45 MPa; 66.14 MPa, with average compressive strength of 63.01 MPa. For a vertical lamina, test results are 71.62 MPa; 80.53 MPa; 73.91 MPa; 74.15 MPa; 72.14 MPa, with average compressive strength of 74.47 MPa. The vertical lamina has better compressive strength compare with the horizontal lamina. Failure mode at the vertical lamina is bamboo crack with good bonding of a glued layer. Failure mode at the horizontal lamina is slips on a glued layer.

From flexural test results, the largest MoE at horizontal lamina is 7,926.55 MPa, and at vertical lamina is 12,357.21 MPa. Average MoE at horizontal lamina is 6,890.17 MPa, and at vertical lamina is 10,742.01 MPa. Vertical lamina has better MoE compare with the horizontal lamina.

The largest MoR at horizontal lamina is 48.13 MPa, and at vertical lamina is 78.17 MPa. Average MoR at horizontal lamina is 41.94 MPa, and at vertical lamina is 64.41 MPa. Vertical lamina has also better MoE compare with the horizontal lamina.

The largest flexural strength (F_b) at horizontal lamina is 25.64 MPa, and at vertical lamina is 38.91 MPa. Average F_b at horizontal lamina is 21.01 MPa, and at vertical lamina is 32.05 MPa. Vertical lamina has also better MoE compare with the horizontal lamina.

Relative percentage differences between vertical lamina and horizontal lamina for MoR, MoE, and Fb, are 34.88%, 35.86%, and 34.43%, respectively.

Several failure modes that happened at flexural tests which could be classified into two failure types; first, failure at bonding layer, such as slip at glued surface and horizontal shear, and second, failure at bamboo lamina member, such as simple tension at bottom lamina; as shown on Figure 11.

(a). slip at glued surface (b). simple tension at bottom lamina (c). horizontal shear

Figure 11. Failure modes on flexure test

6. SUMMARY

After several tests on physical and mechanical characteristics of glulam bamboo, important summary could be expressed as follow:

Water content of a bamboo bar is varying from 25.44 % up to 48,24 %, and specific gravity is varying from 0.51 up to 0.78.

From flexural test results, average MoE at horizontal lamina is 6,890.17 MPa, and at vertical lamina is 10,742.01 MPa. Average MoR at horizontal lamina is 41.94 MPa, and at vertical lamina is 64.41 MPa. Average flexural strength, F_b at horizontal lamina is 21.01 MPa, and at vertical lamina is 32.05 MPa. Vertical lamina has better MoE compare with the horizontal lamina. Relative percentage differences between vertical lamina and horizontal lamina for MoR, MoE, and Fb, are 34.88%, 35.86%, and 34.43%, respectively.

Glulam bamboo-sawn wood ratios in inertia and stiffness at horizontal lamina and vertical lamina are 0.56 and 0.86.

Amount of lamina layers affects flexural properties of glulam bamboo. Incremental amount of lamina layers generates decrement in inertia, stiffness, MoE, MoR, and flexural strength, F_b.

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RIVERBANKS RESCUE WITH HOLE BIOPORE INFILTRATION (LRB) TECHNIQUE AS ENVIRONMENT FRIENDLY TECHNOLOGY SOLUTIONS

Bambang Aris SISTANTO[1]

ABSTRACT: River as a major supplier to a dam, the water being stored in the reservoir comes from the main stream and a small river which flowing in chachment area, river length can reach distances of many of kilometers. Problems arise when the farmer activities began to spread to areas along the riverbanks. It is difficult to avoid because it is an area of land which guaranteed a continuous supply of water. Farming activity along the banks of the river who did not heed the rules of preservation of soil and water to lower soil aggregation stability, eroded soil into rivers as sediment and will be deposited at the bottom of the river so that the river is reduced capacities.The objective of the research is to improve the function of riparian vegetation hydrological services, by increasing the absorption of rainwater and surface water. Research carried out by combining the plants in strips (biological) and making a hole biopore infiltration techniques (LRB). The results of analysis of soil hardness measurements near the hole around the LRB, showed that no changes in the structure of the soil, it's means that at the soil surface is not became a crumb and resistant to erosion. The observation through the soil profile (2x1.5x2 meters) showed that soil microbial activity was not up to the mouth of the LRB, only up to a of 30-35 cm height from the bottom of the hole. Reliability the LRB can increase water infiltration ability of the surface water flow rate, so it does not negatively impact the river (as a natural exhaust channel).

KEYWORDS: riverbanks, the stability of soil aggregation,hole biopore infiltration (LRB)

1. INTRODUCTION

Dam or reservoir that is a huge reservoir built with a very large investment costs, because the expected economic life of the reservoir must achieve a minimum of 30 to 40 years. The intercepted water in a reservoir is derived from the major rivers and streams flowing in a river basin. The flowing river before reaching its maximum point (reservoir) can usually achieve a distance of tens of kilometers. The problems eventually arise when public cultivation processing activities began to spread to the area beside the river (riparian), or along the riversbank. It is difficult to deny because of area along the banks of the river, an area of land which guaranteed a continuous supply of water, because it was near the river.

Activity in the cultivation of land along the banks of the river will result in adverse impacts to the condition of the river, this is because the processing work the land. carelessly or ignore the rules of preservation of land and water will cause a decline in soil aggregate stability, so that the land will be sensitive to scour the rain and runoff water. Subsequently transported soil will carry over into the river as most of the sediment will be deposited at the bottom of the river, this deposition will cause a reduction in carrying capacity of the river. At the river which has a steep slope, the water flow will be heavy, so it would not deposited sediment in the bottom of the channel, but will continue to drift ultimately deposited at the base of the reservoir. The above conditions are further exacerbated by the selection of cultivation commodities that are less supportive of the stability of soil aggregation. In addition, farmers habit is an attempt to use inorganic fertilizers are mostly exceeding dose (over dose) is recommended. Most of the fertilizer leaching process, will carry a payload of chemicals that will simultaneously increasing the sediment deposition process

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In the dry season, due to low rainfall and soil water absorption, the available water in West Java only 8.1 billion cubic meters per year, the need for water for domestic purposes, industrial and agricultural irrigation only about 17.5 billion cubic meters per year . The result is difficult to avoid the severe drought in some areas in West Java. It was, among others due to non-functioning of natural catchments such as forest, lake, dam and river commensurate region. In addition, generally placed along the river industrial activities, which will throw waste into the river, in some areas (such as in Citarum river) water quality becomes very poor due to the discharge of waste containing heavy metals from industrial activities.

Whatever as a narrow as the riparian area, its have an important role in the life cycle of various types of aquatic life, and ecologically to balance the rate of growth of the region. Because of that, the land along the river (riparian) need to be conserved as riparian community banks to recover naturally, through habitat rehabilitation, enrichment types of plant, as well as to foster socialization wisdom surrounding communities. Looking at the above, it is necessary to approach the technology that can be applied in order to restore the condition and function of the riverbanks. The selected technology must be environmentally friendly technologies and refers to the rules of preservation of soil and water by involving the active participation of communities along the riverbanks.

2. OBJECTIVES AND AIMS

To determine the reliability Hole Infiltration Biopore (LRB) in an effort to improve the absorption ability of the soil of the water surface flow rate, so it does not negatively impact the river (natural exhaust channel).

3. WATERSHED (DAS)

All human activities on land took place in a region called the Watershed (DAS) is a land area that is bounded by a topographic ridge separator that receives rainwater and flow into downstream and empties into the sea. DAS consists of several sub-watershed is a tributary that empties into the reservoir, dam, lake or river (Dwiatmo Siswomartono, 2008). Management of water resources based on the Law No. 7/2004 on Water Resources, which mandates the division of the river basin, the basin either district / city, cross the River Basin District / Municipal, Cross River Basin Province, Region Cross River State and Territory National Strategic River.

Regarding the Watershed (DAS), Government of West Java Province seeks to strategic management, including the strengthening of flood mitigation commitments across sectors and regions, the formation of community groups concerned about the environment, strengthening of disaster information systems and hybrid modeling of flood management, and reforestation of degraded land productive land and land located in the area around the river (riparian) flow. The Riverbanks Destruction Process can be described schematically, as shown below :

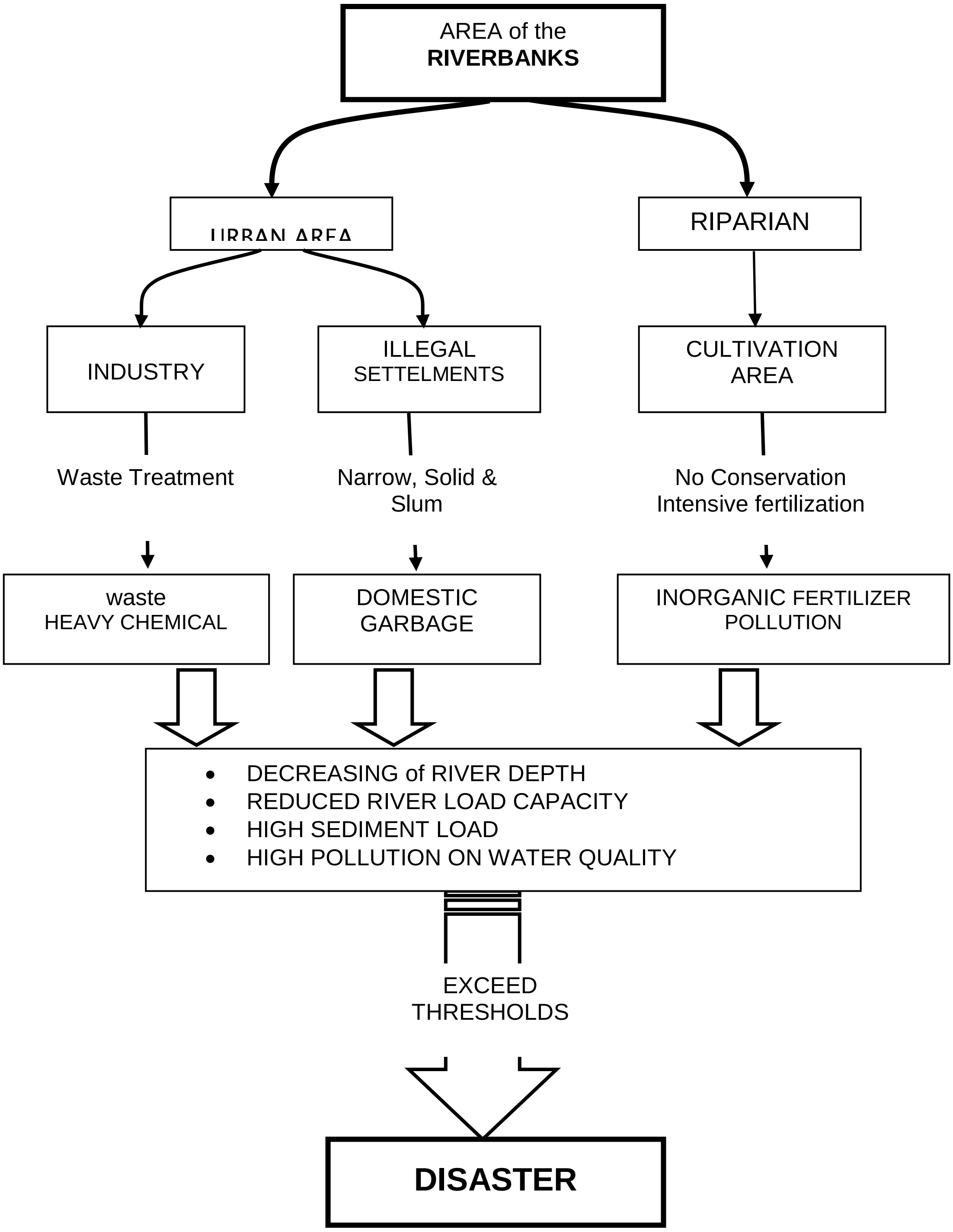

Figure 1. Schematic Diagram of the Riverbanks Destruction Process

Along the river as a flood plain is an area of the river flow reserve. In normal circumstances exceed the water flow, the flow of water will meet the riverbanks. In a state of extraordinary rainfall greater (50 years or more cycles), the water will overflow into the lower areas around the riverbanks, so area along the river is not intended or not reserved for residential land actually. In current conditions the role of the riverbanks (riparian) as a green corridor that provide services bio-eco-hydrological not been taken into account. Uncontrolled flood plains were converted into residential land. In fact, the lake / there is supposed to be transformed into a catchment area of a residential area.

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Plants such as trees, grasses and shrubs or a mixture of various forms and types of vegetation planted along the left and right edges of the river called riparian buffers or filter strips in the Indonesian language is riparian buffer strips or riparian buffer or filter strip. In general use the Green Line of the river. Riparian buffer serves to preserve the stream function by holding or catching the ground (mud) eroded and nutrients and chemicals, including pesticides carried, Of the land on the left and right of the river so as not to go into the river. Riparian buffer also stabilize the riverbanks. Trees were planted along the river are also more cool river water which creates a good environment for the growth of various types of water animals.

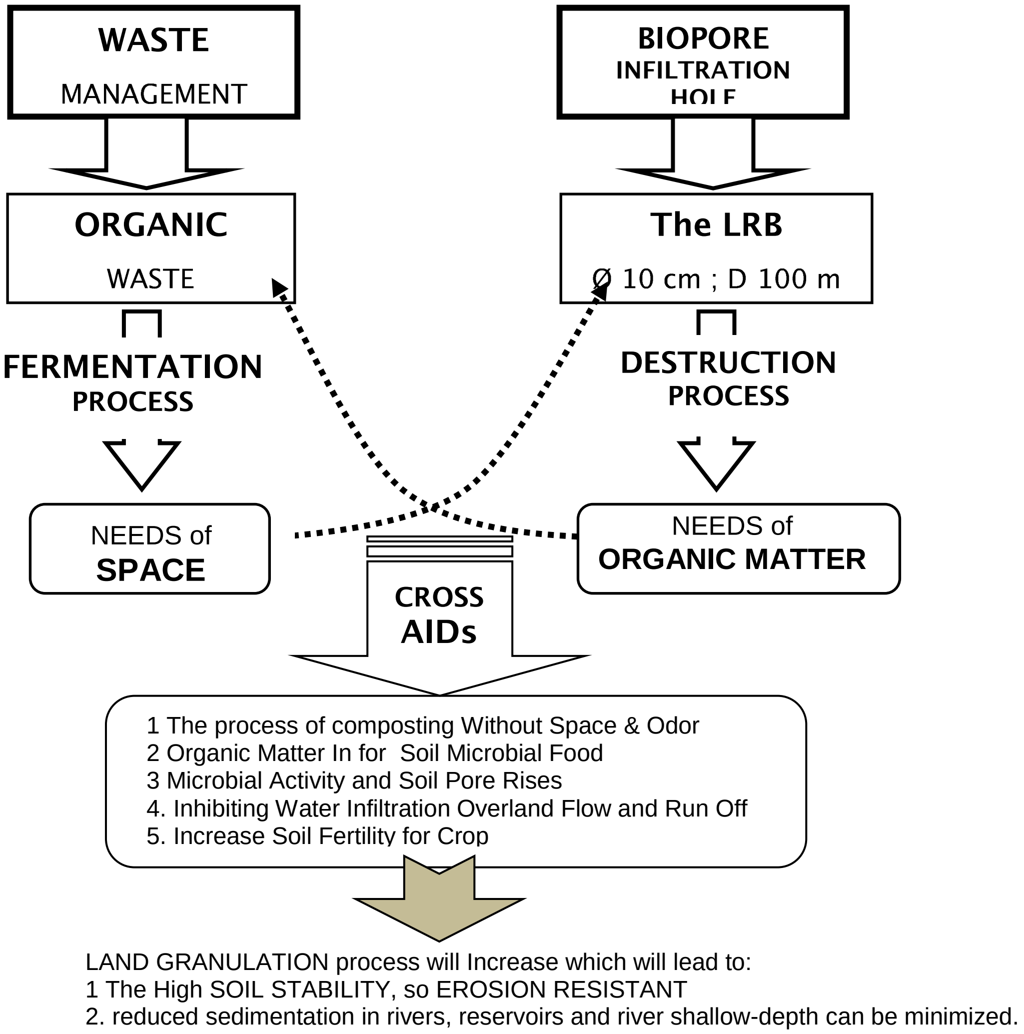

Figure 2. Schematic of the Relationship Organic Matter Management and the LRB.

Riparian in ecology context is ekoton, namely the transition between terrestrial and aquatic. While in the context of soil and water conservation, riparian buffer strips is more meaningful as a strip crop trees, grasses and shrubs or a mixture of various forms and types of vegetation planted or grown along the left and right edges of the river and serves as a filter against so that sediment eroded soil and nutrient erosion results do not go into a body of water (river). In principle the goal line with the objectives of riparian riparian same. Is very much in line if the line of the river border planted with various types of vegetation that is really into Green Line.

According to the data in West Java Forest Service, forest land or critically damaged in West Java reached about 600 thousand hectares. To restore the damaged forest preservation area that would cost around Rp 9 trillion, with a period of rehabilitation for 9 years. The impact of degraded land showed that 25 watersheds (DAS) in West Java (Jabar) is currently in critical condition, especially watershed Cimanuk, Citarum, Ciliwung, and Citanduy. Visual observation (visible) to determine the criticality of the signs of the watershed water quality very easily, can be viewed as the physical color of the water in a watershed. The water color is became dark blackish or black, due to the polluted and toxic definitely smelled no odor. Sedimentation is caused by rainwater that fell in the first plateau was not restrained, so that the volume of run-off became very high, and before going into the river, into a mud flow. This condition, getting worse during the rainy season, where the soil is constantly rain becomes saturated and easily carried by the flow of water. In contrast, in the dry season, the soil can not absorb water to the maximum, thus diminishing water supplies

Biopore is a small hole or Tunnel in the soil formed by a variety of soil fauna activity, such as earthworms and plant roots. Biopore formed fills with air, and will be the passage of water in the soil which ultimately facilitate water infiltration into the soil. The Hole Biopore Infiltration attract the animals, ants, worms or termites enter and make biopore form as a small tunnels so that water can quickly absorbed. The Hole Biopore Infiltration (LRB) is an alternative method to infiltrate the rainwater or water runoff into the soil, in addition to the recharge wells. It could also be referred to biopori the "worm castles", although not the only worm biopore occupants. With biopore will create a natural balance is maintained, organic waste which often cause odor can be handled, besides that we can save water for the dry season.

The LRB can also be implemented at household, to find the organic matters is quite simple because the household’s organic waste will produce every day. We do this by filled the household organic waste into biopore after separating inorganic waste into another container. That way organic waste which often cause odor will be consumed by "residents" the LRB. Rain water is absorbed into the LRB will replenishes groundwater. Schematically the relationship between the management of organic waste with the LRB activities is presented in Figure 2 above. When the size of the LRB of ten centimeters in diameter, with vertical depth of one hundred centimeters depth, each hole can hold 7.8 liters of organic waste. That means that each the LRB can be filled organic waste from the kitchen for two to three days.

4. RESEARCH METHOD

The experiment was conducted in Kampung Hilir Cikumpay, Village Sangkan Hurip, District Ketapang, which is the location of Bandung Regency, a village located on the banks of the Citarum river, so it can be considered suitable as a place of study. Research conducted at the beginning of August 2013 to the end of October 2013, for about three full months.

The tools used for making a hole at the soil are modified Hand Auger with iron material that is lighter than the original. Originally was a hand drill for making vertically soil sampling to make descriptions soil layer, standards-based of "American Soil Experimental Standard", with details:

a. Drill Stem : iron pipe
b. Eyes Drill : wrought iron
c. Hand-pad : rubber
d. Drill Stem Height : 100 cm
e. Eyes Drill Diameter : 10 cm
f. High Eyes Drill (vertical) : 20 cm

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The materials used for fill the hole are in the form of organic matters (leaves, grass and organic waste, including household organic waste).

Research method in this study is descriptive method, by comparing and analyzing the rate of water infiltration into the soil with make a in the LRB hole placed on some kind of a stretch of land formations. Stretch of land taken for the making of the LRB hole is at the riparian /riverbanks which has high potential of water flow into the river.

5. PLACEMENT OF THE LRB

The LRB placement along the riverbanks, with some placement pattern, which is placed at the parallel position of the river, but it is distinguished on the basis of the Distance and Distribution of the LRB has made, such as the following:

Table 1. The LRB Placement Pattern on the Riverbanks.

LRB PATTERN	DISTANCE (cm) between LRB	DISTANCE (cm) Inter PATTERN	DISTRIBUTION
Strips	30	200	Parallel to the Rivers / cut slopes of the river
Furrow	40	300	Overlooking the River body / cut slopes of the river
Zig-zag	50	400	Random / cut slopes of the river

6. THE LRB PLACEMENT ON THE RIVERBANKS

In accordance with the distinction of three kinds of patterns mentioned above, it is to be able to give a clearer picture can be seen in the image below:

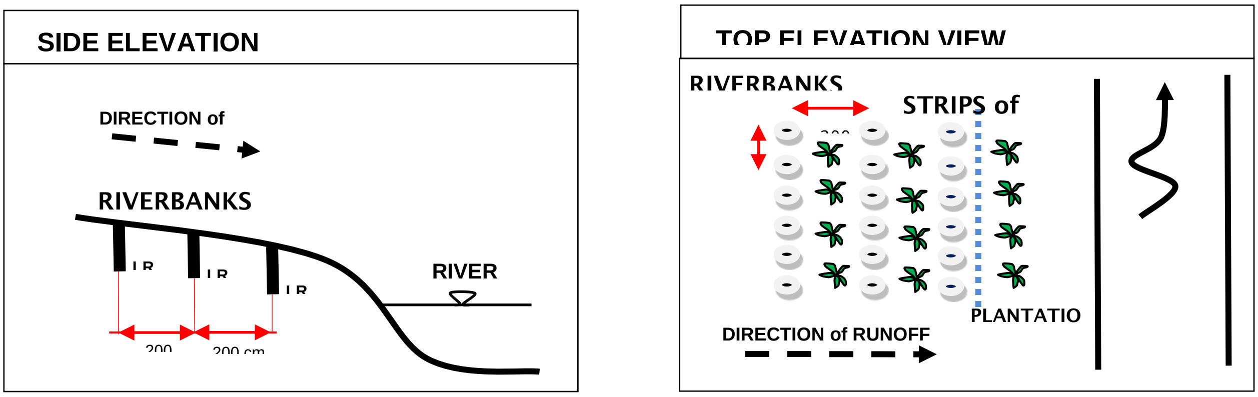

Figure 3. Pattern (1) "STRIPS"

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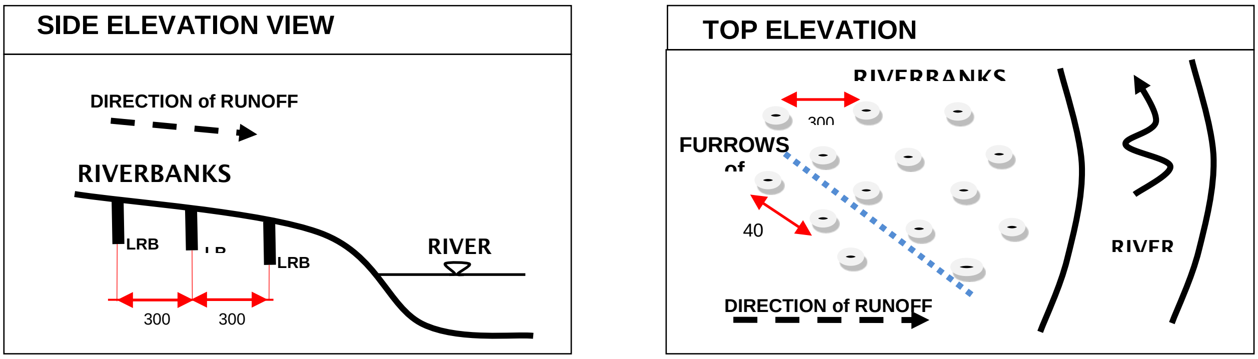

Figure 4. Pattern (2) "FURROWS"

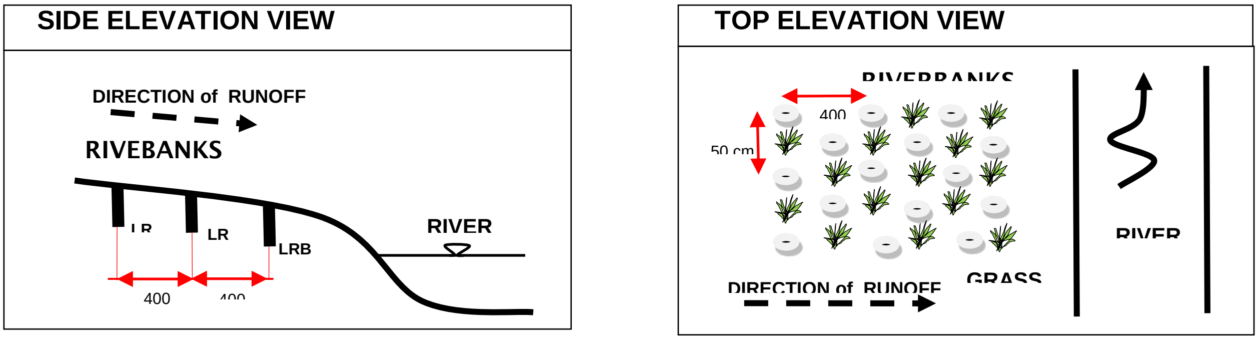

Figure 5. Pattern (3) "ZIG-ZAG"

7. RESULTS AND DISCUSSION

7.1. PLACEMENT PATTERN LRB

Based on the results of the implementation of the research for the LRB pattern placement gives the following results:

Table 2. Criteria of Various the LRB Placement Pattern

LRB Pattern	Water Retained on Land (l / h)	Water Infiltration Rate on LRB (l / min)	Runoff (l / h)	CRITERIA
Srtips	43	18.7	15.7	MEDIUM-GOOD
Furrows	30	15.8	20.4	MEDIUM
Zig-zag	56	23.6	9.3	GOOD

Source: Results of Data Processing

The results of the analysis of the observations in Table 2. show that Random Pattern, which is a combination of the LRB placement with plant species of grasses (Gramineae sp.) Give very significant results compared to the other two types of patterns. This is because the plant grasses (Gramineae sp.) Has a stable root development already well compared with cultivated plants, so with this random pattern of water that can be retained (in the same time unit) gives the highest amount (56 l / hours), with this condition, then the value of water runoff can be minimized (9.3 l / hours) so that the risk of environmental pollution of river water by runoff water charge flowing into the river can be resolved by either (do no harm).

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8. THE DISTANCE BETWEEN LRB

The distance between each the LRB Placement Pattern divided into 3 distances, namely the Pattern 1 (strips) is 30 cm; on Pattern 2 (furrow) is 40 cm and Pattern 3 (random) is 50 cm. Determination of differences in distance between the LRB is intended to measure the possibility of damage the LRB due to scour of flowing surface water flow (erosion) in the study sites. Data processing distance between the LRB, assisted by measuring the ground hardness with a penetrometer to a depth of 70 cm above the soil surface (Figure 6) and for the measurement of water infiltrate around the LRB held by infiltration measurements using a double-ring infiltrometer.

Figure 6. The Measurements of Soil Hardness and Infiltration around the LRB.

The results of analysis of soil hardness measurements around the hole around the LRB showed that no changes in soil structure, the soil around the LRB remains in the initial conditions, meaning the soil at the surface is not a crumb and not resistant to erosion.

The analysis of infiltration measurements (Figure 6) shows that the absorption of water around the LRB occur in accordance with the initial infiltration when the soil is not equipped with LRB. Constant infiltration rate (fc), can be seen in figure 7 the value 0.3 becomes constant infiltration rate on this measurements using a double ring infiltrometer. The results of infiltration measurements with a double ring infiltrometer are presented in graphical form as shown in figure 9 below:

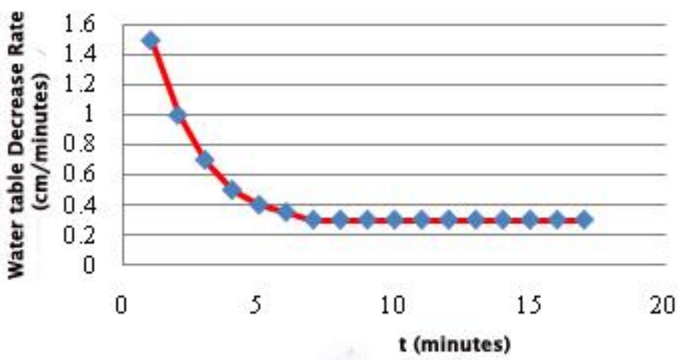

Figure 7. Surface Infiltration Rate of Soil

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9. SPACING OF LRB HOLE PLACEMENT PATTERN

Distance between Strips; Furrows and Zig-zag on each pattern distinguished 3 types of distance, which is 200 cm; 300 cm and 400 cm. It is intended that the LRB placement can be maintained for long periods of time (1-2 years), and the hydraulics can accommodate the flow of water into the LRB accordance with the absorption of water into the soil.

Figure 8. Soil Description on The Soil Profile beside the LRB

This measurement is completed by making the soil profile with the dimension of 200 cm long; 100 cm width and 200 cm depth to determine the soil crumble that occur (in 100 cm depth) beside the LRB due to soil microbes activity. The observation through the soil profile, indicating that the activity of soil microbes in the made biopore (hole/small hole) occurs only of 30-35 cm height from the bottom of the LRB. Soil microbial activity did not occur until the surface part of the LRB.

10. CONCLUSION

Based on the research that has been conducted, it can be seen clearly that the reliability Hole Infiltration Biopore (LRB) may increase the absorption capability of the soil surface water flow rate, so it does not negatively impact the river (natural exhaust channel).

Hole Infiltration Biopore (LRB) are finding that the technology can be applied to support the recovery and function of riverbanks, it is proved that the LRB technology is environmentally friendly technologies and refers to the rules of the land and water conservation. At the implementation can also involve the active participation of communities along the riverbanks.

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THE ANALYSIS OF SAND LAYER THICKNESS UNDER THE FOUNDATION OF MASONRY HOUSES FOR THE REDUCTION OF EARTHQUAKE VIBRATION

SARWIDI[1]

ABSTRACT: Masonry walled houses are very popular in Indonesia. The majority of the victims and loses in a series of earthquake disasters in the country were caused by the failure of such structures. In damaging areas, a-story masonry walled houses applying the concept of BARRATAGA (a kind of earthquake resistant people houses) were built before the 2006 Yogyakarta earthquake. Spreading sand layers under the foundation of those houses are necessary. In the case of the 2006 earthquake, inhabitants of several BARRATAGA believed that their houses were far more resisted comparing to surrounding houses due to adequate thickness of the sand layer under their house foundation. Whether sand layer spread under the foundation is able to reduce the earthquake vibration toward the structures and how thick the effective sand layer needs to be investigated.This paper summarizes the research of the thickness of the sand layer under the foundation of masonry walled BARRATAGA having a story by using a computer simulation. Having the research scope limitations, the sand layer is able to reduce earthquake vibration to the house structure, and the thickness of 15 cm or more is considered to capable of significantly reducing ground vibration.

KEYWORDS: sand, house, earthquake

1. INTRODUCTION

Most territory of Indonesia is hazardous to strong earthquake shaking (BNPB, 2011; Erickson, 1998; Supartoyo and Surono). For example, there were a series of major earthquake disasters for last ten years as mentioned in Table 1.

Table 1. Earthquake disasters for last 10 years (http://bencana.bappenas.go.id)

Date	Place	Magnitude (SR)	Death	Loss (Trillion Rupiah)
26 December 2004	Aceh	9.1	220,000	41.4
27 May 2006	Yogyakarta	5.9	6,223	29.1
12 September 2007	Padang, Bengkulu,	7.9	25	1.9
17 November 2008	Jambi	7.7	4	0.1
17 July 2006	West Barat	7.7	529	7.9
30 September 2009	West Sumatra and vicinity	7.6	1,100	21.6

The majority of the victims and loses in the earthquake disasters were caused by the failure of masonry walled houses that are very popular in Indonesia (CEEDEDS, 2007; CEVEDS International, 2014). In the 2006 Yogyakarta earthquake damaging areas, a-story masonry walled houses applying the concept of BARRATAGA (a kind of earthquake resistant people houses) had been built (Sarwidi, 2007).

Spreading a sand layer under the foundation of such houses is obligatory. In the case of the 2006 earthquake, several BARRATAGA's inhabitants believed that their houses were far more resisted comparing to surrounding houses due to adequate thickness of the sand layer

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under their house foundation in addition to set properly simple structural frames to the houses (Sarwidi, 2007).

Whether sand layer spread under the foundation is able to decrease the earthquake vibration toward the structures and how thick the effective sand layer needs to be investigated through this research (Sarwidi, 2014). This paper summarizes the research of the thickness of sand layer under the foundation of masonry walled BARRATAGA having a story by using a computer simulation (Plaxis 8.2, 2010).

2. METHOD

2.1 PROCEDURE

The procedure of the research follows Figure 1 and applies the formulas in equation (1) to equation (12) referring also to Figure 2 and Figure 3.

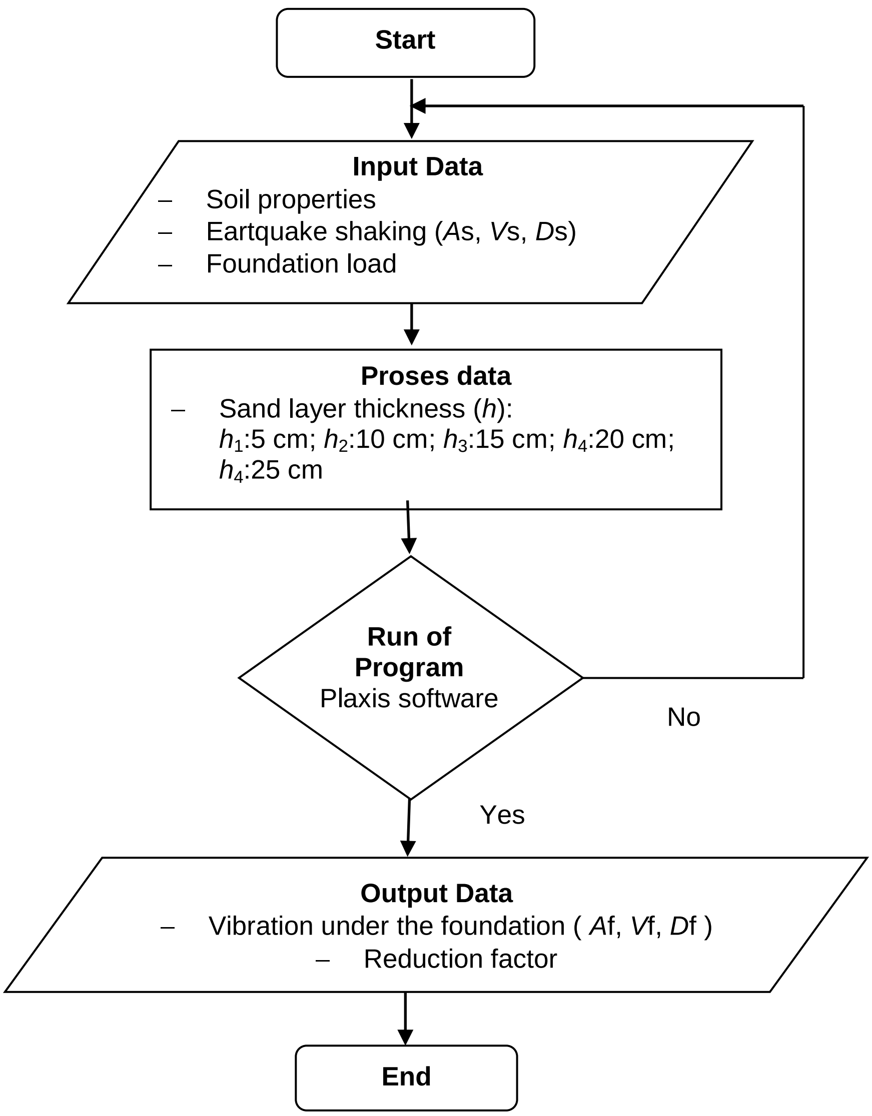

Figure 1. Flowchart of the research

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2.2 FORMULAS

Reducton factors of maximum vibration (ρ) are deteminined by using following equations.

$$\rho_A = \frac{|A_s|_{max} - |A_f|_{max}}{|A_s|_{max}} \ (\%) \tag{1}$$

$$\rho_V = \frac{|V_s|_{max} - |V_f|_{max}}{|V_s|_{max}} \ (\%) \tag{2}$$

$$\rho_D = \frac{|D_s|_{max} - |D_f|_{max}}{|D_s|_{max}} \ (\%) \tag{3}$$

Where:

ρ_A = the reducation of maximum acceleration,
ρ_V = the reducation of maximum velocity, and
ρ_D = the reducation of maximum displacement

``

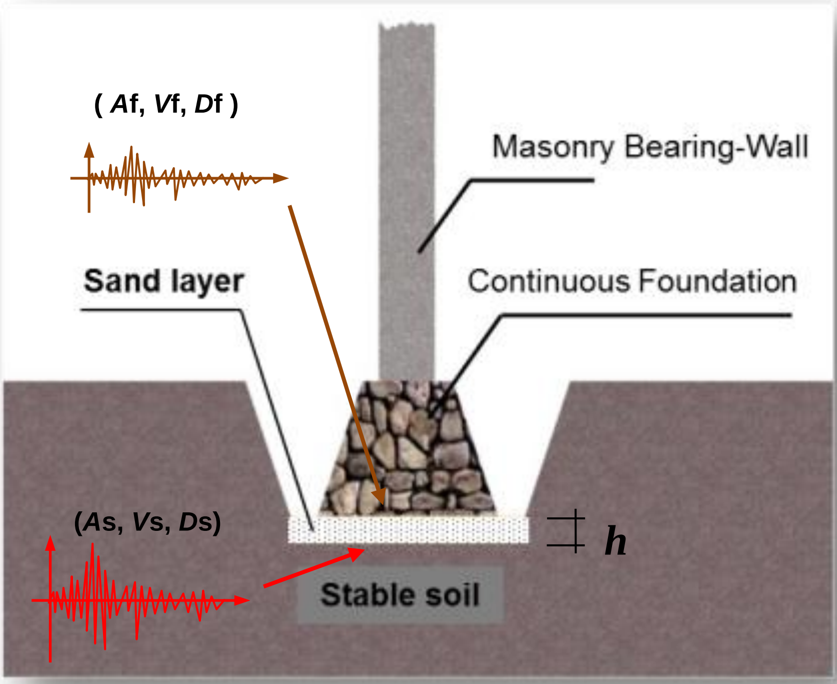

Figure 2. Geometrical Model of the foundation along with the sand layer

Reducton factors of total vibration along duration (ρ) are deteminined by using equations (4), (7), and (10) as follow.

The reduction factor of total acceleration is:

$$\rho_{E_A} = \frac{E_{A_s} - E_{A_f}}{E_{A_s}} \ (\%) \tag{4}$$

Where E_{A_s} is the total acceleration energy beneath the sand layer:

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$$E_{A_s} = \int |A_s(t)| dt \quad (5)$$

and E_{A_f} is the total acceleration energy beneath the foundation:

$$E_{A_f} = \int |A_f(t)| dt \quad (6)$$

The reduction factor of total velocity is:

$$\rho_{E_V} = \frac{E_{V_s} - E_{V_f}}{E_{V_s}} (\%) \quad (7)$$

Where E_{V_s} is the total velocity energy energy beneath the sand layer:

$$E_{V_s} = \int |V_s(t)| dt \quad (8)$$

and, E_{V_f} is the total velocity energy beneath the foundation:

$$E_{V_f} = \int |V_f(t)| dt \quad (9)$$

The reduction factor of total displacement is:

$$\rho_{E_D} = \frac{E_{D_s} - E_{D_f}}{E_{D_s}} (\%) \quad (10)$$

Where E_{D_s} is the total displacement energy energy beneath the sand layer:

$$E_{D_s} = \int |D_s(t)| dt \quad (11)$$

and E_{D_f} is the total displacement energy beneath the foundation:

$$E_{D_f} = \int |D_f(t)| dt \quad (12)$$

2.3 LIMITATIONS

Constrained by the research time and budged, this research has following limitations. Firstly, soil material is categorized as sand that is available in the Plaxis software having characteristics that relatively closes to ones of the sand of Opak River in the slope of Merapi Volcano, Yogyakarta (ASTM, 1992; Bale, 2011). Secondly, the numerical method uses the Plaxis software in two dimensions (Plaxis 8.2, 2010) to evaluate 15-second vibration, excluding for 25-cm thickness of sand layer that is only for 10-second shaking. Thirdly, earthquake shaking is El Centro Earthquake that applies in a direction (Widodo, 2012). Fourthly, the river stone masonry foundation is to support a single story masonry housing having the concept of BARRATAGA (Sarwidi, 2007). Lastly, the limitation of this paper space leads to the limitation of vibration that is focus on the acceleration of vibration (Sarwidi, 2014).

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3. RESULTS AND DISCUSSION

3.1 RESULTS

Following the process shown in Figure 1, the vibration of the top sand layer was calculated. The numerical results are transformed to the time-history acceleration graphs of the upper sand layer (A) to be compared with the time-history of acceleration excitation of the bottom sand layer (B). The position of point A and point B can be seen in Figure 3 (see also Figure 2). Graphical espressions of the comparison are illustrated in Figure 4 to Figure 8. It shows that the differences become more apparent as the sand layer thickness increases.

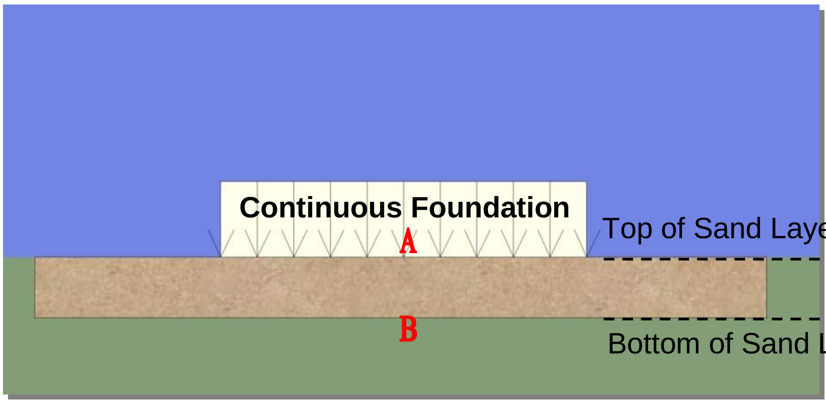

Figure 3. The position of point A and point B in the simplification model of the foundation along with the sand layer for computer simulation

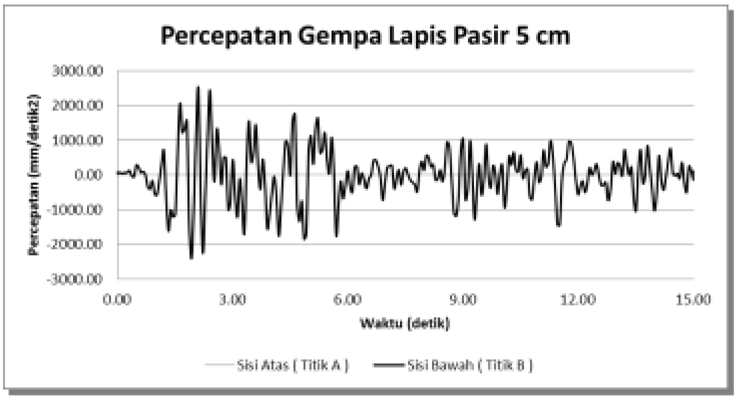

Figure 4. The time-history of acceleration for 5-cm layer thickness. Axis: time (s). Ordinate: acceleration (mm/s^2). Thick: acceleration of bottom layer (A_s). Thin: acceleration of top layer (A_f).

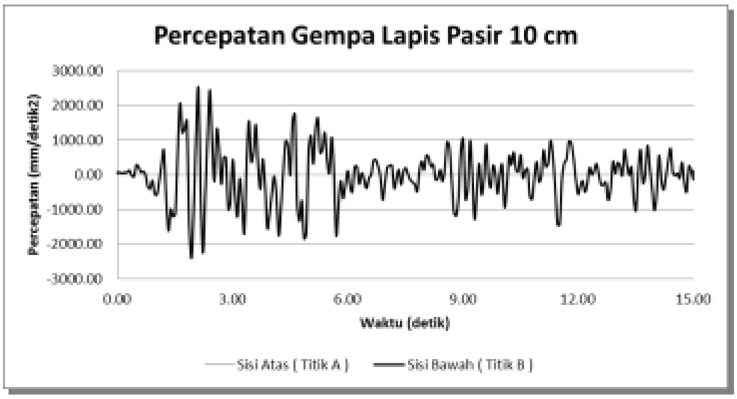

Figure 5. The time-history of acceleration for 10-cm layer thickness. Axis: time (s). Ordinate: acceleration (mm/s^2). Thick: acceleration of bottom layer (A_s). Thin: acceleration of top layer (A_f).

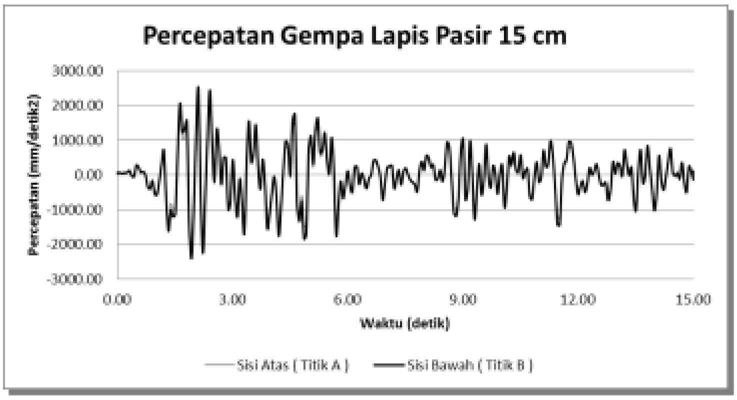

Figure 6. The time-history of acceleration for 15-cm layer thickness. Axis: time (s). Ordinate: acceleration (mm/s^2). Thick: acceleration of bottom layer (A_s). Thin: acceleration of top layer (A_f).

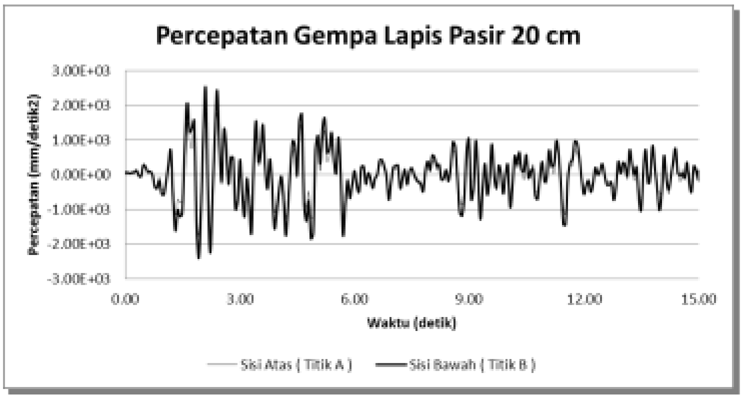

Figure 7. The time-history of acceleration for 20-cm layer thickness. Axis: time (s). Ordinate: acceleration (mm/s^2). Thick: acceleration of bottom layer (A_s). Thin: acceleration of top layer (A_f).

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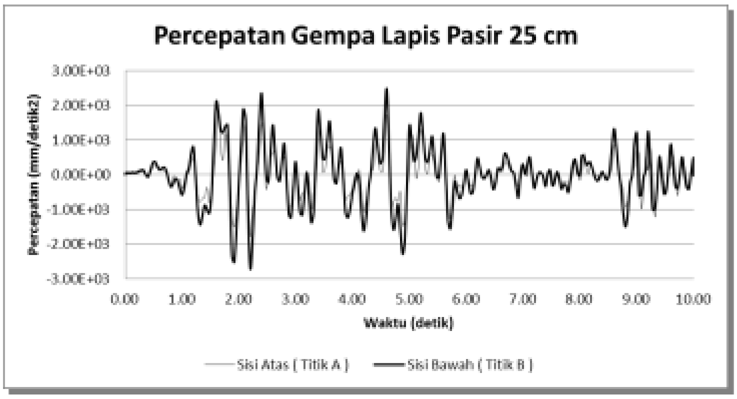

Figure 8. The time-history of acceleration for 25-cm layer thickness. Axis: time (s). Ordinate: acceleration (mm/s^2). Thick: acceleration of bottom layer (A_s). Thin: acceleration of top layer (A_f).

To obtain more obvious differences, numerical results applying equation (1) and equation (4) are provided in Table 2 and Table 3 that demonstrate the factor of reduction.

Table 2. Maximum acceleration ($|A|_{max}$) and the reduction factor

Sand Layer Thickness	5 cm	10 cm	15 cm	20 cm	25 cm
$\|A_f\|_{max} = \|A\|_{max}$ of top layer (A) (mm/s^2)	2500.22	2390.91	2163.66	1901.00	1868.80
$\|A_s\|_{max} = \|A\|_{max}$ of bottom layer (B) (mm/s^2)	2499.76	2499.76	2499.76	2499.76	2681.61
$\square_A$ = Reduction factor	-0.02%	4.35%	13.45%	23.95%	30.31%

Table 3. The total energy of acceleration E_A and the reduction factor

Sand Layer Thickness	5 cm	10 cm	15 cm	20 cm	25 cm
$E_{Af} = E_A$ of top layer (A) (mm/s)	8241.43	7861.81	7007.16	6123.25	4121.74
$E_{As} = E_A$ of bottom layer (B) (mm/s)	8240.06	8240.96	8240.96	8240.96	6168.20
ρ_{EA} = Reduction factor	-0.01%	4.60%	14.90%	25.70%	33.37%

3.2 DISCUSSION

Dynamic characteristics of soil are shear modulus, damping value, and shera wave velocity (Widodo, 2012). Shear wave propagation in vertical direction in one-dimension soil layer system is assumed that homgeneous soil having endless distance horizontally and the vibration only in horizontal direction sourched from rock layers. The analisys of soil response in one dimension deals with soil mass density, horizontal displacement, depth, duration, shear stress, and proportonal damping coeficient of mass (Kramer, 1996; Makrup, 2013).

Refering to the results of maximum acceleration that are grapically and numerically expressed shows that acceleration of top sand layer decreases as the layer thickness increases. The reduction of maximum acceleration increases as the layer thickness increases. Newton's Second Law states that a force is proportional to the mass and acceleration. Therefore, maximum inersia force of structure decreases as the sand layer thickhness incerases, vise-a-versa.

Based on the results of total acceleration energy that are grapically and numerically expressed show that total acceleration energy of top sand layer decreases as the layer thickness increases. The reduction of total acceleration energy increases as the layer thickness increases. Refering to Newton's Second Law, total force applied to structures during the vibration decreases as the sand layer thickhness incerases, vise-a-versa.

The results also indicates that sand layer spread between the foundation and stable soil having 5-cm thickness is considered insufficiently to be a media for vibration reducer, where most houses in Indonesia seem to apply that thickness. Sand layer applied between the foundation and stable soil having 10-cm thickness is considered sufficiently to be a media for vibration reducer, however sand layer applied between the foundation and stable soil having 15-cm thickness or more is considered effectively to be a media for vibration reducer of a non-engineered wall masonry houses having a story. It should be noted that applying too thick sand layer could be more risky for structure foundation to experience liquefaction when the sand layer is under water during earthquake shaking.

In the issues of disaster risk reduction (DRR), therefore, an effort in the form of spreading proper thickness of sand layer under the foundation of structures is able to decrease the vulnerability of the structures caused by strong earthquake shaking (Dowrick, 1993; Kaminetzky, 1991; Naeim, 1991; Paulay, 1992). This means that the effort could lead to reducing earthquake disaster risk.

4. CONCLUSIONS AND RECOMMENDATION

Many physical parameters of soil are not accommodated in this numerical simulation using computer software (Sarwidi, 2014; Sarwidi and Satrio, 2004), therefore, these conclusions should be validated using a series of physical experiment in the laboratory in order to obtain more accurate images.

4.1 CONCLUSIONS

The results of this numerical simulation research and the discussion bring up the following conclusions.

1. The maximum inertia force and total inertia force along vibration duration through structures due to earthquake shaking decrease as the thickness of sand layers beneath the foundation increases.
2. Sand layer applied between the foundation and stable soil having 15-cm thickness or more is considered to be effective for media to reduce ground vibration of non-engineered wall masonry houses having a story.
3. It should be noted that spreading too thick sand layer could be more risky for structures to experience liquefaction once the sand layer is under water table during earthquake shaking.
4. Spreading proper thickness of sand layer under the foundation of structures can reduce earthquake disaster risk.

4.2 RECOMMENDATION

The subsequent recommendation is based on the results of the research along with relevant needs in the future.

1. Future research needs to compose a sand layer to become several sub-layers. Each sub-layer has different type of sand. In addition, it should be investigated for different dynamic behavior due to different amount of load.
2. Numerical model used for this research is a simplification; consequently, it does not accommodate all physical parameters of sand. More accurate results would be

obtained from upcoming physical experiments in the laboratory.

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FLEXURAL PERFORMANCE OF RC BEAMS WITH VARIETY JOINTS OF REINFORCING STEEL REBARS

Novia MAHLISANI[1], Mochamad TEGUH[2]

ABSTRACT: Flexural strength of reinforced concrete (RC) beams is commonly affected by several factors for instance: compressive strength of concrete, yield stress of reinforcing rebars, reinforcement ratio, beam length, and beam stiffness. Another important factor when a beam having long span more than the practical maximum length of rebar, there will be some problems in jointing the reinforcing steel rebars to meet the SNI standard. This research examines flexural performance of reinforced concrete beams utilizing variety joint techniques in the reinforcing steels. The RC beams were simply supported looking at the behavior of flexural effects when the joint of reinforcing steel rebar was positioned at midspan of the beam. Strain gauge instruments were carefully installed in the right position of concrete and rebars to monitor stress-strain relationships. Three-variety of joint technique was used in this research, i.e., normal (without cutting off), overlapping connection, and welded connection. Based on this research, indicative results concerning the flexural performance of RC beams having variety joints of reinforcing steel rebars in tensile fiber can be drawn. The flexural strength comprising load-displacement response, flexural crack propagation, displacement ductility is extensively discussed in this paper.

KEYWORDS: flexural strength, reinforced concrete beam, reinforcing steel connection

1. INTRODUCTION

In the recent decades, research on reinforced concrete has drawn attention to knowledge acquisition and application techniques concerning structural component deficiencies due to material deterioration, revision of load standards, and other reasons. Reinforced concrete structures make up of a set of elements that interact together as a one unit to carry the dead loads, live loads, and other load combination placed on the structure safely. Most reinforced concrete structures are subdivided into beams and slabs, which are subjected primarily to flexure (bending) and shear, and columns, which are subjected to axial compression and bending. A good design requires accurate calculation of loads on structure to get the requirements of any design, which are safety and economy. A beam is a structural element of frame structure and has an important function in transferring applied loads on slab to column structures. The axial compression or normal and bending forces on column are distributed to the foundation system.

In modern practice, purely reinforced concrete beams in building structure longer than about 20 m are quite unusual; therefore concrete girders utilizing this size are usually prestressed. However, there is no fundamental reason why such structures should not be built. Most building component sizes are decided by architectural considerations not structural ones. If the architect, for instance, specifies a longer span beam, then the structural engineer will design a suitably stronger one. As aforementioned that the beam acting as a structural component of building structure usually resists flexure (bending), shear, and torsion. In the case of flexural beam, its strength is affected by compressive strength of concrete; yield stress of reinforcing bars, reinforcement ratio, beam length, and beam stiffness. When the beam having long span more than a practical maximum length of rebar (12 m), the lap welded joint of reinforcing steel rebar can be used as an alternative solution to overcome the

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problem in connecting the reinforcing steels, however this should be done by a certified operator in order to meet the SNI standard (SNI 03-2847-2013). Despite of this technique, overlap with the minimum length of 40D (D = reinforcement diameter) or a combination between these techniques may be utilized in practical construction.

The aim of this research is to investigate flexural performance of reinforced concrete beams employing variety joint techniques in the reinforcing steels. The RC beams were simply supported looking at the behavior of flexural effects when the joint of reinforcing steel rebar was positioned at midspan of the beam. This paper discusses the main flexural strength of RC beams consisting of load-displacement response, flexural crack propagation, and displacement ductility.

2. RESEARCH METHODOLOGY

2.1 REINFORCED CONCRETE BEAM SPECIMEN

The RC beam specimen was modeled as a simply supported beam with span of 1800 mm as presented in Figure 1. Incremental static one third loadings were gradually applied to the beam to reach ultimate load. The typical beam dimension was 150x300x2000 (mm) as detailed in Table 1. The material properties of reinforced concrete were designed as follows: 25 MPa for compressive strength of concrete and 240 MPa for yield stress of reinforcing steel. A typical cross section of the beam as shown in Figure 1, three tensile reinforcements with diameter of 12 mm and two compressive reinforcement with diameter of 8 mm were precisely positioned. Each beam was confined with minimum stirrup of 8 mm diameter and spacing of 150 mm. Plain reinforcements having variety of diameters were used in this research. The experimental tests were conducted at the Material and Structure Laboratory, Civil Engineering Department, Islamic University of Indonesia.

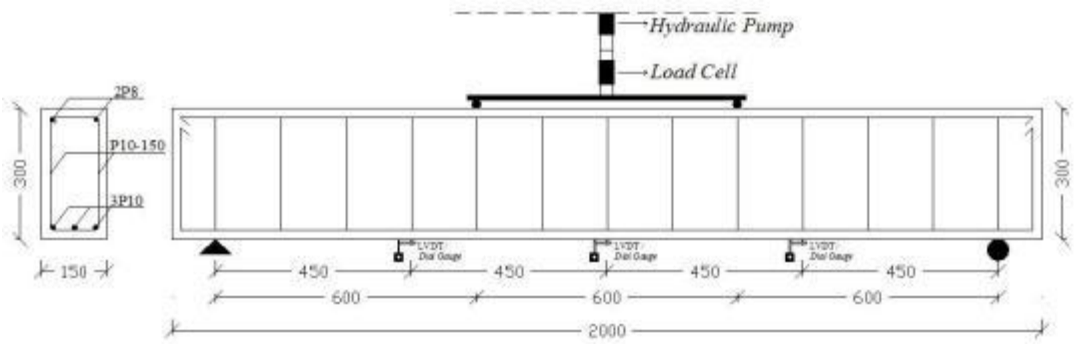

Figure 1. Beam section detail

Table 1. Variety RC beam specimens

Specimen type	Typical joint		Beam dimension (mm)		
	Number of reinforcements	Type of joint	Width	High	Length
BU-1	3 P12	Normal	150	300	2000
BU-2	3 P12	Overlap with 40D length	150	300	2000
BU-3	3 P 12	Welded with 50 mm length	150	300	2000

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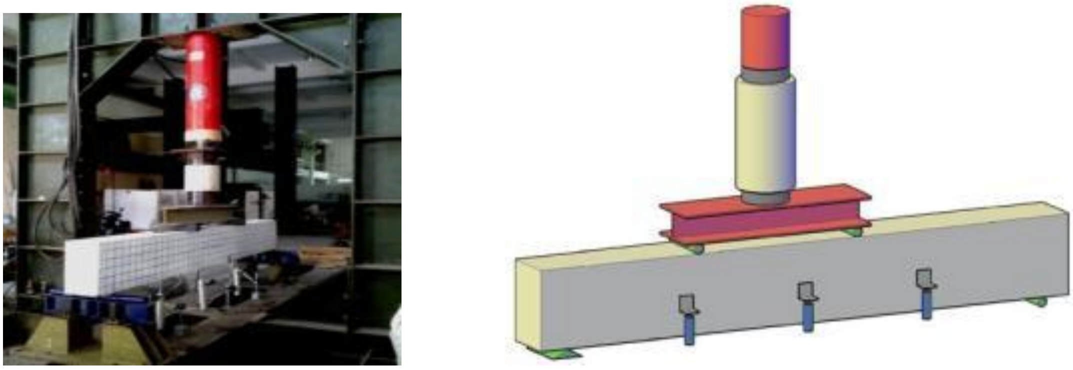
2.2 EXPERIMENTAL SETUP

The experimental tests conducted in this research were focused on the effect of three different joints of reinforcing steel rebars acting on simply supported flexural beams. Figure 2 depicts the experimental setup used to test all specimens. Each beam installed at the loading frame and laid on hinge-rolled supports was applied to two points of one-third loadings and was gradually increased up to maximum or ultimate load. Three Linier Variable Displacement Transducers (LVDT) were installed at midspan and one-fourth (quarter) span of the beam to monitor vertical deflections.

This research examined flexural performance of typical simply supported reinforced concrete beams where load-displacement response, strength and ductility, crack propagation, and beam failure were carefully measured based on the installed LVDT's and strain gauges. The data were recorded in the data logger and stored in the computer with high-speed machine. Crack damages were consistently scratched on both sides of the beam during the applied load steps. To achieve the research objectives, the recorded data were extensively analyzed and briefly discussed in the following sections.



(a) Beam installed in loading frame **(b) Beam in 3D view**

Figura 2. Experimental setup

3. RESULTS AND DISCUSSION

3.1 MATERIAL PROPERTIES OF REINFORCED CONCRETE

In this research, three concrete cylinders were made to determine an average compressive strength of concrete at each beam specimen and the results are tabulated in Table 2. The mix design of concrete was prepared with compressive strength of concrete (f_c') equals to 25 MPa. All plain reinforcements and welded joint of reinforcing steel rebars used in the specimen were experimentally tested to investigate the yield stress and tensile strength as depicted in Table 3. The expected yield stress of rebar was 240 MPa.

Table 2 presents the compressive strength of concrete for all cylinders have reached over the expected strength of 25 MPa. This strength achievement was directly affected by several factors, such as material quality, mix design, compacting and curing processes. It can be summarized that the concrete quality of specimens for BU-1 and BU-2 is catagorized as high strength concrete based on SNI 03-2847-2013 where the compressive strength is higher than 41 MPa. Whilst the concrete quality of speceimen BU-3 is normal strength or normal concrete. It should be noted that the concrete strength was significantly increased and this might be as a result of over estimating in the mix design of concrete where each material

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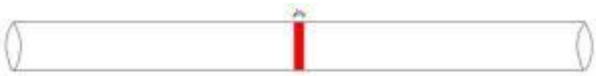
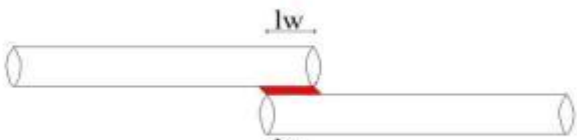
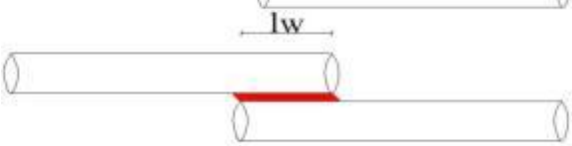
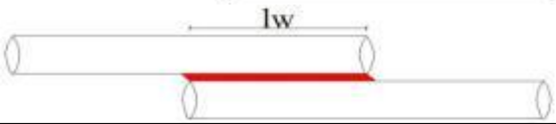
characteristic was inaccurately measured and the additive added was neglected in the mix design of concrete.

Table 2. Compressive strength of concrete

Specimen type	Cylinder no	Compressive strength (MPa)	Average compressive strength (MPa)	Percentage (%) strength increases
	1	37.03		
BU-1	2	44.51	41.28	65
	3	42.29		
	1	38.40		
BU-2	2	41.04	41.04	64
	3	43.69		
	1	27.86		
BU-3	2	38.50	34.79	39
	3	38.00		

Five typical joints of reinforcing rebar used in this research were experimentally tested for measuring the tensile stresses and tensile strengths. The main reason of having variety joints of reinforcement is to chose reasonable welded joints to be used in the specimen BU-3. Table 3 presents experimental tests on variety joints of reinforcement. All typical joints were welded having different length of welding except no. 1 as a normal reinforcement without cutting off.

Table 3. Tensile stress tests on variey joints of reinforceing steel rebar

No	Typical joint	Welded length (l_w) (mm)	Tensile strength (MPa)	
			Yield stress	Max tensile
1		-	247.207	377.316
2		0	255.0139	328.742
3		50	252.412	386.857
4		100	252.412	383.388
5		150	261.085	383.388

Based on the test results, the yield stresses between each typical joint are not significantly different values, because the yielding points are similarly occurred at midspan for normal reinforcement (sample number 1) and at end point of welded joint for sample numbers 2-5. For a practical reason, the typical joint number 3 with welded length of 50 mm was chosen to be used in the specimen BU-3. The measured tensile stress is higher than the allowable yield stress. The other test results will be published in journal paper elsewhere.

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A series of tests on flexural reinforced concrete beams as listed in Table 4 has indicated that the predicted maximum loads between theory and testing were absolutely different having higher percentage of applied loads. The defference of maximum applied loads is over 45% compared to the treoretical prediction. The reason for this condition is probably because of the very high compressive strength of concrete as well as yield stress of reinforcing steel at each specimen occurred. Another reason, the Sikka additive added into the mix design of concrete was not taken into account resulting significant increase on the compressive strength of concrete and the maximum applied load. This big gap of different maximum loading scheme is unusual in practical purposes because it will spend an expensive cost of construction. Given this higher maximum loading scheme, the beam strength has significantly increased producing severe failures at midspan beam.

Table 4. Maximum loading scheme

Specimen type	Max applied load (kN)		% of incremental applied load
	Theory	Test	
BU-1	56.27	107.00	47.41
BU-2	56.26	136.39	58.75
BU-3	57.10	107.18	46.72

3.2 LOAD-DISPLACEMENT RESPONSE

As aforementioned, three LVDTs were installed at the tensile fiber of beam as shown in Figure 1. The measurement of LVDT-2 positioned at midspan was the main indicator for vertical deflection of the beam, while LVDT-1 and LVDT-3 were used to measure vertical deflection underneath the two point-loads (Figure 3).

Load-displacement responses for all specimens are clearly described in Figure 3. Based on the experimental results, the beam BU-2 provides the highest strength and more ductile RC beam with the maximum load of 136.39 kN and maximum displacement of 56.42 mm compared to other two specimens of BU-1 and BU-3. Figures 3a-c show that the load-displacement response relationships measured from LVDT-1 and LVDT-3 tend to accurate measurement resulting redundant graphs. The maximum loads achieved by the beam BU-1 and BU-3 are very close to each other producing small value of load difference and having similar strength as well as ductility.

Figure 3d presents a comparison of load-displacement responses for all specimens tested and indicates flexural performance of each typical beam. At early stage of loading, the beam BU-1 shows more ductile and other two beams BU-2 and BU-3 tend to brittle but the achievable strengths for all are relatively the same. This different behavior of beams is more likely caused by the material characteristics, workmanship, and experimental devices installed at each specimen. In other words, the beam BU-2 is stronger than other resulting higher strength as well as ductility demand. In contrast, the beam BU-1 has similar strength and ductility with the beam BU-3 but they are slightly different structural behavior especially at early stage of loading. In addition, the beam BU-2 was actually not only used 40 times reinforcement diameter for overlap joint in length but also seismic hooks at the end of reinforcement. For this reason, its strength has significantly increased to reach the optimum applied load but the strength degradation was suddenly occurred afterward. The beam BU-1 has consistant strength up to ultimate load and more stable because of no special treatment at joint reinforcing rebar (normal reinforcement without cutting off). Strength reduction at the beam BU-3 was experienced after its ductility achieving 50%.

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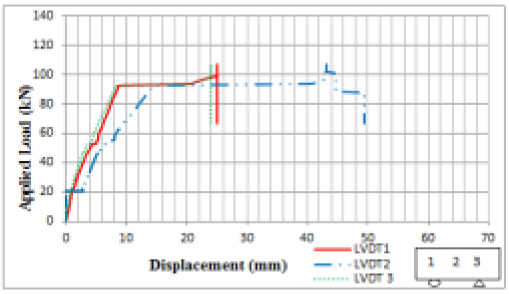
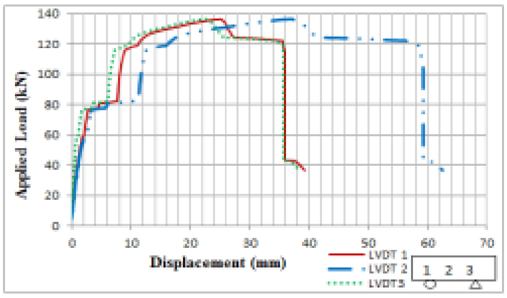
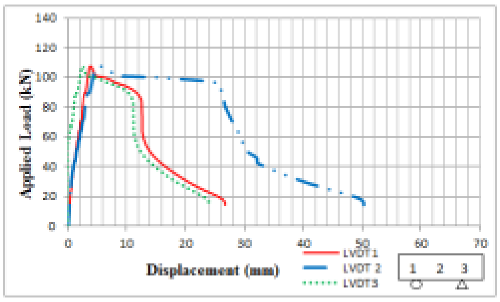


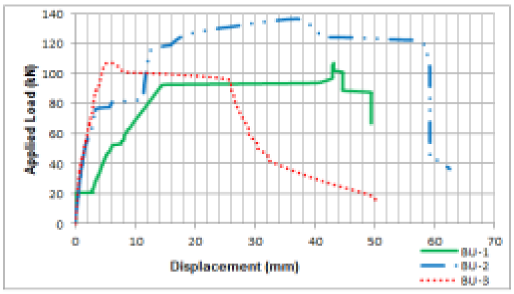
(a) Beam BU-1



(b) Beam BU-2



(c) Beam BU-3



(d) Comparative results at midspan

Figure 3. Load-displacement relationships

3.3 STRESS-STRAIN RELATIONSHIPS

To determine stress-strain relationships every material, strain gauges were installed at the compressive fiber of concrete and at the tensile reinforcement located at midspan of beam. One strain gauge was used to measured compressive strain of concrete, and another two strain gauges were utilized to monitor tensile strain of reinforcement. In general, two strain gauges installed at the reinforcement were compared each other and selected the best strain measured.

Figure 4a shows accurate strain of concrete measured in the three specimens and it seems that stress and strain relationships are very close to each other. Based on the applied loads, the stresses were calculated at every stage of loading and the maximum stresses were highly achieved camparing to the design compressive strength of concrete (25 MPa). Based on the theory, the strain range for concrete material (ε_c) is 0.002 – 0.003 or $0.002 \leq \varepsilon_c \leq 0.003$, but the maximum strain of concrete has been reached for all specimens. Given the stress and strain achieved, this experemental tests met with expected research outcome.

The stress-strain relationships fitted at the tensile reinforcement of all specimens are presented in Figure 4b showing that the highest stress was reached by the BU-2 while others (BU-1 and BU-3) were lower stresses occurred. In contrast, the highest strains were tended to occur in the BU-1 and BU-3 meaning that longer reinforcement elongations at the normal and welded reinforcements were experienced during the process of reaching ultimate loads. The BU-2 strain, however, has achieved normal strain for overlap plain reinforcement resulting lowest strain or shortest elonggation

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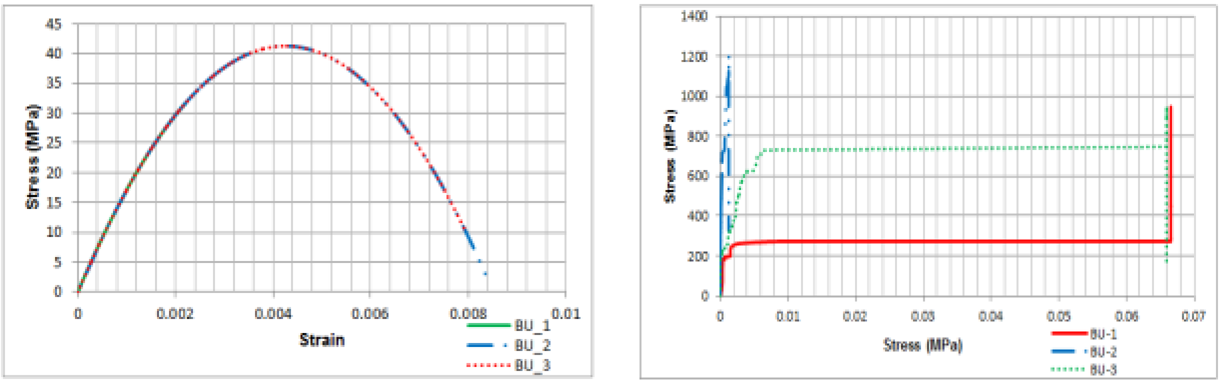

(a) Concrete **(b) Reinforcement**

Figure 4. Stress-strain relationships

3.4 STRENGTH AND DUCTILITY

According Kwan, Ho et al. (2002), in the design of reinforced concrete beams, especially those made of normal to high strength concrete and those in earthquake-resistant structures, both the flexural strength and ductility need to be considered. From the numerical results obtained in a previous study on the post-peak behavior and flexural ductility of reinforced concrete beams, the interrelation between the flexural strength and the flexural ductility that could be simultaneously achieved was evaluated and plotted in the form of charts. Using these charts, a new method of beam design called ‘concurrent flexural strength and ductility design’ that would allow engineers to consider both the strength and ductility requirements at the same time before deciding on whether to use normal or high strength concrete or add compression reinforcement has been developed. For application to flexural cases in which the concrete grade is prescribed, a simpler method of first determining the limits of steel ratios that would satisfy the ductility requirement and then designing the reinforcement details according to the strength requirement was proposed. Experimental results are presented to illustrate the application of these methods of joint reinforcing rebar.

In the design of a reinforced concrete beam, both the flexural strength and ductility need to be considered. Although usually more attention is paid to the flexural strength and only a simple check is carried out to ensure that a certain minimum level of flexural ductility is provided by keeping the beam under-reinforced, this does not mean that the flexural ductility is unimportant. From the structural safety point of view, ductility is at least as important as strength. A good ductility would provide the beam with a much better chance of survival when it is overloaded, subjected to accidental impact or attacked by a severe earthquake (Kwan, Ho et al. 2002). Ductility is generally measured by the ratio of the ultimate deformation to that at the first yielding of steel reinforcement (ε_{sy} = 0.002) (Bsisu, Hunaiti et al. 2012).

Since the flexural ductility of beams depends heavily on the concrete strength, the use of existing deemed-to-satisfy rules derived many years ago based on the behavior of normal strength concrete (NSC) would render a significantly lower level of flexural ductility provided to high strength concrete (HSC) beams. It would also cause the design of beams to have a wide range of available flexural ductility depending on the design concrete strength. Therefore, the existing deemed-to-satisfy rules are not conservative in the sense of ductility design (Ho and Kwan 2008).

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In the general concept of earthquake resistant design (SNI 03-1726-2012), for collapse prevention following approximate relationship holds “quality of seismic behavior = strength x ductility” and to survive an earthquake different combination of strength and ductility are possible. The flexural ductility of a beam section may be expressed in terms of the curvature ductility factor μ and the art of ductilities is theoretically consisted of strain, curvature, rotation, and displacement ductilities. The strain ductility can be determined based on the stress-strain relationship. The curvature ductility as formulated in Equation 1 is defined from moment-curvature relationship either calculated numerically using softwares (Response 2000 or Extract) or experimentally. The curvature ductility μ_φ is expressed as follows:

$$\mu_\varphi = \frac{\varphi_u}{\varphi_y} \quad (1)$$

where φ_u and φ_y are the ultimate and yield curvatures, respectively. The ultimate curvature φ_u is taken as the curvature when the resisting moment has dropped to 0.8 M_p after reaching M_p, where M_p is the peak moment. The yield curvature φ_y is taken as the curvature at which the peak moment M_p would be reached if the stiffness of the section is equal to the secant stiffness at 0.75 M_p.

Furthermore the rotation ductility is theoretically determined based on the moment-rotation relationship. Equation 2 can be used to estimate the displacement ductility based on the experimental test results or numerical analysis. The displacement ductility μ_Δ is defined as a ratio between the ultimate Δ_u and yield Δ_y displacements, respectively, as expressed in the following equation.

$$\mu_\Delta = \frac{\Delta_u}{\Delta_y} \quad (2)$$

The displacement ductilities for all speciments are completely listed in Table 5. The beam BU-2 produced the highes ductility due to the use of 40D overlap reinforcement and seismic hooks at the rebar ends. Wilst the beams BU-1 and BU-3 have similar ductilities. These results have met with theoretical flexural ductilty as clearly described in the text books (Nilson 1997; Park and Paulay 1975).

Table 5. Displacement ductility

Specimen type	Displacement (mm)		Ductility
	Δ_y	Δ_u	μ_Δ
BU-1	6.068	43.185	7.12
Bu-2	4.967	57.117	11.50
BU-3	3.845	32.307	8.40

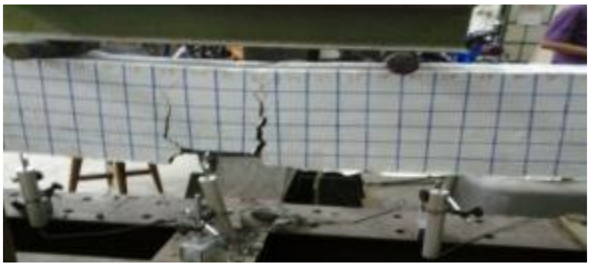
3.5 FLEXURAL CRACK PATTERN AND BEAM FAILURE

The behavior of the specimen under loading was typical of a beam subjected to flexural stresses; maximum failure load was at 136.39 kN. Crack pattern propagated uniformly spaced cracks were formed in the bending region which formed concrete blocks connected by the dowel action of the bottom steel as depicted in Figure 5. Beam failure was formed at the point of two point-loads and the mid-span of beam. Maximum deflection at mid-span of beam BU-2 was 59.15 mm when the ultimate load reached 136.39 kN. Vertical deflections as well as ultimate loads were occurred in the rest two beams (BU-1 and BU-3) with the values as follows: 49.75 mm and 50.45 mm for the deflections; 107 kN, and 107.18 kN for the loads, respectively. Given this beam flexural performance, the displacement ductility achievement each beam is absolutely relevant as tabulated in Table 5.

The beam BU-1 (Figure 5a) started propagating vertical crack damage at midspan and spreading out in between two point-loads when the load was gradually increased to reach the ultimate. The pattern of beam failure performed vertically showing the flexural performance of the beam since the maximum concrete strain was over 0.003 and the plain reinforcement was yielded and over the allowable tensile strength. The beam behavior has satisfied with the research objectives exposing crack width was measured over the limit state of concrete.

(a) Beam BU-1

(b) Beam BU-2



(c) Beam BU-3

(d) Typical reinforcement failure

Figure 5. Flexural crack pattern and beam failure

The beams BU-2 and BU-3 (Figures 5b-c) were severely damaged due to the joint reinforcing rebars were treated differently where the overlap reinforcements and welded joint rebars were used in these specimens. Large portion of concrete spalled out at tensile fiber underneath of left point-load was experienced in the beam BU-2 as result of the maximum ultimate load applied to it and effect of seismic hooks as well bonding effect. This beam did not equally perform large portion of failure at both sides below the two point-loads. Small shear crack tended to occur at the left side of the beam BU-2 but the shear behavior was out of the research objective. Different failure was occurred in the beam BU-3 where at the end of welded joint rebars were failure subject to rebars cutting off (Figure 5d) and wide portion of concrete spalled out along middle one-thirth span or underneath the two point-loads span. In addition to the beam failure, the beam BU-3 consistently performed wide portion of concrete at the tensile fiber to serious damage in flexural length of the beam.

4. CONCLUDING REMARKS

Based on the brief decription of experimental test on three reinforced concrete beams specimens to seek the flexural performance at each beam with different characteristic and joint reinforcing steel rebars, the concluding remarks can be drawn as follows.

a. The flexural ductility of normal compressive strength of concrete beams has been studied by extensive parametric studies based on variety joint reinforcing steel rebars taking into account the stress-path dependence of steel reinforcement.
b. The major factors affecting the flexural ductility of beams are the reinforcement ratio, material characteristics, and typical joint treatments.
c. The ductility increases as reinforcement ratio decreases, however joint treatment is another key point contributing to the displacement ductility as well.
d. Crack pattern and beam failure for all specimens meet with theoretical basis of flexural performance of reinforced concrete beams under static incremental loads.

5. ACKNOWLEGMENT

The first author would like to gratitude to the Bureau of Planning and International Cooperation, Ministry of Education and Culture of Indonesia who has provided an excellent scholarship for completing Master Program in Civil Engineering concentrating on Earthquake Engineering Management at the Faculty of Civil Engineering and Planning, Islamic University of Indonesia.

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COMPRESSION STRESS OF CONCRETE WITH VARIATION OF CORE DRILL DIAMETER

Harsoyo bin Muhammad SHODIQ[1]

ABSTRACT: Concrete is a building material which most widely used in a variety of buildings, such as multi stories buildings, bridges and waterworks. The long life building depends to the quality of the building materials. So, it is necessary to check the quality of the concrete in the site to ensure that it does not deviate from the plan (quality of concrete). The deviation of the quality of concrete will be less sustainable to support the building. Testing is began with fresh concrete, until the concrete is 28 days old or more. The site test of concrete is conducted by core drilling with varying diameters. Because the diameter of the core drill is smaller than the standard sample (cylinder diameter 150 mm x height 300 mm), then the questions arise how the effect of variations in the size of the diameter of the core drill in measuring standard compression strength of concrete, thus it is necessary to study the influence of the diameter size of the core drill to its standard compression strength. Therefore, this paper aims to describe the effect of variations in the diameter of the test specimen to its compression strength and to determine the conversion coefficient due to the variation of diameter core drill. For the sake of presentation, the concrete quality varies from 25 MPa to 45 MPa of 5 MPa intervals and diameter core drill used are 2", 3" and 4" as those are widely used in the site. The result shows that the values of strength are vary and do not show good consistency. In general, it shows that compressive strength of core drill 3" tends to be lower than the diameter of 2" and 4". However, by using the trend line is obtained the same tendency in the form of powered equation. Finally, the suggested conversion formula is in the form of powered equation. By knowing the formula, the compressive strength of concrete used in any building can be checked by core drilling sample any diameter. Then the result can be used to justify the sustainability of the building under specified load that will be imposed.

KEYWORDS: concrete, standard compression strength, core drill, conversion formula

1. INTRODUCTION

Concrete is a building material that is most widely used in a variety of buildings, such as high rise buildings, bridges and waterworks. As widely used, it is necessary to check the concrete quality of a building to ensure its quality does not deviate from the design. Usually, concrete building collapses because the quality of the concrete is under estimate. Therefore, for concrete buildings can sustain in the long run, the quality of concrete used shall be ensured in accordance with the plan.

To maintain the quality of concrete, concrete testing begins early in the fresh concrete. The first test is slump test. This test is intended to determine the level of viscosity of the fresh concrete. Small slump value indicates the degree of dilution is cloggy, it means that the water ratio is small or less water, on the hand, the greater the value the more dilute the fresh concrete, it means that the water content ratio is bigger or more water. The less water on fresh concrete will produce better concrete quality.
Concrete testing begins early in the mixing of concrete that is often called the fresh concrete. The first test performed was testing slump value. This test is intended to determine the level of dilution of fresh concrete is already in line with the dilution rate plan. Small slump value indicates the degree of dilution of concentrated, the greater the value of slump the more dilute the fresh concrete.

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The second test is testing the strength of concrete, at the age of 3 days, or 7 days to find out the quality of the concrete is reached at the age of 3 days or 7 days which can be converted to the strength of the concrete at the age of 28 days as standard concrete strength. The third test is conducted to the concrete of the age of 28 days or after, as the age of standard concrete strength (Tjokrodimuljo, 1996). This concrete testing is only performed on the sample, rather than on casted concrete in the building. However, the quality of a casted concrete on building cannot be guaranteed if the concrete strength is the same as the sample concrete produced in the test. Therefore, concrete testing has to be conducted to prove if the quality of the concrete is met predetermined quality. Testing of casted concrete can be performed as Non Destructive Testing or Destructive Testing.

Testing on core drill is one of destructive testing (SNI 03-3403-1994). The test is conducted using samples of concrete taken from the casted concrete. Drill diameters are available 4 ", 3" and 2 ", so the diameters of core drill are as well as the diameters of drill. These sample are tested in the laboratory to determine the compression strength of concrete. However, these core drill diameters do not have a definite standard compared to standard cube test or cylinder test. Since the drill core diameters are smaller than the standard samples, it is necessary to study the influence of the diameter core drill to compression strength of concrete based on standard sample.

Based on the explanation above, the issue that arises is whether the variation in the size of the diameter of the core drill will affect the measurement of standard concrete strength?

2. STUDY OBJECTIVES

In accordance with the issues raised, the study objectives are as follows.

a. Determine the effect of variations in the diameter of the test specimen to the compression strength of concrete
b. To determine the conversion factor of core drill diameter to standard compression strength of concrete.

3. SCOPE OF STUDY

The scope of study has to be set in order to the study becomes more focused. The scope in this study are as follows.

1. The strengths of concrete used are 25 MPa, 30 MPa, 35 MPa, 40 MPa, and 45 MPa respectively, according to the concrete strength currently and widely in used the site
2. Mix Design of concrete uses SNI 03-2834-1993 method.
3. Standard samples of concrete use cylinder specimen of diameter of 150 mm with 300 mm height, each strength type is represented by three samples.
4. Core drill diameters are 2 ", 3", and 4 ", in accordance with the available tools, each strength type is taken three samples per diameter.
5. The tests conducted is for compression test only.

4. EARLIER STUDIES

Quality control in a building is needed to ensure that buildings constructed capable of supporting the load planned in order to avoid the risk of loss of life and property in case of maximum load on the building due to earthquake loads and other loads are taken into account in the building.

In concrete buildings, the concrete quality can be known only after construction has been finished. Therefore, in constructing concrete shall make samples as a control on the quality of concrete made (SNI 03-1974-1990, Nugraha et al 2007, Tjokrodimuljo 1996, Murdock and Brock, 1991, etc.). Not every concrete work meets pre-defined strength (quality) of the concrete. To determine the strength of casted concrete, it must be checked using various testing, such as hammer test (SNI 03-4803-1998) or core drilling test (SNI 03-3403-1994). Core drill conducted on installed concrete using a certain diameter. The drilling is only for the concrete itself. This sample is then tested in the laboratory to obtain its compression strength.

The study of compression strength measurement of concrete used core drill test and hammer test showed satisfactorily correlations (Mulyati and Febriyanto, 2011). However, the core drill size was only one size of the diameter of 6.9 cm and 13.8 cm high, it is not known yet if the different sizes (diameters) are used.

The influence of the ratio of length to diameter core drill for high strength concrete has been studied at ITS (Irwanto, 2009) to seek a multiplier factor, C1, to some ratios of length to diameter of core drill from 1 to 2. The results showed that the ratio of length to diameter is considered the most well, C1 = 1 if the ratio is 2.

Studies on compression strength of concrete by comparing core drill test with Ultrasonic Pulse Velocity (UPV) has been conducted by Kurtulus and Bozkurt (2011) with core drill test specimens taken from several points on buildings in Turkey with the diameter of 10 cm. The aim of this study was to determine the relationship between the values of compression strength with the value of the UPV. Study results showed that the higher value of UPV the higher the value of the compression strength of concrete. The relationship between concrete strength and UPV can be expressed as an equation of:

$$CCS = 0.0544\ (UPV) - 15{,}343 \quad (1)$$

Where: CCS = compression strength of core drill (kg / cm2)

UPV = is the red of UPV (m / s).

The question arises whether the effect of different diameters influence on the strength of concrete, because according to the 1971 PBI, sample size determines the test results on compression strength as presented in Table 1 below.

Table 1. Shape factor for Strength Compression of cross section variation

Sample	Shape factor
Cube 15 x 15 x 15 cm	1.00
Cube 20 x 20 x 20 cm	0.95
Cylinder 15 x 30 cm	0.83

Source: PBI 1971

From Table 1 above, the difference in sample size influences the strength of the concrete, it means that conversion factor is required to convert the differences in the size (diameter) of core drill.

5. METHODOLOGY

The study is conducted to find the conversion factor of compression strength of various diameters of the core drill samples to the standard compression strength of concrete. It is carried out experimentally. The implementation of this experimental study is conducted in the laboratory of Civil Engineering Program, Faculty of Civil Engineering and Planning, Islamic University of Indonesia. The study begins with an examination of ingredient materials of concrete to determine the suitability of the used materials to the conditions stipulated by

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regulations such as PBI 1971, SNI 03-1974-1990 and SNI 03-2834-1993. Samples were made based on the results of mix design for each concrete quality

6. STUDY RESULTS AND DISCUSSION

This study begins with a mix design using local materials. These materials include: sand, gravel, cement and water. Conditions and the characteristics of each material must be known in advance before doing mix design in order to obtain suitable mix design method will be used. The next step is to make samples based on the suitable mix design. The samples consist of standard samples and core drill samples. After of age samples are 28 days, compression test is conducted.

Concrete strength test results of standard samples are presented in Table 2 below.

Tabel 2. Test Result of Standard Sample

Concrete Quality (Mpa)	f'c (Mpa)	f'c average (Mpa)
25	25.691 28.512 26.425	26.876
30	27.378 31.249 33.195	30.607
35	31.376 38.829 38.816	36.340
40	42.323 40.485 41.735	41.514
45	44.365 42.966 48.508	45.280

By obtaining the value of the standard concrete compression strength as mention above, these values will be used as a standard comparison of test results of concrete compression strength core drill which is shown in Table 3 below.

Table 3. Concrete Compression Stress (MPa) of various diameters

Type of sample Diam. (in)	45 MPa	40 MPa	35 MPa	30 MPa	25 MPa
2	36.35	36.01	32.81	27.73	25.31
3	33.66	33.69	30.20	37.28	22.58
4	45.80	44.27	41.24	42.66	31.96
Standard (6)	45.28	41.51	36.34	30.60	26.87

If the result in Table 3 is drawn graphically for each type of sample, then taken each its trend line, they will be respectively shown in figure 1 – 5 as follows.

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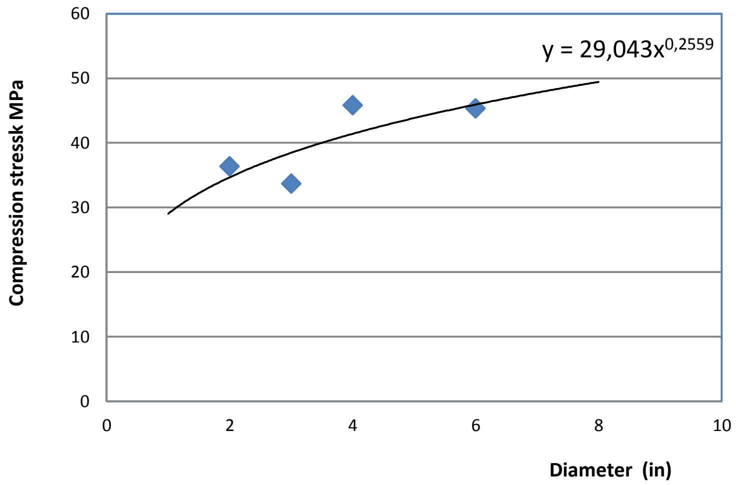

Figure 1. Compression Stress of Sample of 45 MPa

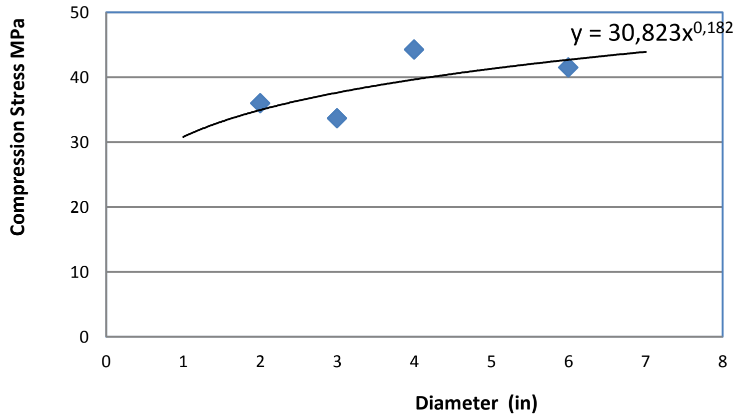

Figure 2. Compression Stress of Sample 40 MPa

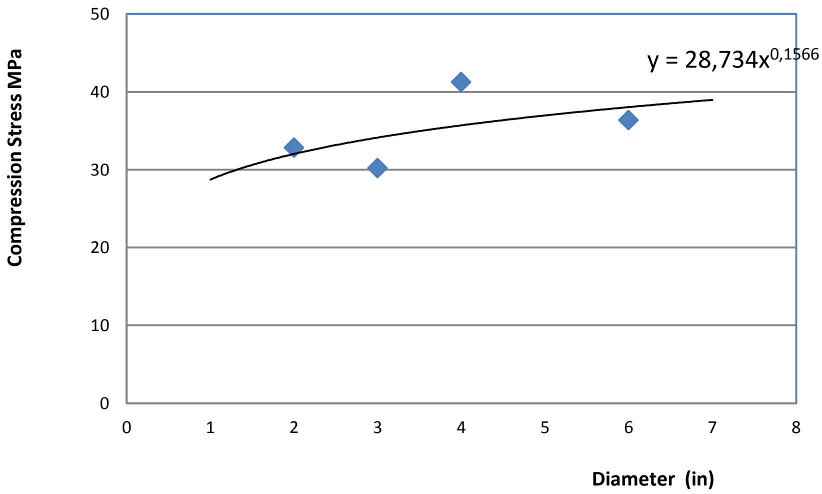

Figure 3. Compression Stress of Sample 35 MPa

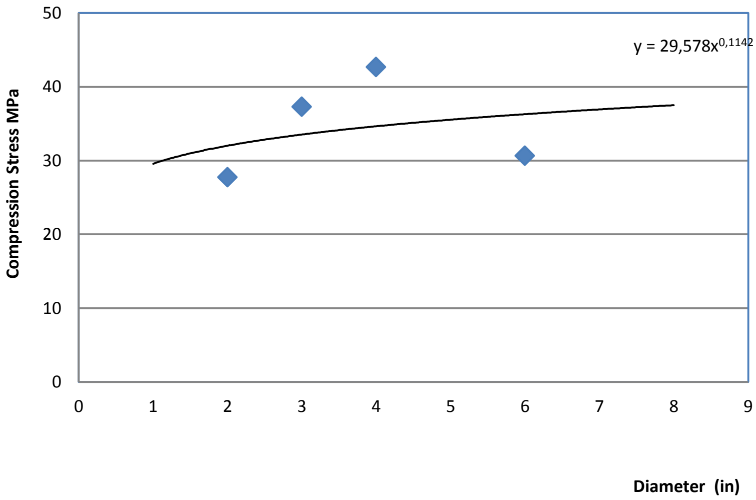

Figure 4. Compression Stress of Sample 30 MPa

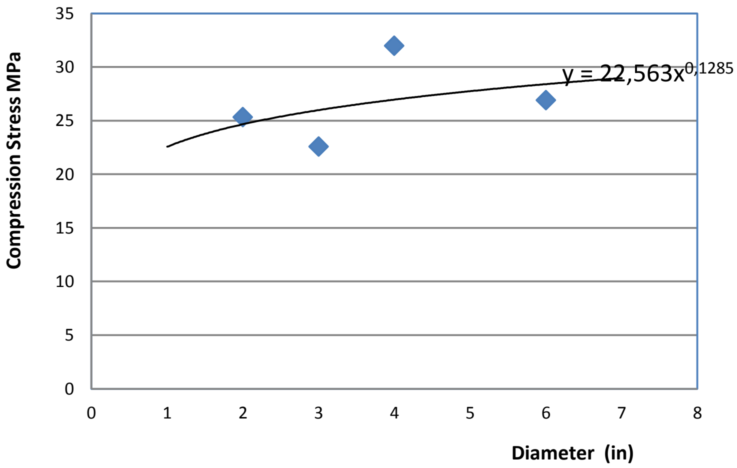

Figure 5. Compression Stress of Sample 30 MPa

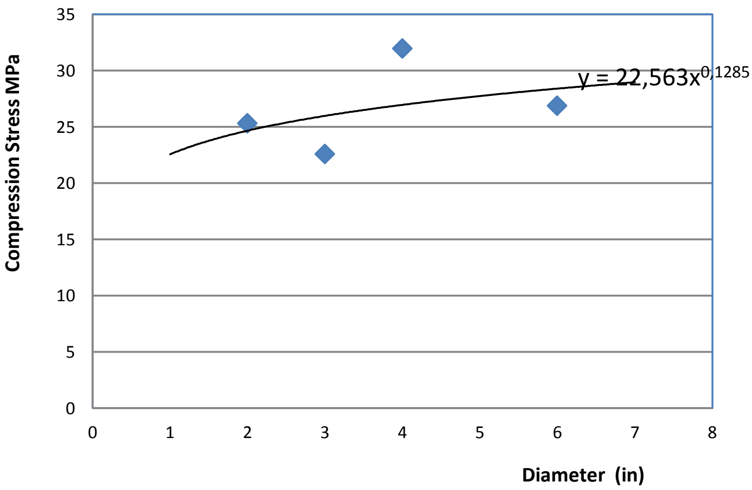

Figure 6. Compression Stress of Sample 25 MPa

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Based on the compression test results on core drill samples of diameter of 2, 3, 4 inches and standard samples of concrete, the four types of concrete show the same pattern, whereas different pattern is on the type of concrete of 30 MPa. In addition, samples of drill core with a diameter of 4 inches show greater strength than the standard sample strength. The lowest strength of concrete for each type of concrete is sample of 2-inches diameter.

If excel soft ware is used to search for the trend line to all charts of concrete types being tested, it is obtained the most appropriate trend line in the form of power equation. Each formula based on the trend line of each type of concrete is as shown on each figure of the type of concrete above. The trend lines for all types of concrete are as follows.

For sample 45 MPa:

$f'c = 29.04\ x^{0.225}$

For sample 40 MPa:

$f'c = 30.82\ x^{0.182}$

for sample 35 MPa

$f'c = 28.73\ x^{0.156}$

For sample 30 MPa:

$f'c = 29.57\ x^{0.114}$

For sample 25 MPa:

$f'c = 22.56\ x^{0.128}$

where:

f'c = Compression stress of concrete

x = diameter of sample

7. CONCLUSION

Based on the trend lines of all types of the concrete, then a formula that can be generalized the correlation between diameter of core drill to the standard compression strength of any type of concrete has to be found. By using the trial and error, then the relationship between the compression strength of any type of concrete for any diameter is proposed to use the conversion formula as follows:

$$f'_{CD} = \left(f'_C\right)^{0.95} . (x)^{0.117} \qquad (2)$$

Where:

f'_{CD} = compression strength of sample with diameter of x

f'_c = the actual compression strength of concrete

Using the formula above, compression strength of any concrete for any variation of the diameter of the cylinder samples can be converted to the actual concrete strength, so to a certain compression strength of concrete, f'c, with a certain diameter core drill the mean compression strength of the samples should be exceed or equal to f'_{CD} based on the formula above.

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DEVELOPMENT OF HAZARD DEAGGREGATION MAP FOR INDONESIA WITH EARTHQUAKE OF 2500 YEARS RETURN PERIOD

L.L. MAKRUP[1]

ABSTRACT: Ground motion hazard caused by earthquake in Indonesian islands is calculated in probabilistic framework. Certain magnitude and distance can be calculated from hazard by deaggregation analysis. Deaggregation calculation is initiated by calculating the ground shaking with hazard level 2% probability of exceedance in 50 years. Indonesian earthquake source models are constructed. Standard publishing attenuation relations are used to calculate the peak ground acceleration for rock site conditions. The earthquake catalogs are developed or modified and declustered, to include independent earthquakes only. The catalogs results are used to define the source zones that characterize earthquakes in Indonesian's tectonic environments: subduction zone interface earthquakes, subduction zone deep intraslab earthquakes (benioff zone), and shallow crustal earthquakes zones. The recurrence rates and sizes of historical earthquakes on the known and inferred faults and across zones are also determined from this modified catalog. Source zones, the two major faults that are historically known to generate large earthquakes in Indonesia: the subduction zone in western and southern side of this country, in other and also the transform fault (known or inferred) in the entire of country land. The result of the study is map of the earthquake's magnitude and distance (deaggregation map) that is calculated based on peak ground acceleration with level hazard 2% probability of exceedance in 50 years.

KEYWORDS: hazard analysis, deaggregation analysis, distance, magnitude.

1. INTRODUCTIONS

Indonesia has an earthquake hazard map issued by Indonesian Department of Public Work i.e. hazard maps in Indonesian Seismic Code 2002 (SNI 03-1726-2002). The map (i.e. Figure-1) is a peak ground acceleration with rock site condition and 500 years return period as a standard of Earthquake Resilience Planning Building Structure, used from year 2002-2010. The map now has been updated to be 2010 Indonesia seismic hazard map and it will be used as Indonesian National Standard of seismic code (Figure-2).

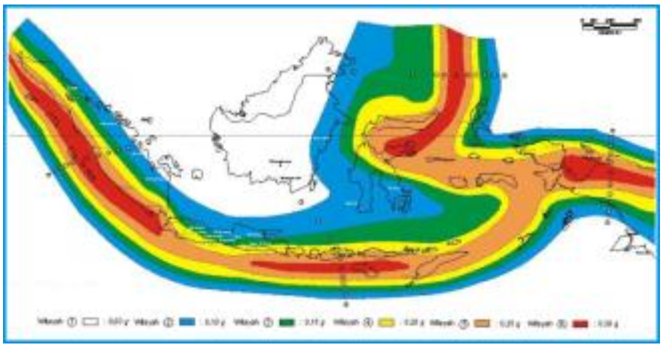

Figure 1. Indonesia seismic hazard map 2002 (SNI 03-1726-2002)

One of the hazard maps that can be utilized to derive seismic loading of a structural is the deaggregation map (i.e. magnitude and distance contour map). Such map is not employed in some seismic codes yet, however, the map will be important to account for an artificial time

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history at a site in the future. In this paper, the map is developed employing an up-to date probabilistic seismic hazard analysis (PSHA) methodology and the most recent seismo tectonic input as those which have been used by experts (Petersen *et al*., 2008; Sengara *et al*., 2008; Irsyam *et al*., 2010) to develop seismic hazard zonation maps before.

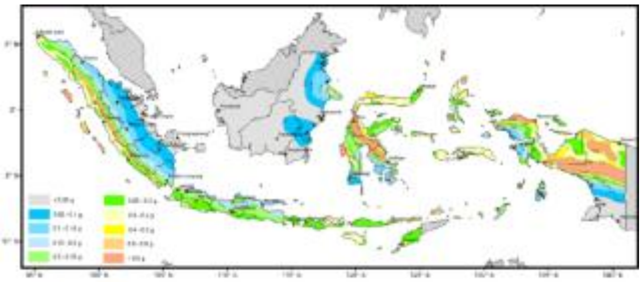

Figure 2. Indonesia seismic hazard map planed for 2010 seismic code.

2. TECTONIC SETTING

The Indonesian archipelago is laid on some big plate converging each others. The plates are Eurasia, India, Australia, and Pacific. Convergences of those plates have caused the form of micro plates (Figure 3) i.e. Burma, Timor, Banda Sea, Molucca Sea, Philippine, Bird Head, Caroline, Maoke, and Woodlark (Bird *et al*., 2003). Those convergences have also formed many earthquake source zones in Indonesia (Figure 4).

In the western part of Indonesia, the convergence of Indian-Australian plate and the Eurasian plate form the Sunda trench (Sunda subduction source zone). The trench runs along the western side of the Sumatra island chain to the southern side of Java, Bali, Lombok, Sumbawa, Flores, and Sumba islands. Those islands are located a few hundred kilometres from the trench. The convergence is nearly orthogonal to the trench axis in the south area of Java, but it is highly oblique in the southwest area of Sumatra (Megawati, 2003).

Figure 3: Plates in vicinity of Indonesian region (based on Bird, 2003)

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Figure 4: Trench and faults in vicinity of Indonesian islands (based on Irsyam et al., 2010 and Stevens, 1999)

The largest earthquake was instrumentally recorded in the Sumatran subduction zone, occurred on December 24th, 2004 M_w 9.2 (USGS poster, 2005). Another great earthquake that were reportedly happened in the zone was, the first, the great 1833 event with an M_w estimated between 8.8 and 9.2 (Zachariasen *et al*., 1999) and the second, the event with an Mw estimated between 8.3 and 8.5 that was occurred beneath Nias island in 1861 (Newcomb and McCann, 1987).

Within the Java-Sumba subduction zone, earthquakes that produce damage from shaking or tsunamis have been originated as the result of thrust-faulting on the plate interface and as the result of faulting within the Australian or Sunda plate (Petersen et al., 2008). Since 1900, the largest interface thrust earthquakes in the Java – Timor zone were the shocks of 1994 June 2 (Mw 7.8) and 2006 July 17 (Mw 7.7). Both of which produced such destructive tsunamis but neither of which caused damage from shaking. The 1994 and 2006 earthquakes, commonly called ″tsunami earthquake″ were an example of unusual type of earthquake, which produced relatively low-levels of the high-frequency energy that would cause shaking damage to buildings, but, considering their magnitudes, they were unusually efficient at generating tsunami waves (Petersen et al., 2008).

The Sumatran fault lies roughly 250 km in the northeast area of the trench. Geological and geophysical evidence identify the fault as a seismically active, right-lateral strike–slip fault (Sieh and Natawidjaja, 2000). The fault is a trench-parallel fault system, whose basic kinematic role is to accommodate a significant amount of the strike–slip component of the oblique convergence between the Indian–Australian plate and the Eurasian plate in the southwest area of Sumatra (Fitch, 1972; McCaffrey, 1991 and 1992). The 1650 km long fault runs along the western side of the Sumatra, coinciding with the Bukit Barisan mountain chain (Megawati, 2003).

The overall shape of the fault is sinusoidal. The northern half of the fault is concave to the southwest, whereas the southern half of the fault is concave to the northeast. Unlike many other great strike–slip faults, the Sumatran fault is highly segmented (Megawati, 2003). It is composed of 19 major segments with cross-strike width of step-over between adjacent segments of about 5 to 12 km (Sieh and Natawidjaja, 2000). The length of the segments ranges from 30 to 220 km (Figure 4). The historical records show that segments of the Sumatran fault have caused numerous major earthquakes but their magnitudes are limited to about 7.5–7.7 with rupture lengths are not greater than 100 km (Sieh and Natawidjaja, 2000). The influence of these step-over on historical seismic source dimensions suggests that the dimension of future events will also be influenced by the fault geometry. Geologist and geophysics identified faults and thrust in Java and Nusatenggara. The faults were Cimandiri, Bumiayu, Semarang, Yogyakarta, etc.

In the eastern area of Indonesia including Papua New Guinea (PNG), the convergence of Pacific, Australian, Eurasian and Philippine Sea plate, creating a broad region of deformation (Stevens, 1999). Plate motion models predict that the Australian and Pacific Plate converge obliquely at rate of 109 mm/yr N68^{0}E in northern New Guinea (DeMets, 1994). Australian-Eurasian convergence is about 77 mm/yr at N14^{0}E at the Timor trough and about 74 mm/yr N19^{0}E at the Java trench. Pacific-Eurasia plate convergence is about 88 mm/yr at an azimuth of about 288^0 at the Molucca Sea, while to north is predicted Philippine Sea-Eurasian plate convergence is about 112 mm/yr at 294^0 (Seno et al. 1993) (Figure 3)

Global plate motion model, which predict the relative motion between major tectonic plate, are not sufficient for explaining the tectonics and fault geometries in eastern area of Indonesia and PNG and they also do not agree with geophysical data such as earthquake slip vector (Stevens, 1999). One example of this is at the Banda arc, where slip vector indicate that Australian-Eurasian plate convergence is mostly happens north-south at the Java trench, in agreement with plate motion model. In the East of Timor, however, the trend of subduction zone and the slip vector azimuths are rotated counter-clockwise a full 180^0 along the Timor, Aru and Seram troughs (Figure 4) (Stevens, 1999). In eastern area of Indonesia and PNG shallow seismicity are spread throughout a broad region, so the major plate boundaries are not well defined features. The tectonic may be complicated further by the existence of micro plates that are trapped within the collision zone and move relatively to the major plates (Stevens, 1999). Several authors (Tregoning et al., 1998; Hegarty, 1983; Weissel and Anderson, 1978) have identified possible micro plates here, such as the Caroline Sea and North and South Bismarck Sea plates, but the relative motions of these plates are poorly constrained.

In PNG, Pacific-Australian plate convergence may be distributed over a several hundred kilometer wide zone (Figure 3). Many poorly understood tectonic features are found within this zone. These features include the Ramu-Markham fault, where the southern edge of the Finistirre island terrane meets the northern margin of Australian continent, and active the E-W trending Highland fold and thrust belt that extends throughout central PNG, where mountains reach elevations in excess of 4 km (Stevens, 1999). Relating to the question about how much the total plate convergences is accommodated at each of these features, is unknown. Plate collision may be complicated further by the presence of two micro plates, the north and south Bismarck Sea plates, that are trapped between the Australian and Pacific plates (Tregoning et al, 1998).

The highlands fold-and-thrust belt extends into western area of New Guinea (Irian Jaya), where the major tectonic and geologic features trend east-west and are oblique to the direction convergence. Plate convergence in western area of New Guinea may be partitioned between shearing on the left-lateral Sorong and Yapen strike-slip fault than trend east-west along the northern coast and the thrusting in the Mamberambo and Highlands thrust belt where the shortening occur (Stevens, 1999). There is a little evidence for the activity at the New Guinea trench, where few earthquakes are located. Seismic profile at New Guinea trench suggests that it is inactive at 134.5^{0}W (Misolm et al., 1992) but accommodates an active southward subduction in the farther east, near 142.8^{0}E (Hamilton, 1979).

Westward at the Banda arc, Pacific-Australian convergence is further complicated by the presence of the Eurasian plate (Figure 4). While it is widely believed that continental crust is too thick to be subducted to great depth, tectonic features and earthquake slip vector indicate that continental crust from the Bird's Head (BH) region of New Guinea is thrust beneath the Banda basin at the Seram trough. Thus this region may be gravitationally unstable. The Tarera-Aiduna fault, which connects at its western end to the Seram trough and extends eastward into Irian Jaya, has produced several large left-lateral strike-slip earthquakes, but its significance to the regional tectonic is unknown (Stevens, 1999).

The Timor trough, which trend east-west along southern edge of Banda arc, has long been considered as the boundary separating the Eurasian and Pacific plates (Figure 4). Earthquake indicates that oceanic crust has been subducted to the depth greater than 600 km beneath the Banda arc. In time the transition of normal subduction here to a continental collision zone, it will have significant effects on the tectonics and plate geometries (Stevens, 1999). Recent GPS result (Genrich et al., 1996) indicates that the long history of plate convergence at the Timor trough has largely stopped and plate motion are now accommodated at back arc thrusts.

North of Banda Sea and Seram trough is the Molucca Sea, where the predicted convergence between the Pacific and Eurasian plates is 88 mm/yr at an azimuth of about 286^0 (DeMets et al., 1994). Here the tectonic may be complicated by the presence of the Philippine Sea Plate (PSP). Seno (1993) predicts 112 mm/yr at 294^0 azimuth of PSP-Eurasian convergence. Seismically the Molucca Sea is very active, but the question about how much of the Pacific-Eurasian or Philippine-Eurasian convergence accommodated here is unknown (Stevens, 1999).

Westward the island of Sulawesi is bisected by the NNS trending left-lateral Palu strike-slip fault (Figure 4). Few earthquakes from earthquake catalogs are located on fault trace, but Katili (1970) and Hamilton (1979) report hydrothermal activity and stream offsets, which suggest the fault is active. To the north, the Palu fault connects to the E-W trending North Sulawesi trench. To the south, it merges with the western end of the E-W trending Matano fault system, where both of strike slip and extension occurs. The role of these faults play in the tectonics of eastern Indonesia is poorly understood (Stevens, 1999).

3. EARTHQUAKE CATALOGS

The estimation of future seismic activity is based on the rates of past earthquakes i.e. through earthquake catalogs. From the frequency-magnitude distributions of past earthquakes, it can be computed the frequency of future larger shocks that control the hazard (Petersen *et al*., 2004). For this study, it has been compiled a new catalog of instrumentally recorded earthquakes by combining four preexisting catalogs: (1) the BMG (Bureau of Meteorology and Geophysics) catalog, (2) the EHB (Engdahl, van der Hilst, and Buland, 1998) catalog, (3) the ISC (Bulletins of the International Seismological Centre) catalog, and (4) the PDE (Preliminary Determination of Epicenters catalogs of the US Geological Survey) catalog. The combined four catalogs cover an area from 90E to 142E longitude and 12S to 10N latitude.

A basic assumption of seismic hazard methodology is that earthquake sources are independent (Petersen *et al*., 2004). Thus, catalogs that are used to estimate future seismic activity must be free from dependent events such as foreshocks and aftershocks. In this study, the computer program (SHAP, Hendriyawan, 2007) has been used to marked duplicates and foreshocks as well as aftershocks earthquakes then it deletes them, so that leaves main shock only.

4. SOURCE ZONES

The source models were developed using earthquake catalogs, tectonic boundaries, and fault information (Figure 4). Source zones are defined on the basis of the distribution and focal mechanisms of the cataloged earthquakes, and on the locations of the earthquakes with respect to the boundaries of major tectonic plates. The source zones used in this study are: (1) the shallow earthquakes near the subduction zone (megathrust zone, depth ≤ 50 km), (2) shallow seismicity in transform fault (shallow crustal area), (3) deep earthquakes associated with subduction zone (benioff zone, depth > 50 km), and (4) shallow seismicity associated with back arc area (Figure 4). In this study, it has been estimated the magnitude of the largest earthquake in each source zone based on historical or geological evidence. The maximum magnitude is generally set at greater M 7.0 (Petersen *et al*., 2004). Typically the maximum magnitude is also higher than the historical magnitude because that calculated the long-term hazard uses a catalog that spans a relatively short time period (Petersen *et al*., 2004).

For the fault zones, the slip rates and earthquake size estimated define the rate of large-magnitude earthquakes on crustal fault in this study. The length of mapped and inferred faults entire of Indonesia and down-dip width estimated from seismicity may be used to calculate maximum magnitude expected to occur on these fault (Well and Coppersmith, 1994). The hazard calculation for fault sources, applies a combination of 50-percent characteristic (Youngs and Coppersmith, 1985) and 50-percent the Gutenberg-Richter magnitude frequency distribution and uncertainty (±M0.25) are applied to the characteristic earthquake magnitude and the maximum magnitude of Gutenberg-Richter distribution (Petersen *et al*., 2004).

In over the world, the subduction zone has become the focus of several large and great earthquakes. As an example, the great Sumatran earthquake M9.2 on December 2004 was occurred on Sunda subduction plate boundary (i.e. Sumatra subduction zone). To account for hazard of the great and smaller earthquakes along the zones we use seismicity with magnitude range between 5 and 9.20 for Sumatran subduction zone and magnitude range between 5 and 9.0 for others. Hazard is modeled by Gutenberg-Richter magnitude frequency relation (Gutenberg-Richter, 1944).

5. ATTENUATION RELATIONS

The earthquakes considered in this analysis are generated in different tectonic environments for rock site conditions. However, earthquake ground motions have been shown to vary dramatically among these different environments. Therefore, this study applied several different attenuation relations to account for these different tectonic environments. Ground-motion prediction equations, or attenuation relations, relate ground motions to a given magnitude, distance from the source to the site, fault type, soil condition, and tectonic environment. The prediction equations have been developed for earthquakes associated with four types of tectonic environments: (1) crustal interplate, (2) crustal intraplate, (3) subduction interface, and (4) deep within the subducting slab (Petersen *et al*., 2004).

Interplate crustal earthquakes are generated near plate margins where the crust is relatively hot and plate interactions also result in frequent earthquakes. Intraplate crustal earthquakes occur well away from the plate margins where the crust is cooler and thicker (Petersen *et al*., 2004). Based on those conditions, it has been considered a few attenuation relationships to calculate hazard.

***For crustal fault* (*interplate/intraplat*)**, the US National Seismic Hazard Maps (1996), utilized three attenuation relations to calculate the ground motions from shallow crustal interplate earthquakes (Petersen *et al*., 2004). Atenuation relations were Boore *et al*. (1997), Campbell (1997) and Sadigh *et al*. (1997). For seismic hazard map of Sumatra and Malaysian Peninsula, Petersen *et al*., (2004) selected Sadig *et el*. (1997) for calculating the ground motions from shallow crustal interplate earthquakes. The Seismic hazard map of Southeast Asia (2008), Petersen *et al*., selected attenuation relations Toro et al. (2005; wt. 0.2), Frankel et al. (1996; wt. 0.1), Atkinson and Boore 140 bar stress drop (2006: wt. 0.1), Atkinson and Boore 200bar stress drop (2006; wt .0.1), Somerville et al. (2001; wt. 0.2), Campbell (2002; wt. 0.1), Tavakoli and Pezeshk (2005; wt. 0.1), and Silva el al. (2005, wt. 0.1) to calculate ground motion from intraplat earthquakes (*wt mean weighting*). Based on study result by Petersen *et al*., and other, above, this study used Sadigh et al., (1997, wt 0.5) and Atkinson and Boor (2006, wt 0.5) to calculate the ground motion for the crustal fault and also to compute seismic hazard and to develop deaggregation map for Indonesia.

***For subduction zone earthquakes* (*interface/intraslab*)**, several ground-motion prediction equations have been developed for the subduction zone earthquakes. Attenuation equations of Youngs et al. (1997) were used in the US National Seismic Hazard Maps (Petersen *et al*., 2004). This attenuation relation was selected by Petersen *et al*., (2004) to develop Sumatran and Malaysian Peninsula hazard map. Petersen *et al*., (2008) used Young *et al*. (1997, wt 0.25), Atkinson and Boor (2003, wt 0.25) and Zhao *et al*. (1997, wt 0.5) to develop Southeast Asia Hazard map. Based on the above study, Young *et al*. (1997, wt 0.5), Atkinson and Boor (2003, wt 0.5) were selected to calculate seismic hazard and develop deaggregation hazard map for Indonesia.

6. HAZARD MAP

Hazard map is needed as a basis to develop deaggregation map. Map of peak ground acceleration is presented here is for hazard level 2% probability of exceedance in 50-year of Indonesia (Figure 5).

7. DEAGGREGATION MAPS

Probabilistic seismic hazard analysis calculates the earthquake threat base on aggregate result from all possible seismic occurrences and ground motion. The nature of such analysis, most likely magnitude and source-to-site distance that will create the largest risk is not clear. As the result the PSHA lack the idea of a single, dominant M-R (magnitude-distance) design earthquake. To make up which earthquakes that contribute most (dominantly) to the hazard in Indonesia, the hazard was deaggregated to account for the sources that contribute at hazard levels of 2% probability of exceedance in 50 years. Deaggregation is a statistical decomposition of a hazard to show the relative contribution by magnitude, distance, and ground motion deviations (McGuire, 2004). Deaggregation calculation is based on the hazard map that is performed in Figure 3. Result of this deaggregation is performed on deaggregation map of Indonesia in Figures 6 and 7.

8. CONCLUSION

The hazard across Indonesian islands is relatively high, it mainly happens in the bigger islands such as Sumatra, Java, Sulawesi and Papua. It is caused the islands proximity to earthquake-generating structures: transform faults and or subduction plate boundary. The

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contour maps of hipocenter distance and magnitude (*deaggregation map*) with PGA period at level hazard 2% probability of excedance in 50 years are considered in this analysis. These may be important to account for artificial time history at a site in the future. The developed map employs an up-to date PSHA methodology and the most recent seismo tectonic input which have been used by experts to develop seismic hazard zonation maps before. The maps can be considered as a pilot because such maps for Indonesian islands have not found yet, especially in Indonesia.

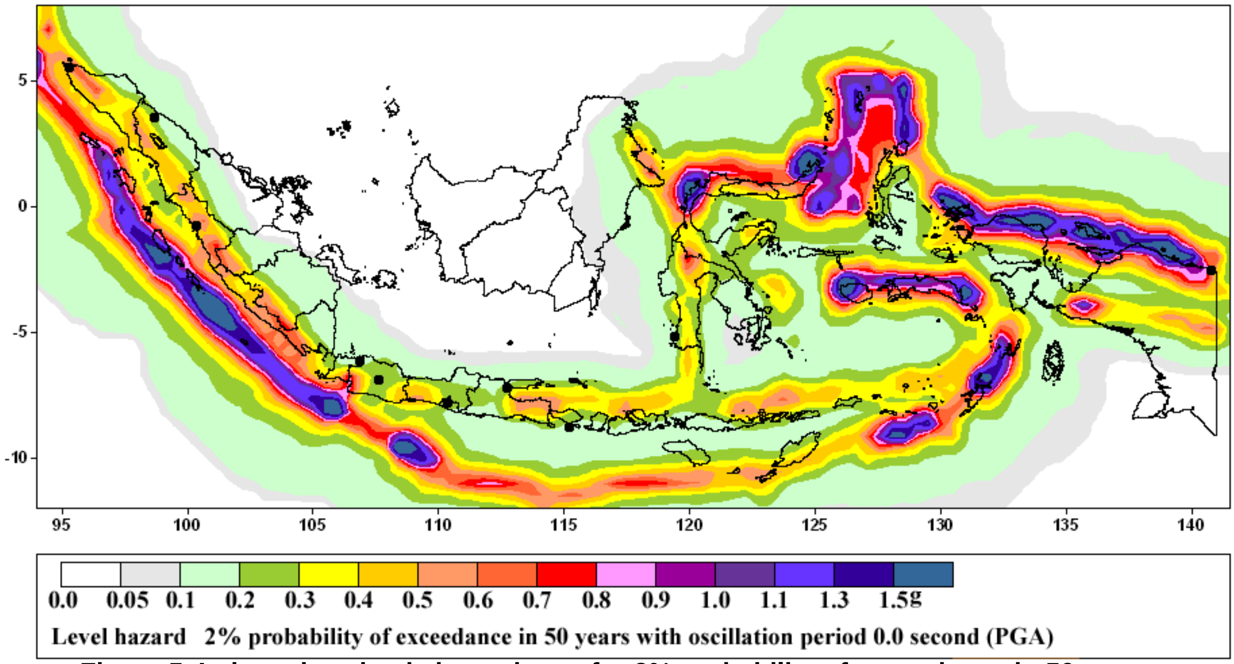

Figure 5. Indonesia seismic hazard map for 2% probability of exceedance in 50 years

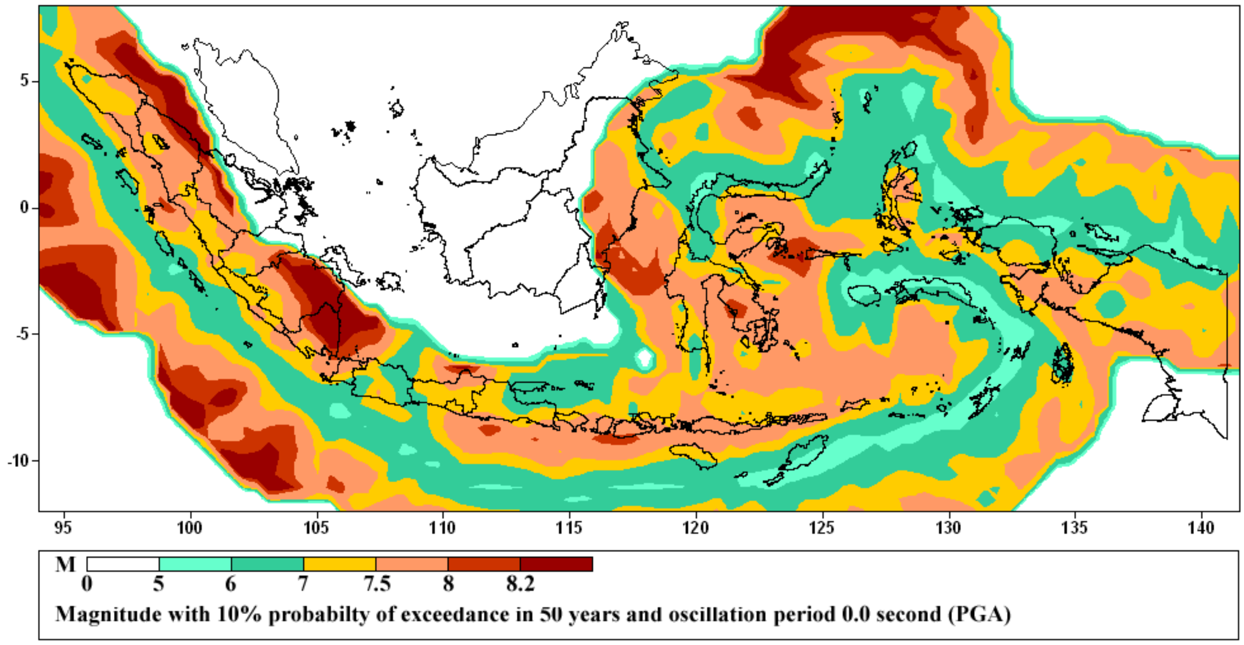

Figure 6. Contour maps of magnitude for 2% probability of exceedance in 50 years

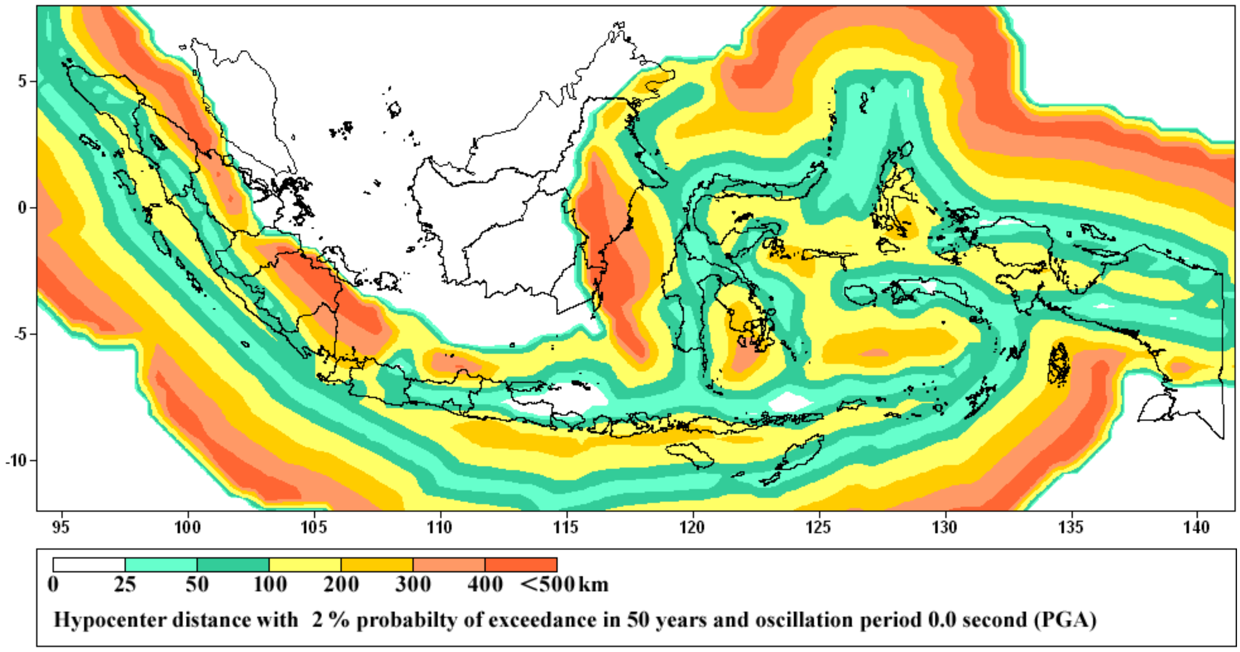

Figure 7. Contour maps of distance for 2% probability of exceedance in 50 years

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COMPARATIVE STUDY OF EOQ AND POQ METHODS IN MATERIALS INVENTORY COST EFFICIENCY – A CASE STUDY IN BLOCK PAVING COMPANY

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ABSTRACT: Construction material company is one of the most important project stakeholders as its provide building material for a construction project. To run the company efficiently, the company manager needs to be effective. Its means that the manager will provide raw materials of his product just in time it needs and could keep low storage cost. For that reason, therefore, the company manager is in dire need of accurate, relevant and efficient information. Information is not only needed for decision-making, but also for planning and controlling. One of the most important information is inventory information. Inventory information will determine the survival of the company due to lack of inventory. Therefore, the company needs inventory control calculation, or excess inventory will have direct impact on the survival of the company. This paper was written based on a research that conducted in concrete material company. The objective of the research is to analyse the inventory of sand material for paving block production. Methods to analyse inventory control and material measures used in this research were Economic Order Quantity (EOQ) and Period Order Quantity (POQ). The case study in this research is in the company of the paving block Merapi Volcanic Materials Innovation Centre - Islamic University of Indonesia (PIMVM - UII). Object of this research is the sand material inventory. The data to be processed is the data of required volume of sand, also the cost of ordering, purchasing and storing of sand material. The result of this research showed the cost of EOQ is Rp. 22.505.098,-, and the cost of POQ is Rp. 44,577,478,-. From the results of these two methods, it can be seen that the difference in the price of sand inventory from EOQ is 49.5% cheaper than POQ. It is because the cost of storage on the POQ greater than EOQ so the costs for materials become more expensive. Thus, the optimal inventory control methods in the production of paving blocks PIMVM-UII is EOQ.

KEYWORDS: Material Inventory, Economic Order Quantity, Period Order Quantity

1. INTRODUCTION

1.1 BACKGROUND

Current construction materials projects, as part of the Indonesian economy in supporting the growth of a wide range of facilities and infrastructure, are required to improve its quality continuously in all respects. One of the most important aspect of the company is inventory. Because in inventory there are an investment in the purchase of materials and storage processes, so the inventory problems have a direct effect on company profits. In the procurement of material that need to be considered is a material inventory control. This case often get over stock material or under stock material. Under stock will result at risk of delay in congestion events. While over stock will result in a load of financing company only concentrated on the storage of raw materials.Based on these things, we need a good inventory management so that the policy of the material inventory / inventory system can be applied to establish and ensure the quality and availability of materials in a timely manner. If the project of construction materials gets an over stock, it will result in some losses, which are a waste of warehousing.In addition to over stock, anunder stock material may result the

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construction projects experienced delays in work activities.The method often used in the management of inventory are Economic Order Quantity (EOQ) and Period Order Quantity (POQ).Both of these methods can minimize the total cost of inventory.Where the method of EOQ ordering is done as needed, while POQ ordering done periodically. The case study in this research is in the company of the paving block; Merapi Volcanic Materials Innovation Centre - Islamic University of Indonesia (PIMVM - UII).Object of this study is sand material supply for the production of paving blocks. The data to be processed are the sand volume requirements are used, the cost of ordering, purchasing and storing the sand material for the production of paving blocks.Expected these methods can be compared, in order to discover which is the most appropriate method to be applied in block paving company PIMVM-UII, so the material needs can always be met with supplies and minimal costs.

1.2 PROBLEM STATEMENT

a. In paving block company PIMVM - UII, how much total sand material inventory costs in the calculation of EOQ and POQ?
b. Among the methods of inventory control EOQ and POQ, which is the most suitable method to ensure the presence of sand material inventory at optimal levels in block paving company PIMVM - UII?

1.3 RESEARCH OBJECTIVES

a. Knowing how much the total cost of sand material inventory on the EOQ and POQ calculation.
b. Knowing the most suitable method among EOQ and POQ to ensure the presence of sand material inventory at optimal levels in block paving company PIMVM - UII.

2. RESEARCH METHODOLOGY

2.1 RESEARCH OBJECT

Research object is the sheer volume of sand needed for production activities, the cost of purchasing, ordering costs and storage costs of sand materials. Needs sand data in the production of paving blocks were obtained took place on January 14, 2013-20 Oktober, 2013.Storage costs are assumed to the interest that has to be incurred to place an order with constant prices during the time control.

2.2 DATA ANALYSIS METHOD

The method used in this study is the Economic Order Quantity (EOQ) and Period Order Quantity (POQ).

2.2.1 Economic Order Quantity (EOQ)

Economic Order Quantity (EOQ) is one of the classic and simple methods in inventory management. The formulation of the EOQ method first discovered by FW Harris in 1915, but this method is often called the Wilson EOQ, because this method was developed by a researcher named Wilson in 1934. This method is used to calculate the total cost of inventory minimization based on the equation level or equlibrium curve point of save costs and message costs (Setiawan, 2014).

EOQ method assumes certain demand with constant reservations and no shortage of supply. Things that must be met in the EOQ method are:

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1. The level of demand is known.
2. Not allowed to run out of inventory.
3. Materials are ordered and produced at one time.
4. The cost of order each unit is constant.
5. Single goods ordered.

Here is a composition of the formula used in calculating the EOQ:

a. Average requirement ($\bar{X}$)

$$\bar{X} = \frac{\sum Xi}{N}$$

b. Standard Deviation (S)

$$S = \sqrt{\frac{(N.\sum Xi^2) - (\sum Xi)^2}{N.(N-1)}}$$

c. Average requirement plan during lead time ($\bar{D}$)

$$\bar{D} = LT \times \bar{X}$$

d. Variance during lead time ($\sigma^2 D$)

$$\sigma^2 D = LT \times S^2$$

e. Standard Deviation during lead time (σD)

$$\sigma D = \sqrt{\sigma^2 D}$$

f. Inventory Buffer (B)

B = K x S x $\sqrt{LT}$

g. Reorder Point (ROP)

$$ROP = B + \bar{D}$$

h. Optimal Order Quantity (Q*)

$$Q^* = \sqrt{\frac{2.C.\sum Xi.N}{H}}$$

i. OrderFrequency (F)

$$F = \frac{\sum Xi}{Q^*}$$

j. Order Time Interval (I)

$$I = \frac{N}{F}$$

k. Total Inventory Cost (TIC)

TIC = total purchasing cost + total order cost + total saving cost

$$TIC \quad = P.\sum Xi + C.F + \frac{P.Q^*}{2}$$

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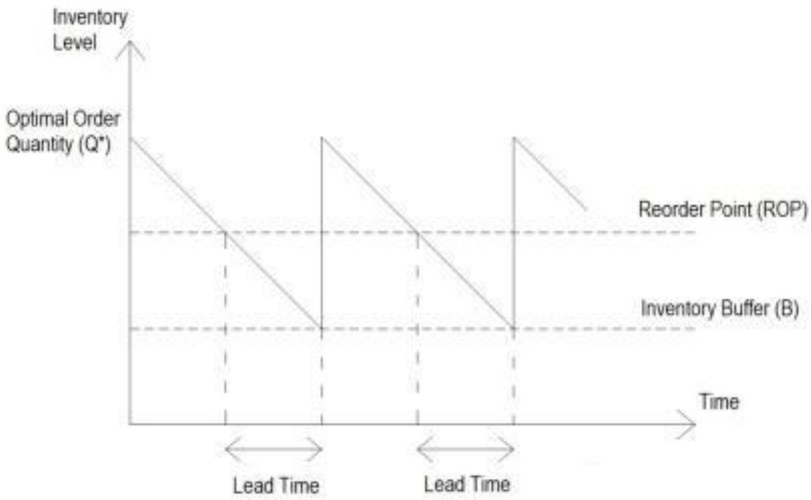

Figure 1. Economic Order Quantity Method

2.2.2 Period Order Quantity (POQ)

Period Order Quantity (POQ) is one of inventory control methodswhich component needs are met by determining the number of demandperiods that must be met (not including zero demand) for each order. This method relates to the EOQ. The number of periods that must be met the needs of its components are obtained by calculating the EOQ divided by the demand on average per period.

Step-by-step formulas of POQ method are as follows:

a. Average requirement ($\bar{X}$)

$$\bar{X} = \frac{\sum Xi}{N}$$

b. Standard Deviation (S)

$$S = \sqrt{\frac{(N.\sum Xi^2) - (\sum Xi)^2}{N.(N-1)}}$$

c. Order Interval Calculation (W)

$$W = \sqrt{\frac{2.C}{H.\bar{X}.5}}$$

d. Minimum Inventory Level Calculation (E)

$$E = \frac{(\bar{X}.5)(W + LT)}{N}$$

e. Number of Order Calculation (Q)

$$Q = R.W$$

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f. Order Frequency (F)

$$F = \frac{R}{Q_{in\ 1\ month}}$$

g. Minimum Cost of Interval Order (W*)

$$W^* = P.R + \frac{C}{W} + \frac{H.R.W}{2}$$

∑Xi : Total of Requirement
N : Duratin
S^2 : Average Plan Variance
LT : Lead Time
K : Constantan
H : Storage Cost during the period
P : Purchase Cost
R : Raw Material Needs during acivities
C : Order Cost

3. RESULT AND DISCUSSION

3.1 THE CALCULATION RESULT OF SAND MATERIAL INVENTORY CONTROL USING EOQ METHOD

a. Average requirement ($\bar{X}$) = 7,96 m^3
b. Standard Deviation (S) = 6,10 m^3
c. Average requirement plan ($\bar{D}$) = 3,98 m^3
  i. Raw material needs during acivities (R) = 318,41 m^3
  ii. Purchase Cost (P) = Rp. 70.000,- / m^3
  iii. Order Cost (C) = Rp. 250,- / order
  iv. Storage Cost (H) = Rp. 28.000,- / m^3 / activity
d. Variance during lead time ($\sigma^2 D$) = 18,58 m^3
e. Standard Deviationduring lead time (σD) = 4,31 m^3
f. Inventory Buffer (B) = 4,31 m^3
g. Reorder Point (ROP) = 8,29 m^3
h. Optimal Order Quantity (Q^*) = 15,08 m^3
i. Order Frequency (F) = 21,11 ≈ 21 times
j. Order Time Interval (I) = 1,9 weeks
k. Total Inventory Cost (TIC) = Rp. 22.505.098,-

Table 1. Result of Sand Material Inventory Control on the Paving Block Production with EOQ Method

No.	Parameters	
1.	Optimal Order Quantity (Q^*)	15,08 m^3
2.	Inventory Buffer (B)	4,31 m^3
3.	Reorder Point (ROP)	8,29 m^3
4.	Lead Time (LT)	3 days
5.	Total Inventory Cost (TIC)	Rp. 22.505.098,-

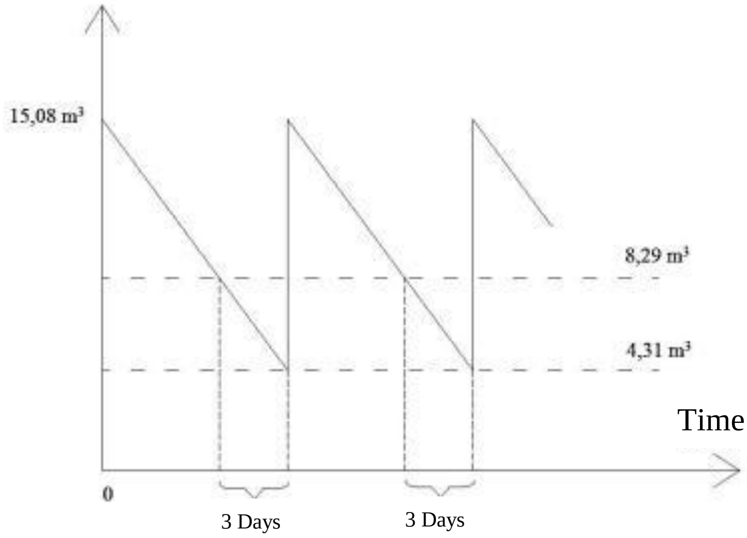

Figure 2. EOQ Graph of PIMVM-UII Sand Material

3.2 THE CALCULATION RESULT OF SAND MATERIAL INVENTORY CONTROL USING POQ METHOD

a. Average requirement ($\bar{X}$)		= 7,96 m^3
b. Standard Deviation (S)		= 6,10 m^3
i. Purchase Cost (P)		= Rp. 70.000,- / m^3
ii. Raw material needs during acivities (R)		= 318,41 m^3
iii. Order Cost (C)		= Rp. 250,- / order
iv. Storage Cost (H)		= Rp. 28.000,- / m^3 / activity
v. Lead Time (LT)	= 3 days	= 0,5 weeks
vi. Effective Working Days		= 243 days
c. Order Interval (W)	= 5,19	≈ 5 days
d. Minimum Inventory Level (E)		= 1,31 m^3
e. Order Quantity (Q)		= 6,74 m^3 (every 5 days)
f. Opltimal Order Quantity (Q*)		= 35,07 m^3 (every month)
g. Order Frequency (F)	= 9,08	≈ 9 times
h. Minimum Cost of Interval Order		= Rp. 44.577.478,-

Table 2. Result of Sand Material Inventory Control on the Paving Block Production with POQ Method

No.	Parameters	
1.	Optimal Order Quantity (Q^*)	35,07 m^3
2.	Minimum Inventory Level (E)	1,31 m^3
3.	Order Frequency (F)	9 times
4.	Lead Time (LT)	3 days
5.	Minimum Cost of Interval Order	Rp. 44.577.478,-

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3.3 SAND MATERIAL NEEDS ANALYSIS

3.3.1 Sand Material Needs and Inventory with EOQ Method

Table 3. Tableof Sand Material Needs and Inventory with EOQ Method

Week	Material Needs	Material Inventory	The Rest	Storage Cost	
1	12,96	17,27	4,31	Rp	2.321
2	6,48	19,39	12,91	Rp	6.952
3	2,38	12,91	10,54	Rp	5.673
4	8,85	25,62	16,77	Rp	9.030
5	6,75	16,77	10,02	Rp	5.396
6	1,09	10,02	8,94	Rp	4.811
7	8,29	24,02	15,73	Rp	8.470
8	1,03	15,73	14,70	Rp	7.916
9	4,27	14,70	10,43	Rp	5.619
10	6,88	25,52	18,64	Rp	10.037
11	5,91	18,64	12,73	Rp	6.853
12	8,53	27,81	19,27	Rp	10.379
13	13,87	19,27	5,41	Rp	2.912
14	3,20	20,49	17,29	Rp	9.309
15	20,90	32,37	11,47	Rp	6.179
16	18,93	26,56	7,62	Rp	4.104
17	16,54	22,70	6,17	Rp	3.321
18	16,35	21,25	4,90	Rp	2.637
19	0,00	19,98	19,98	Rp	10.758
20	6,58	19,98	13,40	Rp	7.213
21	16,41	28,48	12,07	Rp	6.500
22	11,20	27,15	15,95	Rp	8.589
23	14,96	31,03	16,07	Rp	8.653
24	6,56	16,07	9,51	Rp	5.122
25	3,63	9,51	5,89	Rp	3.169
26	1,37	20,97	19,60	Rp	10.551
27	5,12	19,60	14,48	Rp	7.794
28	19,83	29,56	9,73	Rp	5.237
29	17,92	24,81	6,89	Rp	3.708
30	0,00	21,97	21,97	Rp	11.828
31	0,00	21,97	21,97	Rp	11.828
32	6,40	21,97	15,57	Rp	8.382
33	9,60	30,65	21,05	Rp	11.334
34	10,33	21,05	10,72	Rp	5.771
35	6,51	25,80	19,28	Rp	10.383
36	5,98	19,28	13,30	Rp	7.164
37	8,59	13,30	4,71	Rp	2.536
38	1,56	19,79	18,23	Rp	9.815
39	2,67	18,23	15,56	Rp	8.379
40	0,00	15,56	15,56	Rp	8.379

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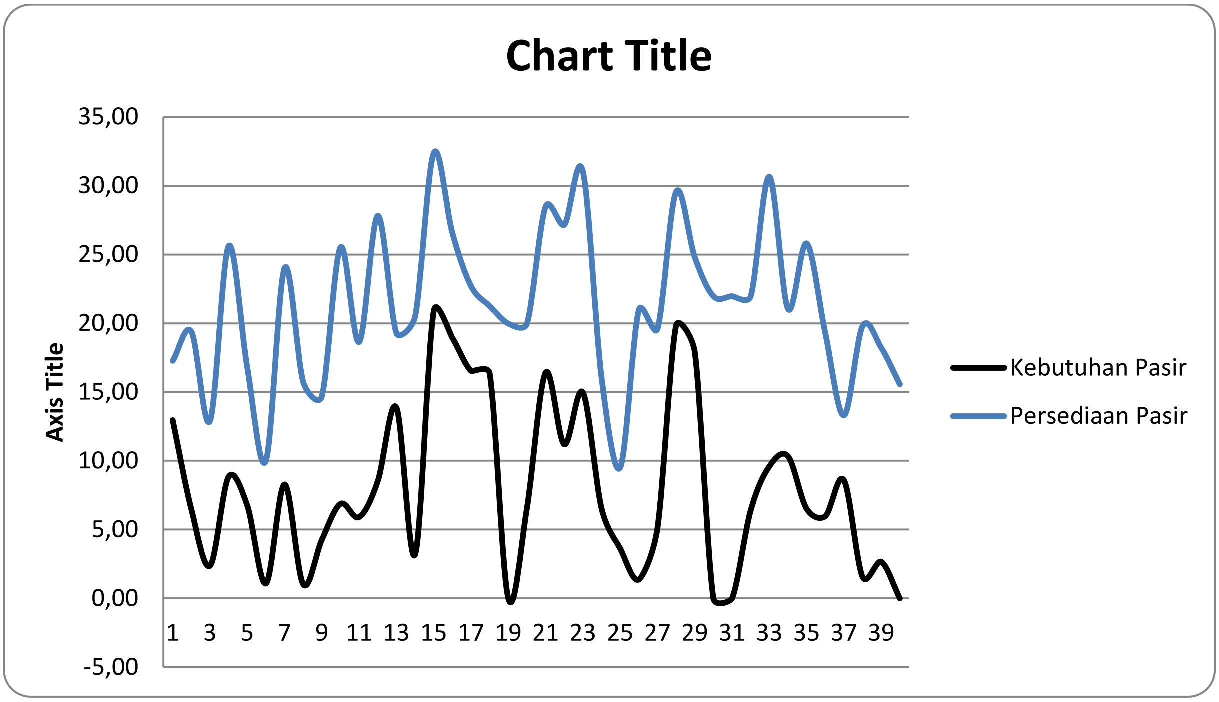

Figure 3. EOQ Graph of Sand Material Needs and Inventory

3.3.2 Sand Material Needs and Inventory with POQ Method

Tabel 4. Table of Sand Material Needs and Inventory with POQ Method

Week	Material Needs	Material Inventory	The Rest	Storage Cost
1	12,96	35,07	22,11	Rp 11.906
2	6,48	22,11	15,63	Rp 8.417
3	2,38	15,63	13,26	Rp 7.138
4	8,85	13,26	4,41	Rp 2.374
5	6,75	39,48	32,73	Rp 17.624
6	1,09	32,73	31,65	Rp 17.040
7	8,29	31,65	23,36	Rp 12.578
8	1,03	23,36	22,33	Rp 12.024
9	4,27	57,40	53,13	Rp 28.611
10	6,88	53,13	46,26	Rp 24.909
11	5,91	46,26	40,35	Rp 21.725
12	8,53	40,35	31,81	Rp 17.130
13	13,87	66,88	53,02	Rp 28.547
14	3,20	53,02	49,82	Rp 26.824
15	20,90	49,82	28,92	Rp 15.573
16	18,93	28,92	9,99	Rp 5.378
17	16,54	45,06	28,52	Rp 15.359
18	16,35	28,52	12,17	Rp 6.555
19	0,00	12,17	12,17	Rp 6.555
20	6,58	12,17	5,59	Rp 3.010
21	16,41	40,66	24,25	Rp 13.060
22	11,20	24,25	13,05	Rp 7.030
23	14,96	48,13	33,16	Rp 17.857
24	6,56	33,16	26,61	Rp 14.326
25	3,63	26,61	22,98	Rp 12.373
26	1,37	22,98	21,61	Rp 11.635
27	5,12	56,68	51,56	Rp 27.762
28	19,83	51,56	31,73	Rp 17.084

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29	17,92	31,73	13,81	Rp	7.435
30	0,00	13,81	13,81	Rp	7.435
31	0,00	48,88	48,88	Rp	26.319
32	6,40	48,88	42,48	Rp	22.873
33	9,60	42,48	32,88	Rp	17.704
34	10,33	32,88	22,55	Rp	12.141
35	6,51	57,62	51,10	Rp	27.517
36	5,98	51,10	45,12	Rp	24.298
37	8,59	45,12	36,53	Rp	19.670
38	1,56	36,53	34,97	Rp	18.828
39	2,67	70,04	67,37	Rp	36.276
40	0,00	67,37	67,37	Rp	36.276

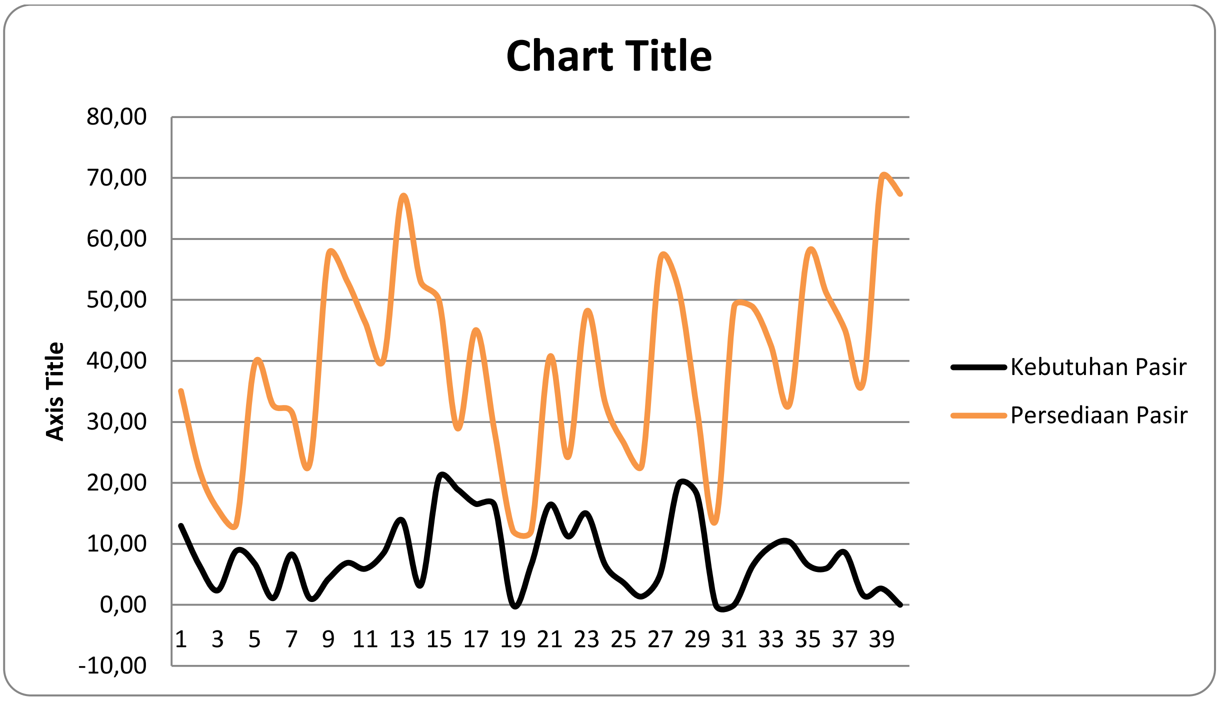

Figure 4. POQ Graph of Sand Material Needs and Material

3.3.3 Comparison of EOQ and POQ Calculation

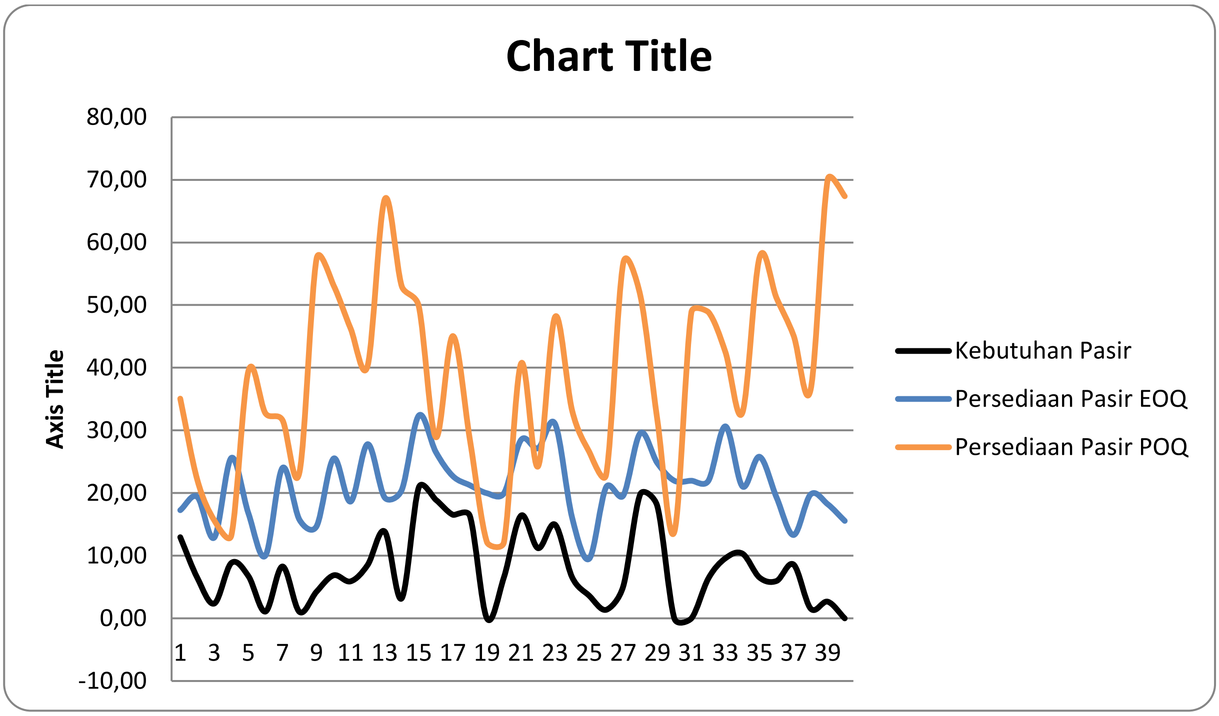

Figure 5. Comparison Graph of EOQ and POQ Calculation

Table 5. Comparison Table of EOQ and POQ Calculation

No.	Parameters	EOQ	POQ
1.	Optimum Order	15,08 m^3	35,07 m^3
2.	Inventory Buffer	4,31 m^3	1,31 m^3
3.	Reorder Point	8,29	-
4.	Order Frequency	21	9
5.	Order Cost	Rp. 5.250,-	Rp. 2.250,-
6.	Storage Cost	Rp. 211.134,-	Rp. 22.286.514,-
7.	Purchase Cost	Rp. 22.288.714,-	Rp. 22.288.714,-
8.	Total Cost	Rp. 22.505.098,-	Rp. 44.577.478,-

From Table 5 it can be seen that the EOQ method makes 21 order and POQ method only makes 9 order. Therefore, the order cost of EOQ higher than POQ. However, because the volume of sand in POQ method which is 35,07 m3 greater than EOQ which is 15,08 m3 thus the storage cost of POQ is greater than EOQ. Since the unit cost of storage is more expensive than unit cost of order, it results in greater cost of POQ than EOQ. From this discussion, the economic method that result in cheaper price is a method that use more order frequency with less volume, which is EOQ.

4. CONCLUSION

Based on calculations using the ordering and controlling method EOQ (Economic Order Quantity) and POQ (Period Order Quantity) of the sand material in the production of paving blocks at Merapi Volcanic Materials Innovation Centre - Islamic University of Indonesia (PIMVM - UII), showed the cost of EOQ is Rp. 22.505.098,-, and the cost of POQ is Rp. 44,577,478,-.From the results of these two methods, the difference in the price of sand on the EOQ is 49.5% cheaper than the POQ. It is because the cost of storage on the POQ

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greater than EOQ so the costs for materials become more expensive.Thus, the optimal inventory control methods in the production of paving blocks PIMVM-UII is EOQ.

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MATERIAL CHARACTERISTIC TESTS ON INNOVATIVE LIGHTWEIGHT BRICKS APPLIED TO EARTHQUAKE RESISTANT BUILDINGS

Wisnu ERLANGGA[1], Mochamad TEGUH[2]

ABSTRACT: Indonesia can be categorized as a vulnerable country in the world to earthquake disaster. Over the past few years, large earthquakes occurred frequently in Indonesia, such as recent earthquakes occurring in Aceh (2004), Yogyakarta (2006) and Padang (2007 & 2009). In general, an earthquake gives a wide impact on the loss of life, property and building damages. More importantly, building damage typically comprises minor, moderate and severe (total collapse) damages. It has been observed that damaged buildings subjected to seismic action are likely affected by low strength of their structural components such as beam-column joint, beam, column, and foundation structures. Another possibility is found on low material quality under the Indonesian Standard (SNI). For future a better design of earthquake resistant building, it is necessary to improve material quality by innovating its materials, composition, and production technique in order to meet all requirements for an earthquake resistant building (SNI 1726-2012). This research proposed an innovation material utilizing lightweight brick wall. In this research, a lightweight brick is made from cement, sand, clay, gypsum, lime, and aluminum pasta. A variety of the lightweight brick composition as well as specimen model was successfully proposed. The result shows that the optimum compressive strength and volume weight of the lightweight brick was innovatively achieved. Utilizing the same composition of mill lime and burn lime produces the compressive strength of 2,904 MPa and 3,312 MPa, and the density of 1,223 gram/cm3 and 1,076 gram/cm3, respectively. The maximum flexural strength was reached up to 0,762 MPa and 0,613 MPa.

KEYWORDS: light weight brick, innovative material, earthquake resistant building

1. BACKGROUND

Indonesia is geologically situated among three major plates in the world, Australian Plate, Eurasian Plate, and Pacific Plate affecting this region is prone to earthquake disaster. A main factor causing the huge number of people deaths during the earthquake was the ruin of walls and other non-structural components. Given this condition, strengthening to structural component of conventional houses is sufficiently provided and non-structural component such as brick wall should be innovated with a variety of material composition to improve its material quality. This material innovation produces better compressive strength of brick wall in withstanding lateral forces against seismic actions. According to Teguh (2014), the brick wall strengthened with reinforced concrete frame provides sufficient earthquake resistance of conventional houses. This will be achievable whenever the brick wall has adequate compressive strength and construction method is likewise improved. In the seismic design of building, it is recommended to utilize lightweight material either for structural or non-structural components so that the gravity load computed from self-weight building components will be significantly reduced. More heavy gravity loads causes more expensive construction cost as a result of required dimension of structural elements. This research aims to propose building material innovation having a variety of material composition applied to earthquake resistant building. In this research, lightweight brick made from different material, composition, and technique was investigated. The experimental test results of compressive strength and volume weight of lightweight brick are then compared with conventional brick as presented in the following sections.

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In this research, lightweight brick material was made from cement, lime, gypsum, sand, and aluminum paste. A variety of the lightweight brick composition as well as specimen model was successfully proposed. Referring to previous researches Marzuki et al. (2007), Nurchasanah et al. (2011), Pahlevi et al. (2013), the use of lime in the composition material might increase compressive strength of lightweight brick. A similar effect occurred in different composition when the gypsum was added. A different composition in order to improve compressive strength and fire resistance has been shown by substituting clay. According to Wulandari (2012), using aluminum paste could decrease brick density, where chemical reaction will occur when aluminum paste mixed with pasta, increasing the number of pores that makes brick become lighter. The purpose of this research is to determine the characteristics of innovative lightweight bricks to classify the compressive strength of brick referring to SNI 03-0349-1989. The results of innovative lightweight bricks are compared considering the thickness difference, compressive strength, and economic value.

2. RESEARCH METHODOLOGY

This research was undertaken a variety material composition to obtain optimum compressive strength of brick. The materials mixture used in this research was consisted of the following materials.

1. Portland cement (PC) type 1 (Gresik Cement product).
2. Mount Merapi sand with 1.2 mm diameter in average.
3. Pulaman Argorejo clay (Sedayu, Bantul). The clay was dried in the oven and was crushed afterward to make dried clay powder.
4. Fresh water or drinking water or water with free of oils, acids, alkalis, and salts as well as organic substances or other materials that can that can damage concrete or steel reinforcement.
5. Other materials: lime, gypsum and aluminum pasta.

There were seven different composition types tested in this research to examine lightweight brick characteristics. The proposed composition of brick mixture used is completely presented in Table 1. In the composition, Portland cement was fixed 30%, whilst the powder of lime, gypsum, and dried clay were varied 5-15%. Merapi sand was specified having a range of 35-45% and water cement ratio was 1.0. Low percentage of aluminum paste was varied from 0.1 to 0.3 of total cement weight.

Table 1. Proposed composition

Composition type	Percentage of total weight					Aluminum pasta (% of total cement weight)	Water cement Ratio (WCR)
	Cement	Lime	Gypsum	Dried clay	Sand		
P1	30	15	5	5	45	0.1	1
P2	30	15	5	5	45	0.2	1
P3	30	15	5	5	45	0.3	1
P4	30	10	10	5	45	0.1	1
P5	30	5	15	5	45	0.1	1
P6	30	15	5	10	40	0.1	1
P7	30	15	5	15	35	0.1	1

Specimen types to measure the brick characteristics were comprised cube-shape and flexural beam with dimension of 15 x 15 x 15 (cm), 40 x 10 x 10 (cm), respectfully. While the typical thickness of brick specimen dimensioned 60 x 10 x 20 (cm), 60 x 9 x 20 (cm), and 60 x 8 x 20 (cm), respectfully. The specimen test was orderly carried out after 28 days achieved.

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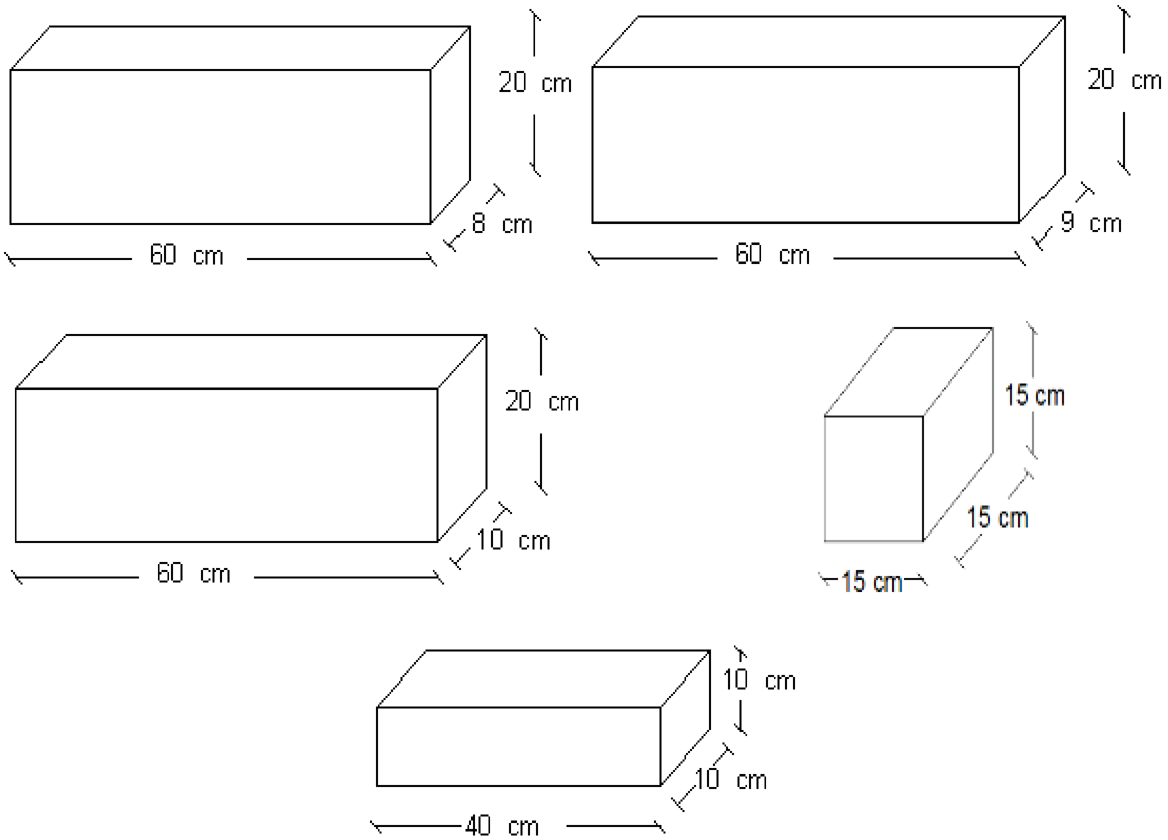


Figure 1. Typical specimens used in this research

3. RESULTS AND DISCUSSION

Each specimen was used to measure different characteristics of bricks such as compressive strength and strain, flexural strength, water absorption, and density. All characteristics of proposed composition are listed in Table 2.

Table 2. Characteristics of proposed composition

Composition type	Compressive strength (MPa)	Compressive strain	Flexural strength (MPa)	Water absorption (%)	Density (g/cm^3)
P1	2.484	0.00363	0.639	34.548	1.225
P2	2.094	0.00673	0.537	39.586	1.144
P3	1.634	0.00951	0.608	44.716	1.105
P4	2.601	0.00438	0.735	36.863	1.259
P5	1.172	0.00420	0.273	43.000	1.143
P6	2.574	0.00520	0.684	34.479	1.224
P7	2.765	0.00550	0.672	35.180	1.223

Table 2 presents increasing and decreasing percentage of materials used in the mixture resulting to the different values of their characteristics. When the percentage of aluminum paste added to the paste mixture (P1, P2, P3) reduced compressive strength and density, but increased compressive strain and water absorption. However, these compositions inconsistently produced flexural strengths. In other words the greater percentage of aluminum paste resulted the lower values of density and compressive strength but the opposite effect to decrease the strain and water absorption was occurred. Addition and subtraction of clay and sand compositions (P1, P6, P7) have inversely different values of their characteristics except compressive strength. To improve higher compressive strength, percentage of the clay should be increased instantly. There were difference with the addition and subtraction of lime and gypsum (P1, P4, P5). Increasing percentage of gypsum produced higher compressive strength to reach maximum point but then it decreased. The values of flexural strength, water absorption and density, however, were not affected by addition and subtraction of lime and gypsum. From the data collection created the optimum composition that could achieve the optimum value of compressive strength. The optimum composition is shown in Table 3 and the characteristics of optimum compositions are depicted in Table 4.

Table 3. Optimum proposed composition

Composition type	Percentage of total weight					Aluminum pasta (% of total cement weight)	Water cement Ratio (WCR)
	Cement	Lime	Gypsum	Dried clay	Sand		
O	30	10	10	15	35	0.1	1

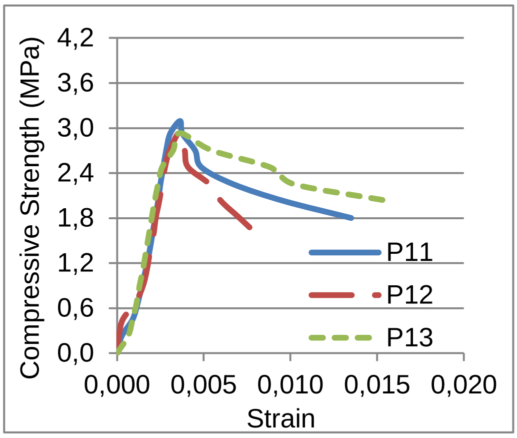
Table 4 presents two kinds of optimum composition resulting a little bit different characteristic values due to the use of mill and burn limes added in the composition types of POA and POB, respectively. It can be summarized that burn lime powder is better material compared to mill lime powder when it was used as filler in the composition to increase the compressive strength of brick. In contrast, adding the mill lime powder in the optimum composition gives higher compressive strain, flexural strength, water absorption and density.

Table 4. Characteristics of optimum composition

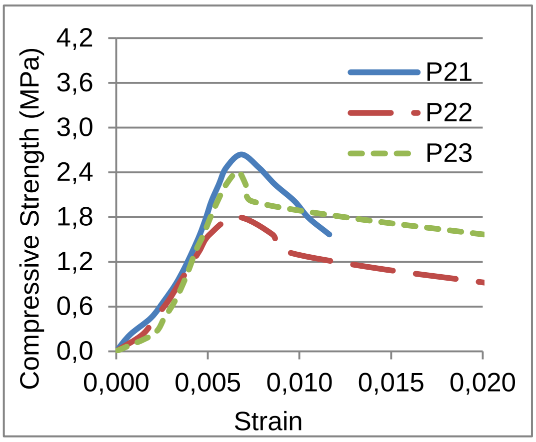
Composition type	Compressive strength (MPa)	Compressive strain	Flexural Strength (MPa)	Water absorption (%)	Density (g/cm^3)
P0A	2.904	0.00577	0.762	37.025	1.223
P0B	3.312	0.00442	0.613	36.310	1.076

Figures 2 and 3 present nine compressive strength and strain relationships showing their different composition types. Higher compressive strengths lower compressive strains are depicted by the compositions P1 and P4, but on the contrarily the lower compressive strengths higher compressive strains are experienced the compositions P2 and P3. Similar condition having variety compositions is briefly shown in Figure 3.

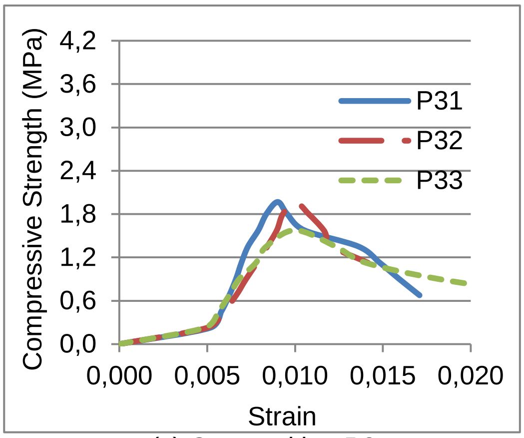
Table 5 completely illustrates a brief product comparison between regular and innovative lightweight bricks. The comparison focuses on some parameters such as typical products, dry density, compressive strength, usefulness, aging, quality level (according to SNI code), advantage, disadvantage, price, and unit weight of masonry. Four variants of brick consisting of innovative brick, ordinary brick, ACC brick (Hebel product), and CLC brick were differently produced based on their material compositions. The proposed innovative bricks, however, are still categorized as quality level IV (lowest quality).



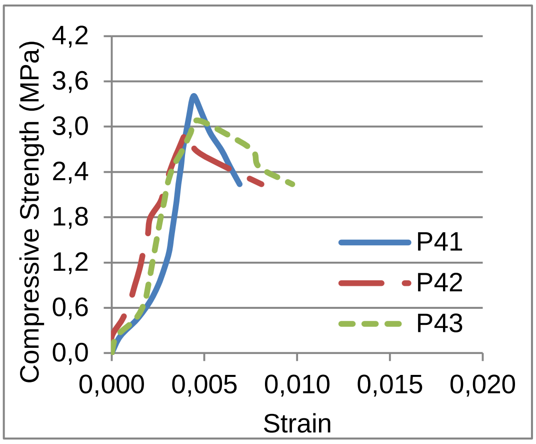
(a) Composition P1



(b) Composition P2



(c) Composition P3



(d) Composition P4

Figure 2. Compressive strength-strain relationships of P1 – P4

It should be noted from Table 5 that the price per square meter for the innovative lightweight brick is higher than ordinary brick, but it is close to ACC and CLC bricks prices. The innovative brick weight is lighter than ordinary brick, but it is still a little bit heavy than other two bricks. The advantages of innovation brick are light, cut able, drilled, nailed, and fast fixing time. Furthermore, the disadvantages of innovative brick are higher absorption, less compressive strength, and expensive price. For this reason, further researches on different material composition as well as material technology should be performed in the future in order to define an innovative lightweight brick precisely with high quality level based on the recent SNI code. More importantly, an innovative lightweight brick should have high compressive strength, but it is lighter and cheep price, so that its product can be applied to masonry walls of the earthquake resistant building. It has been observed that applying lightweight material either for masonry walls or structure elements is the best choice to reduce the gravity load of multi or high-rise buildings being designed. Consequently, the building owner should pay more expensive compared to the ordinary design using normal weight material.

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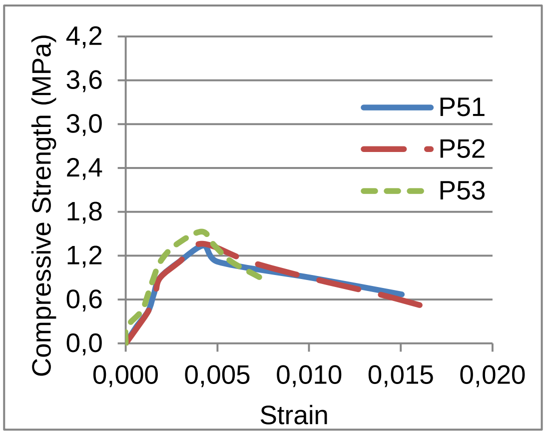
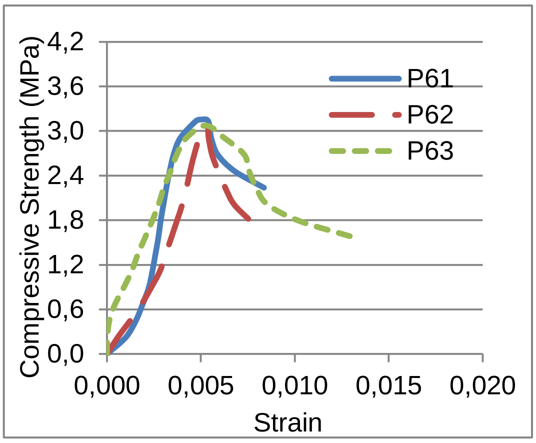
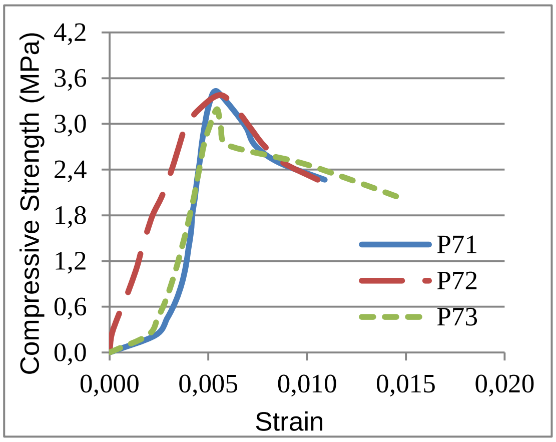


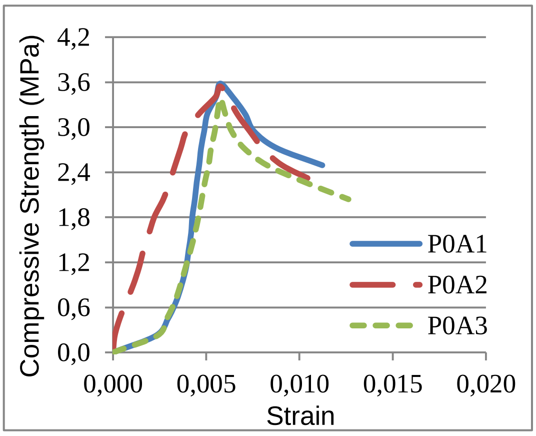
(a) Composition P5



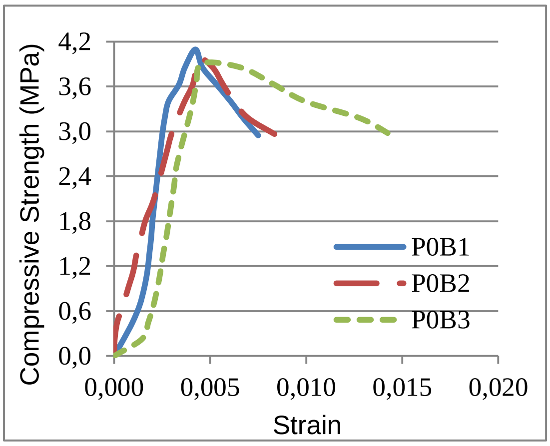
(b) Composition P6



(c) Composition P7



(d) Composition POA



(e) Composition POB

Figure 3. Compressive strength-strain relationships of P5-P7, POA and POB

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Table 5. Product comparison between regular and innovative lightweight bricks

Parameter	Innovative brick		Regular brick	ACC brick (Hebel product)		CLC brick (foam)		
Dry density (kg/m^3)	1223	1076	1500-1700	650	750	400-600	800-1000	1200-1800
Compressive Strength (kg/cm^2)	29.04	33.12	25 – 250 (SII-0021, 1978)	40	40	10-15	25-35	60-250
Usefulness	Non-structural wall protected from weather		General	Non-block load	Strengthened with panel	Isolation	Partition non-load	Load bearing
Aging	The older the stronger		None	None		The older the stronger		
Quality level	IV		I – I V	III	III	-	IV	I
Advantage	Lightweight, cut able, nailed, drilled, faster fixing time		Small size, easy mobilization, can be done by anyone, cheap	Uniform size and quality, light, faster fixing, cut able, nailed, and drilled		Uniform size and quality, light, faster fixing, cut able, nailed, and drilled		
Disadvantage	More water absorption, low compressive strength, expensive.		Difficult to make a neat masonry, absorbing temperature, heavy, longer installation time	Need skilled worker to avoid non-vertical masonry, special adhesive, expensive, and impermeable		Need skilled worker to avoid non-vertical masonry, special adhesive, expensive, and impermeable		
Price/1 m^2 (Rp.)	123.916	129.603	58.75	119.860		94.360		
Price /1 m^3 (Rp.)	1.118.605	1.174.134	812.500	1.079.000		830.000		
Unit weight (kg/m^2)	151.94	137.24	250	94.64	104.64	69.64-89.64	109.64-129.64	149.64-209.64

4. CONCLUDING REMARKS

Complete description for the experimental results have been briefly cited and based on the results, the concluding remarks can be drawn as follows.

a. Optimum compressive strength was achieved with optimum composition made from 30% cement, 15% clay, 35% sand, 10% lime, 10% gypsum and 0.1% aluminum paste of cement weight.
b. The optimum values of compressive strength are 2,904 MPa for optimum composition using mill lime and 3,312 MPa for optimum composition using burn lime. Based on SNI 03-0349-1989, the proposed innovative lightweight brick is classified into quality level IV (or class IV).
c. The difference thickness of innovative lightweight brick does not affect to compressive strength.
d. The cost per square meters for brick walls having different thicknesses of innovative lightweight brick is still expensive.
e. In the earthquake resistant building design, lightweight materials are preferable to reduce gravity load of the building.

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RISK MANAGEMENT APPLIED IN CONSTRUCTION PROJECT

Tuti SUMARNINGSIH[1]

ABSTRACT: Construction projects are very complex, which risks may arise from a variety of sources. During the execution of the construction project, decisions must be taken to anticipate the risks and uncertainty conditions. Construction projects often experience delays in completion time and cost overruns due to various unexpected reasons.This makes the implementation of risk management in construction projects becomes very important. Risk management is carried out through the phase of risk identification, measurement and evaluation of risk, and risk response. Risk identification is performed to determine the sources of risk. Risk measurement is performed to determine the probability and severity of risk, risk evaluation conducted to better understand of the characteristics of the risk. Risk response to avoid the loss is done by various means : risk avoidance, risk retention, risk diversification, risk transfer, and risk control. There are two types of risks faced by the construction project, which is a pure risk (which always results in a loss) and speculative risk (which may be harmful or beneficial). Pure risk cover occupational accident, property damage, and litigation. There are various type of speculative risk, one of them that has strong impact is monetary policy and global trade. Failure in manage risk will result in poor performance on a construction project, can even result in huge losses. Risks faced by construction projects in Indonesia is specific. Indonesia is located on top of a fault with many volcanoes and oceans, causing Indonesia face the risk of natural disasters such as earthquakes, floods, tsunamis, landslides, and volcanic eruptions. Natural disasters can instantly destroy construction projects, causing huge losses not only in the form of property (buildings, roads, water dams, and other vital installations), but also human lives.

KEYWORDS: construction project, losses, risk, uncertainty condition.

1. INTRODUCTION

Risk management is the process of identification, analysis and either acceptance or mitigation of uncertainty in investment decision-making. Essentially, risk management occurs anytime an investor or fund manager analyzes and attempts to quantify the potential for losses in an investment and then takes the appropriate action (or inaction) given their investment objectives and risk tolerance. Inadequate risk management can result in severe consequences for companies as well as individuals (Investopedia, 2014).

There are two types of risk : pure risk and speculative risk. Pure risk is the risk that inevitably lead to the loss, such as work accidents, fires, and natural disasters (earthquakes, volcanic eruptions, floods, tsunamis). The speculative risk is the risk that may result in the loss but may also be profitable. Speculative risks occurs on business activity (Hanafi, 2012).

Risk is also differentiated between static risk and dynamic risk. Static risk is the risk that arises from certain equilibrium conditions. Characteristics of static risk is do not change over time. Dynamic risk arises from conditions changes, such as changes in community conditions and changes in technology. Risk can be both subjective and objective. Objective risk is the risk that is based on the observation of objective parameters, whereas a subjective risk associated with a person's perception of risk.

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Risk management is carried out through these phases :

- risk identification,
- risk measurement and risk evaluation
- risk response

Risk identification is performed to determine the sources of risk. This phase is very important, because without knowing the risks well, it would be difficult to manage these risks. Risk identification can be done through brainstorming, risk checklist, interviewing experts, making models and perform analyzes for various scenarios.

Risk measurement is performed to determine the probability and severity of risk, risk evaluation conducted to better understand of the characteristics of the risk. After the risks have been identified, they must be evaluated in terms of the probability of occurrence and impact. An understanding of the possible effects on project objectives is needed, since most projects have only a limited amount of resources to use for risk management, concentration on only the major risks is essential (Klemetti, 2006).

Risk response is done by various means to avoid the loss. There are several ways of risk response : risk avoidance, risk retention, risk diversification, risk transfer, and risk control. Klemetti (2006) suggests four ways to cope with risk :

- Avoid : change in project plans in a way that an identified risk is no longer relevant
- Transfer : transfer risks to other parties by contracts or insurances
- Mitigate : find ways to reduce the probability and/or impact of risk
- Accept : take a concious riks and deal with negative consequences as they occur, but take no action beforehand.

Enterprise risk management consists of two elements, (1) infrastructure consisting of soft and hard infrastructure, and (2) the risk management process. There are two issues related to software infrastructure, that is developing culture of risk awareness and management support. The purpose of build risk awareness culture is that every member of the organization /company considers aspects of risk in every decision taken. Top management support is realized through the approval of the vision, mission, procedures, and policies related to risk management. Top management support is also demonstrated by pay participation in implementation of risk management programs.

The risk management process consists of three steps: planning, implementation, and control. The risk management plan is to set the vision, mission, and purpose of risk management applications. The operational implementation is execute programs related to risk management. Control of risk management includes periodic evaluation of the implementation of risk management, reporting, and feedback.

2. RISK MANAGEMENT IN CONSTRUCTION PROJECT

The construction industry is one of the industries that face the highest risk level. Risks faced by a construction project has been around since the beginning of the project until the project ends, even at an early stage before the start of the project. The construction industry is also a highly competitive business with a high degree of likelihood to go bankrupt if not managed properly.

All building and construction projects have risks. Most of the risk insurable (eg workers, damage to property), but others do not. This is because each construction project is on a different situation in terms of size, financing, and contracting expertise, making it difficult for

insurance agencies to calculate risk accurately. This condition makes the application of risk management in construction projects are very important (Browne, 2014).
In the construction project risk management is a method that systematically manage the risks that may occur during the execution of the project, so that the risks can be identified, quantified, modeled, managed, and monitored. Project construction is inherently risky. The risk mitigation methods can be applied to project cost, schedule, quality/performance, safety, and business operations. Good risk management procedures allow the introduction of corrective actions, monetary contingency, and schedule float in order to minimize looses to the project and increase the likelihood of the project being completed on schedule and within budget (Cullen, 2012).

By implementing risk management in construction projects, it can be detected problems and opportunities that will arise, so that capital and all efforts can be focused on the design and construction phase to reduce vurnerability, insurance costs, business interruption or mission, and claims. Risk management applied in construction project is a step forward from the traditional approach, which the immediate (and typically expensive) response is given after the problem has occurred, which may be able to reduce the impact on the project but can not prevent the project from losses. The implementation of risk management allow the project team get experience and lessons learned, therefore they can manage their projects better in the future.

Some of the risks inherent in construction projects are (Cullen, 2012): schedule risk, cost risk, risk of technical obsolescence, dependencies between a new project and other projects, and physical events beyond direct control. Baloi and Price (2003) make categories of risk in construction projects into two groups: the general risks and risk impacts.

Table 1. Typical Construction Risk Categorisation (Baloi and Price, 2003)

Technical	Social
Construction	Economic
Legal	Financial
Natural	Commercial
logistic	Political

Table 2. Construction Risk Categorisation by Impact (Baloi and Price, 2003)

Dynamic vs static
Corporate vs individual
Internal vs external
Positive vs negative
Acceptable vs unacceptable
Insurable vs non-insurable

Other categories expressed by Mills (2001) who distinguish risk in construction projects into three : weather, labor productivity and the quality of the material. Especially weather and labor productivity can not be easily controlled or predicted by the contractor prior to the implementation of the project.

Cohen and Palmer (2004) states that risk on construction projects can be determined at the stage of feasibility studies and project planning, but the impact can only be known after the project began. Cohen and Palmer (2004) says there are 6 sources of risk construction projects as shown in Table 3.

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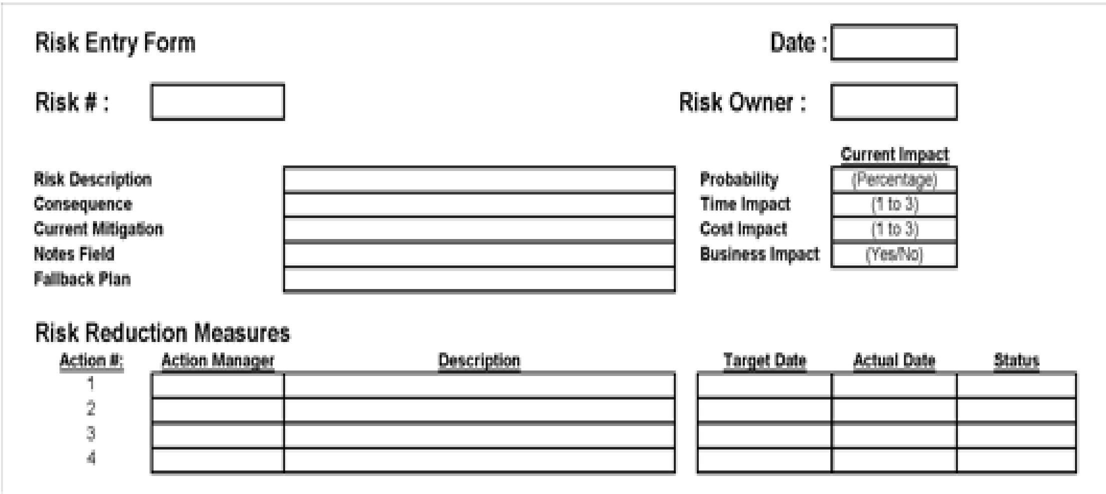
Table 3. Typical Risk Sources in Construction Projects (Cohen and Palmer, 2004)

Changes in project scope and requirements
Desaign errors and omissions
Inadequate defined roles and responsibilities
Insufficient skilled staff
Force majeure
New technology

There are several strategies to manage risk, avoiding the risk by eliminating sources of risk, transferring the risk to another party through insurance agencies, or anticipate the impact of risk with certain ways. Accept the risk should not be done except the risks can not be addressed by other means. The mitigation steps must be appropriate, cost effective, and achievable (Klemetti, 2006).

The risk assessment sheet (RAS), or Risk Entry Form, is the appropriate place to record all known information about the risk, is shown in Figure 1.



Risk Entry Form

Date :

Risk # :

Risk Owner :

Risk Description
Consequence
Current Mitigation
Notes Field
Fallback Plan

	Current Impact
Probability	(Percentage)
Time Impact	(1 to 3)
Cost Impact	(1 to 3)
Business Impact	(Yes/No)

Risk Reduction Measures

Action #:	Action Manager	Description	Target Date	Actual Date	Status
1					
2					
3					
4					

Figure 1. Sample Risk Assessment with Action Items (Cullen, 2012)

Risks in construction projects are generally resolved based on experience, assumptions, and judgment. Since the risks are highly situation specific, an expert assessment provides sufficient means of risk management. The problem is, the knowledge and experience of experts is often not documented. Other risks that have similarities there are likely to be resolved in a way that is not right by others who do not has sufficient knowledge.

3. RISK MANAGEMENT IN CONSTRUCTION PROJECT IN INDONESIA

Delays in completion of the project is one of the risks faced by construction projects in Indonesia. Odeh and Battaineh (2002) stated seven significant causes of delays in construction projects in Far-East : owner interference, inadequate contractor experience, financing and payments, labour productivity, slow decision making, improper planing and subcontractor. Experience and capability of project participants have the most effect on these causes of delays.

Risks faced by construction projects in Indonesia is specific, related to the contractor's conditions, political conditions, economic conditions, and geographical conditions. Indonesia is located on top of a fault with many volcanoes and oceans. This condition causing Indonesia face the risk of natural disasters such as earthquakes, floods, tsunamis, landslides, and volcanic eruptions. Natural disasters can instantly destroy construction projects, causing huge losses not only in the form of property (buildings, roads, water dams, and other vital installations), but also human lives.

To anticipate the occurrence of natural disasters, territory arrangement must meet the provisions of Law No. 26 Year 2007 (Undang-undang Nomor 26 Tahun 2007) about Spatial Planning (Penataan Ruang) and the Minister of Settlement and Regional Infrastructure (Keputusan Menteri Permukiman dan Wilayah) No. 327 / KPTSM / M / 2002 about the Determination of Six Guidelines of Spatial Division (Penetapan Enam Pedoman Bidang Penataan Ruang). To apply the risk management of natural disasters in the region of the arrangement, to do an analysis of some of the following (Widiati, 2008):

a. Analysis of zones that include disaster-prone areas, disaster-prone areas, and the area of disaster risk.
b. Analysis of the plan protected areas, cultivated areas, and certain areas to determine the natural disaster risk management accordingly.
c. Analysis of the transportation system plan, the system kom, unication, and system utilities/facilities especially relating to evacuation and communication lines.
d. Consideration of the various technologies available in relation to the prevention and management of natural disasters.

4. CONCLUSION

Risks that may occur in construction projects affect a very large loss, not only the cost of the project, but also non-material loss, so it must be well managed risk management. Construction projects involve many stakeholders, risks and uncertainties can be sourced from all parties involved. Application of risk management should be implemented and the responsibility of each party involved to avoid disputes and claims.

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TECHNO ECONOMIC EVALUATION OF CONCRETE BLOCK MINI PLANTS FOR PEOPLE IN THE VICINITY OF MERAPI MOUNT

Setya WINARNO[1], SUHARYATMA[2], and Jaka SRIYANA[3]

ABSTRACT: Recently, many local people in the vicinity of Merapi mount have utilized volcanic sand for mass production of concrete blocks in order to get additional income.Initial investigation has shown that their products are low in quality. On the other hand, the demand for good quality of concrete blocks is increasing in Yogyakarta, the biggest and closest city near Merapi mount.This paper presents techno economic evaluation for those people who have begun new bussines on concrete block production to supply the current customer interest.The method of this research was to investigate a techno economic evaluation through laboratory test and interview. Physical laboratory test on 20 concrete blocks made by local people has revealed that the compression strength is only 19.4 kg/cm^2 in average which was lower than the minimum Indonesian standard of 25 kg/cm^2. Through repeat testing and trial in laboratory, to achieve the standard specifications, the concrete mix design of water cement ratio should not be more than 0.64 by weight basis. The proportion of sand as aggregate content for making good concrete block should not be more than 9 parts to 1 part by volume of Portland cement.During the laboratory test, production cost of the concrete block was also considered. The basic price was Rp 1,820 for each concrete block with 10 cm thick, 19 cm height, and 38 cm length. In addition, an investigation has shown that Rp 2,000 as a normal market price is relatively competitive for this opportunity. The strategies to win the competitive market on mass production of concrete blocks are focus in quality, building relationships with consumer, rapid respond to customer need, continuous innovation by product diversification, promotion in social media, and strict financial management.

KEYWORDS: concrete block, good quality, and techno economic evaluation

1. INTRODUCTION

Dramatic eruption of Merapi Mount accured on early morning November 5th 2010. There were up to 140 million cubic meters of volcanic materials down its slopes, spewing in all directions and creating a new historical record. The last biggest eruption in 1872 was reported to have blasted out 100 million cubic meters of volcanic material (Wahyuni, 2010). All the 12 rivers originating from Merapi were burdened with volcanic material as far as 15 kilometers from the peak of the volcano. Volcanic material along the Gendol river is estimated to be the greatest in volume compared to the other 11 rivers that originate in Merapi. Almost all of the existing sabo dams along the rivers are no longer able to accommodate the volume of volcanic material that exceeds the capacity (Susanto, 2010). The majority of volcanic material is sand.

Currently, many local people are getting benefit by utilizing the volcanic sand for mass production of cement based construction material such as concrete blocks and paving, in order to get additional income. They have been able to afford a small concrete machine from donors during reconstruction dan rehabilitation stages after Merapi eruption disaster in 2010. This effort is due to the growing public awareness of the advantages of the product coupled with increase in the government and financial support for permanent housing after the disaster. Increasing need for housing as a basic human necessity would ensure and accelerate a healthy growth in the concrete block demand. For example: the increasing

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demand for housing which is 12.3% per year in Yogyakarta and surrounding areas is closely related to the growing number of concrete block production of 14.1% in sorrounding Merapi mount area.

Recent surveys have discovered that there were about 12 new mini plants of concrete blocks in Cangkringan District area. In average, one person has been able to make about 250 pieces of concrete blocks in a single day, although the quality of their concrete blocks is still questionable.

Yogyakarta District is the biggest and closest city from Merapi mount. Many property bussinesses are growing fast here and need good quality of concrete blocks for their activities. In fact, property actors are reluctant to use concrete block produced by local people in Merapi because of their low quality and bad delivery management. Good quality of concrete blocks can be purchased from big companies that have established and experienced for more than 20 years; although the current purchase in the established companies needs long queue as many people intend to get their good quality of concrete blocks.

Based on the explanation above, there are huge volcanic sand spewed by Merapi mount and local people start utilizing the sand by producing concrete blocks in order to get additional income. Because of low quality of concrete blocks and less capacity, local people were not able to seize the increasing demand for good quality concrete blocks (similar with Norman, 2008). Therefore, this paper presents techno economic strategies for those people who have begun new activities on concrete block production to supply the current customer interest with high quality construction materials.

2. METHODOLOGY

This study embraced both physical laboratory test and economic evaluation analysis. The methodology involved a triangulated quantitative and qualitative approach. Data collection involved a laboratory test together with a detailed structured interview of economic aspects. Physical laboratory examined 20 concrete blocks made by common local people. The Indonesian standard of concrete block for wall construction which was considered is SNI 03-0349-1989. Through repeat testing and trial in laboratory, the need of cement water ratio for this mix was formulated to fulfill the minimum strength standard of concrete blocks. According to the economic evaluation, interview with 31 local people has been done to get an average production cost. The production cost then was compared to competitive market price which was interviewed to 35 respondents from common construction actors. Based on the previous interviewes, the strategies to win the competitive market on mass production of concrete blocks were also expressed. The qualitative data was processed using NVivo software to code prominent patterns in the views and opinions of the respondents. Using these methods, trends in the quantitative and qualitative data could be established and integrated to highlight the rudiments central to answering the questions posed by the objectives.

3. CONCRETE BLOCK

Currently, concrete blocks are modern construction materials and primarily usd as a building material in the construction of walls. It is sometimes called a concrete masonry unit.The blocks are also alternative to burnt clay bricks. As construction industry is growing fast, the demand for concrete block for residential, commercial, and industrial building construction is always high. People tend to use the concrete blocks by virtue of their good durability, small dead load, and high speed of construction. Concrete blocks being usually larger in size than

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the normal clay building bricks and less mortar and plastering are required, faster of construction is achieved.

In general, concrete block is made of a mixture of ordinary Portland cement, coarse sand, and water. The water used in preparing the concrete combines with the cement to form cement paste. Cement paste fills gap and cavities among sand and also lubricates the sand to form a plastic and workable mass. Cement paste and sand then shape a hardened concrete. The water that combines with the cement usually puts together in term of water cement ratio by weight basis. The ratio for concrete blocks varies from about 0.55 to 0.70.

Coarse sand which is used for concrete block is normally 90% passing through the No.4 or 4.7 mm SI Standart sieve. The maximum size of the coarse sand that may be used in cement concrete blocks is 12.5 mm. However, the particle size of the coarse aggregate should not exceed one third thickness of the thinnest web of the blocks.

Ordinary Portland cement is the cementing material used in cement concrete blocks. Cement constitutes the highest priced material per unit weight of the concrete. Hence, the cement, coarse sand, and water are combined in such proportions that the resulting concrete is workable and has minimum cement content for the desired quality.

The process of manufacture of cement concrete blocks involves the following 6 stages: proportioning, mixing, pouring, compacting, curing, and delivering to conctruction work (Jaymowa, 2011).

(1) Proportioning
The determination of suitable amounts of raw materials needed to produce concrete of desired quality under given conditions of mixing, placing, and curing is known as proportioning. As per Indonesian Standard specifications, the combined aggregate content in the concrete mix used for making blocks is not yet determined. The standard focuses only on the compression strength and water absorbtion. However, there have been instances of employing a lean mix of as high as 1:9 by manufacturers. The water cement ratio of 0.60 – 0.70 by weight basis can be used for concrete hollow blocks.

(2) Mixing
When the overall raw materials are ready to thorough mixing, the use of concrete mixer is compulsory for making homogenous fresh concrete. The cement-water paste completely covers the surface of the coarse sand and fills cavities among sand. All the raw materials including water are collected in a concrete mixer, which is rotated for about 1 ½ minutes. The prepared mix is discharged from the mixer and ready to be poured into metallic mould within 30 minutes.

(3) Pouring
The fresh concrete is then poured into metallic mould. The mould is already assembled with a vibrating machine. Thorough vibration during pouring is a part to achieve compacted cement concrete blocks.

(4) Compacting
The purpose of compacting is to fill all air cavities with fresh concrete as a whole. The mechanism for compaction is through action of vibration together with the weight of metallic stripper head. As usual in Indonesia, the machine consists of a vibrating unit, a lever operated up and down metallic mould box, and a stripper head contained in a frame work.

Wooden pallet is kept on the vibrating platform of the machine. The mould box is lowered on to the pallet. Concrete mix is poured into the mould and evenly levelled. The motorised vibrating causes the concrete to settle down the mould by approximately 3 cm. More of concrete is then raked across the mould level. The stripper head is placed over the mould to bear on the levelled material. Vibration causes the concrete come down to its limit position. Then the mould box is lifted by the lever. The moulded blocks resting on the pallet is removed and a new pallet is placed and the process repeated. The machine can accommodate interchangeable mould for producing blocks of different sizes of blocks.

(5) Curing
Blocks removed from the mould are protected until they are sufficiently hardened to permit handling without damage. This may take about 24 hours in a shelter away from sunshine and rain, also other disturbance. The blocks thus hardened are taken out from wooden pallet and stacked in stocking pile in a curing yard to permit complete chemical reaction between cement and water in order to form hardened concrete for at least seven days to achieve desired degree of dryness. During curing time, the blocks are moistured by pouring water two times a day. The greatest strength benefits occur during the first three days and the blocks are ready to deliver securely to users at least seven days. The longer the curing time permitted the better the product.

(6) Delivering to Construction Work
After seven days curing time, the blocks are ready to deliver to the construction work. As the chemical process between cement and water is not yet complete before the first 28 days, it is therefore essential that the blocks should be allowed to dry out gradually in shade before they are used in the construction work.

4. QUALITY SPECIFICATIONS

SNI 03-0349-1989: Indonesian Standard: “Concrete Block for Wall Construction” specifies requirements for these parameters: dimensions, grades of blocks, compressive strength, and water absorption. Table 1 describes solid and hollow concrete block for their compressive strength and water absorbtion. In this paper, the desired quality for solid concrete block is Quality Grade IV with 25 kg/cm^2 in compressive strength

Table 1. Physical requirements for concrete blocks (SNI 03-0349-1989)

Components	Unit	Quality Grade For Solid Block				Quality Grade For Hollow Block			
		I	II	III	IV	I	II	III	IV
Minimum average compressive strength	kg/cm^2	100	70	40	25	70	50	35	20
Mininum compressive strength per piece	kg/cm^2	90	65	35	21	65	45	30	17
Maximum average water absorbtion	%	25	35	-	-	25	35	-	-

5. ECONOMIC FEASIBILITY STUDY

A feasibility study’s main goal is to assess the economic viability of the proposed business of concrete block mini plant that many people in the vicinity of Merapi mount begins this business. The feasibility study will answer the question: “Does the idea make economic sense?” The study provides a thorough analysis of the business opportunity based on comparison between basic production cost and the market price. The outcome of the feasibility study will indicate whether or not to proceed with the proposed venture. If the results of the feasibility study are positive, then the cooperative can proceed to develop a business plan.

If the results show that the project is not a sound business idea, then the project should not be pursued. Although it is difficult to accept a feasibility study that shows these results, it is much better to find this out sooner rather than later, when more time and money would have been invested and lost.

Myers et.al. (1998) mentions that it is tempting to overlook the need for a feasibility study. Often, the steering committee may face resistance from potential members on the need to do a feasibility study. Many people will feel that they know the proposed venture is a good idea, so why carry out a costly study just to prove what they already know? The feasibility study is important because it forces the people to put its ideas on paper and to assess whether or not those ideas are realistic. It also forces the people to begin formally evaluating which steps to take next.

6. STRATEGIES TO WIN COMPETITIVE MARKET

Today, the objective of new business needs to redesign for striving to meet customer interest and expectations at all times with quality deliverables and improvise to exceed expectations. As consumers become increasingly bombarded with rapid information, messages, images, and ads, new business actors are increasingly challenged to break through the evergrowing clutter, get noticed and received positively. They can use new tactics and channels like widgets and social networks to reach out and build relationships with consumers in an efficient, effective, and less-cluttered way. In order to win competitive market, some above ideas and strategies need to be elaborated further for a sound business in cement concrete blocks.

7. RESULTS

There were 5 concrete block mini plants in Dongkelsari and Plosokerep villages (near Merapi) in which the samples were taken. The type of samples are solid concrete blocks. Table 2 mentions the laboratory result test of compressive strength for 20 samples.

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Table 2. The compressive strength of solid concrete block samples

Producers	#Sample	Compressive strength (kg/cm^2)	Average (kg/cm^2)	Standard deviation (kg/cm^2)
Pak Amin	1	20.1		
	2	17.2		
	3	14.2		
	4	20.2		
Pak Waluyo	5	19.5		
	6	20.5		
	7	21.5		
	8	22.2		
Pak Narto	9	19.6		
	10	19.5		
	11	20.3	19.4	0.95 (about 5% of average)
	12	18.7		
Pak Wahyu	13	19.2		
	14	20.4		
	15	19.2		
	16	16.9		
Pak Gunarso	17	16.9		
	18	19.3		
	19	21.5		
	20	20.2		

Based on Table 2, 20 concrete blocks made by local people has indicated that the compression strength is only 19.4 kg/cm^2 in average which was lower than the minimum Indonesian standard of 25 kg/cm^2 for Grade IV (Table 1). This quality is not good enough to enter the competitive market as current consumers need a good quality of construction material.

In order to improve the quality, sand as raw material from the plant was tested in laboratory to determine sand gradation zone. Figure 1 presents that the sand used by Merapi people is categorised to Zone II as not fully coarse sand.

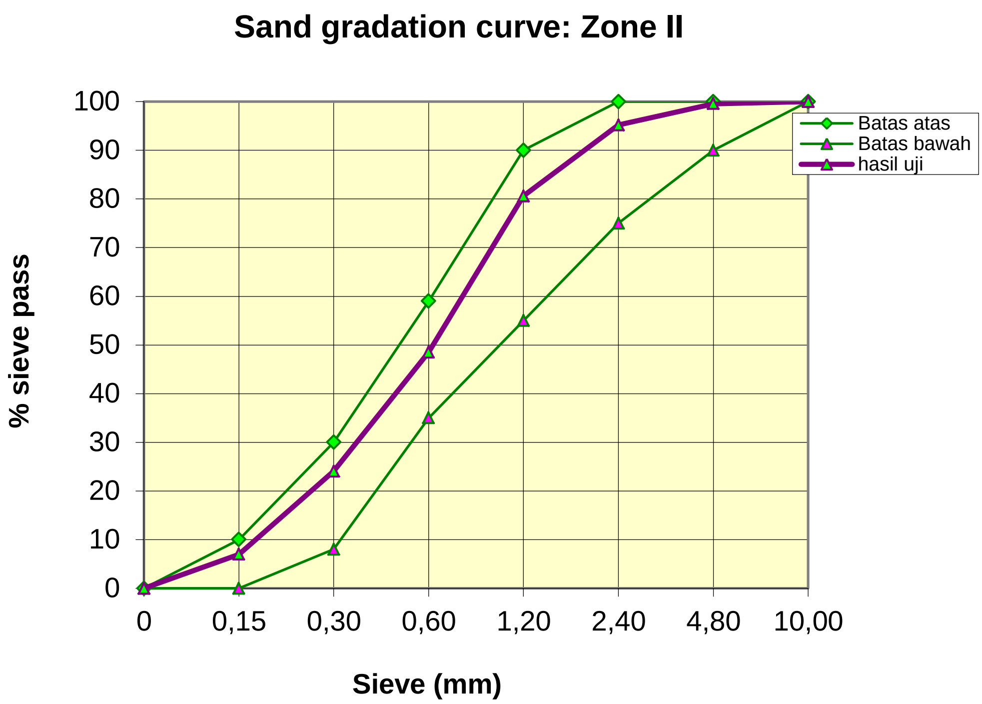

Figure 1. Sand gradation category of samples

As shown in Table 2, the minimum compressive strength for Quality Grade IV is 25 kg/cm^2. To fullfil the standard, there were four tests with different water cement ratio, starting from 0.55 till 0.70. The higher water cement ratio is the lower compressive strength. Safety factor of 105% is utilised to facilitate deviation standard of 5%. Figure 2 describes that Quality Grade IV with safety factor 105% can be achieved with maximum water cement ratio of 0.64

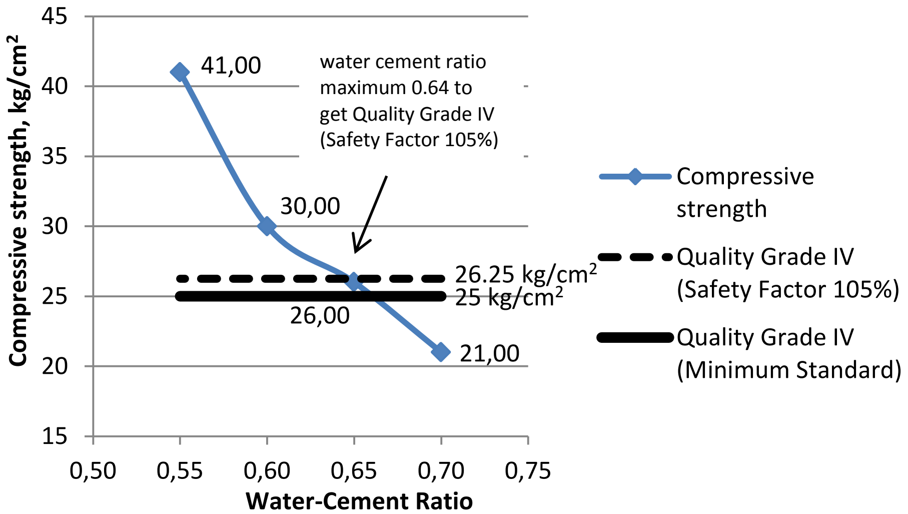

Figure 2. Determining ideal water cement ratio for a good quality of concrete block

After the ideal water cement ratio was determined, the following step was to find a good proportion between cement and sand bu volume basis. Similarly, there were four tests with different proportion of cement and sand. Referring cement as a constant value, the

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proportion of sand varies from 7 till 10. The higher proportion of sand is the lower compressive strength. Figure 3 mentions that Quality Grade IV with safety factor 105% can be achieved with maximum proportion of sand is 9.

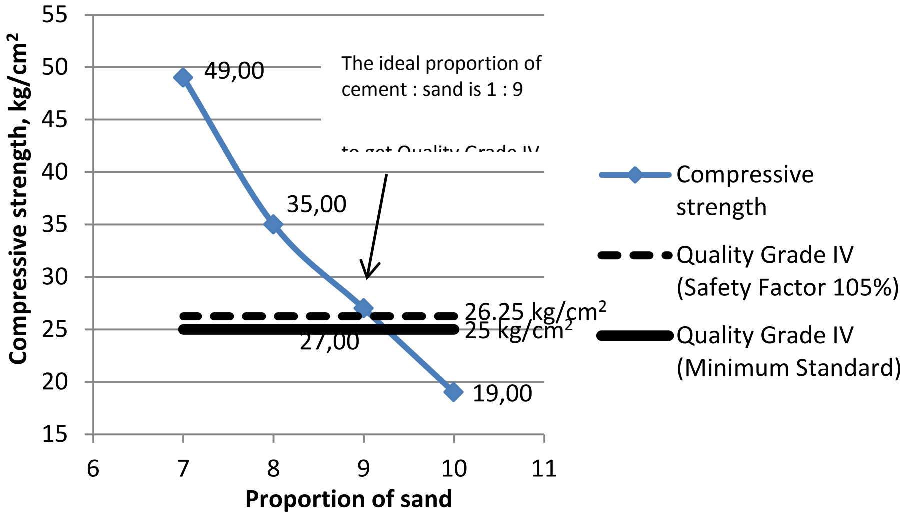

Figure 3. Determining maximum proportion of sand for a good quality of concrete block

An investigation of basic production cost in 5 concrete mini plants has elaborated. They make concrete block with 10 cm thick, 19 cm height, and 38 cm length. The expenditure and income data are based on the daily basis. Each plant can produce 450 pieces of concrete block daily. As a normal business, the profit is expected to be 10% of total income per day. The description is as following.

Daily expenditure is Rp. 737,100.00, as follows:

a. Equipment depreciation Rp. 6,000.00
b. Workshop rental Rp. 5,000.00
c. Electricity Rp. 1,600.00
d. Wooden palette Rp. 81,200.00
e. Wages Rp. 210,000.00
f. Material Rp. 308,400.00
g. Lunch Rp. 40,000.00
h. Contigency Rp. 3,000.00
i. Tax Rp 81,900.00 (10% of income)

Daily income expectation Rp. 819,000.00
Profit = income – expenditure = Rp. 81,900 or about 10% of income per day

As the production number of concrete block is 450 pieces in a day and the expected income is Rp 819,000.00 (including profit), the basic price is Rp. 819,000.00 / 450 = Rp. 1,820.00 per piece.

In addition, there were 35 respondents as common construction actors who were interviewed to get their opinion of the price of a good quality of concrete block. They have mentioned Rp 2,000 as a normal market price. Comparing to basic price Rp 1,820.00, the market price is is relatively competitive for this opportunity.

Respondents also have said that strategies to win the competitive market on mass production of concrete blocks are focus in quality, building relationships with consumer, rapid respond to customer need, continuous innovation by product diversification, promotion in social media, and strict financial management.

8. CONCLUSIONS

People in the vicinity of Merapi mount are still producing low quality of concrete block in which the average compression strength is only 19.4 kg/cm^2 which was lower than the minimum Indonesian standard of 25 kg/cm^2. A good quality of concrete block should be based on the concrete mix design of water cement ratio not be more than 0.64 by weight basis and the proportion of sand as aggregate content should not be more than 9 parts to 1 part by volume of Portland cement. In addition, market price of Rp. 2,000.00 per piece concrete blocks is relatively competitive for this opportunity as the basic price is only Rp. 1,820.00. The strategies to win the competitive market on mass production of concrete blocks are focus in quality, building relationships with consumer, rapid respond to customer need, continuous innovation by product diversification, promotion in social media, and strict financial management.

9. ACKNOWLEGEMENT

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GEOTECHNIC REVIEW OF BORED PILE FOUNDATION CONSTRUCTION AT LEMAH IRENG BRIDGE, SEMARANG - SOLO TOLL ROAD

Edy PURWANTO[1]

ABSTRACT: Lemah Ireng Bridge, section VI, Semarang – Bawen toll road is a monumental structure of PT. Trans Marga Jateng, Publics Work Departement, Province of Central Java. The bridge has span of : 85 m – 130 m – 85 m and 25 m width, more than 35 m height above the land surface. The upper structure of the bridge is box girder and the sub-structure is bored piles foundation. The bridge foundation structure laids on the clay shale, so to ensure the structure stabilities needed geotechnical studies on construction.

The success of bridge construction on clay shale relies on proper planning, design, construction control and site supervision.The construction methods employed at site also have significant effect to ensure the successfully. This paper presents the results of the geotechnical review of the bored pile foundation at Pier P1.

KEYWORDS: Lemah Ireng Bridge, Clay shale, Bored pile, PDA test and PIT.

1. INTRODUCTION

Toll road construction is verry important activity to provide a good transportation public and to solve the traffics jam in the national road from Semarang to Solo and the surrounding cities in the Central Java province. Toll road Semarang – Solo is constructed in two phases.

The main road alinnement passes at the villages, hilleys, forresters and agricultures areas. Based on the topography, the bridge should be bulit along from station 22+125 to station 22+840, that is Lemah Ireng Bridge (see Figure 1) . The structure of the bridge consists of two piers (Piers P1 and P2) and two abutments (Abutment A1 and A2). The Lemah Ireng Bridge has tree spans of 85 m – 130 m – 85 m and 25 m witdh. The upper structure of the bridge is box girder and the sub structure is bored piles foundation. (see Figure 1.)

This paper presents case histories and a brief guide to ensure successfull construction of bride foundation on clay shale.

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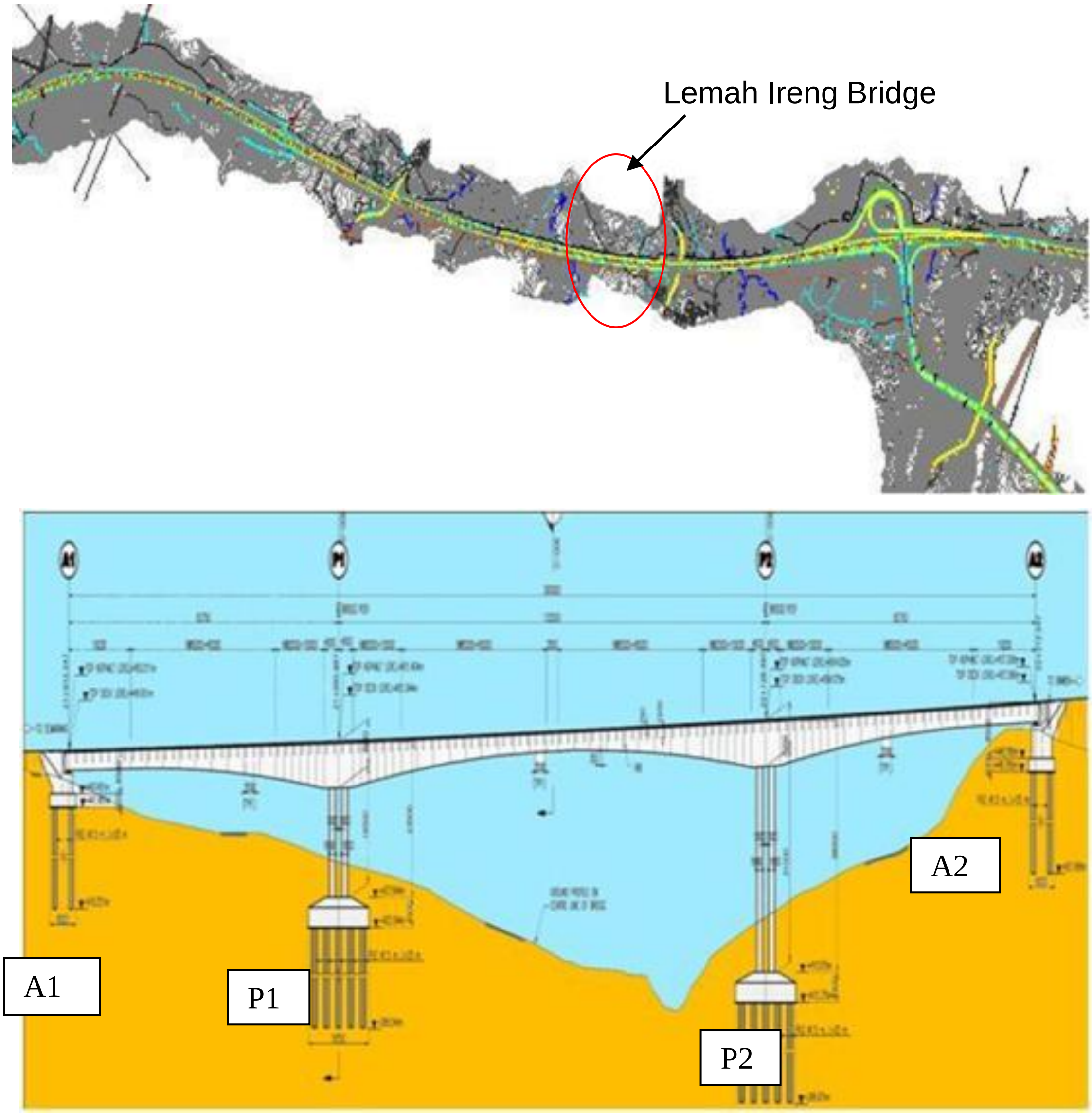

Figure 1. Structure of Lemah Ireng Bridge

1.1. GENERALE PARAMETERS

Structural concrete for all members of the bridges shall comply with the following : Ec = 33234 Mpa, Deck = f'c= 40 Mpa., Pilecap and Abutment = f'c= 35 Mpa,

Pile = f'c=30 MPA and Strength at jacking = f'c= 35Mpa. Where f'c is the specifiied compressive strength of concrete at 28 days.

1.2. GEOTECHNIC REVIEW

The success of bridge construction the following major factors : Planning of subsurface Investigation, Analysis and Design Contruction Control and Supervision.

The result of the soil investigation at site for platform Pier-P1 is presented at Figure 2 below.

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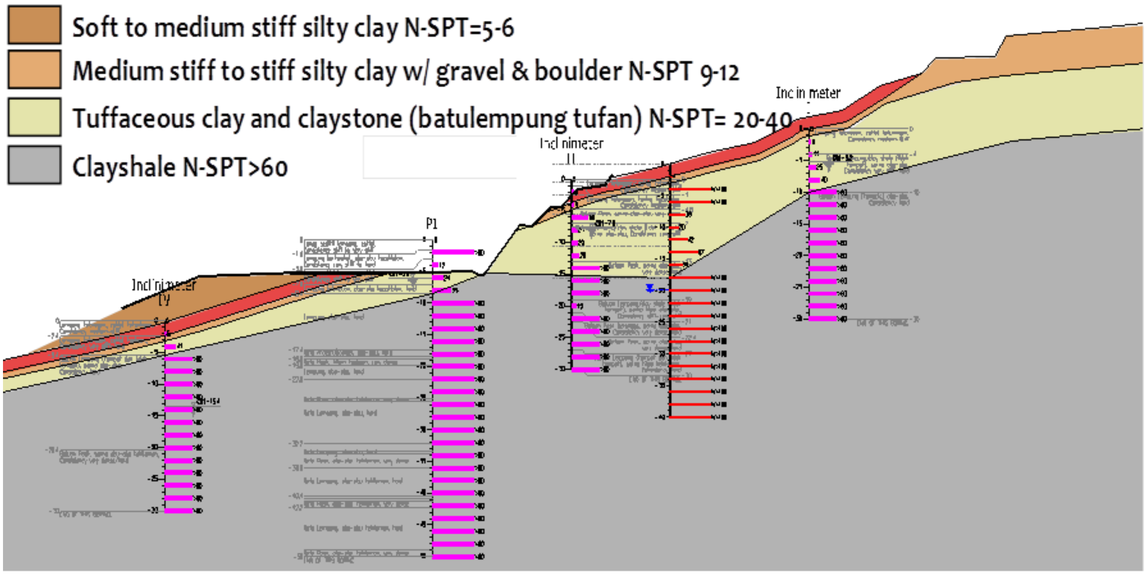

Figure 2. Subsoil profile of the site

2. SLOPE STABILITY

Structure of Pier P1 supports the maximum bridge load because this structure located at the longest bridge span. The other hand, this structure laids on the steep valey with the natural slope steep. When the platform for Pier P1occured the slip failure happen at the slope beside Pier P1 (see Figure 3).

This failur is identified caused by preparation work for plat form the structure of the Pier P1, the water rainfall infiltre into the soil and finally water get out at the plat form area. Based on that conditions and the topography exist in the filed, the slope built in two steps form with 1 m berm width and the slope is made 1 V : 2 H.

Figure 3. Slip Failure at Slope beside the Pier P1 structure (1)

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Figure 3. Slip Failure at Slope beside the Pier P1 structure

3. INCLINOMETER

An Inclinometer or Clinometer is an instrument for measuring angles of slope (or tilt), elevation or depression of an object with respect to gravity.

Inclinometer measure both inclines (positive slopes, as seen by an observer looking upwards) and declines (negative slopes, as seen by an observer looking downward) using three different units of measure : degrees, percent and topo.

To indiquate a movement of soil in site Pier-P1 structure, we install several inclinometers to measure the landslide or lateral mouvement at the slope. The observation with the inclinometers take long more than 30 days and 50 m depth from the surface land existing. Layout of the Inclinometers is presented at Figure 4 below.

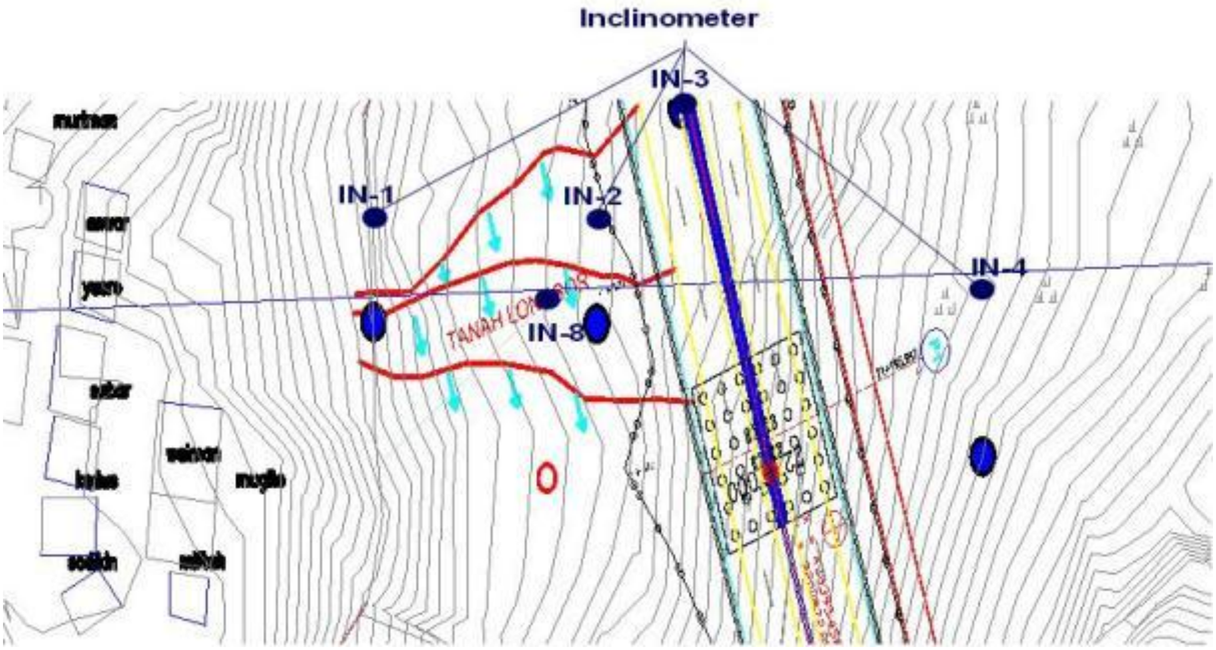

Figure 4. Layout of the Inclinometer at Pier-P1 Sta. 22+625

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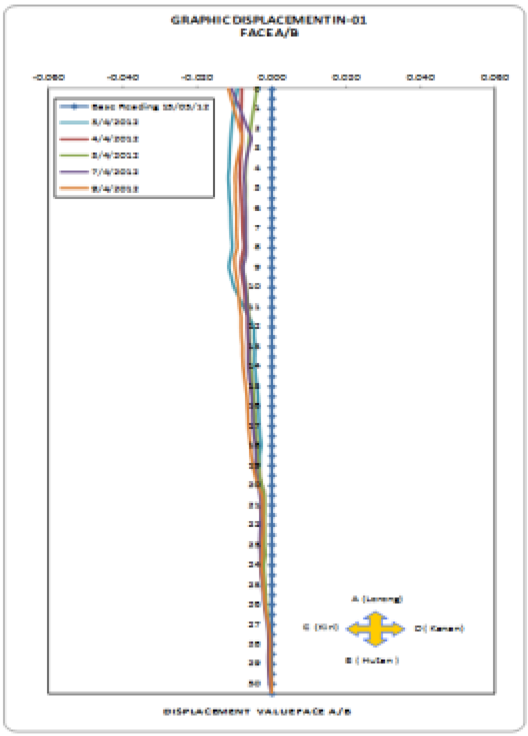
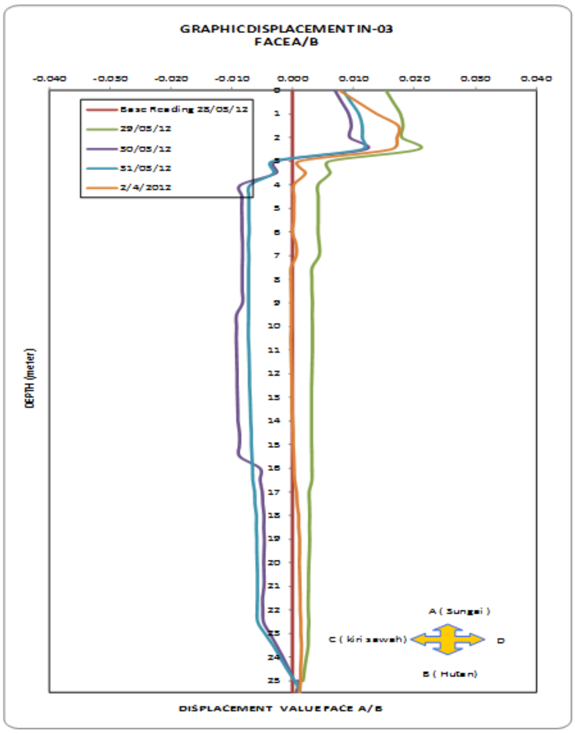
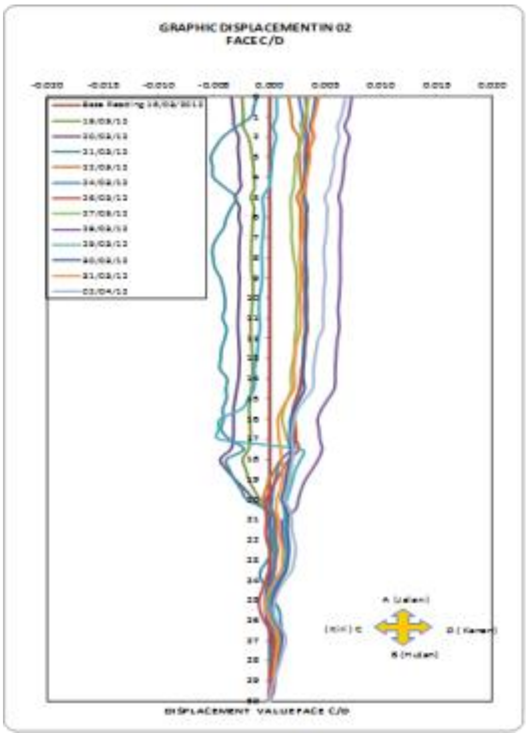
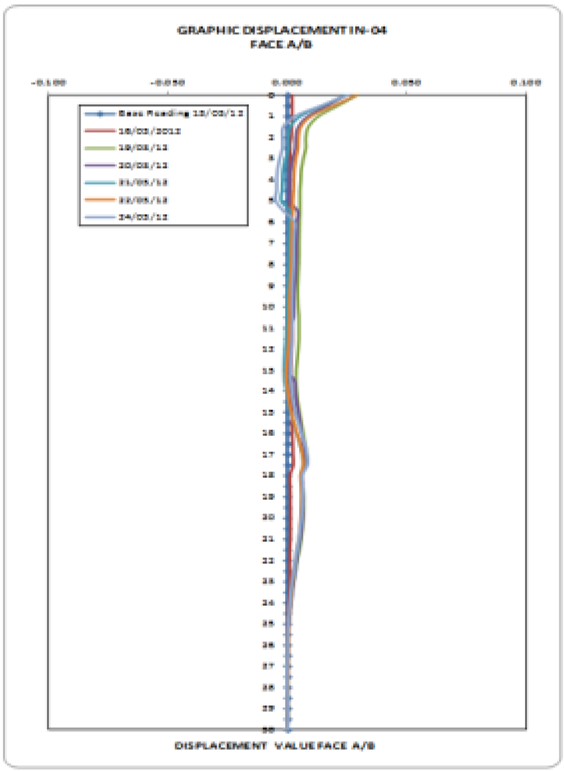
The results of the mesurement with five inclinometers shows at Figure 5.









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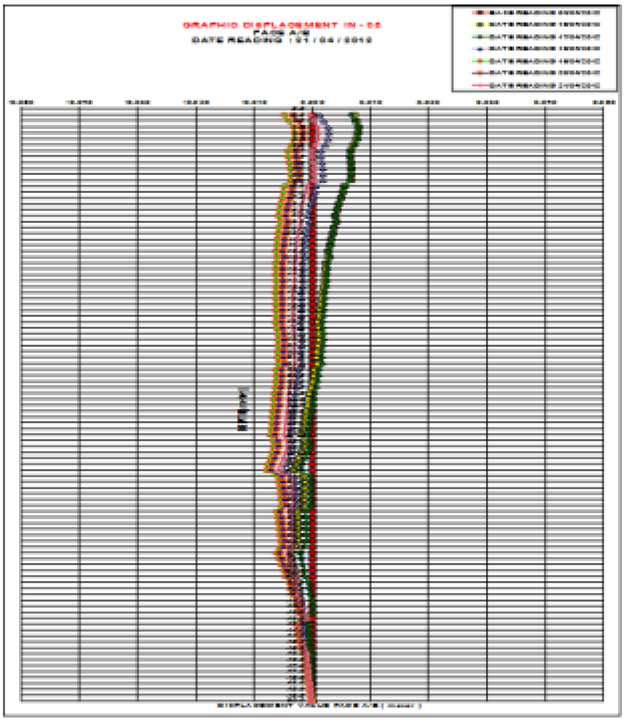

Figure 5. Results of mesurement Inclinometer at Sta. 22+625

The figure 5 indicates nothing movement of soil from the land surface until 50 m depth for all inclinometer installed.

4. BEARING CAPACITY OF BORED PILE FOUNDATION

Meanwhile, when boring occurs to make bor hole for pile number 1 and pile number 6, boths holes are collapting at the – 17 m to -19m from the pile head.This failure happened at the twoo layers differentes, it mean the top layer is soft soil and the below layer is hard soil (clay shale). This zone is undiscontinue, so the water rainfall can infiltre to bore hole and it made instable the bore hole.

When the bor log is occour, to prevent the collaps of the wall bore hole use a metal cassing with 1,50 m diameter and 9 m length from the pile head. The failure zone is produced under the cassing. To ensure stability of the bore hole is used a cement paste method.This methode has been worked verry well in the field and cappable to prevent the bore hole wall collaps, so all bored pile at Pier P1 can do until finish successfully with the same method.

The bored piles foundation with diameter 150 cm, 2500 cm length and 1875 x 1875 cm2 pilecap is used at the structure foundation of the Pier-P1 at Sta. 22+625. The formation of bored pile group is 6 x 6 piles. The calculation of bored pile bearing capacity for Pier-P1 is presented in the below description.

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Meyer (1976) in Rahardjo,P. (2005):

$$\text{Qultimate} = Qp + Qs - Wp \quad (1)$$

Where : Qp = end bearing ultimit (kN)
Qs = friction bearing ultimate (kN)
Wp = pile weight (kN)

End bearing pile : Qp

$$Qp = qp * Ab \quad (2)$$

End pile laids at clay shale with:

NSPT = 60 =→ Cu = 240 kN/m2
Qp = 9 * Cu * Ab = 3815,10 kN.

Friction: Qs

Layer soils : >-20.00m Nspt = 60 =→ Cu = 240 kPa, α = 0,46

$$Qs = Fs * L * p \quad (3)$$

Alpha methode :

$$Fs = \alpha * Cu \quad (4)$$

Qs = α * Cu * L * p = 12999,60 kN

The result of bored piles bearing capacity is presented at Table 3 below

Table 1. Bearing capacity of Bored pile at Pier-P1 (n = 6x 6 piles, L = 25m)

Pile diameter	Single pile bearing capacity (kN)			Group piles bearing capacity (kN)		
	SLNC	SLSC	ULSC	SLNC	SLSC	ULSC
	3,00	1,25	1,00	3,00	1,25	1,00
Φ 150 cm	2,00	1,25	1,00	2,00	1,25	1,00
	7771,50	13451,76	16814,70	279774	484263,40	605329,2

Source : PT Wiecon Consultant, 2012

The bearing capacity of bored pile is bigger than maximum load applicated at Pier-P1, so the bored pile group is safe.

5. PILE INTEGRITY TESTER (PIT)

Pile Integrity Tester is compact equipment by Pile Dinamic Inc. (PDI) consist of mini-computer, accelerometer and hand-held hammer. The propose of conducting PIT on pile is to verify the pile integrity, profile, toe condition and penetration depth.

Integrity testing on pile using PIT equipment was done by analyzing transfered wave occur in pile as result of force given by a hand-held hammer on the top of pile without cause a

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deformation so the pile can be assumed in elastic condtion. Wave tranferred occur in concrete will be in range of 3300 m/s to 4500 m/s. if there is any reflection at the travelling wave time, than a conclusion can be made that there is an impedance change happen in pile.

The impedance change (BTA) is the comparison between recorded pile section areas to design pile section area in percentage. BTA change in pile shown by reflection on velocity curve at location where pile impedance change.

PIT shall conduct on flat, smooth surface to obtain uniform tranferred wave. Analyzing of pile integrity based on interpretation of vilocity wave traveled characteristic along the pile which depends on its structural integrity and soil resistance along pile. Anomaly along the section af pile will illustrate by an early reflection velocity curve. If the is any change in impedance, BTA value will show as a comparision value between remain area to desing area in percentage.

The result of Bored Pile Integrity are presented on Table 1 below AND Figure no.6 below.

Table 2. Result of the PIT

No.	Pile Number	Diameter (cm)	Discussion	Remarks
1	ABT 2 -P 11			
2	ABT-2 - P12	150	No anomaly occurs along the pile shaft.	Undamaged
3.	ABT2 – P1		Pile is considered as good pile	
4.	ABT2 – P6			

Source : PT Waskita Karya, 2012

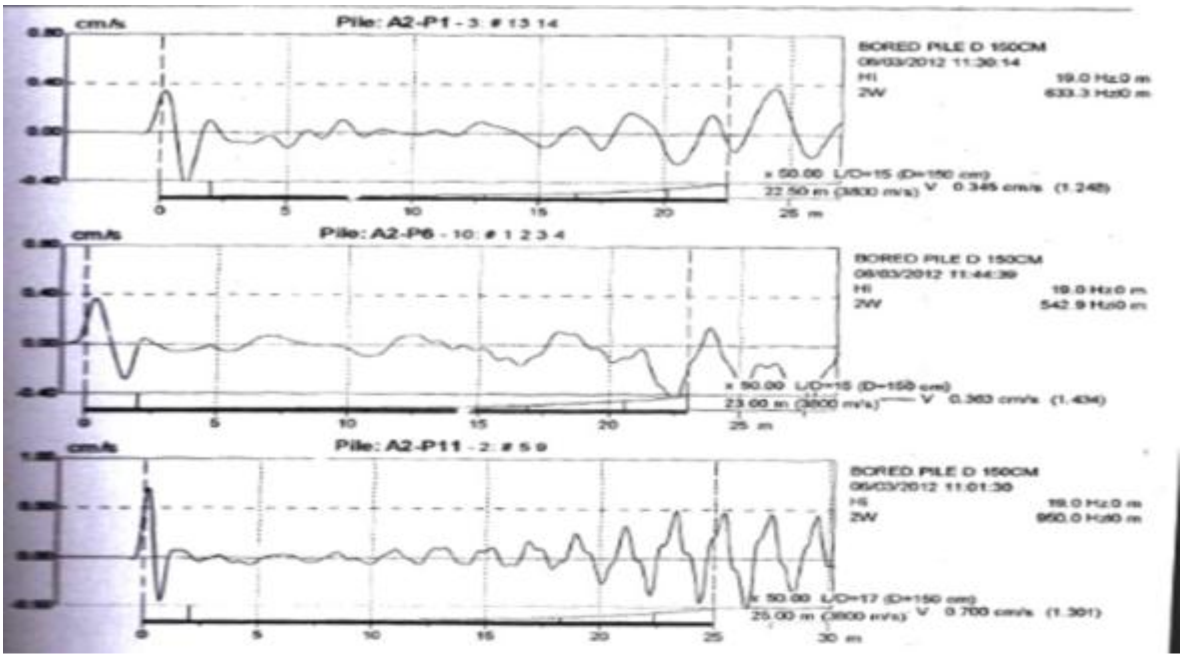

Figure 6. Result of the PIT in the field.

Figure 6. Result of the PIT in the field.

6. PILE DRIVING ANALYZER (PDA)

Pile Driving Analyzer (PDA) is a complete full-system computer with special strain transducer and accelerometer to determine the force and velocity graphic form when pile struck by a hammer. Results of PDA consist of pile capacity, displacement, hammer energy, etc. In general, PDA testing done after pile have enough strength to resist impact from hammer, another anticipation can be done using cuhion or lower the hammer stroke and use heavier. PDA test will be carried out in accordance with ASTM D4945-08. After preparation, testing will conducted on pile by struck the pile head using proper hammer until sufficient energy and maximum pile stresses reached without breaking the pile. During the driving, some variable related to the test pile are monitored, such as bearing capacity, elastic sttlement, integrity, etc. After PDA test conducted, analyzing done by CAPWAP program to simulate the load transfer in pile and soil behavior, friction ang end-bearing capacity, elastic and net settlement. The result of CAPWAP Analysis is presented at Table 2 and the Figure 7 below.

Table 2 : Result of PDA for pile at ABT-1 pile no 9 and ABT-2 pile no 12.

Pile No.	Diameter (mm)	Pile Length (mm)	Pile Penetration (mm)	CAPWAP			
				Bearing Capacity (Ton)	Friction Capacity (Ton)	End-Bearing Capacity (Ton)	Settlement (mm)
ABT-1 P.9	150	29800	27300	1085	1043,60	41,40	3,80
ABT-2 .12	150	27000	24900	1210	1157,80	52,50	3,60

Source : PT Waskita Karya, 2012.

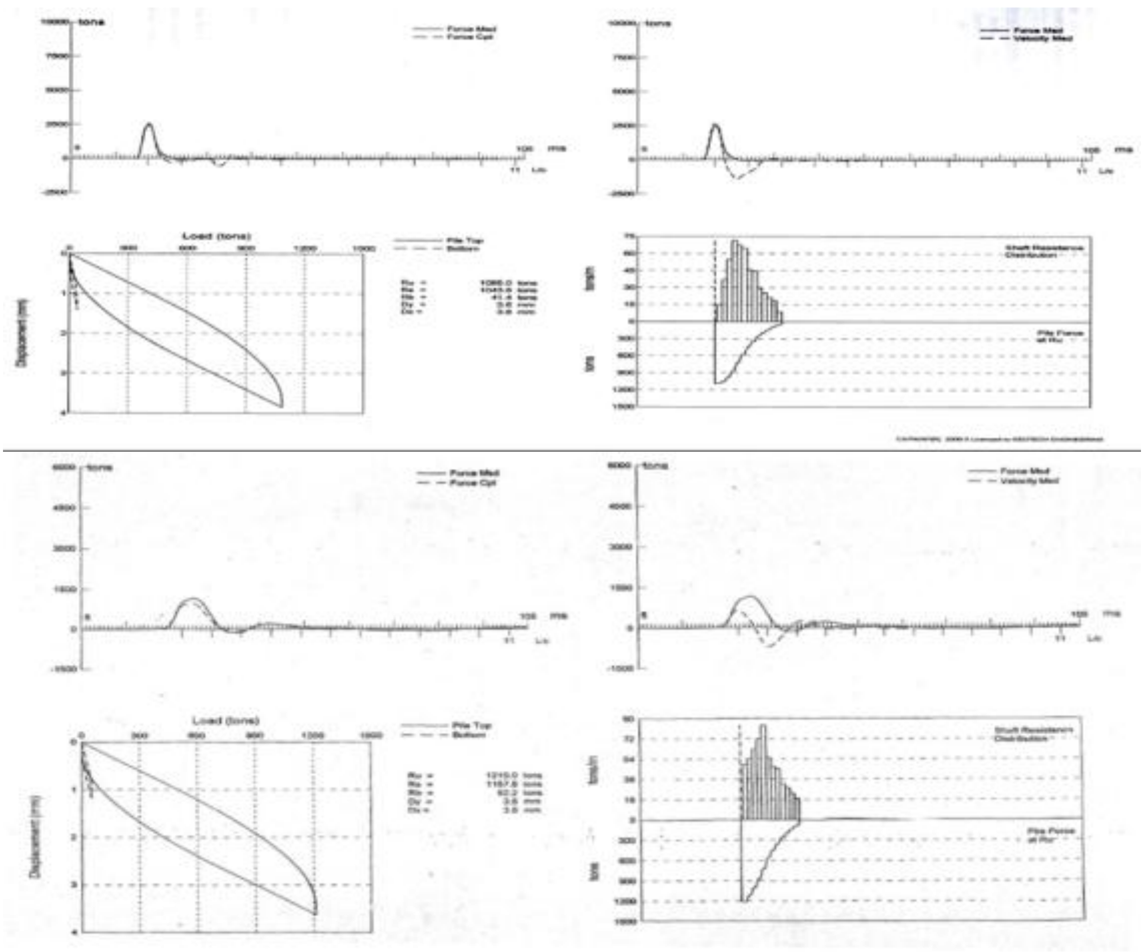

Figure 7. Result of the PDA tests at ABT-1 P.9 and ABT-2 P.12

The Table 2 and Figure 7 shows a bearing capacity result, consist of shaft friction and of end bearing capacity. The total residual settlement is 3,80 mm and 3,60 mm, respectively. This implies that test pile was promarily borne by its shaft resistance.

7. CONCLUSION

The geotecnic review has been done to ensure the successfull of bored pile foundation construction. The bearing capacity of bored pile is capable to support the load existing in site. It is important for a civil engineering consultant, consultant supervisi and contractor to have some fundamental geotechnical knowledge to prevent failure occurs.

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INFRASTRUCTURE

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EFFECT OF DENSITY SOIL TO WATER RECHARGE (INFILTRATION) IN URBAN OVERLAND FLOW

Dian Noorvy KHAERUDIN[1]

ABSTRACT: Soil has different conditions depend on its formation in the past and their treatment in the period of running time. The process of the hydrological cycle is also influenced by soil conditions, namely the rain fall on the surface of the ground. Land has undergone many changes due to the treatment needs of human activity. The process of soil influence on the hydrological characteristics is the presence of drainage and water infiltration into the soil that affect the water balance in the soil and on the surface of the earth. This study aims to determine the effect of soil density on water infiltration (infiltration) of several types of land in urban areas. In this case, the transactions are carried out research on some soil types with different densities to obtain the effect of soil density on soil type influence on infiltration. According Halidin Primary Arfan & Abraham (2012), the value of infiltration will decrease if the slope of the land surface increases. Infiltration value will increase if the rainfall intensity increased. Infiltration value will decrease if the density of the soil increases. This study is based on the study of some of the research that has been done and the result thus obtained the novelty from literature review of studies that have been done. This study as a basis for determining the time of concentration on mathematical models of urban land drainage. That is the time of concentration in the timing of the concentration of urban drainage planning with environmental (eco drainage).

KEYWORDS: eco drainage, infiltration, soil density, soil type

1. INTRODUCTION

Discharge of water flowing in the earth is a modification rain that falls to the earth's surface into a discharge. The rain that falls to the earth's surface will be infiltrated into the ground and there were melimpas above ground level. Factors affecting runoff divided into two groups, namely the meteorological elements and physical properties of elements (characteristics) the drainage area (Sosrodarsono & Takeda, 1978: 135).

The influence of rainfall intensity on surface runoff is highly dependent on the rate of infiltration, surface runoff will occur in line with the increase in rainfall intensity, however, the increase in surface runoff is not always proportional to the increase in rainfall intensity due to flooding at ground level. Rainfall intensity effect on the discharge and runoff volume. The total runoff from a rain directly related to the duration of rainfall with a certain intensity.

Development of a city demands on the local infrastructure. The level of technological development of the city also is more advanced. Urban development carried out on land. Soil has different conditions depending on the formation of the past and their treatment in the period running time. The process of the hydrological cycle is also influenced by soil conditions, namely the rain fall on the ground. Land has undergone many changes as a result of the treatment activities of human needs. The process of soil influence on the hydrological characteristics is the presence of drainage and water infiltration into the soil that affect the balance of water in the soil and on the surface of the earth.

Treatment of land for building is related to the stability of the buildings built on the land. Soil conditions that affect the calculation of the structure of the building. The structure in question

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is from the foundation, floors, columns, up to the roof of the building. The purpose of compaction is to increase the strength of the soil and improve its carrying capacity, and reduce compressibilitas and soil permeability. Compaction will be implemented during the construction of a building. Changes compaction occurs when soil is compacted volume of air in the soil pores will be reduced, so that the soil becomes more dense, the shear strength and bearing capacity increases, as well as the compressibility of the soil.

The concept of environmentally sustainable drainage (eco-drainage) requires completion with sustainable systems approach. Constraints faced by a planner is the determination of the discharge plan. Determination of drainage discharge plan on the concept of environmentally sound also expected to collect rain water that falls to the ground, but can be managed and accommodated soak into the ground and continue the hydrological cycle.

2. LITERATURE REVIEW

Precipitation that falls in an area will flow on the surface of the ground as surface runoff or get into the soil layer. According Sosrodarsono, 1993 understanding of infiltration is the process of entry of rain water into the surface layer down to the surface of the soil and ground water or ground water.

According Asdak (2002), infiltration can be defined as the process of entry into the soil as a result of capillary forces (water movement laterally) and gravity (water movement in the vertical direction). After a state of saturation in the upper soil layer is exceeded, a portion of the water flowing into the deeper soil sebgai due to gravity and is known as the percolation process. Maximum rate of water movement into the soil is called infiltration capacity. Infiltration capacity occurs when the rainfall intensity exceeds the soil's ability to absorb moisture in the soil. Conversely, if the rainfall intensity is less than the infiltration capacity, the infiltration rate equal to the rate of rainfall.

Surface conditions, such as pore properties and low water levels, largely determines the amount of rain water that is infiltrated and the amount of runoff. Thus, a high infiltration rate not only increases the amount of water stored in the soil for plant growth, but also reduces flooding and erosion bersarnya activated by runoff. Blows rain beads on the surface of the open land destroys soil aggregates and disperse the resulting blockage of soil pores in the surface. This will decrease the rate of infiltration. The decline in the rate of infiltration can also occur due to overgrazing and soil compaction due to the use of heavy equipment (Judge, et al, 1986).

In the soil, the water was in the pore spaces between soil solids, if the ground water in the saturated state, the pore space occupied by water. In this state is called "maximum water storage capacity" ". Furthermore, if the soil is allowed to run into the drying partly filled with water. In this state the land said to be saturated (Islami and Wani, 1995).

According to (Indarto, 2010), infiltration is the movement of water down through the soil surface into the soil profile. Based on the conceptual model of hydrologic that rain will terinterprestasikan be discharge runoff and infiltration, the infiltration will affect the amount of rain that falls to the surface teralihragamkan urban land becomes runoff discharge.

Several factors affect the rate of infiltration is soil structure, soil density, intensity of rainfall, slope, roughness of the land. Events increased the dry weight of the load volume is called dynamic compaction. By a result of dynamic load, soil grains move closer to one another as a result of reduced air cavity. The purpose of compaction can be achieved by the selection of soil material stockpiles, compaction ways, the selection compactor machine, and the amount of the corresponding trajectory.

Quantitatively measured soil density of the dry weight of the volume of soil, which is heavy or dense granular soil oven dry weight divided by the overall volume of the soil (ie soil volume including the volume of solid grains and pore cavity). Total soil volume (V), in general, relatively fixed by changes in water content, except on expansive clay. If as a result of changes in soil water content of the total volume (V) fixed, while the dry weight of the soil grains (Ws) also does not change, then the value of the volume of dry weight (density) $\gamma_d = W_s/V$ konstant, although the water content changes.

3. METHODS OF RESEARCH

The study was conducted with the implementation of field observations by testing the soil structure, soil density, slope of the land at the same rainfall intensity. Observations infiltration by using a Tec Turf, soil density by using a Proctor. As for the statistical analysis using experimental design and is supported by the mapping of data fields. The loop consists of several types of soil (soil structure), the intensity of rain and some slope, as well as for the carrying out of the experiment is to treat the land, namely the density of mild, moderate and severe.

4. ANALYSIS AND RESULTS

The process of infiltration is the process of entry of rain water through the pores of the soil surface, tertampungnya the rainwater in the soil, and the process flow of water to another place (bottom, sides and top), though not interconnected but these three processes are interrelated (Asdak , 2002).

In the process of rain falling on the ground sparks of water, the strength of the volume of water, is able to compress the soil surface to the water sparks close the pores of the soil. Closing of the pores of the soil will affect the rate of infiltration. Treatment of soil compaction on soil structure will affect some degree of infiltration. This was stated by (Halidin Arfan, December 2012), that there is the influence of density, rainfall intensity and slope of the land to the value of the recharge (infiltration). From the experimental results in the laboratory is that the recharge value is proportional to the intensity of rainfall, the infiltration will be more in line with the rainfall. However, the value of the recharge will go down along with the dense soil, and infiltration will increase at a decreasing slope.

Soil density caused by the presence of dynamic load that occurs in the soil. Dynamic loads that can occur because there is a process of natural and man-made processes. Soil density that occurs due to natural processes usually occur on land that is not utilized as a land use. And compacting process occurs naturally due to the sparks rain, the presence of motion of the earth, natural compaction of the soil due to the closure of the ground grains carried by wind and rain, and can also occur due to the natural movement of the lifting and shifting crop soil structure to pores of the soil cover each other. While the process is made by humans is due to the utilization or land use. Ground that there would be enabled to human needs. Like many urban areas in the land, the land use or land into residential use, high rise buildings and other urban facilities (shop, mall, college, etc.).

Density of land in urban areas will reduce the ability of land to absorb rainwater. The concept of environmentally sustainable urban drainage (drainage eco) functioning of urban areas to be able to manage the rainwater that falls to be back on the ground and in the ground then flows expected to be a backup groundwater or seep back into the ground and flows back into the river as the flow base (base flow).

Infiltration rate is also influenced by soil structure. The structure of land for building urban infrastructure by assessing the size of the known density of the soil. Construction of a building to make certain the soil density to support the soil bearing capacity. The density of the soil to absorb water from the rain water is the density of the soil that occurs at ground level on urban land.

According to (Sucipto, 2007), a higher density of soil erosion, the land will be greater until at a certain optimum point then erosion will be reduced. This means that the higher the density of the soil of the land, the infiltration that occurs will be smaller. Then according Sucipto 2007, the intensity of 80mm / h erosion that occurs in soil test greater than the intensity of 60mm / h. This is due to the higher intensity of rainfall, the soil will receive more rain falling so that the erosion is also getting bigger. It also means that the greater the intensity of the rainfall will increase the infiltration rate.

Based on the above statement about the growing influence of the growing intensity of rain and an average slope of land against the infiltration rate, the effect of soil density on infiltration (infiltration) will have a decrease and an increase of the value of infiltration rate different from the rainfall intensity and slope of the land is different-also vary. Because of the ability of the land to be affected by soil structure have treated soil density, respectively. So the value of the ability of the infiltration rate will vary on soil structure and soil bulk density. So the infiltration rate when performed on soil structure and soil density mild, moderate, and severe with rainfall intensity and slope of the land will have the same value infiltration different. That is the solid ground, then the value of the lower infiltration rate. And when some observations on the land with rain intensity enlarged and reduced slope, then the infiltration rate should be greater, but in this case there is the effect of soil density and soil structure. So that changes depending on the influence of soil factors.

Change the basic shape of ground can be caused by strength or carrying capacity. Change the basic shape of ground will soon change as the carrying capacity is low (ground easily collapse), development, shrinkage and densification and consolidation of subgrade soil under subgrade. These things depend on the type of soil, dry bulk density and water content (soil density). This soil is very important role in the planning or execution of the building because the land serves to support the existing load on it.

If the urban infrastructure and has an average density is the density of the soil is the carrying capacity of land for building houses, shops and buildings, for example, the ability of urban land would also be possible to have the average being. But if the soil bearing capacity of the soil density is high, the ability to infiltrate urban land will be low.

This connection the influence of soil density on infiltration is to design the concept of environmentally sound urban drainage (drainage eco). In this case, if high density, the ability to infiltrate the soil is low then the dimension of the analysis is as follows:

$$[V] = \frac{[S]}{[t]} = \frac{[L]}{[t]} \quad (1)$$

$$[t] = \frac{[V]}{[L]} \quad (2)$$

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With :

$[L] = [S] =$ dimensions of length, units of meters (m) which is the path length of the flow of water that infiltrated into the soil

$[V] =$ dimensional velocity, unit m / s, m / h, length / time, the infiltration rate.

$[t] =$ dimensions of time.

Low level of infiltration rate due to the influence of high soil density, but the time taken will be long. The concept of the infiltration rate can be expressed in mm / h. In a state of constant inifltrasi rate it will reach the minimum conditions or critical time. With this in mind, the time derivative of the concentration will be obtained from the kinematic wave equation that occurs in the relationship between speed, flow length, and time. Where is the critical time can be a time when the concentration reaches a constant infiltration rate. And there is a concentration that can become a reference in planning the design of the building environmentally sound urban drainage.

Planning for drainage in a city, there are many who use the conventional concept because the land is still widely available, climate change and human demands will influence land use change is still balanced (Noorvy, 2013). But now, the ratio of the population birth and death of a large population, and demand for housing needs, facilities, infrastructures population is increasing, so the conventional concept is no longer possible to accommodate excess water. Excess water is discharged into water bodies already have a condition that does not allow longer covered by water with slope engineering made. This is due to changes in environmental conditions include changes in land use, climate change, environmental policy changes, and changes in lifestyle of the people so that the carrying capacity of the environment are already experiencing criticality.

Under the deal the world, saving the environment which includes the soil, water and air began in earnest. It is also beginning to be applied in the cities, such as Surabaya and surrounding areas who have applied the concept of environmentally sustainable drainage.

Based on research (Yoon, 2009) states that one way to determine the time of concentration for the design of hydraulic structures is the observation in the field and finishing with the relationship between rainfall and runoff discharge (hydrograph). Hydrograph method is by using the concept of IUH (Instanoneus unit hydrograph) or with the concept of Model Clark and Nash models. These concepts becomes easier when faced with the constraints of availability of secondary data available, especially in Indonesia, which is still in the stage of completion of hydrological data collection system. Then Will, 1986, stating that the time of concentration can be done with basic physical method using the concept of the balance of water flow (kinematic wave). The concept of this study combines the concepts of Green Ampt infiltration models on the concept of balance of water flow (kinematic wave). Effect of infiltration is assumed to be the only loss of the rainwater that falls to the ground. Concentration time models that have been developed by Chen, 2002, with a combination of a concentration of kinematic wave equation with Darcy Weisbach equation. Chen stated that the temperature and viscosity affect the flow time of concentration, ie with the flow is laminar, turbulent using the Reynolds number. Furthermore, studies of Tommy, in 2005, to develop research in the study of Chen before but this Tommy, rain intensity factors included in the equation of time of concentration. In 2008 by Ming-Han Li and Pamaiit Chibber in his research stated that the time of concentration is affected by rainfall, soil conditions, and land cover. The equation is made has included the effect of soil moisture and land cover through n (Manning coefficient value), slope and rainfall intensity. Based on the analysis of the

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research that has been done, then factor that into the variable soil conditions in the equation does not include the condition of the soil density.

The influence of density of soil, slope and rainfall intensity to infiltration has been done, but not until the influence of the time of concentration. The resulting concentration time on urban drainage land in Indonesia is still not represented by existing equations from previous studies. Its application is made for planning the design of environmentally sustainable urban drainage.

This study aims to create a model of concentration by combining the concept of balance of water flow in the area with the concept of water loss due to infiltration. The concept of infiltration that is made separately using the influence inifltrasi rate for soil treatment. Soil treatment in this case is the density of the soil that is linked in the use of land as land use that design to avoid inundation occurs is through planning environmentally sustainable urban drainage.

Infiltration rate is also influenced by the physical condition of land that make up the type of soil, such as void ratio, soil porosity, water content, and degree of saturation. Furthermore, according to research (Pratt, 2012) that the infiltration in addition affected the physical condition of the soil, is also influenced by rainfall intensity and average slope of the land. Thus, in this study, there needs to be an adjustment and modification time of concentration to overcome drainage plan design with environmentally friendly concept that is by adjusting the conditions in the field. The adjustment is the physical condition of the soil-forming soil types with treatments that affect the density of the soil infiltration rate, which is then applied in a mathematical equation concentration time.

5. CONCLUTION

a. The concept of environmentally sound drainage has an important role to improve the urban hydrology. Urban in Indonesia is advancing along with the increasing number of urban population is also growing lifestyle and needs of the population.

b. Rainwater that falls on the surface of urban land management time to be back so that the rain water that falls can be reused directly or indirectly.

c. With the needs of the population will be in line with the needs of facilities, and infrastructure, it is also associated with land use that requires a strong capacity of the soil. Carrying capacity is strongly associated with the Traffic ground to soil density. The density of the soil will affect the design concept of environmentally sound drainage.

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STUDY INVESTIGATION OF HYDRAULIC MODEL ON STEPPED SPILLWAY

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ABSTRACT: A spillway is designed to prevent overtopping of a dam at a place that is not designed for overtopping. The function of a spillway is to pass down the surplus water from the reservoir into the downstream river. In the last decade there has been an increase in the rate of construction of dams using the method of roller compacted concrete. This method provides a fast, cost-effective way of constructing. Potentially high energy dissipation on stepped overflow spillway would imply a significant reduction of the size of downstream stilling basins. In general, it was found that the loss of energy in such spillways depends on two parameters : (1) the ratio of the critical depth and the height of steps, (2) the number of steps. Flow over a stepped spillway can be divided into three separate flow regimes, namely, nappe, skimming and transition flows.

KEYWORDS: stepped spillway, flow regimes, energy dissipation.

1. INTRODUCTION

Stepped spillway was quite common in the 19th century and present practice is confined to simple geometries. Generally, a stepped channel is used for river training, irrigation system, storm waterways, fish-way and step pool streams. The steps act as roughness elements to reduce flow acceleration and hence terminal velocity. A stepped spillway has a stepped ogee-profile spillway instead of the traditional smooth ogee-profile spillway, where a series of drops are made in the invert from the vicinity of the crest to the toe. Stepped spillway can reduce dimension construction of special energy dissipaters because of its special shape, thus reduces construction cost and time of the project.

Flow over a stepped spillway can be divided into three separate flow regimes, namely, nappe, skimming and transition flows. Schematic representations of nappe, transition and skimming flow regime are shown in Fig.1. Nappe flow occurs for small discharges. There are three types of nappe flows: nappe flow with fully developed hydraulic jump, nappe flow with partially developed hydraulic jump, and nappe flow without hydraulic jump. Transition flows occurs for intermediate discharges. This regime is characterized by significant aeration, splashing and chaotic appearance. It is also observed that flow properties vary from step to step. Skimming flow occurs if the depth of flow is sufficiently large when compared to the step height on a relatively steep stepped spillway. In the skimming flow regime, the water flows down the stepped face as a coherent stream, skimming over the steps and cushioned by the recirculating fuid trapped between them. The external edges of the steps form a pseudo-bottom over which the flow skims. Beneath this, recirculating vortices form and are sustained through the transmission of shear stress from the water flowing past the edge of the steps. At the upstream end, the flow is transparent and has glossy appearance and no air entrainment takes place. After a few steps the flow is characterized by air entrainment similar to a self-aerated flow down a smooth invert spillway.

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2. LITERATURE REVIEW

Detailed investigation into its various elements started only about 1971 with the comprehensive laboratory tests by Essery and Horner (1971). The synthesis of the works of specialized authors in the field shows that classification by flow regime is the most used Sorensen (1985), Rajaratnam (1990), Peyras et al. (1991), Christodolou (1993), Chanson (1995), Chanson (1996), Yasuda et al. (2001), Boes and Hager (2003). Essery and Horner (1971) and Sorensen (1985) studied the flow over stepped spillway can be divided into nappe flow and skim flow regimes. The conceptions of weak channel slopes contribute to the appearance of nappe regime. Yasuda and Ohtsu (2001) were probably the first introduce the concept of a transition flow regime, although they did not elaborate on its flow properties. For given steped channel chute geometry, a range flow rates gives an intermediary flow regime between nappe flow at low discharge and skimming flow at large flow rates.

Rajaratnam (1990) used the idea of a fully developed region with a Reynold shear stress between the skimming flow and the recirculating region on the steps, and developed an expression for the relative energy loss over a stepped spillway in terms of that on a smooth spillway and showed that significant energy losses could occur on a stepped spillway.

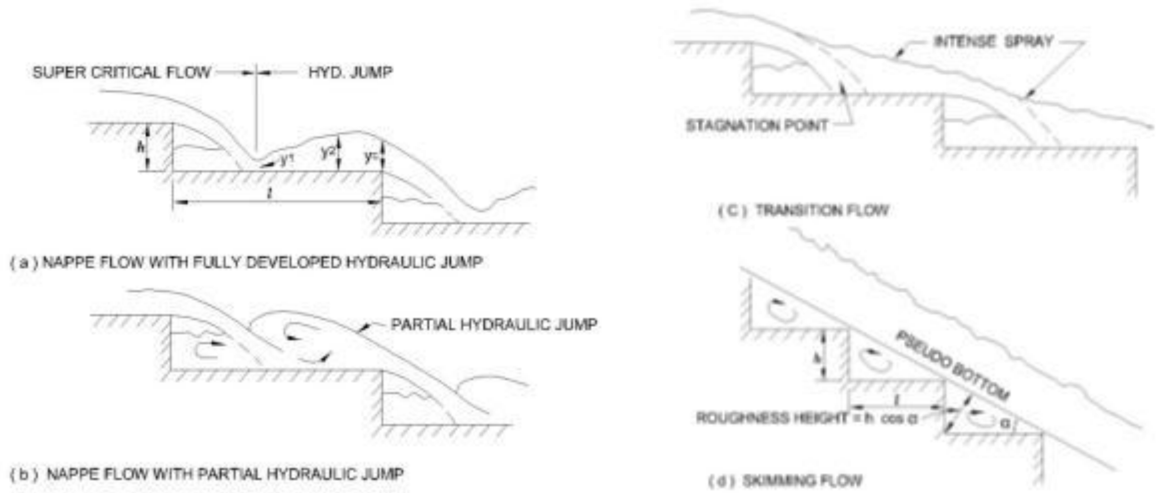

Figure 1. Flow regime on stepped spillway (Khatsuria, 2005)

In general, it was found that the loss of energy in such spillways depends on two parameters : (1) the ratio of the critical depth and the height of steps, (2) the number of steps. Sorensen (1985) performed a physical model investigation for stepped spillways, where he found that adding a few steps to the face of the spillway eliminated the deflecting water jet. Christodolou (1993) found that energy loss due to the steps depends primarily on the ratio of the critical depth to the height of the step, as well as on the number of steps. Sorensen (1985) studied the design of steps and their spacing on the spillway face in order to optimize the energy dissipation.

Chanson (1994) has presented the following equations for the energy dissipation, for the nappe and skimming flow regimes, respectively:

$$\frac{E_0 - E}{E_0} = 1 - \frac{0.54\left(\frac{y_c}{h}\right)^{0.275} + 1.715\left(\frac{y_c}{h}\right)^{-0.55}}{\frac{3}{2} + \frac{H_{dam}}{y_c}} \tag{1}$$

$$\frac{E_0 - E}{E_0} = 1 - \frac{\left(\frac{f}{8\sin\alpha}\right)^{\frac{1}{3}}\cos\alpha + \frac{1}{2}\left(\frac{f}{8\sin\alpha}\right)^{-\frac{2}{3}}}{\frac{3}{2} + \frac{H_{dam}}{y_c}} \tag{2}$$

Chamani and Rajaratnam (1994) studied relative loss on stepped spillways presented an equation that is given below:

$$\frac{\Delta E}{E_0} = 1 - \left[\frac{(1-\alpha)^N\left[1 + 1.5\left(\frac{y_c}{h}\right)\right] + \sum_{i=1}^{N-1}(1-\alpha)^i}{N + 1.5\left(\frac{y_c}{h}\right)}\right] \tag{3}$$

In which α is the proportion of energy loss per step a function of $\left(\frac{y_c}{h}\right)$ dan $\left(\frac{h}{l}\right)$.

Peyras et al. (1992) described energy loss below the stepped gabion for the isolated nappe flow by the equation:

$$\Delta E = Nh + 1.5y_c - \left(\frac{q^2}{2gy_1^2}\right) \tag{4}$$

The result of Peyras et. al (1991,1992) show for a gabion spilway, that the energy dissipation of skimming flow is clearly less than which is realized during nappe flows.

Stephenson (1991) expressed the relative energy loss as:

$$\frac{\Delta E}{E_0} = \left(\frac{0.84}{\theta^{0.25}}\right)F_0^{-\frac{1}{3}} \tag{5}$$

Stephenson (1991) indicated that the maximum energy dissipation is observed for a value of non-dimensional ratio $\frac{h}{y_c} = \frac{1}{3}$ .He has also noted that the energy dissipation is inversely proportional to the discharge values.

Dermawan (2011) studied that the number of steps significantly increases the relative energy loss. For each number of steps, relative energy loss decrease as the ratio of $\frac{y_c}{h}$ increase. The result of energy loss through a stepped spillway that is given below:

$$\frac{\Delta E}{y_c} = 1.4452 + N\frac{h}{y_c} - \frac{y_1}{y_c} \tag{6}$$

Dermawan (2011) studied that for long stepped channels where uniform flow conditions are reached, higher energy dissipation take place in skimming flow regime.

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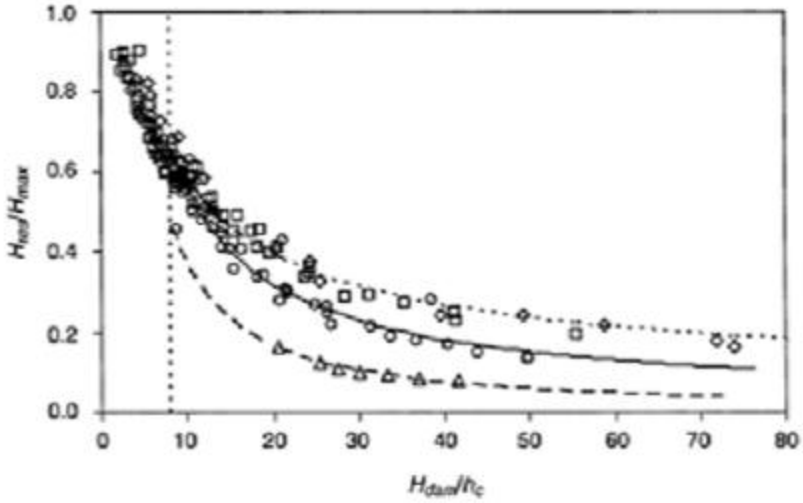

Figure 2. Relative residual energy head ratio H_{res}/H_{max} as function of relative spillway height H_{dam}/h_c with variation θ and K (Valentin,G. et al.,2004)

3. ANALYSIS OF THE FLOW REGIME

The type of stepped flow regime is a function of the discharge and step geometry. Chanson has reanalyzed a large number of experimental data related to change in flow regimes. Most of data were obtained with flat horizontal steps.

Overall the result sugest that upper limit of nappe flow may be approximated as:

$$\frac{y_c}{h} = 0.89 - 0.4\ \frac{h}{l} \qquad \text{nappe flow regime} \qquad (7)$$

$$\frac{y_c}{h} = 1.2 - 0.325\ \frac{h}{l} \qquad \text{skimming flow regime} \qquad (8)$$

$$\frac{y_c}{h} > 1.057 - 0.465\frac{h}{l} \qquad \text{onset skimming flow regime} \qquad (9)$$

The table 1 show that several authors have taken the proposition to predict the regime change (nappe / skimming) with non-dimensional parameters $\frac{y_c}{h}$ and $\frac{h}{l}$.

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Table 1. Values of $\frac{y_c}{h}$ as of regime change condition parameters from the nappe flow to skimming flow

Author	Values of y_c / h
Essery et al. (1978)	$y_c/h = 0.81$
Degoutte (1990)	$y_c/h = 0.69$
Rajaratnam (1990)	$y_c/h = 0{,}8$
Christodoulou (1993)	$y_c / h = 1{,}34$
Chanson (1994-a)	$y_c/h = 1{,}057 - 0{,}465\ (h/l)$
Mondardo et.al (1995)	$y_c/h = 1{,}1974 - 0{,}59501\ (h/l)$
Chamani & Rajaratnam (1999)	$h/l = \sqrt{0{,}89\left[\left(\frac{y_c}{h}\right)^{-1} - \left(\frac{y_c}{h}\right)^{-0{,}34} + 1{,}5\right] - 1}$
Tatewar and Ingle (1999)	$y_c/h = 0.888 - 0.00385\ \theta_0 - 0.01195\ (h/l)$
Kells (1995)	$y_c/h = 0.50$
Boes & Hager (2003)	$y_c/h = 0{,}91 - 0{,}14 \tan\theta$
Chanson (2001)	$y_c /h = 1{,}2 - 0{,}325\ (h/l)$
Chafi (2010)	$y_c/h = 0.67$
Felder (2011)	$0{,}70 < (y_c /h) < 1{,}90$
Boes & Hager (2011)	$y_c / h = 0{,}97$
Dermawan (2011)	$y_c / h = 0{,}80$

Figure 3 represented the region of flow conditions on stepped spillways.

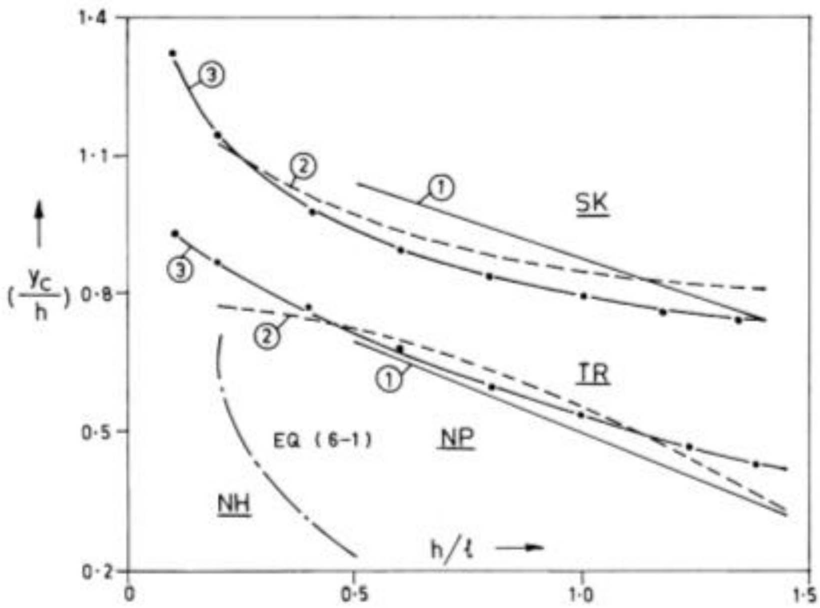

Figure 3. Flow regimes on stepped spillways: (1) Chanson (2001), (2) Yasuda et al. (2001), (3) Chinnarasi (2002), NH is nappe flow with hydraulic jump, NP is nappe flow, TR is transition flow, and SK is skimming flow. (Khatsuria, 2005)

Chanson (2001) has recommended avoiding the design of stepped spillways with transition flows regime, unless a rigorous hydraulic and structural modeling of the flow instabilities is conducted.

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4. CONCLUSION

The results of the research study indicated that:

- The stepped spillway dissipates the energy flow better than the spillway of a smooth profile.
- The average value of y_c/h for regime change conditions from nappe flow to skimming flow is above 0.8.
- The energy dissipation of stepped spillway depends on the number of spillway steps, the discharge, spillway slope, friction factor and Froude number.

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DEVELOPMENT OF HYDRAULIC DESIGN CRITERIA OF DRAINAGE SYSTEM IN RESIDENTIAL AREA

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ABSTRACT: Increasing of residential area caused land use change and increased impermeable surface. This condition affected infiltration rate and total run off, particularly in residential area. Besides, increasing of population influenced water use and water management.. The objectives of this research were: (i) to analyse drainage coefficient of drainage system; and (ii) to analyse hydraulic design criteria for drainage system in residential area. The research was conducted in Bogor Nirwana Residence from May to October 2013. The drainage coefficient was analyzed based on runoff discharge, precipitation, land use, topography and residential area. Runoff discharge was calculated using rational method. Development of hydraulics design criteria had been done based on the characteristic of channel, permitted water velocity on channel, discharge, slope, and roughness of drainage channel. The result showed that drainage coefficient was 0.088-0.110 m^3/s.ha for discharge runoff : 0.43-0.54 m^3/s on residential area with surface : 4.80 to 4.93 ha and green open spaces (RTH): 17-37% and building based coefficient (KDB): 33.0-67.3%, topography : 2.2-4.1%, and rainfall design: 144.6 mm. Hydraulic design criteria was identified based on these drainage coefficients and the results were developed in nomograph.

KEYWORDS: drainage coefficient, hydraulic design criteria, nomograph, residential drainage system, runoff

1. INTRODUCTION

Developmemt of residential area increases impervious area, and consequently, increases storm-water runoff. This situation influenced hydrological processes because it made landuse change from vegetated land cover to impervious surfaces. Impervious surfaces reduced infiltration and finally reduced base flow, but increased runoff. Artificial ditches and conduits alter runoff pathways and by using drainage channels surface flow may be diverted to artificial ponds (reservoir) or flood detention ponds. This situation can reduce flood risks and the water can be reuse before it goes to the river.

Generally population growth was not followed by adequate provision of urban infrastructure and it make landuse change. A land use change caused by urban growth and development of construction sector lead to a significant impact on land cover and finally increased runoff. It was happened because the surface of pervious area decreased and also the infiltration rate. According to this, during heavy rainfall *discharge* runoff would be increased, in proportion to the magnitude of changes in land cover, and the maximum runoff would be reached faster. Due to this and lack of appropriate drainage system, this condition can cause flood. To prevent this problem, it was necessary to plan a good drainage system in each catchment area. The construction of a drainage system aimed to convey rainfall excess and waste water in residential area.

Construction of drainage system in the urban area is a part of urban infrastructure provision. Ministry of Public Work had made drainage planning criteria (KP-03) as a standard channel planning in Indonesia (DPU 1986). Drainage system planning was made based on several

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criteria, including the type of pavement lines, the maximum permissible velocity, water depth ratio and channel base width, channel slope, and the magnitude of the discharge channel. Feyen (1980) described planning method of drainage channel hydraulic design, for agricultural land using channel with trapezoidal form. Gómes (2011) also explained the method that can be used in drainage channel design planning, but using different design criteria. The method which was applied had a different design criteria and the parameter were interrelated and had a range of values for each criterion that sometimes it made difficulties in applications on the field (McCuen 1998 and TxDOT 2002).

Several literature showed that various methodologies had been developed by researchers for different flow conditions of drainage channel system (Feyen 1980; TxDOT 2002; Dhakal *et al.* 2012). Various methods have been carried out for each type and shape of the channel. But there are some obstacles on the field implementation, particularly for urban/residential area,.

Regarding to the drainage system, generally the concept of drainage management in a residential area was to convey the escess water immediately from drainage channel or collector channel to the main drain/outlet. Water availability depends on the condition of land use, catchment area, rainfall, and existing of drainage system. Characteristics of watershed determined volume of surface runoff water that would be produced. Rainfall excess from heavy rainfall especially such as in residential area were still unutilized and flowed directly to drainage channel and then to the river through the outlet and finally arrived at the sea. Therefore to develop appropriate drainage planning, it was need analysis and development of hydraulic design criteria of drainage channel. According to above explanation, the purpose of this study were (i) to determine the drainage coefficient of residential drainage systems and (ii) to make nomograph of hydraulic design criteria for residential drainage systems.

2. METHODS

The research was conducted from May to October 2013 in Bogor Nirwana Residence (BNR), West Java. The equipment used were gauge, GPS, bulkhead measure, rain gauge, stopwatch, digital camera, altimeter, clinometer, and computer included AutoCad, Microsoft Word, Microsoft Excel, SigmaPlot 8, and CimSta software for processing climate and rainfall data. For analysis this research used rainfall data from Automatic Rainfall Recorder (ARR), 30 years maximum daily rainfall data (1982-2012) from (BMKG) Dramaga Bogor, drainage pattern map, topography map and BNR master plan.

In the beginning, observation and tracing channel were done to determine drainage pattern and also measurements of drainage channel dimensions (depth and bed width), channel slope and channel length to make the drainage pattern map. From tracing result, it could be specified the measurement location of drainage discharge, based on the lowest slope of collector channels or at outlet channel. Discharge data during rainfall were compared with rainfall data from ARR .

Determination of hydraulic design criteria ware based on surface drainage channels considering the characteristics of channels, permissible velocity, discharge, channels slope, and roughness coefficient. Determination of channel dimensions associated with the magnitude of peak discharge when rainfall events. Before determining discharge runoff, runoff coefficient values must define (C) based on type of land use and rainfall. The return period of rainfall was specified by the maximum daily rainfall data and analysed by Gumbel method. For small area, mostly impervious areas, rainfall frequency is the dominant factor. For larger drainage basins, the response characteristics were the primary influence on frequency. For drainage areas with few impervious surfaces (less urban development), antecedent moisture conditions usually govern, especially for rainfall events with a return period of 10 years or less (TxDOT 2002). This research used a return periode of 5 years for block area less than 5 hectare.

The rate of runoff resulting from any constant rainfall intensity is maximum when the duration of rainfall equals to the time of concentration. If the rainfall intensity is constant, the entire drainage area contributes to the peak discharge when the time of concentration has elapsed. This assumption becomed less valid as the surface of drainage area increases. For large drainage areas, the time of concentration can be so long that the assumption of constant rainfall intensities for such long periods is not valid. Besides, shorter but more intense rainfalls can produce larger peak flows. Additionally, rainfall intensities usually vary during a storm (TxDOT 2002). Then rainfall data were analyzed to obtain the rainfall intensity with the time of concentration using Darmadi(1990) equation, that explain relationship of rainfall intensity and rainfall duration in several location of watersheds area in Indonesia. Darmadi (1990) mentioned that rainfall duration of 2, 3, 4, 5, and 6 hours was collected for 10 years period based on single rainfall data.

Analysis of hydraulic design criteria was defined based on width of channel base (B) and channel depth (h). The analyzed was conducted with trial and error method, based on geometric elements and range of discharge (Q) channels related with ratio B / h. The ratio of B / h = 1 for discharge Q < 0.5 m^3/s; B/h = 2 for discharge 0.5 <Q <1.1 m^3/s; B / h = 2.5 for discharge 1.1 <Q <3.5; and then B / h = 3 for discharge Q> 3.5 (DPU 1986). After that the results were used to develop the hydraulic design criteria for drainage system network. The design criteria will be used in the decision-making process for the development of housing as well as the drainage network standard drainage design on the surface drainage network.

3. RESULTS AND DISCUSSION

The amount of discharge is determined by rational method that is commonly used to estimate the design discharge at various forms of drainage in urban areas for a small catchment area (Dhakal et al 2012). Calculation of design use rainfall intensity discharge that occurs every hour which is influenced by the time of concentration flow. Rainfall design of incidence data were analyzed based on maximum daily rainfall for 30 years (1982-2012) using Gumbel method. Analysis of return periods of rain in study area used 5-year return period rainfalln and were obtained from the analysis of the plan for rainfall depth of 144.6 mm. Rainfall duration was conducted based on single rainfall data on Cisadane watersheds in Bogor City and rainfall intensity was obtained as 48,2 mm/hour.

The difference of design discharge value in each residential block were directly proportional with the value of run-off coefficient in each section. The magnitude of design discharge was comparable to any changes in land cover defined as runoff coefficient (Dhakal et al 2012). Based on the design discharge value for each residential block, drainage coefficient for the design of channel on any area could be analysed. Table 1 showed the analysis results of design discharge and drainage coefficient of each residential block.

Table 1. Characteristics of drainage pattern system

Parameters	Block 1	Block 2	Block 3
Catchment area, A (ha)	4.87	4.80	4.93
Channel slope, S (%)	2.50	2.20	4.10
Runoff coefficient, C	0.66	0.72	0.82
Rainfall intensity, I (mm/hour)	48.20	48.20	48.20
Design discharge, Q (m^3/s)	0.43	0.46	0.54
Drainage coefficient, q ($m^3/s.ha$)	0.088	0.096	0.110

The amount of peak discharge and runoff volume were an important parameter in the analysis of hydraulics design criteria on hydrological aspects of engineering (Dhakal et al 2012). Hydraulics design criteria in an urban area can be determined from existing several drainage path (McCuen 1998). Table 2 shows the analysis results of hydraulics design criteria in the study area.

Table 2. Characteristics of drainage pattern design in residential area

Parameters	Block 1	Block 2	Block 3
Design discharge, Q (m^3/s)	0.43	0.46	0.54
Drainage coefficient, q ($m^3/s.ha$)	0.088	0.096	0.110
Manning's roughness coefficient, n	0.017	0.014	0.014
Channel slope, S (%)	2.80	2.60	2.30
Depth of flow, h (m)	0.46	0.39	0.30
Bed width, B (m)	0.46	0.39	0.60
Freeboard, FB (m)	0.20	0.20	0.20
Depth of channel (m)	0.70	0.60	0.50
Cross-sectional area of flow, A_S (m^2)	0.22	0.15	0.18
Wetted perimeter of flow, P (m)	1.39	1.18	1.20

The potential of flow discharge sourced from a collector drainage channel in block 1, block 2, and block 3 respectively 0.43; 0.46; and 0.54 m^3/s. The results of analysis showed that each block had a different design dimensions. Determination of the design was based on the maximum permissible velocity and range discharge value associated with the ratio B / h of DPU channel planning standard (DPU 1986). In the design of hydraulics in a residential area on block 1 which wide 4.87 ha with a pavement masonry channel required flow depth of 0.46 m, bed width of 0.46 m, bottom slope of 0.012 and freeboard of 0.20 m. In the hydraulics design criteria for block 2 which wide 4.80 ha with pavement concrete channel required flow depth of 0.39 m, bed width of 1.1 m, bottom slope of 0.012, and freeboard of 0.20 m. At block 3 wide of 4.93 hectares required hydraulics design criteria with flow depth of 0.54 m, bed width of 0.3 m, bottom slope of 0.011, and freeboard of 0.20 m.

The development of hydraulic design criteria in this research was done based on opened rectangular hydraulics channel parameters which were commonly used in residential areas. This research tried to develop a nomograph for hydraulics design criteria in two forms of nomograph, i.e nomograph of drainage coefficient (Figure 1) and nomograph of flow depth (h) and bed width (B) (Figure 2).

The nomographs were made based on channel scheming criteria (KP-03) commonly used as a standard of channel planning in Indonesia (DPU 1986). The hydraulics design criteria that determined by the nomogram was possible to be used in another location with a surface of catchment area less than 10 hectares and rainfall planed less than 150 mm. The determination of hydraulics design criteria with nomogram could be done as follows:

1. Determine of time duration on each watersheds based on rainfall even condition from single rainfall data (Darmadi 1990).
2. Calculate of the rainfall design (CH_{design}) from maximum daily rainfall of BMKG local data which 10 years minimum period with a method commonly used such as Gumbel Methods, log Pearson III or other methods.
3. Determine of the rain intensity (I, mm/h) from rainfall design per time duration.
4. Determine of the drainage coefficient (q, $m^3/s.ha$) in Figure 1 through rainfall intensity (I) and the runoff coefficient (C) that previously analyzed by area and type of plan land of the master plan map.

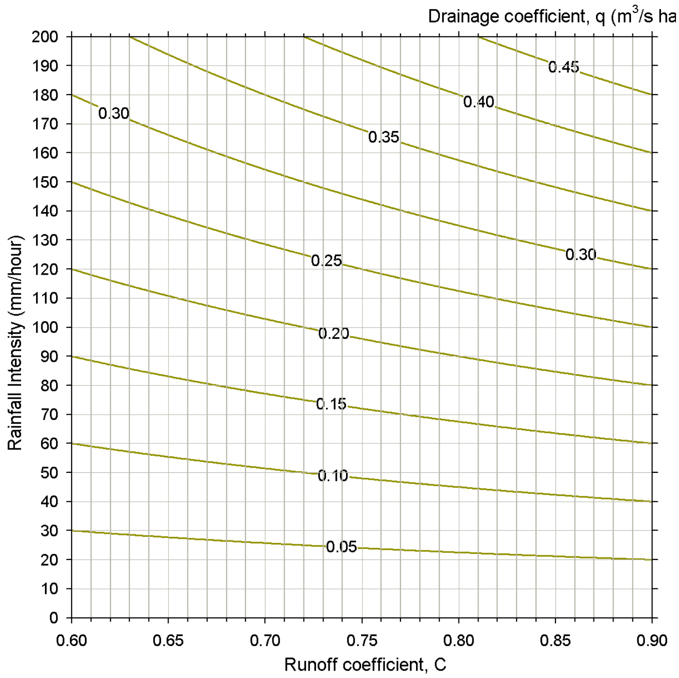

Figure 1. Nomograph of drainage coefficient

5. Calculate the design discharge (Q_R) of the drainage coefficient (q) multiplied with of wide the area based on the master plan map. Then design discharge used as freeboard height estimation refers to the planning criteria No.03 Ministry of Public Work(DPU 1986)
6. Determine the width of base (B) and the depth of channel (h) in Figure 2 (concrete channel) or Figure 3 (masonry channel) based on the range discharge and the ratio of B to h (B/h). The determination of hydraulics design criteria for grades B and h were also based on the maximum permissible velocity on the type of pavement channel that 2 m/s for the type of masonry channel and 3 m/s for the type of concrete pair channel, which is intended to avoid sedimentation in the drainage channel.

Figure 1 was nomograph of drainage coefficient determination (m^3/s.ha) of each rain event (rainfall intensity, mm/h), which occured in an area described by the runoff coefficient. From the runoff coefficient then it could be determined the value of drainage coefficient, based on the value of rainfall intensity that would occur. From the drainage coefficient then it could be determined the discharge of surface runoff (Q, m^3). The amount of runoff discharge was obtained by multiplying drainage coefficient with wide of land area (ha).

The surface flow discharge (Q) on a plan area (ha) was calculated based on the drainage coefficient, and it could be determined based on channel width (B) and the channel depth (h). Based on surface runoff discharge (Q) was determined the value of B and h and according to DPU standard (DPU 1986). In residential area, generally rectangular channel were used with masonry or concrete type. For drainage plan, rectangular with a concrete pair channel types can used nomograph Figure 2 and masonry channel types can used nomograph Figure 3.

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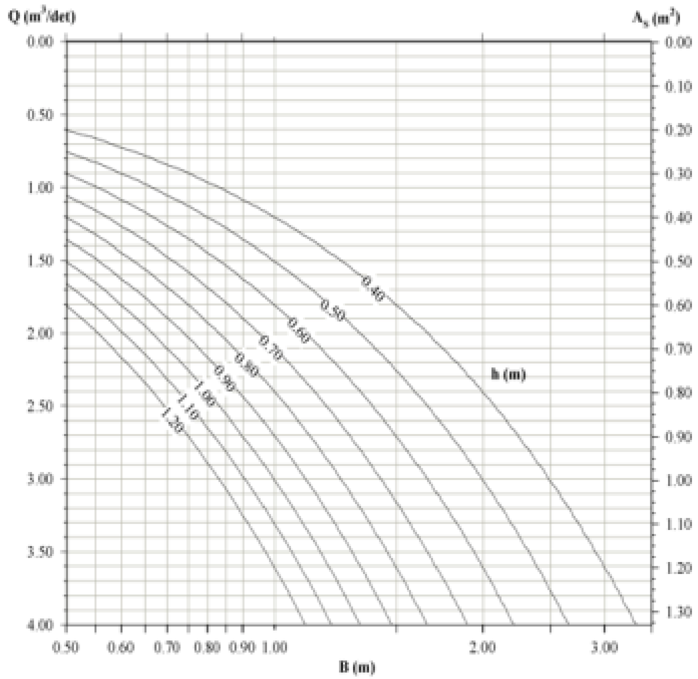

Figure 2. Nomograph of hydraulics design criteria for concrete drainage channel

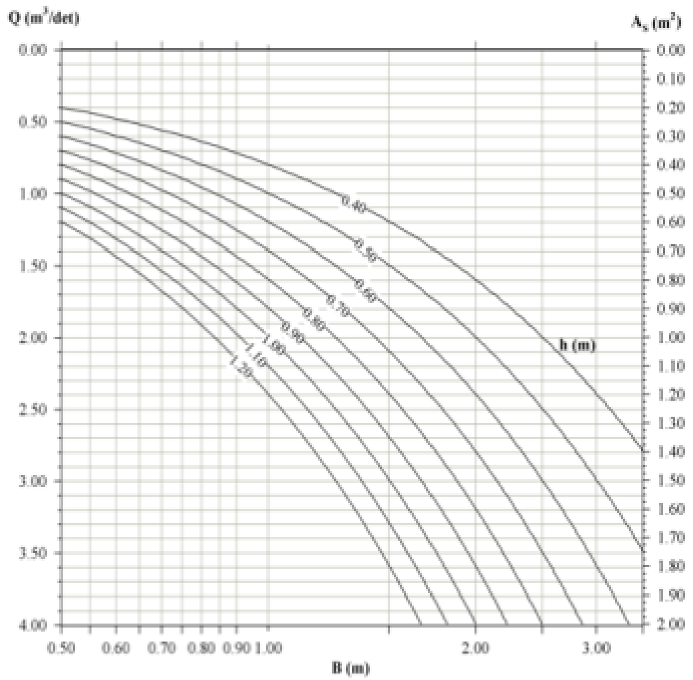

Figure 3. Nomogram of hydraulics design criteria for masonry drainage channel

4. CONCLUSION

Drainage coefficient could be determined around 0.30-0.35 m^3/s.ha for runoff of 1.43 to 1.75 m^3/s and design of 144.61 mm for residential areas of 4.80-4.93 ha with topography of 2.2-4.1%. The hydraulics design criteria have been developed in the form of nomograph.

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FEASIBILITY ANALYSIS OF INVESTMENT WITH LIFE CYCLE COST APPROACH ON PRASTI TUNNEL WATER TREATMENT PLANT (WTP) CONCEPTUAL DESIGN

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ABSTRACT: Jakarta's problems such as flood and traffic inspired a PRASTI (Public Railway and Stormwater Infrastructure) infrastructure design, which is a multifunctional tunnel whose one of its function is to drain Western Canal Flood (BKB) overflow. The feasibility study of this project initiated the development of PRASTI Water Treatment Plant (WTP) which aimed to increase the added functions of this infrastructure design. Before the construction of WTP, project feasibility study was required to see investment feasibility so that investors could join in developing this infrastructure. This study aimed to analyze the feasibility of the infrastructure using Life Cycle Cost (LCC) method by considering cost of development, operational, and maintenance costs as well as revenue components in 2014-2045 period. Cost analysis was obtained from benchmarking to several countries and applications of different technologies. Based on the study it's discovered that investment feasibility of a WTP project was strongly influenced by field condition (electricity and chemical needs) which will be used. Difference of operational and maintenance cost schemes in Life Cycle Cost analysis in PRASTI WTP project indicated that the project is financially feasible with IRR amounting to 23% (optimistic) and IRR value of 8% (pessimistic).

KEYWORDS: Water Treatment Plant, Life Cycle Cost, Cost Component, Internal Rate of Return

1. INTRODUCTION

Jakarta as the capital of Indonesia is the center of economy and governance of the nation. Jakarta is 661,52 km^2 which consists of 6.977,5 km^2 sea and total population is 10.187.595 (BPS, Jakarta Dalam Angka 2012, 2012). Total population in Jakarta is different in day and night. In 2010 total population of Jakarta at night was around 9,6 million and increased to 12,5 million in the day (BPLHD, 2011). Significant population grown was directly proportional with the needs for clean water in DKI Jakarta region. According to Badan Regulator PAM DKI Jakarta (2011), piping clean water service scope in 2010 was 62,31% from the targetted 64,89%. The rest of the population use groundwater to meet their personal water needs. Data of ADB in 2003 (Dinas PU DKI Jakarta, 2008) also stated that clean water service in Jakarta was still low due to coverage (low), service reliability (high), alternative source *(medium)* and affordability aspect (low). So one of the bases of this study was the expectation that the designing of PRASTI WTP could increase piping clean water supply of the public.

On the other hand, an infrastructure design called PRASTI Tunnel was on conceptual design stage. PRASTI *(Public Railway and Stormwater Infrastructure)* is a tunnel with three main functions which are as supporting facility of airport train transportation, MRT infrastructure and runoff storage (from BKB and from several nearby rivers). PRASTI Tunnel is 10 km in length with inner radius 17 m and outer radius 19 m. Based on previous study by ID-TECH (Integrated Design and Technology) UI, total water which flows in PRASTI Tunnel is 212 m^3/s or 212074 l/s (Novi, 2013). It illustrates that the amount of raw water of the city is enough for clean water for the city. Based on the two gaps (lack of clean water and surplus

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raw water source) Water Treatment Plant development concept was proposed with an approach of being the function of city clean water problem solution integrated with flood control function in PRASTI Tunnel. The PRASTI WTP development is expected to increase the number of people who receive clean water service as it's predicted that in 2015 (according to IWI, Indonesia Water Institute) clean water needs is 35.879 l/s while total production capacity of PAM Jaya is only 21.828 l/s.

In the development stage of Water Treatment Plant investment feasibility is required to encourage investors to invest capital in the project. Investment feasibility analysis can be done by various methods but the analysis used in the conceptual design of Water Treatment Plant in PRASTI Tunnel was Life Cycle Cost analysis because this analysis starts at research and development, design, production, marketing/distribution to service stages so that services can reach customers. Analysis with LCC is used to consider all costs during the life cycle of Water Treatment Plant (Dearmont, dkk., 1998). Feasibility level of IRR value of PRASTI WTP was expected to increase the IRR value of PRASTI Tunnel project in general. Life Cycle Cost of a Water Treatment Plant consists of Initial Costs (land acquisition cost and construction cost), O&M Costs (Operation and Maintenance Costs) (Wichitra Singhirunnusorn and Michael K. Stenstrom, 2010) and *Revenue* for life-cycle period of this project about 30 years (Novi, 2013). The main purpose of this study was to obtain investment feasibility value using Life Cycle Cost Analysis.

2. RESEARCH METHODS

This study was a field study at conceptual design phase. The method used in this study was Life Cycle Cost Analysis. In this study there were three components which could influence the result of the study. The three components were initial cost, operation and maintenance costs and collected revenue. From the description of the three variables are as follows:

a. Initial Cost: land, building and technology installation, DED cost, pipeline transmission, transportation, security and licensing costs.
b. Operational and maintenance costs: cost of electricity, maintenance cost, membrane replacement cost, depreciation, manpower cost and chemical cost.
c. Revenue. This study assumed that 60% and 50% water was sold in which water price was between Rp 4.500 and Rp 7.000/m^3.

Another assumption used in this study was 5,95% inflation and 6,81% BI Rate (Bank Indonesia, 2013). The flow of this research stated with benchmarking study to construct a conceptual WTP. Based on criteria and condition in the field, we would get the correct design for WTP. WTP design would determine initial cost and operational and maintenance costs. Afterward, from various assumptions, revenue during the life cycle of this project was obtained. Based on Life Cycle Cost analysis which produced NPV (Net Present Value) and IRR (Internal Rate of Return), the most optimum WTP design would be found.

3. ANALYSIS AND DISCUSSION

3.1 CAPITAL COST

Capital cost was obtained from the comparison of PRASTI WTP conceptual design which would use MF UF membrane system with Roetgen WTP (Germany) and Varberg WTP (Sweden). The components of capital cost in WTP conceptual designs were:

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a) The cost of land acquisition

Land acquisition cost was obtained by analyzing land price per area unit (in this case m^2). Based on comparison of Roetgen WTP, Varberg WTP with the conceptual design of PRASTI WTP, it's discovered that the land used to build PRASTI WTP with 14.500 l/s capacity was 6457,5 m^2 and 7.500 l/s capacity was 4252,5 m^2. Based on survey results, we assumed that the price of land in the area Pluit Rp 8.000.000/m^2.

b) The construction cost of buildings and membrane technology

Construction and membrane technology installation costs consisted of 5 parts: building cost, technology process cost (without membrane), membrane cost, cost of electricity and control cost. Roetgen WTP, built in 2008, has capacity 1944,44 l/s and construction cost € 25,5 million. In order to get the value of the Initial Cost PRASTI WTP with a capacity of 14.500 l/s, the value of Initial Cost Roetgen WTP was then converted by the formula:

$$\text{IC WTP Jakarta} = a \times b \times c$$

Where:

a = IC Cost from Benchmarking
b = IKK, Construction Index
c = Comparison of WTP

c) Detail engineering design (DED) cost

Detail engineering design cost in every project differs and average DED cost is 5% - 10%. In this PRASTI WTP project, it's assumed that DED cost is 10% of WTP construction cost. By using benchmarking scheme of Roetgen WTP, DED cost which should be expended was Rp 256.414.007.000 (for 14.500 l/s capacity). While by using benchmarking scheme of Varberg WTP, DED cost which should be expended was Rp 234.428.253.000.

d) Transmission pipe and equipment procurement cost

Transmission pipe and equipment procurement cost was obtained from the comparison of PRASTI WTP with WTP in Banyuwangi where the cost percentage was 1,42% of land acquisition, building and equipment costs. In benchmarking 1 (Roetgen WTP), cost of transmission pipe and equipment procurement was Rp 37.368.572.000, while in benchmarking 2 (Varberg WTP) cost of transmission pipe and equipment procurement was Rp 34.596.750.000.

e) Operational transportation facility cost

Operational transportation facility cost was obtained from the comparison of PRASTI WTP with WTP in Banyuwangi where the cost percentage was 3,57% of land acquisition, building and equipment costs. In benchmarking 1 (Roetgen WTP), operational transportation facility cost was Rp93.421.431.000, while in b*enchmarking* 2 (Varberg WTP) operational transportation facility cost was Rp 86.491.876.000.

f) Cost of security system software

Cost of security system software was obtained from the comparison of PRASTI WTP with WTP in Banyuwangi where the cost percentage was 1,42% of land acquisition, building and

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equipment costs. Cost of security system software with benchmarking Roetgen WTP was Rp 37.368.572.000,- while cost of security system software with benchmarking Varberg WTP was Rp 34.596.750.000,-.

g) Cost of licensing, environmental impact study, ISO

Cost of licensing, environmental impact study, ISO was obtained from the comparison of PRASTI WTP with WTP in Banyuwangi where the cost percentage was 0,71% of land acquisition, building and equipment costs. Cost of licensing, environmental impact study of PRASTI WTP project with benchmarking Roetgen WTP and Varberg WTP with 14.500 l/s capacity were, respectively, Rp 18.684.286.000,- and Rp 17.298.375.000,-.

3.2 OPERATIONAL AND MAINTENANCE COST ANALYSIS

Operational and maintenance costs are the most important costs in water processing installation unit. Water quality and the technology used would influence the amount of this cost. The components of operational and maintenance costs were:

a) Cost of electricity

The assumption of cost of electricity was influenced by total kWh ratio used. The price of electricity used was Rp 1.352,-/kWh.

b) Maintenance Cost

Maintenance cost by using MF UF membrane system was obtained from equipment cost in which maintenance cost was 2% of equipment cost (process technology, membrane, electrical and control costs).

c) Membran Replacing Cost

Membrane on WTP was replaced within 2 or 5 years. But in other cases, replacement of membranes was made in 2-3 years. In conceptual design PRASTI WTP membrane replacement was done in the next 5 years, so we used a formula for membrane replacement cost below.

$$Membran\ replacement\ cost\ (per\ year) = \frac{Membran's\ price}{Life\ years\ membran} \quad (1)$$

d) Depreciation cost

e) Manpower cost

f) Chemical Cost

For this research, there are 8 schemes for operational and maintenance cost. The difference operational and maintenance cost can be seen from the percentage as follows.

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Table 1. Percentage of Cost Components PRASTI WTP Based on Roetgen WTP

Type	Electricity	Mainte-nance	Membrane	Depreciation	Manpower	Chem.	Note
1	29%	12%	12%	11%	24%	18%	Electricity (Rp2.100), Chem. (Rp 350,-)
2	46%	8%	8%	8%	16%	18%	Electricity (Rp5.100), Chem. (Rp 525,-)
3	27%	11%	11%	11%	22%	24%	Electricity (Rp2.100), Chem. (Rp 525,-)
4	49%	9%	9%	8%	17%	13%	Electricity (Rp5.100,-), Chem. (Rp 350,-)

Source: Author (2014)

In addition, the percentage of operational and maintenance cost components using the benchmarking of Varberg WTP seen from the table below.

Table 2. Percentage of Cost Components PRASTI WTP Based on Varberg WTP

Type	Electricity	Mainte-nance	Membrane	Depreciation	Manpower	Chem.	Note
1	30%	12%	12%	11%	25%	18%	Electicity (Rp2.100), Chem. (Rp350,-)
2	47%	8%	8%	7%	17%	18%	Electricity (Rp5.100), Chem. (Rp525,-)
3	27%	11%	11%	10%	23%	25%	Electricity (Rp2.100), Chem. (Rp525,-)
4	50%	8%	8%	8%	18%	13%	Electricity (Rp5.100,-), Chem. (Rp350,-)

Source: Author (2014)

Based on assumptions of Initial cost, operational and maintenance cost and revenue, LCC simulation chart for 48 schemes below was made.

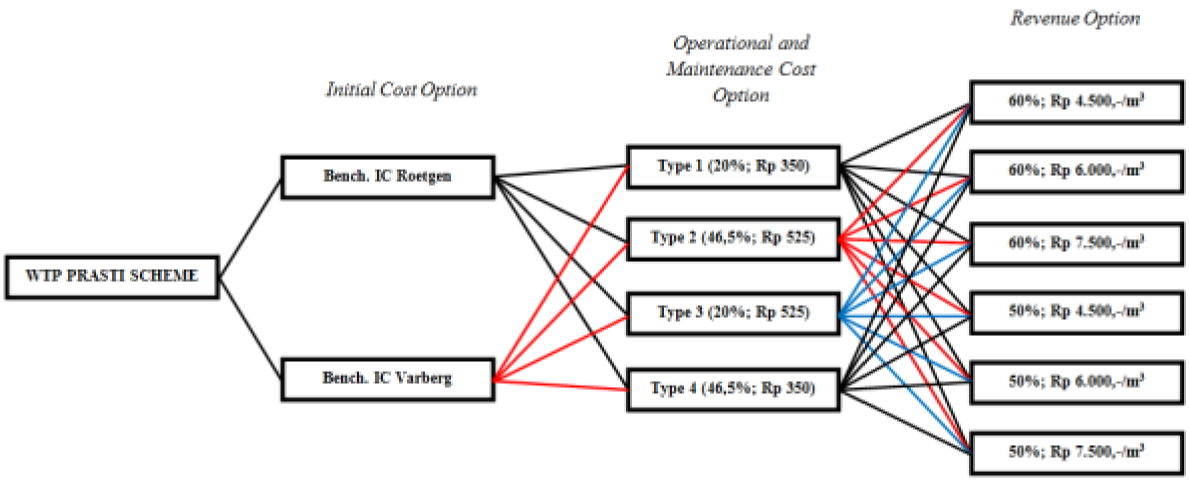

Figure 1. Scheme Simulation WTP PRASTI

Source: Author (2014)

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This simulation produced 48 schemes in which 5 of them were considered financially feasible. Results of each scheme were:

Table 3. Feasible schemes

NO	SCHEME	IRR	NPV	NOTE
3	IC Roetgen, OM Type 1, Revenue 60% (Rp 7500)	21%	Rp. 4.757.040,30	Feasible
6	IC Roetgen, OM Type 2, Revenue 60% (Rp 7500)	10%	Rp. 623.686,38	Feasible with PPP scheme
9	IC Roetgen, OM Type 3, Revenue 60% (Rp 7500)	19%	Rp. 3.985.021,51	Feasible
12	IC Roetgen, OM Type 4, Revenue 60% (Rp 7500)	12%	Rp. 1.395.705,17	Feasible with PPP scheme
15	IC Roetgen, OM Type 1, Revenue 50% (Rp 7500)	9%	Rp. 519.342,58	Feasible with PPP scheme
26	IC Varberg, OM Type 1, Revenue 60% (Rp 6000)	9%	Rp. 411.581,37	Feasible with PPP scheme
27	IC Varberg, OM Type 1, Revenue 60% (Rp 7500)	23%	Rp. 5.273.847,67	Feasible
30	IC Varberg, OM Type 2, Revenue 60% (Rp 7500)	12%	Rp. 1.140.493,74	Feasible with PPP scheme
33	IC Varberg, OM Type 3, Revenue 60% (Rp 7500)	21%	Rp. 4.501.828,87	Feasible
36	IC Varberg, OM Type 4, Revenue 60% (Rp 7500)	14%	Rp. 1.912.512,53	Feasible
39	IC Varberg, OM Type 1, Revenue 50% (Rp 7500)	11%	Rp. 1.036.149,94	Feasible with PPP scheme
45	IC Varberg, OM Type 3, Revenue 50% (Rp 7500)	8%	Rp. 264.131,14	Feasible with PPP scheme

Source: Author (2014)

Financially feasible schemes where IRR value > MARR WTP (13% - 18%) was scheme number 3, 9, 27, 33 and 36. Moreover, there were 7 feasible schemes which had to be applied with PPP scheme. The seven schemes had smaller IRR values than MARR but still bigger than existing bank interest. Based on the 48 schemes, optimistic and pessimistic schemes were made in which optimistic scheme was scheme number 27 with IRR 23% and pessimistic scheme was scheme number 45 with IRR 8%.

4. CONCLUSION

Based on the research, the following conclusion could be drawn:

- The combination of Initial Cost, Operation and Maintenance Cost and Revenue produced 48 schemes which could be applied on the conceptual design of PRASTI WTP. From the existing schemes, only 5 of them were financially feasible where Internal Rate of Return > Minimum Attractive Rate of Return WTP, and 7 of them had Internal Rate of Return > bank interest. Internal Rate of Return (IRR) is one of parameters as decision making tools in this project, beside Net Present Value (NPV).
- Optimistic scheme was in scheme number 27 which used Initial Cost component which referred to Varberg WTP, operational and maintenance costs type 1 and revenue from the sale of 60% produced water which cost Rp 7.500/m^3. Internal Rate of Return in this scheme was 23%.
- Pessimistic scheme was in scheme number 45 which used Initial Cost component which referred to Varberg WTP, operational and maintenance costs type 3 and

revenue from the sale of 50% produced water which cost Rp 7.500/m^3. Internal Rate of Return in this scheme was 8%.

- Water treatment plant project with membran technology is feasible to adapt in DKI Jakarta because that city has large price of clean water.

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THE EFFECT OF EXPANSIVE SOIL ON PAVEMENT

Faizul CHASANAH[1]

ABSTRACT: Sub grade has an important role in the pavement structure. This research was conducted to analyze the influence of potential and expansive pressure of sub grade soil on flexible pavement. This research is located from Purwodadi to Solo road and from km 66+650 to km 87+180. Subgrade have predicted as expansive soil that effect to road damages. The analysis is done by evaluating the road damages based on secondary data from Bina Marga Department in Purwodadi and direct survey on the field., The research was begun by putting the sample, then analyse it in the laboratory and the soil classification was determined by the Unified system and AASHTO. The analysis of the potential expansive soil in this study is used measurement method (indirect method) by Seed (1962) and the classification method (indirect method) by Chen (1975). The result showed that the types of road damages such as surface texture deficiencies, potholes, edge defect, longitudinal cracking, block cracking and rutting. Based on the laboratory tests, the soil condition has a critical expansive degree and high expansive pressure. The average value of the expansive degree to all sample show > 10 %. This classification is high expansive degree. The result of expansive pressure in laboratory test has an average value > 300 kPa. This classification shows that subgrade on the Purwodadi road has low quality. So, this research can be concluded that subgrade on the Purwodadi - Solo road is an expansive soil, which very potential to occur to high road damages.

KEYWORDS: expansive soil, potential and expansive pressure, road damages.

1. INTRODUCTION

Latif (2005) stated that in the construction of highway pavement there are important things like subgrade conditions. The subgrade is the foundation that will receive the entire load of the pavement layers and the existing traffic load on it so that the condition of the subgrade layer greatly affect the existing construction on the land. A lot of road damage caused by poor subgrade like clay in the form of expansive clays. This expansive soil conditions capable of providing large losses in highway construction.

Based on the observations, Purwodadi - Solo often damaged roads. The government has made efforts to improve the road on it, but the results do not provide for the better change. The purpose of this study was (1) to identify road damage on flexible pavement Purwodadi – Solo roads at km 66 to km 87 + 650 + 180. Based on secondary data (2) analyze the effect of potential and land development pressures on the base layer of pavement.

2. LITERATURE VIEW

2.1. SUBGRADE

Hardiyatmo (2011) stated that the pavement serves to provide a smooth surface on the vehicle for all seasons. Pavement performance is influenced by the characteristics of the subgrade. Soil as a foundation that directly receives the traffic load of a pavement which was called the land above the base (subgrade). Subgrade is the foundation, where the foundation below (subbase), foundation (base) or pavement are, then inegritas of pavement structure depends on the stability of soil structure basis.

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2.2. EXPANSIVE SOIL

Hardiyatmo (2002) states that expansive clays have several characteristics. In general, expansive clay contains minerals that show changes in volume when the addition of high water content. To analyze the potential for development, the methods are used:

2.2.1. Method of Measurement (Indirect Method)

Seed et al (1962) stated that the potential for development (swelling potential) is the percentage of development under the pressure of 6.9 kPa on the soil samples were compacted at optimum water content so as to achieve the maximum dry weight of the volume according to AASHTO standards. Classification according to the degree of expansive Seed (1962) is shown in Table 1.

Table 1. Classification of Expansive degree (Seed dkk, 1962)

Potential development (%)	Degrees expansive
0 – 1,5	Low
1,5 – 5,0	Medium
5,0 – 25,0	High
> 25,0	Very High

2.2.2. Classification Method (Indirect Method)

Almeyer (1955) in Latif (2005) suggest classification of the potential for development based on the amount of shrinkage limits and linear shrinkage. Based on the quote Chen (1975) makes reference to its relationship with the degree of development of clay percentage linear shrinkage and shrinkage percentage Atterberg limits. Classification based on the development potential of Chen (1975) are shown in Table 2.

Table 2. Classification based on the potential for expanding the boundaries of Atterberg (Chen, 1975)

Shrinkage limit (%)	Linear shrinkage (%)	Degrees expands
< 10	> 8	Critical
10,0 - 12,0	5,0 - 8,0	Medium
> 12	0 – 5	Not Critical

2.3. CHARACTERISTICS OF ROAD DAMAGE ON THE EXPANSIVE GROUND

The characteristics of the damage on the ground based on guidebook expansive Public Works Department are as follows:

1. Cracks (cracks in the pavement caused by shrinkage and development of land. Cracked is cracked lengthwise starting from the edge of the shoulder of the road toward the middle of the pavement).

2. Increase in soil (soil or cembungan increase pavement can be caused by the expansion of expansive soil under the pavement).

3. Decrease (reduction in pavement surface can occur due to changes in the basic properties of soil in soft ground or the diminution of volume shrinkage due process).

4. Avalanches (water surface is above the pavement can get into a big gap, so that the soil becomes saturated and the water content in it increases).

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3. BASIS THEORY

3.1. SOIL CLASSIFICATION

Classification of the soil can be determined by various methods such as the Unified system and AASHTO system. In the international system of Soil Classification Unified soil classification system (USCS) is used for foundation engineering works such as dams, airfields and similar construction. In some countries like the United States to use the land for the job specification.

Classification AASHTO (American Association of State Highway and Transportation Official) is used to determine the soil quality in the design of road embankment, subbase, and subgrade. Soil properties that must be known to determine the soil classification is calculated based on the standard ASTM D.

3.2. DEVELOPMENT POTENTIAL AND DEVELOPMENT PRESSURE

Seed et al (1962) suggest the potential for the development of the relationship expressed in function of the percent of the grain size on the activity of soil clays and clay-sand mixture is compacted to standard proctor maximum density and allowed to expand at 6.9 kPa pressure evenly split. Based on the results of the testing-testing, development potentials is expressed by the equation:

$$S = \left(3.6 x 10^{-5}\right) A^{2.44} C^{3.44} \qquad (1)$$

Where S = the potential for development; C = percent clay fraction (grain diameter <0.002 mm); A = activity = PI / C; PI = plasticity index

Seed et al (1962) stated that the amount of strain that occurs in the development of laboratory tests can be analyzed by the equation:

$$S = \frac{\Delta \mathrm{H}}{\mathrm{H}} x 100\% \qquad (2)$$

Where S = the potential for development; ΔH = change in sample height (cm); H = height of the initial sample (cm)

Pressure development (swelling pressure) is the pressure that prevents land development expands. To get great development pressure test conducted in the laboratory development by measuring the test load and use the tool diameter.

4. RESEARCH METHODOLOGY

4.1 SOIL SAMPLING

The test material used in this research is a basic soil (subgrade) were taken at 13 point locations on roads Purwodadi - Solo. Sampling was carried out in the area around the road by using tubes of metal measuring 40 cm long and 7 cm in diameter. The tube is drilled into the soil from a depth of 20 cm to 70 cm depending on the location of the field conditions.

Each location of the sample taken 1 and 1 bag of plastic tubes and plastic tubes containing the test material is sealed so that no shrinkage so that the water level is still maintained in accordance original field.

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4.2 LOCATION OF RESEARCH

In this study they conducted on the Purwodadi - Solo. Especially on the highway and repair damaged roads IE at km 66 + 650 to km 87 + 180. The location of this study is shown in Figure 3.1.

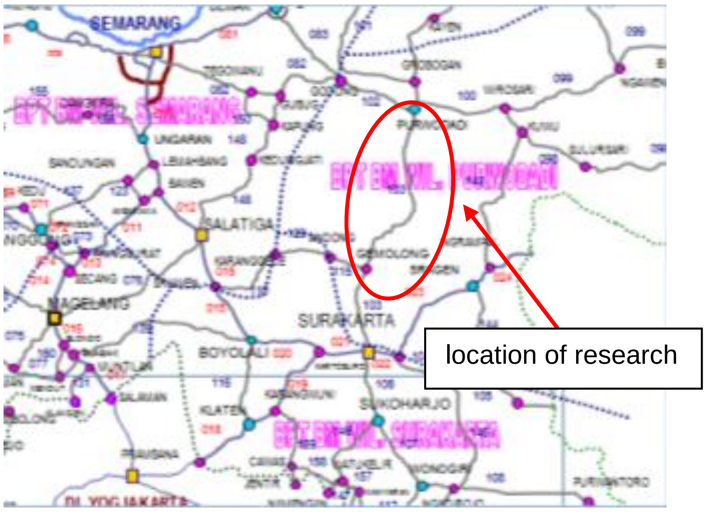

Figure 1. Location of the study

5 FLOW CHART OF RESEARCH

Research flow chart shown in Figure 2.

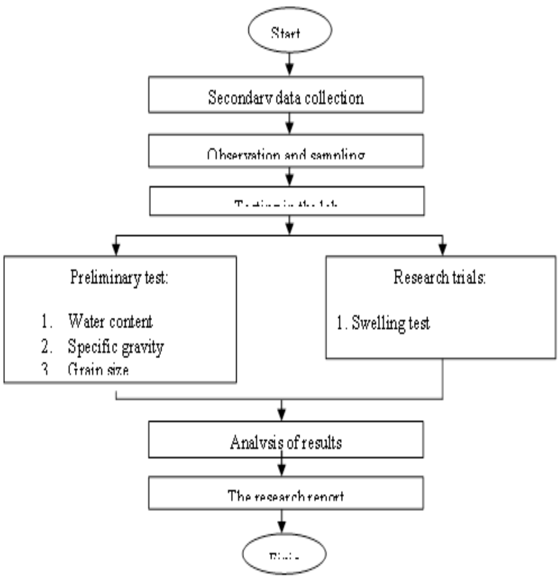

Figure 2. Flowchart of the study

6. RESULTS AND DISCUSSION

6.1 IDENTIFICATION OF ROAD DAMAGE

Based on secondary data obtained from the Provincial Department of Highways Semarang, road conditions Purwodadi - Solo at the beginning of 2012 is very ironic. Roads are the

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center of attention is all the way up to km 66 km 87 + 650 + 100. The roads were damaged roads are quite heavy, so it is very disturbing traffic and even vehicles that cross it often resulted in accidents. Therefore, the Department of Highways, District Purwodadi working with the Highways Agency to Semarang Provincial road improvements at eleven locations that experience high levels of road damage. This data then becomes the reference point for determining the thirteen study sites with the addition of two locations that do not damage the road. This is for comparison later in mengalisis subgrade conditions below. As for the damage to the road conditions are shown in Table 3.

Table 3: The condition of road damage Purwodadi - Solo early 2012

No	Location	Damage to road conditions
1	Km 67 + 000	Good
2	Km 70 + 000	Good
3	Km 74 + 000	Moderately damaged
4	Km 76 + 500	Severely damaged
5	Km 77 + 500	Severely damaged
6	Km 79 + 000	Severely damaged
7	Km 80 + 000	Severely damaged
8	Km 80 + 400	Severely damaged
9	Km 81 + 500	Severely damaged
10	Km 82 + 000	Severely damaged
11	Km 83 + 000	Severely damaged
12	Km 85 + 000	Severely damaged
13	Km 86 + 000	Severely damaged

6.2 BASIC SOIL CLASSIFICATION

To determine the basic soil classification system used two methods: the Unified and AASHTO system. Based Unified classification system indicates that the subgrade on the road Purwodadi - Solo km 67 + 000 to km 86 + 000 clays belonging to the type CH and MH. CH soil is not organic clay with high plasticity (fat clay). MH soil is not soil organic silt or fine sand distornae, elastic silt.

Based on the AASHTO classification system indicates that the subgrade on the road Purwodadi - Solo km 67 to km 86 + 000 + 000 clays belonging to the type A-and A-7-6 7-5. A soil is clay-7-5 with a plastic limit is high enough. A soil is clay-7-6 with a low plastic limit. Therefore, based on a common assessment system AASHTO subgroup is of moderate to poor.

6.3 THE DEGREE OF DEVELOPMENT

The classification method development potential is varied. The results of the classification of the degree of development, according to Chen (1975) ditujukkan in Table 4.

Table 4. Classification of the degree of development, according to Chen (1975)

Location	Limit Losses (%)	Classification
Km 67+000	7,08	Critical
Km 70+000	5,00	Critical
Km 74+000	12,61	Not Critical
Km 76+000	2,01	Critical
Km 77+500	61,57	Not Critical
Km 79+000	10,28	Medium
Km 80+000	11,70	Medium
Km 80+400	13,69	Not Critical

Location	Limit Losses (%)	Classification
Km 81+500	0,84	Critical
Km 82+000	5,94	Critical
Km 83+000	17,98	Not Critical
Km 85+000	8,98	Critical
Km 86+000	7,60	Critical

The results of classification based on the Seed (1962) showed that the subgrade along the segment location, expansive research has a high degree of value. The average value of the degree of expansiveness of all samples showed > 10% so that the subgrade soil has a poor quality. The results of classification based on the Seed (1962) as a whole is shown in Table 5.

Table 5 Classification of the degree of expansiveness (Seed et al, 1962)

Location	$S_{\text{empires (\%)}}$	$S_{\text{pengujian (\%)}}$	Classification
Km 67+000	12,45	17,78	High
Km 70+000	0,86	5,64	High
Km 74+000	2,66	14,94	High
Km 76+000	9,13	22,69	High
Km 77+500	21,34	11,88	High
Km 79+000	3,75	25,69	Very High
Km 80+000	3,60	9,84	High
Km 81+500	1,81	17,96	High
Km 82+000	5,72	15,01	High
Km 85+000	9,69	11,17	High
Km 86+000	1,56	12,40	High

6.4 ANALYSIS OF PRESSURE DEVELOPMENT

Average pressure in the test development worth> 300 kPa. This indicates that the road subgrade Purwodadi - Solo poor quality which can cause severe damage to the pavement. Imposition of the largest found in a soil sample locations Km 83 + 000 which reaches 1286 kPa and produce value for the development of 975 kPa pressure. This value is very large, so that the subgrade at the site is not safe. For low development pressures are worth 88 kPa at Km 80 + 000 locations. This condition causes only mild or moderate damage to the road pavement on it. The results of stress tests in the laboratory development of all the samples are shown in Table 6.

Table 6. Results of stress test in the laboratory with the development of the water content of each sample specimen

Location	Initial Water Content (%)	Pressure development (kPa)
Km 67+000	13,63	324
Km 70+000	17,07	166
Km 74+000	16,31	327
Km 76+000	15,12	629
Km 77+500	11,57	162
Km 79+000	21,27	631
Km 80+000	19,63	88
Km 80+400	31,17	639
Km 81+500	31,81	632
Km 82+000	36,00	327
Km 83+000	28,65	975
Km 85+000	27,54	519
Km 86+000	26,05	327

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6.7 HANDLING PAVEMENT DAMAGE ON THE EXPANSIVE GROUND

The results showed that the degree of development and the development of very high pressure so that the increase in the (overly) cannot be an alternative solution to road damage on the expansive ground. The structural strength of the pavement is only temporary because it is not able to withstand the pressure of expansive soil beneath the development.

In flexible pavement, no protection, soil stabilization and drainage prevention before, so it is likely that the case is going to rain water into the surface of the pavement structure through cracks or open graded asphalt surface. This can lead to accelerated oxidation of the asphalt binder and will increase basis due to the increase in soil, water content, resulting in weakening of the pavement structure, which in turn will be bumpy and the road surface is damaged.

One more pavement damage on the ground is expansive with horizontal and vertical membranes that function to prevent the entry of water content in the pavement structure. The design of horizontal and vertical membrane in the pavement can be shown in Figure 3 and Figure 4.

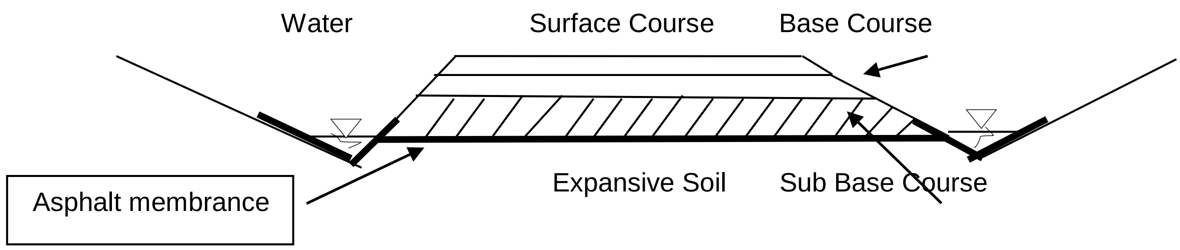

Figure 3. Type of horizontal membranes (Snethen, 1979)

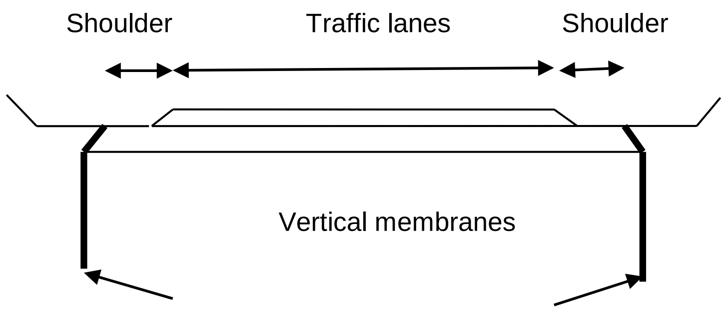

Figure 4. Type of vertical membranes (Snethen, 1979)

7 CONCLUSION

Based on the results of research and discussion in the previous chapter, it is concluded as follows:

1. On the road Purwodadi - Solo Km 66 + 650 to Km 87 + 180 damage is pretty severe way. Type of light damage, including Deficiencies Surface Texture, Potholes, Edge Defect, Longitudinal Cracking, Block Cracking and rutting.

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2. Preliminary test results show samples of expansive clay soil types are high berplastisitas. The unified classification system generates the type CH and MH while the system generates AASHTO soil type A-and A-7-6 7-5.

3. According to Chen (1975) the average degree of development in critical condition, while according to Seed (1992) degrees from moderate to high expansive, so it can be potentially serious damage to the road pavement on it.

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THE GREEN ROOF'S CRITERIAS ANALYSIS BASED ON FAVEUR MODEL

Lisma SAFITRI[1], Emmanuel BERTHIER[2], PRASTOWO[3] and Nora PANDJAITAN[4]

ABSTRACT: Utilization of green roof has increased significantly in the past ten years. It could be seen in the growing number of green roof in cities, in various types. The lack of green roof's hydrological criteria to evaluate its performance is still a problem. The purpose of this study was to determine green roof's hydrological criteria for managing rainfall excess in urban areas. This research was conducted at Ile de France, France and used FAVEUR model. Three criteria were defined: CR (run off criteria), Ab (the retention criteria) and qmax (the value maximum of debit specific criteria) and were analyzed for annual, seasonal and rain-event time-scales. The single simulation was run with the parameters: Ttra (1000 mm), Kcint (1), Cint (12 mm) and Ctra (10 mm) acquired the value of CR an was in interval 0.3 - 0.6, CR_ete was between 0.1-0.5 and CR_hiver was between 0.3-0.9. Besides, the value of Ab_an was between 140-370 mm/year, Ab_ete was between 110-270 mm/year and Ab_hiver was between 30-90 mm/year. The result was : the 1438 rain-event (have the precipitation >1 mm) showed the distribution of hydrological criterias, such as 44% of CR_ev was between 0-0.1, 37% of Ab_ev was between 0-1 mm/rain event and 98% of qmax was between 0-40 l/s/ha.

KEYWORDS: green roof,hydrological criteria,FAVEUR model,Ile de France,managing rainfall excess

1. INTRODUCTION

One of urbanization problems was the increasing of impervious surfaces. This situation reduced infiltration of rain fall and increased surface runoff. Nowadays there has been many activities applied to manage urban storm water, but generally it requires a large surface, which is difficult to find in urban area. Another solution which can be applied was green roof construction. In urban areas with approximately 40–50% impervious surfaces, green roofs are important determinants for the hydrologic restoration and an interesting alternative to conventional building practice (Palla, et al. 2009).

The utilization of green roof, especially in France, has been developing. Green roofs may significantly reduce the runoff peak of the most rainfall events. The reduction consists of delaying the initial time of runoff due to the absorption of water in the green roof system and reducing the total runoff by retaining part of the rainfall and by evaporating in evaporation system (Mentens et al, 2006). Nevertheless, there has been no tool, which is able to design and evaluate the performance of green roof, especially to assess the retention criteria.

Based on this problem a concept of *Toiture Végétalisée pour la Gestion de l'Eau Pluvial* (TVGEP), which is application of green roof for storm water management, was created. This program aimed to improve the understanding and productivity of green roof for urban storm water management. This research was the final project of TVGEP which concern in developing operational tools to assess the retention performance of green roof.

The aims of this research were (1) Applying FAVEUR model (*modèle Fonctionnel pour l'évAluation des performances des toitures VEgétalisées sur le ruissellement URbain*) for analyzing the runoff simulation; (2) Assessing the retention criteria in green roof and it's

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correlation with the interception capacity for a variation of FAVEUR model's parameters; (3) Developing a tools to identify the correlation between physical characteristics of green roof and green roof retention.

A model simulated the hydrologycal performance of green roof which is called FAVEUR model has been built in program of TVGEP by Pinta (2012). This model simulated the complex structure of green roof in 2 reservoirs:

- Interception reservoir, which represented the interception in vegetation and substrates that can hold a part of precipitation and then evaporate it through the process of evapotranspiration. This reservoir was identical to the interception capacity, which showed the volume of precipitation retained by vegetation and substrate.
- Transfert reservoir, which flows down the water as a function of run off excess from interception reservoir.

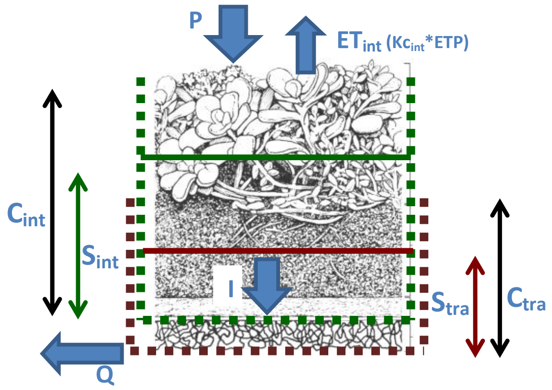

Figure1 Stucture of FAVEUR Model (Pinta 2012)

All the parameters which were related to interception and transfert reservoir were symbolized by "int" and "tra", respectively, which could be seen in structure of FAVEUR model (Figure 1). FAVEUR model consisted of 4 main parameters based on the reservoir function:

a. Interception (C_{int} and Kc_{int})
   In FAVEUR model the interception capacity (C_{int}) was the sum of interception capacity of vegetation (C_{veg}), substrate's water content in field capacity (C_{subfc}) and unpredicted retention capacity in drainage layer (C_{dra}), which is still in study. Crop coefficient in interception reservoir (Kc_{int}) in FAVEUR model was determined based on the type of vegetation. In this case there were 2 type of vegetation: sedum and graminee. Berthier and Ramier (2010) has validated the value of Kc_{int} for sedum = 1 and for graminee = 1.2 .

b. Transfert (C_{tra}, $T_{tra,}$)
   Transfert capacity (C_{tra}) indicated the vertical transfert of green roof, which was affected by the thickness of drainage layer and also the type and thickness of substrate. Another parameter in transfert function was the horizontal geometry of green roof (T_{tra},in meter). T_{tra}in this research presents the comparison between the length of geometry of a green roof (L in meter) and the velocity factor (c, -) in green roof scale.

2. CORRELATION OF FAVEUR MODEL'S PARAMETERS AND PHYSICAL CHARACTERISTICS OF GREEN ROOF

According to the experimental observation in CETE Ile de France, the correlation between FAVEUR model's parameter C_{int} and the physical characteristics of green roof could be determined. Generally, there were 3 common physical characteristics of green roof, such as the type of vegetation, thickness of substrate and water maximum capacity (CME) of substrate (ADIVET 2007). Ramier *et al.* (2013) defined the correlation between C_{int} and thickness of substrate as well as the CME of green roof in equation (1) and (2).

If thickness < 5 cm, C_{int} (cm) = CME (-) x thickness (cm) (1)

If thickness > 5 cm, C_{int} (cm) = CME (-) x50 (2)

3. METHODS

3.1. TIME AND PLACE

This research was conducted in laboratory of hydrology and storm water management of*Centre d'Etudes de Techniques et de l'Equipement*Ile de France (CETE IdF), Trappes, France from February until June 2013.The periods of simulation were 18 years data from 1 July 1993 until 31 December 2011 (noted that the data from 1996 were eliminated because of the missing data of precipitation in this period).

3.2. DATA AND MATERIALS

The data required in this works were Plu1 (series of precipitation per 300 seconds) from the Conseil General de Haute Seine and ET1 (series of potential evapotranspiration in every 300 second) from *Meteo France* Trappes for 1993-2011. For the analysis the materials being used were a computer completed by *Microsoft Office* and *software* Matlab Version 7.13 R2011b 2011 license of CETE Ile de France.

3.3. INITIALISATION OF SIMULATION'S PARAMETER

There were 6 parameters which must be initialized before starting the simulation i.e :

1. ncalc (number of simulation) : ncalc = 1 for single simulation and ncalc=500 for varying parameters.

2. dT1 (time step of data input) and dT2 (time step of data simulation). dT1 was determined as the series of data input 300 seconds. In simulation, dT2 was assumed as dT1.dT2 could be varied for testing the model's sensitivity.

3. d'ev (rain event duration) for predicting the number of rain event. In this research, a rain event was assumed starting when the precipitation was not 0 and ending when precipitation was 0 during 12 hours (d'ev = 12 hours) where the precipitation < 1mm were negligible.

4. Time step of output in 3 time scales different: annually, seasonally and rain eventually. For those, it was required to determine the starting point of each time scales such as ddeb_an for the starting point of annual period, ddeb_sum for summer period, ddeb_win for the winter period, ddeb_ev for the starting point of rain event and dfin_ev for the ending point of rain event.

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5. $S_{intinit}$ (initial water storage of interception reservoir) and $S_{trainit}$ (initial water storage of transfert reservoir). $S_{intinit}$ and $S_{trainit}$ were assumed 0. Therefore, the simulation started when the water storage in minimum condition which similar to summer period. This assumption Thus, the simulation of FAVEUR model was started in 1 July 1993.

3.4. DETERMINATION OF FAVEUR MODEL'S PARAMETERS

For ncalc = 1, parameters used in simulation were derived from the physical characteristics of reference green roof observed in CETE Ile de France which consisted of a substrate for extensive green roof with the thickness 3 cm, sedum as type of vegetation and polystyrene for the drainage layer. From those physical characteristics, (Pinta 2012) determined the value of FAVEUR model's parameters:

- C_{int} = 12 mm ;
- Kc_{int} = 1 for sedum;
- C_{tra} = 10 mm;
- T_{tra} = 1000 mm.

Then, for ncalc=500, the parameters C_{int}, K_{cint}, T_{tra} and C_{tra} were randomly varied as the number of simulation:

- C_{int} = [12 ;100] (mm) ;
- Kc_{int} = 1 for sedum and Kc_{int} = 1.2 for gamine. In this case, for varying the parameters, simulations were done twice for each Kc_{int} different ;
- C_{tra} : [10 ;100] (mm) ;
- T_{tra} : [100 ;1000] mm).

3.5. EQUATIONS IN FAVEUR'S MODEL

For running the FAVEUR's model, Plu1 and ETP1 were required as the main data. The calculation of evapotranspiration was referred to the Instruction no. 56 from FAO (2000) which served the calculation of actual evapotranspiration (ET) as the result of potential evapotranspiration (ETP) assisted by a correction factor that depend on the type of vegetation which is called crop coefficient (Kc). Pinta (2012) calculated ET in interception reservoir in Equation (3).

$$ET = \min (S_{int}, ETP1 x Kc_{in}) \tag{3}$$

Where: ET = actual evapotranspiration (mm), S_{int} = water storage in interception capacity (mm), ETP1 = potential evapotranspiration per 300 seconds (mm), Kc_{int} = crop coefficient in interception reservoir.

Equation (3) showed that ET was not only depend on Kc_{int} but also depend on water storage in interception reservoir. In this case, equation (3) was applicable when Plu1 was 0. Contrary, when Plu1 was not 0, ET was assumed 0 (Pinta 2012). Besides that, Equation (3) was only good for dry condition like in the summer. Therefore, for distinguishing the growth's vegetation of green roof, Pinta (2012) assumed Kc_{int} in winter was a half of Kc_{int} in summer (Equation (4)).

$$ET = \min (S_{int}, ETP1 x Kc_{int} x 0.5) \tag{4}$$

Infiltration from interception reservoir towards transfer reservoir in FAVEUR model was calculated simply as the difference from the excess of actual water storage in interception reservoir compare to its capacity (Equation (5)).

$$I = \max (S_{int} + Plu1 - C_{int} - ET, 0) \quad (5)$$

Where: I = infiltration (mm), Plu1 = Precipitation per 300 seconds (mm), C_{int} = interception capacity of interception reservoir (mm).

The next step was recalculated the actual water storage in both reservoir. Pinta (2012) assumed that the calculation of the different water storage in interception and transfer reservoir as shown in Equation (6) and (7).

$$S_{int} = S_{int} + P - I - ET \quad (6)$$

$$S_{tra} = S_{tra} + I \quad (7)$$

Where: S_{tra} = water storage in transfer reservoir (mm).

For the transfer reservoir, the evaporation was assumed 0 so as the precedent infiltration and water storage in transfer reservoir became main variable in Equation (7). In this transfer reservoir, there were some water ran out. Pinta (2012) formed the calculation of this runoff from transfer reservoir as shown in Equation (8).

$$Q_{tra} = \min (S_{tra}, dT2/T_{tra} x\ S_{tra} x\ (S_{tra}/C_{tra})) \quad (8)$$

Where: Q_{tra} = runoff from transfer reservoir (mm), C_{tra} = transfer capacity (mm), T_{tra} = horizontal geometry of green roof (mm).

For finishing all the steps in FAVEUR model, the actual water storage of transfert reservoir might be recalculated as shown in Equation (9) (Pinta 2012).

$$Stra = Stra – Qtra. \quad (9)$$

3.6. ASSESSING THE RETENTION PERFORMANCE OF GREEN ROOF

After determined all the parameters, the simulations of FAVEUR model were ran for ncalc=1 and ncalc=500. Then the results were used for assessing the green roof's performance to the urban storm water management by analyzing the retention criteria for annual, seasonal and rian event time scales. Retention criteria were a part of the precipitation which was retained in the structure of green roof and then separated by two processes: loose through the evapotranspiration or retained permanently in green roof. Retention criteria represented the different depth between the total volume of precipitation (Plu1) and the total runoff (Q1). The calculation of annual retention criteria (Ab_an) was showed on equation (10).

$$\text{Ab\_an} = \sum_{a=1}^{an} Plu1an - \sum_{a=1}^{an} Q1an \quad (10)$$

For the seasonal time scales, in order to understand the extreme different among the season, it was assumed that there were only 2 season: summer and winter. Thus, each season occured for 6 months: summer started from May until October and winter from November until April in the next year. By using the monthly calculation, summer retention criteria (Ab_sum) and winter retention criteria (Ab_win) were determined by Equation (11) and (12).

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$$\text{Ab\_sum} = \sum_{m=5}^{m=10} Plu1sum - \sum_{m=5}^{m=10} Q1sum \quad (11)$$

$$\text{Ab\_win} = \left(\sum_{m=1}^{m=4} Plu1win - \sum_{m=1}^{m=4} Q1win\right) + \left(\sum_{m=11}^{m=12} Plu1win - \sum_{m=11}^{m=12} Q1win\right) \quad (12)$$

where : a(n) = year, m = month, Q1_an, Q1_sum and Q1_win= annual, summer and winter total (mm), Plu1_an, Plu1_sum and Plu1_win = annual, summer and winter precipitation (mm), Ab_an, Ab_sum, Ab_win = annual, summer and winter retention.

According to the definition of rain event scales in this work, it was found 1438 rain event for the precipitation's depth more then 1 mm. In rain event scales, the retention criteria used were the retention in the beginning of rain event. Rain event retention criteria was defined as the difference of inteception capacity and the water storage in interception reservoir in the beginning of rain event (Equation 13).

$$\text{Ab\_ev} = C_{int} - S_{int}\,(\text{ddeb (ev)}) \quad (13)$$

where : Ab_ev = rain event retention, C_{int} = interception capacity (mm), S_{int} ddeb(ev) = water storage in interception reservoir in the beginning of rain event (mm).

THE DEVELOPPEMENT OF FAVEUR MODEL WITH TOOLS

The last step in this work was to develop faveur model by adding a tools contened the correlation of physical caracteristics and retention criteria of green roof in Excel **©.** For realizing this work, the retention criteria of all time scales were classified based on the value maximum, minimum, average and median. Then all these value of retention criterias were correlated to the variated pparameters of FAVEUR model (Kc_{int}, C_{int}, C_{tra} dan T_{tra}) for analysing which parameters are the most influence to the retention criterias of green roof.

4. RESULTS AND DISCUSSION

4.1. RUNOFF Q

The main output of FAVEUR model is Q1 (green roof runoff in time step dT1). Figure 2 showed a range value of Q1 (mm/dT1) for ncalc = 1 which represent the green roof runoff reference with physical characteristics such as sedum for the vegetation and substrate's thickness 3 cm in an area of 37.5 $m^2$and it's comparison with Plu1 (mm/dT1) during 1993-2011. Those physical characteristics of green roof reference denote the values of FAVEUR model's parameters such as: C_{int} = 12 mm, Kc_{int} = 1, C_{tra} =10 mm dan T_{tra} = 1000 mm (Pinta 2012). Based on Figure 2, the highest value of Q1 were between 0-4 mm /dT1 which the most of them were between 0 – 0.8 mm/dT1and Plu1 were between 0-25 mm/dT1. Generally, Figure 2 showed that Q1 is less than Plu1. But, it exist a few data of Q1 which is higher than Plu1.

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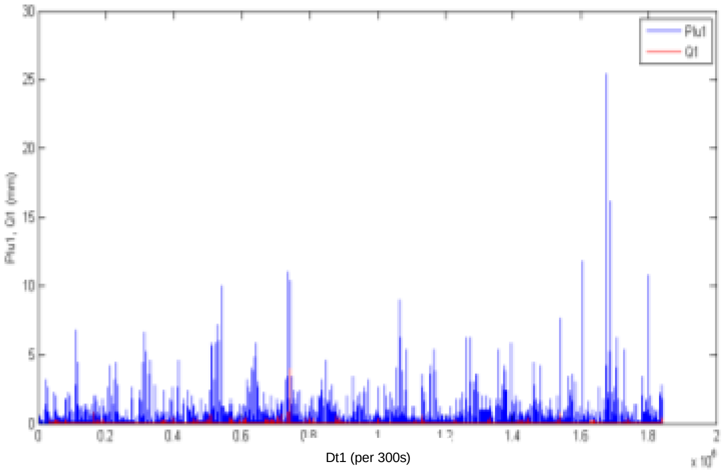

Figure 2. Correlation between Plu1 and Q1 to dT1 (mm / dT1) during 1993-2011

From all the comparison of the sum Plu1 and Q1 130 : 354 (0.37), we can conclude that in this simulation there were 224 mm from the value of Plu1 which did not stream down as runoff and contrary stored in green roof system. Bass and Baskaran (2001) stated that the runoff curve from the reference roof follows the rain curve closely in terms of rate and volume and also the runoff amount from the reference roof was slightly less than the rain incident on the rooftop. Note that in some cases the outflow depth is higher than the rainfall depth; this is related to the actual soil water content at the beginning of rainfall event determined by the antecedent precipitation (Palla *et al*. 2009).

Decreased runoff in this case was the impacts of green roof which could reduce the runoff due to the increasing of storage capacity of substrates and the evapotranspiration from the vegetation (Mentens *et al*. 2006). However, the FAVEUR model used in this simulation is still developing so that in this case there would not a direct comparison between green roof runoff and unvegetated roof runoff.

4.2. THE CORRELATION OF GREEN ROOF RETENTION AND INTERCEPTION CAPACITY

For simulation with ncalc=500, 4 parameters of FAVEUR model were randomly varied: C_{int} [12 ;100] (mm), Kc_{int} (1 atau 1.2), C_{tra}[10 ;100](mm) dan T_{tra}[10 ;1000] (mm). To develop FAVEUR model for assessing the retention criteria of green roof, firstly the relation between retention criteria and those 4 parameters were required. Based on these simulations, there were only C_{int} which had a strong correlation with retention criteria. This was caused by increase of green roof retention which was a function of its storage (Uhl dan Schiedt 2008).

Figure 3-5 showed the annual, seasonal and rain event retention criteria as the result of simulation ncalc =500 and their correlation with C_{int}. Figure 3 indicate the minimum (red), maximum (light blue), average (dark blue) and median (green) value for distribution of annual retention (Ab_an) for 500 ncalc (a) and the curve of correlation between Ab and C_{int} (b). According to Figure 3, the minimum annual retention varied between 138 - 240 mm, the maximum varied between 375 - 614 mm, the average varied between 301-470 mm and the median varied between 309-451 mm. Those, then which were compared to the total annual precipitations resulted: 32% for minimum annual retention, 86 % for maximum annual retention, 66% for average annual retention and 65% for median annual retention. In line to this result, Stifter (1997) deduced that a green roof can absorb the rainfall up to 75%. In this research, the percentages of green roof annual retention provided were more specific and

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detailed than the reference. Simulation with ncalc=500 showed that the value of green roof annual retention was varying.

Figure 3 showed that green roof annual retention was relatively proportional to the interception capacity, C_{int}. Interception capacity act as a storage space where larger the space (C_{int} high), more the water can be stored (Berthier and Ramier 2010). Figure 4 described the correlation of seasonal retention for green roof to the interception capacity:

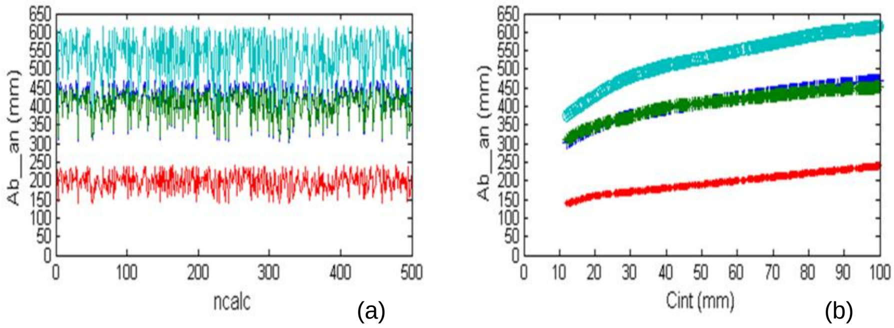

Figure 3. Curve of Annual Retention (a) and Its Correlation to C_{int} (b) for ncalc = 500

summer retention (Ab_sum) (a) and winter retention (Ab_win) (b).

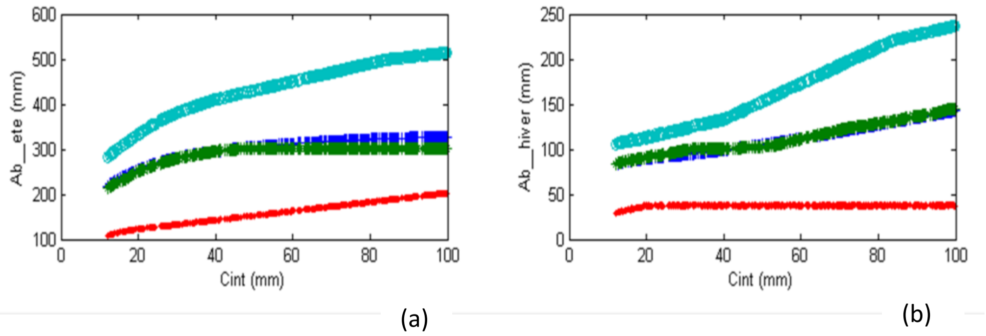

Figure 4 Correlation's Curve of seasonal retention to C_{int} for ncalc = 500

Depending on Figure 4 (a), the minimum summer retention varied between 109-203 mm, the maximum varied between 282–514 mm, the average varied between 218-327 mm and the median varied between 213-302 mm. Hereinafter, the minimum winter retention variedbetween29-38 mm, the maximum varied between 106-237 mm, the average varied between 84-143 mm and the median varied between 84-145 mm.

Figure 4 showed that summer retention and winter retention were relatively proportional to interception capacity, C_{int} and that retention in summer was higher than in winter. Similar to this result, Minke and Witter (1982) conveyed that generally green roof retention in summer varied between 70-100% meanwhile in winter green roof retention varied between 40-50%, depend to green roof's design and climate. Contrary to green roof seasonal retention, the scenario of 3 seasons: summer (1st May – 30th September), period between spring and autumn (15th March – 30th April) and winter (15th November – 15th March) showed that green roof runoff in summer was less than in winter (Uhl and Schiedt 2008).These were caused by the increasing of evapotranspiration in summer which implied the increasing of storage capacity (Uhl and Schiedt 2008).

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Furthermore, the correlation between green roof retention and interception capacity was also showed in rain event scale for ncalc=500 (Figure 5). The simulation could represent the evolution of rain event retention (Ab_ev) but not for each begin and end of rain event. In this case, the value maximums of rain event retention were directly proportional to interception capacity in an interval 12-100 mm which were similar to the value of interception capacity. Contrary, the minimums rain event retention were always equals 0. The averages rain event retention were between 5.13-44.46 mm while the medians rain event retention were between 3.12-38.12 mm.

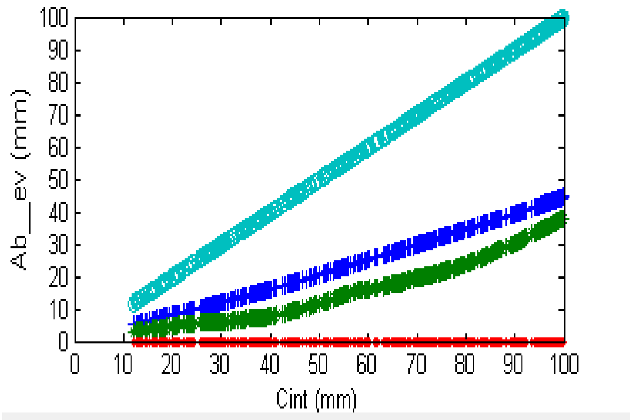

Figure 5 Correlation's Curve of rain event retentiontoC$_{int}$forncalc = 500

The variation of rain event retention from 0 to the maximum value was in line to the result of Hilten *et al*. (2008) which showed that green roof could reduce the runoff but the variation was very large. Therefore, it's necessary to observe rain event retention directly in one rain event. According to Carter and Rasmussen (2007), the maximums rain event retention occurred in the beginning of the rain event.

4.3. DEVELOPMENT OF FAVEUR MODEL COMPLETE WITH A TOOLS FOR ASSESSING RETENTION PERFORMANCE OF GREEN ROOF

This tool was developed in Excel© and showed the minimum, average, median and maximum value of green roof retention criteria. The calculation with this tool started by completing the physical characteristics of green roof such as:

- CME: water content maximum capacity could be filled in %.
- Substrates thickness : in cm
- Type of vegetation : "S" for sedum with Kc$_{int}$ = 1 or "G" for gramines with Kcint = 1.2

Based on that information, the interception capacity C$_{int}$ could be determined. Then, the results of annual, seasonal and rain event retention were directly displayed (Table 1 and Table 2).

Table 1 showed the result of retention performance of FAVEUR model's tool with the water maximum capacity (CME) of substrate: 30 %, substrate's thickness :10 cm and type of vegetation: "S" for sedum. Based on these physical characteristics, C$_{int}$ was 15 mm. According to the value of C$_{int}$ = 15 mm, the maximum of annual retention (Ab_an) was 402 mm, the maximum of summer retention (Ab_sum) was 302.7 mm, the maximum of winter retention (Ab_win) was 108.8 mm, the maximum of rain event retention (Ab_ev) was 14.8 mm.

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Table 1. The Variation of Retention Performance in FAVEUR model's Tools for Green Roof : CME 30%, substrat's thickness = 10 cm and type of vegetation "S" for Sedum

Physical Characteristics of Green Roof		Ab	Green Roof Retention Criteria Ab_an(mm)	Ab_sum(mm)	Ab_win(mm)	Ab_ev>1mm(mm)
CME substrat (%)	30	Minimum	149.4	115.1	32.8	0.0
Substrat's Thickness (cm)	10	Average	322.8	233.7	86.5	6.1
Type of vegetation (S or G)	S	Median	327.4	227.9	87.0	3.9
C_{int} (mm)	15	Maksimum	402.0	302.7	108.8	14.8

Another example of green roof retention performance was presented on Table 2, with the green roof physical characteristics of CME substrate : 20 %, substrate's thickness : 3 cm and type of vegetation: "S" for sedum. Based on these physical characteristics, C_{int} was 6 mm. The result showed that the maximum of annual retention (Ab_an) was 343.7 mm, the maximum of summer retention (Ab_sum) was 222.9 mm, the maximum of winter retention (Ab_win) was 97.7 mm, the maximum of rain event retention (Ab_ev) was 5.8 mm.

Based on green roof operation model in Excel© which was showed in Table 1 and Table 2, it can be concluded that the higher water maximum capacity of substrate and substrate's thickness, the retention performance would be increase. Nevertheless, the substrate's thickness affected the retention performance in interval 0-5 cm (Bethier and Ramier 2010). For the thickness more than 5 cm, it was only CME which influenced the value of retention performance.

Table 2. The Variation of Retention Performance in FAVEUR model's Tools for Green Roof : CME 20%, substrat's thickness = 3 cm and type of vegetation "S" for Sedum

Physical Characteristics of Green Roof		Ab	Green Roof Retention Criteria Ab_an(mm)	Ab_sum(mm)	Ab_win(mm)	Ab_ev>1mm(mm)
CME substrat (%)	20	Minimum	134.6	97.7	14.4	0.0
Substrat's Thickness (cm)	3	Average	282.8	184.9	77.8	2.8
Type of vegetation (S or G)	S	Median	289.9	169.6	81.5	3.4
C_{int} (mm)	6	Maksimum	343.7	222.9	97.7	5.8

After all, this tool can only represent the green roof retention performance in continental region, in particularly in Ile de France (France). The green roof retention criteria assessment would be very required for utilization of FAVEUR model tolls in other region with different climate .

5. CONCLUSION

1. The runoff simulation of FAVEUR model for reference green roof showed that green roof can reduce the runoff (proven by the runoff (Q1) were less than precipitation (Plu1)).
2. The variation of FAVEUR model's parameters for ncalc=500 resulted :

   2.1. The annual and seasonal retention were relatively proportional to the interception capacity, C_{int}.

   2.2. The maximum of rain event retention were directly proportional to interception capacity in an interval 12-100 mm and the minimum of rain event retention were always equals 0. The average and median of rain event retention were relatively proportional to the interception capacity, $C_{int.}$

3. A tool based on the relation between the green roof's physical characteristics and green roof retention criteria with interception capacity has been created. This tools was built by using Matlab© and presented in Excel©. By inputting 3 physical characteristics of green roof such as type of vegetation, substrate's thickness and maximum water capacity (CME) of substrate, this tool can pesent the value of green roof retention performance.

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WADASLINTANG DAM OPERATION ANALYSIS

Sri Amini Yuni. ASTUTI[1], Pradipta Nandi. WARDHANA[2]

ABSTRACT: On 1986 Wadaslintang Dam was built based on heavy rain potential at Wadaslintang Dam basin and topography condition consideration. Wadaslintang Dam is categorized as multipurpose dam, the dam function is irrigation water supplier, hydropower, domestic water supplier, fisheries, and flusher. Reliability level is needed to ensure Wadaslintang Dam can operate properly. Reliability level is calculated as comparison between real suppletion and planned demand. Real suppletion at particular time is derived from dam storage, meanwhile dam storage is influenced by inflow and outflow water balance. Irrigation function reliability level is 92.6%, the irrigation reliability level can be categorized in a good condition. Meanwhile hydropower reliability level is 52%, hydropower reliability level is not a problem because the dam main priority is to supply irrigation water demand.

KEYWORDS: reliability level, real suppletion, planned demand, and dam storage balance

1. INTRODUCTION

1.1. BACKGROUND

Annual rainfall intensity at Wadaslintang basin is 3500 mm, and Bedegolan River monthly mean discharge is 15 m^3/s. Wadaslintang basin area is 196 km^2, inundation area is 13.3 km^2. The inundation area borders are Meganti Hill, Blawong, Sabalegi, Bulupayung, Sibengkul dan Medasih. Factors mentioned before supported development of Wadaslintang Dam.

Wadaslintang Dam is multipurpose dam. The dam main function is to supply 31,425 ha irrigation area water demand. Others dam function is as hydropower, flood control, domestic water supplier, flusher, fisheries, and tourism.

Wadaslintang Dam is located at Kecamatan Wadaslintang, Kabupaten Wonosobo, Jawa Tengah Province. Wadaslintang Dam was built at Bedegolan River reach. Wadaslintang Dam Project owner is Republic Indonesia Government.

1.2. STUDY PURPOSE

Study purpose is to analyze Wadaslintang Dam operation reliability level for 25 years operation (1987 until 2012) by using 25 years data (1951 until 1975).

1.3. STUDY LIMITATION

1. Analysis uses discharge river data from 1951 until 1975.
2. Irrigation demand calculation is based on rainfall data as long as 25 years, irrigation service area, crop pattern, crop rotation, and water losses.
3. Rainfall above dam is calculated together with river discharge.
4. Seepage flows out of dam and groundwater flows into dam are ignored because both factors have small value.

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1.4. STUDY BENEFIT

The study is intended to prove that Wadaslintang Dam can operate properly based on the irrigation and electricity purpose.

2. THEORITICAL CONSIDERATION

2.1. GENERAL

Multipurpose dam are more difficult and more complex than single purpose dam in case of planning and operation. According McMahon (1978), multipurpose dam operation plan is based on unsteady river discharge, water demand (irrigation, hydropower, domestic water), and planned reliability level.

Dam operation analyze done in this study is calculation of dam volumetric (R_v) capacity reliability level. Volumetric reliability level is comparison between real suppletion and planned demand.

2.2. BASIC EQUATION

Dam operation analyze is calculated by using dam water balance equation (Sri Harto, 1983).

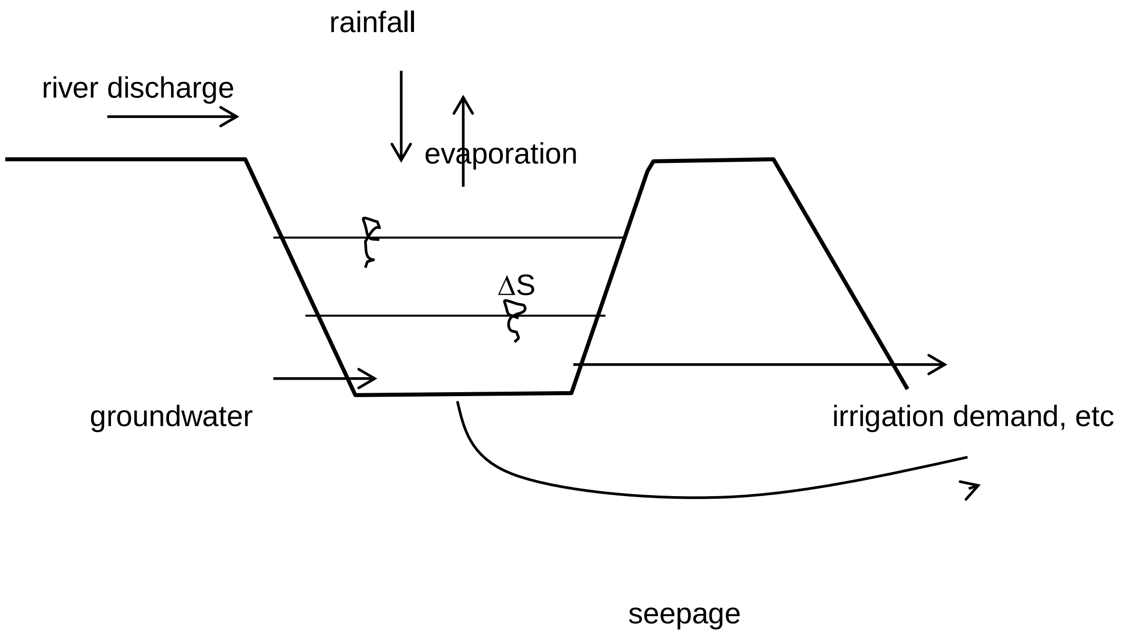

Figure 1. Dam water balance

$$\Delta S = \text{inflow} - \text{outflow}$$

$$\Delta S = \text{river discharge} + \text{rainfall} + \text{groundwater} - \text{evaporation} - \text{seepage} - \text{demand} \quad (1)$$

Description : ΔS = charge in storage
= final dam volume – initial dam volume

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2.3. STANDART OPERATION RULE

Dam standard operation rule can be determined by using rule curve. Rule curve shows dam water volume condition at the end of particular period that must be achieved for particular outflow value.

Rule curve determination is based on annual mean demand, annual mean river discharge, initial wet month dam capacity is assumed at minimum level, dam water surface area is calculated based on dam surface water elevation, and dam surface water elevation derived from dam storage volume.

DAM OPERATION REALIBILITY LEVEL

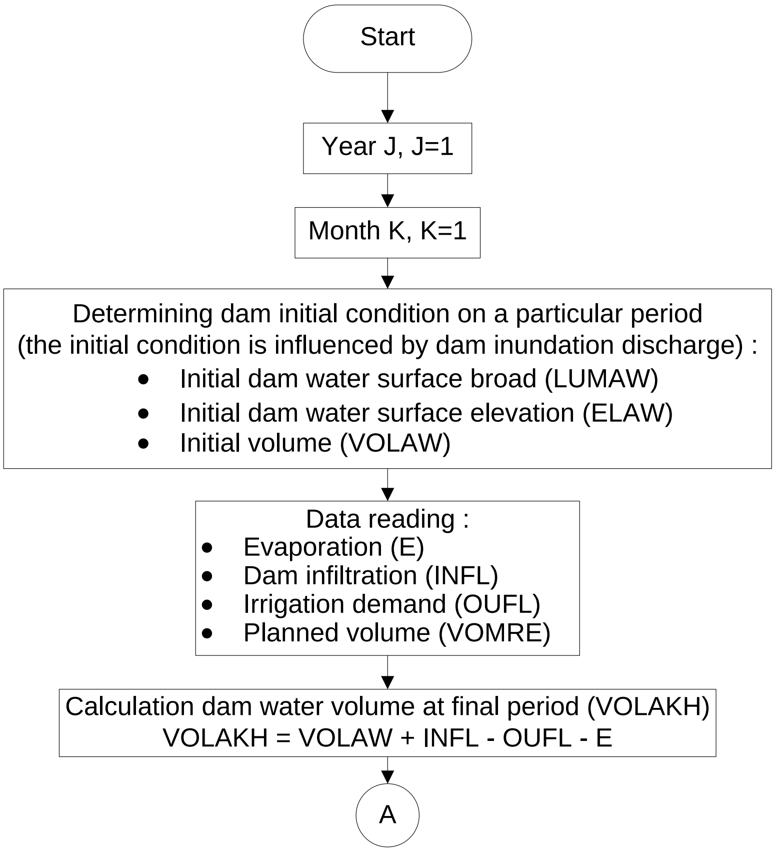
Volumetric (R_v) dam reliability level is calculated by using equation below.

$$R_v = \frac{\text{real supplesion}}{\text{planned demand}} \tag{2}$$

3. CALCULATION

3.1. STANDARD OPERATION RULE

Standard operation rule flowchart can be seen on Figure 1, and Calculated Wadaslintang Dam rule curve is shown at Table 1 below.



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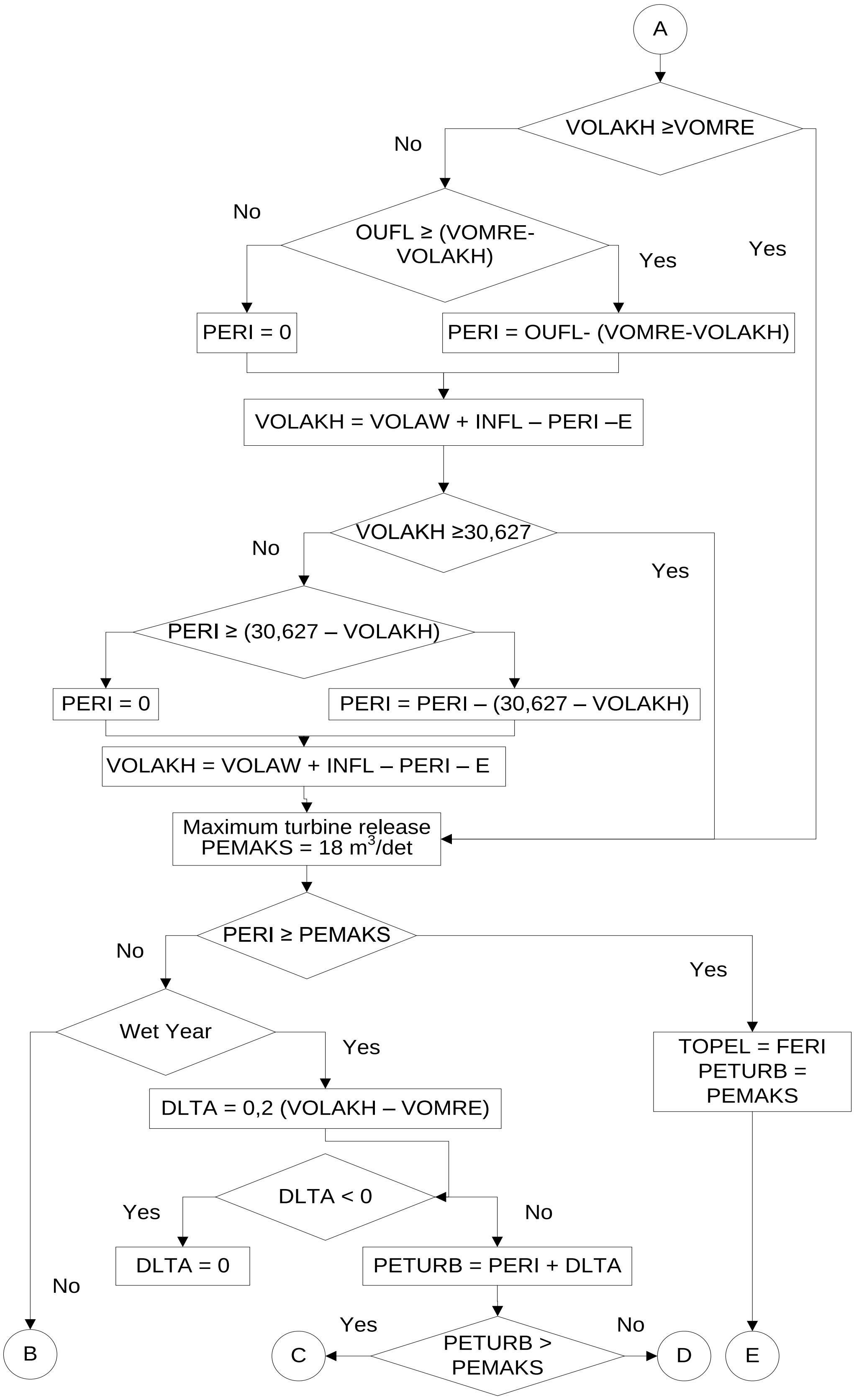

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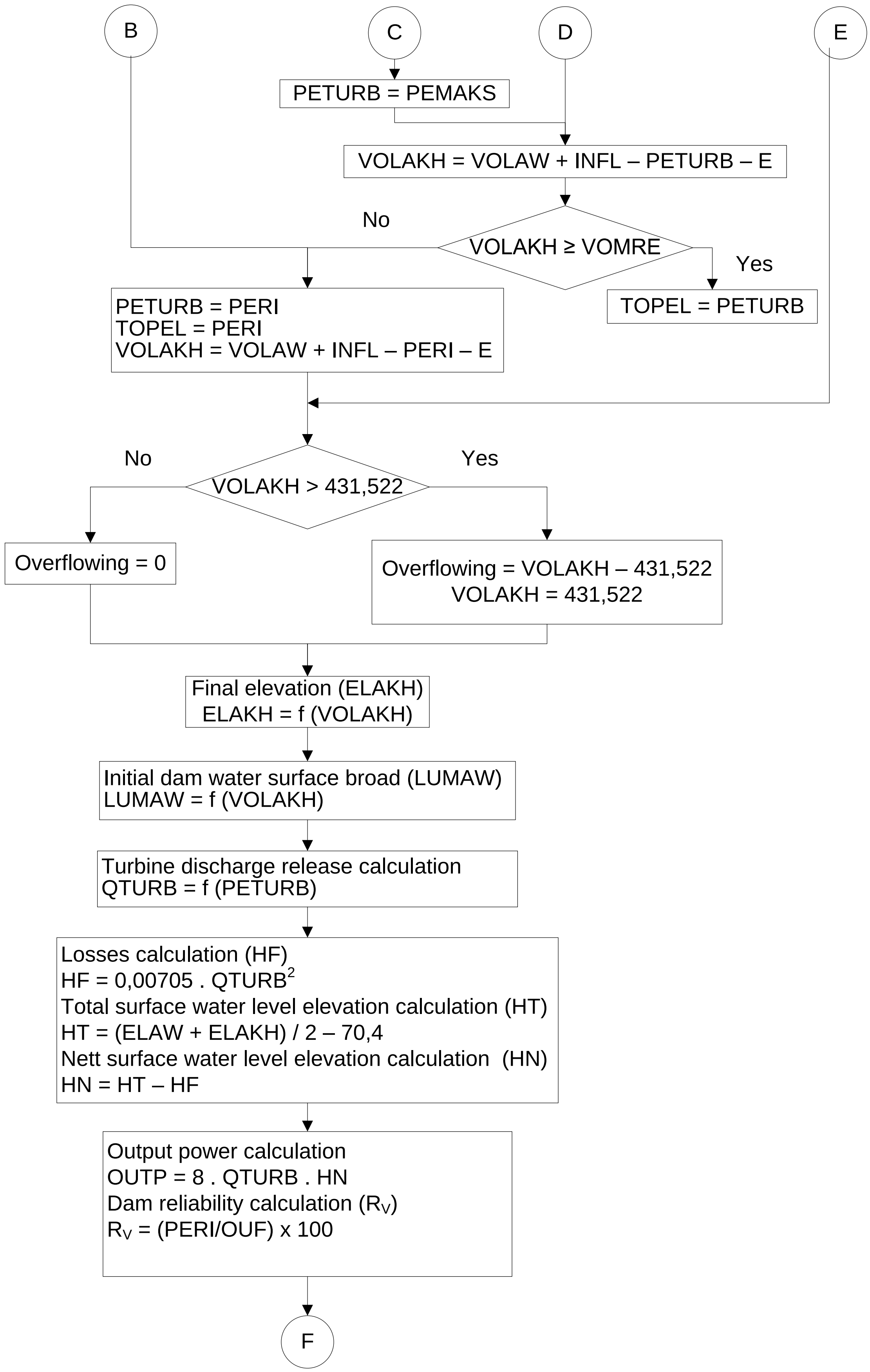

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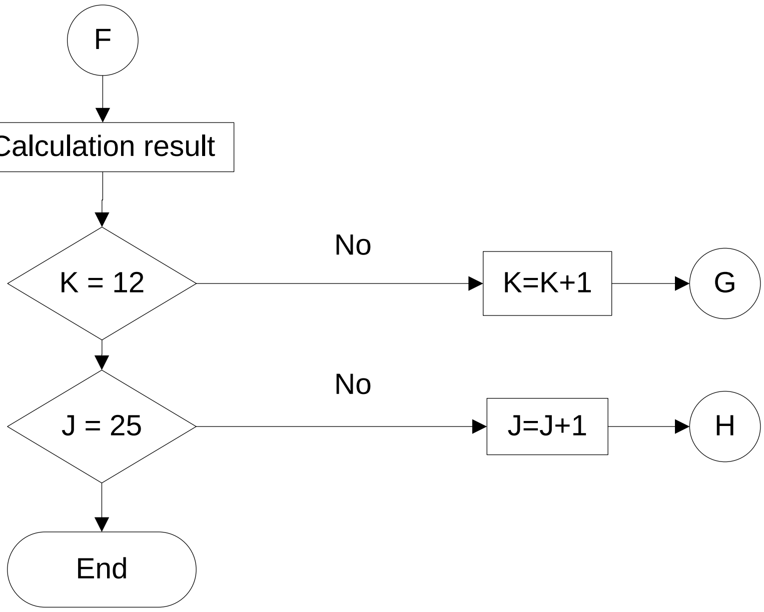

Figure 2. Standard operation rule flowchart

Table 1. Wadaslintang Dam calculated rule curve

Month	Inflow (mcm)	Outflow (mcm)	Evaporation (mcm)	Final elevation (m MSL)	Final volume (mcm)
November	59,62	35,77	0,24	134,089	54,237
December	68,03	12,86	0,33	148,769	109,078
January	66,69	11,78	0,58	158,406	163,409
February	57,82	5,81	0,79	165,378	214,627
March	77,67	21,16	0,91	171,568	270,233
April	55,21	13,74	1,01	175,451	310,692
May	34,28	33,75	1,05	175,404	310,175
June	10,11	42,51	1	172,226	276,772
July	8,84	20,89	0,91	170,908	263,807
Agustus	5,36	21,16	0,95	169,125	247,050
September	4,67	16,59	1,08	167,673	234,046
October	24,91	31,61	1,01	166,781	226,340

3.2. DAM INUNDATION

This study assumes that dam inundation is done based on discharge data on 1951. Year of 1951 is selected because year of 1951 was 27% wet year. If dam inundation is done by using discharge data of 27% wet year, the inundation process will have high reliability level. Inundation process starts on January, and dam operation started on June. Calculation of dam inundation is shown on Table 2 below.

Table 2. Wadaslintang Dam inundation calculation

Month	Inflow (mcm)	Evaporation (mcm)	Final elevation (m MSL)	Final Volume (mcm)
January	69,1	0	138,892	69,103
February	74,51	0,44	155,162	143,172
March	46,87	0,69	162,127	189,352
April	42,77	0,80	167,360	231,320
May	16,07	0,87	169,068	246,524

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4. RESULT AND DISCUSSION

4.1. RESULT

Wadaslintang Dam reliability level is shown on Table 3 below. Initial Wadaslintang Dam water surface level is + 169,07 m MSL.

Irrigation reliability level is derived from mean reliability level as long as 25 years, meanwhile electricity reliability level is obtained from success percentage. Wadaslintang Dam electricity operation is categorized as success if Wadaslintang Dam could produce electricity more than planned electricity (0,98. 10^8 kWh) each year.

Tabel 3. Wadaslintang Dam Operation Analyse Result

Year	Electricity Realibility Power Output (kWh)	Electricity Realibility Success/ Fail	Irrigation Realibility (%)
1	25405355	Fail	36,77
2	112532000	Success	100
3	66294560	Fail	91,9
4	77940090	Fail	100
5	131445000	Success	100
6	115948000	Success	100
7	100352000	Success	100
8	96918535	Fail	100
9	118393000	Success	100
10	110452000	Success	100
11	102431000	Success	84,68
12	90317450	Fail	100
13	63783533	Fail	83,33
14	78750201	Fail	100
15	96425636	Fail	82,97
16	86705689	Fail	89,29
17	104569000	Success	84,53
18	121444000	Success	100
19	109929000	Success	93,38
20	87830793	Fail	98,18
21	64718976	Fail	100
22	67615690	Fail	85,55
23	102500000	Success	100
24	99427561	Success	95,7
25	121900000	Success	100

Irrigation reliability = 92,64 %
Electricity reliability = sum of success / sum of years x 100 %
= 13/25 x 100 %
= 52 %

4.2. DISCUSSION

Assuming of inundation discharge (discharge of 27% wet year) results high irrigation reliability level (92.64%). The realibility level shows that Wadaslintang Dam will operate properly. Higher realibility level can be achieved if dam operation analysis uses higher inundation discharge.

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Analysis shows that Wadaslintang Dam electricity reliability level is 52%. The reliability level analysis suggests that electricity power target must be decreased.

5. CONCLUSION

1. Wadaslintang irrigation reliability level is more than 92.64% if inundation discharge assumes as 12.9 m^3/s (discharge of 27% wet year).

2. Wadaslintang electricity reliability level is 52%. The electricity reliability does not become problem because Wadaslintang Dam main priority is to supply irrigation water demand.

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LONG-TERM EVALUATION OF GEOSYNTHETIC-REINFORCED FLEXIBLE PAVEMENT

Thanongsak IMJAI[1]

ABSTRACT: Asphalt pavement rutting is one of the most commonly observed pavement distresses and is a major safety concern to transportation agencies in Thailand. Research into improvements of conventional hot-mix asphalt materials, mix designs and methods of reinforced pavement structural layers, can provide extended pavement life and significant cost savings in pavement maintenance and rehabilitation. This paper deals with the full-scale testing program that was carried out at Highway No.11, located in Uttaradit Province, Thailand, to evaluate the performance of Geosynthetics-reinforced materials in a conventional flexible pavement. Three test sections consist of a Geosynthetics-reinforced pavements and one unreinforced control test section were constructed in this project. The test sections were subjected to the static load test under truck weights of 20, 30 and 40 tons. Permanent surface deformations and pavement vertical stress were measured during load testing. The test section is intended to use for long-term monitoring of the performance of Geosynthetics reinforced material. This paper presents a series of field measurement for static load test under truck weights and also rut depth observation. The result of this research is a practical framework for developing extensive full-scale testing data base in the field.

KEYWORDS: Geosynthetics, Geotextile, Geogrid, Flexible pavement, Rut depth, Rut

1. INTRODUCTION

Pavements represent the largest component of government investment in public transport. In Thailand, the pavement portion of highways and streets has a current asset value of more than $50 billion (Svasdisant 2008). These pavements deteriorate with time due to traffic loading and environmental exposure. Asphalt pavement rutting is one of the most commonly observed pavement distresses and is a major safety concern to transportation agencies up to 65 percent of all pavements in Thailand. Millions of dollars are spent annually to repair rutted asphalt pavements. As traffic loading increases significantly and Thailand experiences more frequent periods of hot weather due to global warming, the problem of pavement rutting is anticipated to escalate. Flexible pavement rutting is a distress essentially caused by the accumulation of permanent deformation within each layer of the pavement layered system. In the Asia Pacific climate, such as the one encountered in Thailand Highway, flexible pavement structures are relatively thin with strong base courses provided to ensure good behavior when exposed to high temperature environment. As a result, most of the flexible pavement structures is composed of granular materials with relatively high stiffness. The inclusion of Geosynthetics in flexible pavement structures for base reinforcement has long been accepted as a means of reducing overall costs and/or extending pavement service life. As new products recently emerged the road construction market, pavement engineers are forced to speculate concerning the performance benefits of these products when specifying them. Many research efforts have documented and attempted to quantify the performance benefit of Geosynthetics materials (Perkin et al., 1999; Barksdale et al., 1989; Kim el at., 2005). Most researchers have reported that the use of geogrids can result in reduced surface rutting of flexible pavement and aggregate base thickness requirements or extended service live of the pavement (Perkin et al., 1999; Barksdale et al., 1989; Christopher et al., 2001). However, very little research has been completed regarding the full-scale testing of

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Geosynthetics-reinforced flexible pavements (Perkin et al., 1999; Imjai 2013). Recent research work by Berg et al. (2000) have reported that the use of reinforcement material in pavement structure can increase the CBR value at the interface boundary of base and subbase layers. Perkins et al. [2] also concluded that the initial cost of construction for using the reinforcement is higher than the conventional method but the improvement of due to long-term behavior is much better than the unreinforced pavement i.e. mechanism illustrates in Figure 1 shows how Geosynthetics-reinforced flexible pavement could reduce vertical strain and thus decreases rut depth. Barksdale et al, (1989) investigated the behavior of Geosynthetics materials to use as reinforcement at under layer of asphalt concrete of flexible pavement by mean of a numerical study. They demonstrated the possibility of using reinforcement materials for the flexible pavement, mostly between base layers can reduce pavement rutting significantly. However, there was no research to study the behaviors of utilization of reinforcement for overlay and there was no strain field measurement below the reinforced pavement (Svasdisant 2008; Perkin et al., 1999; Moayed etal., 2009)

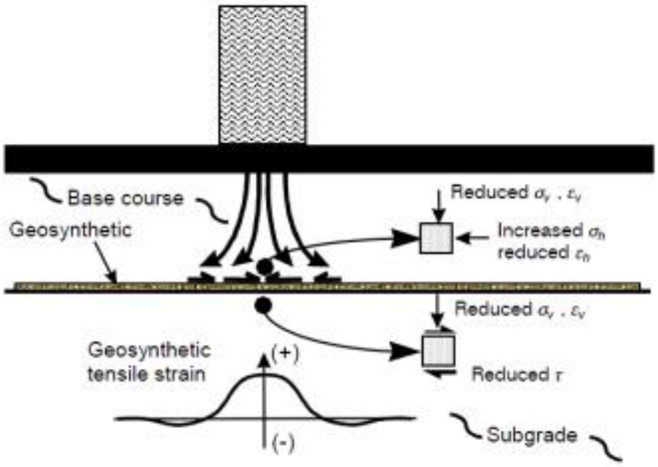
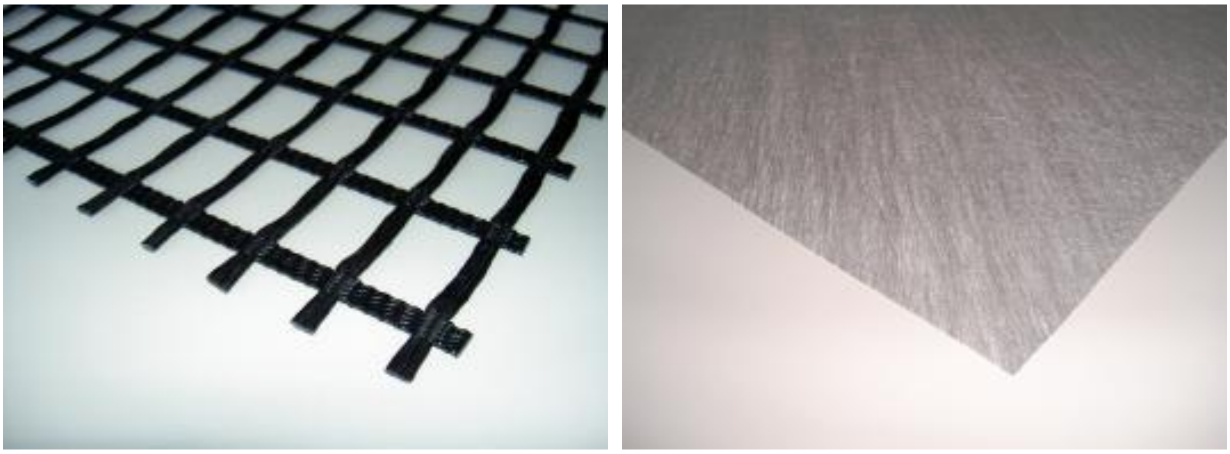


Figure 1. Mechanism of Geosynthetics-reinforced flexible pavement (after Perkins 2005)

In this paper, the behaviors of reinforced flexible pavement and reinforced overlay flexible pavement and the performance of Geosynthetics for structural reinforcement in for rut resistant flexible pavement are investigated through the full-scale test of four sections.

2. FULL-SCALE TESTING PROGRAM

Two types of Geosynthetics are typically used in unpaved structures: geotextiles and geogrids. From the viewpoint of unpaved structure reinforcement, there is a significant difference between geogrids and geotextiles (Figure 2). Due to their large apertures, geogrids may interlock with base course aggregate if there is an appropriate relationship between geogrid aperture size and aggregate particle size. While the degree of interlocking depends on the relationship between geogrid aperture size and aggregate particle size, the effectiveness of interlocking depends on the in-plane stiffness of the geogrid and the stability of the geogrid ribs and junctions. The index properties of these Geosynthetics are given in Tables 1 and 2. Tables 1 and 2 show the properties of the Geosynthetics materials (geotextile and geogrid) used in the experimental program presented in this paper. The thickness and aperture size of geogrid allowed it to provide interlocking with the base layer in the test section P4 and geotextile was used in the test sections P2 and P3 whereas P1 is unreinforced section (Tables 4 and 5).



a) Geogrid   b) Geotextile

Figure 2. Geosynthetic-reinforced materials used in the test section

Table 1. Engineering properties of Geotextile used in the testing program

Properties	Test Standard	Unit	Value
Asphalt retention	ASTM D6140 – 97	Kg/m2	1.1
Tensile strength (md/cd)	-	kN/m	100/100
Elongation at break	ISO 3341	%	3
Strength at 2% strain		kN/m	68/68
E – Modulus of the glass filaments	-	MPa	73,000
Mesh width of the glass filaments	-	mm	40 × 40
Mass per unit area	-	g/m2	430
	EN ISO 9864		

Table 2. Engineering properties of Geogrid used in the testing program

Properties	Test Standard	Unit	Value
Tensile strength (warp)	ISO 10319	Kg/m	100
Tensile elongation (warp)	ISO 10319	%	3
Tensile strength (weft)	ISO 10319	kN/m	100
Elongation at break		%	11
Aperture size	ISO 10319		
Mass per unit area (g/m2)	ISO 9864, ASTM D5261	g/m2	335
Width	-	m	5.2
Length		m	100
	-		

The test section was constructed on the leftest traffic lane (truck lane), consisted four sections (Figures 3 and 4; Tables 3 and 4) as follows:

- Section P1 was between km.102+850 to km.102+900, consisted the conventional flexible pavement without geosynthetic-reinforcement.

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- SectionP2 was between km.102+800 to km.102+850, consisted the geosynthetic-reinforced flexible pavement at asphalt concrete (HMA) course-asphalt concrete bound base interface.
- Section P3 was between km.102+750 to km.102+800, consisted the Geosynthetics-reinforced flexible pavement at asphalt concrete bound base-crushed rock base interface.
- Section P4 was between km.102+750 to km.102+800, consisted the Geosynthetics-reinforced flexible pavement at asphalt concrete bound base-crushed rock base interface and crushed rock base-aggregate subbase interface.

a) Geotextile reinforced pavement

b) Geogrid reinforced pavement

Figure 3. Construction of Geosynthtic reinforced pavement test section

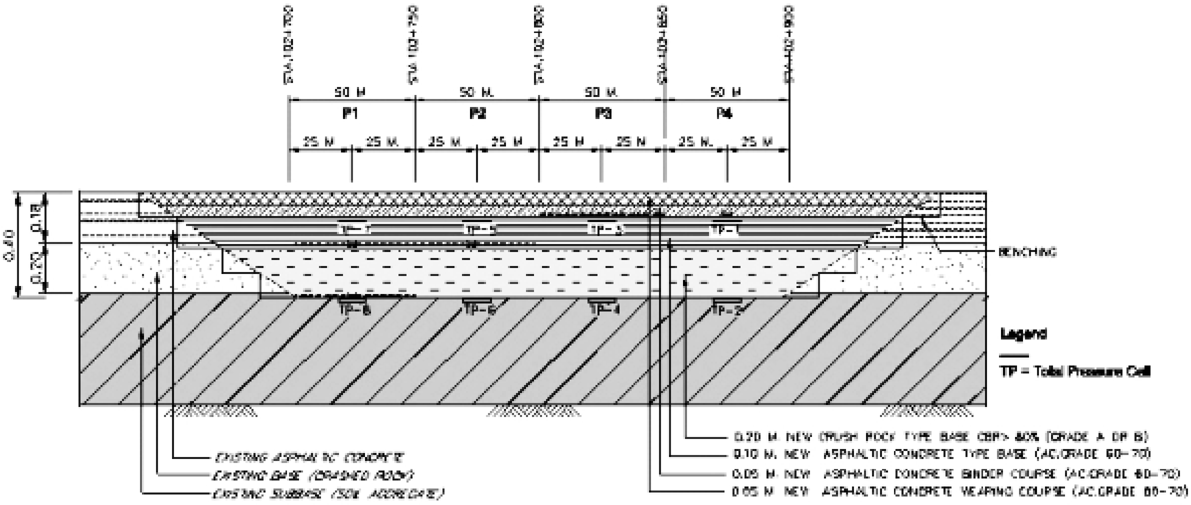

Figure 4. Cross-section and instrumentation of the test sections

Field instruments such as pressure cells, strain sensors (geodetects), settlement plates, and surface settlement points (to measure rut depth), were installed during the construction of the test sections to monitor the performance of the Geosynthetics reinforced flexible pavements in terms of traffic loading effects (stress, strain, defection, and rut depth). Instrument wires from each test section were collected and connected to the instrument houses outside the

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road for data collection. Instrumentation used in this experimental program is shown in Tables 3 and 4 and instrument locations are shown in Figure 5.

Table 3. Instrumentation of the test sections

Section	Total Pressure Cell	Strain Sensor	Settlement Plate	Settlement Point
P1	1 @ depth 200 mm 1 @ depth 400 mm	-	8 points positioned below 100 mm of the pavement surface	14 points on top of the pavement surface
P2	1 @ depth 200 mm 1 @ depth 400 mm	4 @ depth 100 mm on geotextile		
P3	1 @ depth 200 mm 1 @ depth 400 mm	4 @ depth 200 mm on geotextile		
P4	1 @ depth 200 mm 1 @ depth 400 mm	4 @ depth 200 mm on geotextile 4 @ depth 400 mm on geogrid		

Table 4. Details of the test sections

Test Section	Base Thickness (mm)	Bound Base Thickness (mm)	HMA Thickness (mm)	Geosynthetics materials / Reinforced position
P1	200	100	100	Unreinforced section (control section)
P2	200	100	100	Geotextile @ HMA course-bound base interface
P3	200	100	100	Geotextile @ bound base-base interface
P4	200	100	100	Geotextile @ bound base-base interface and, Geogrid @ base-subbase interface

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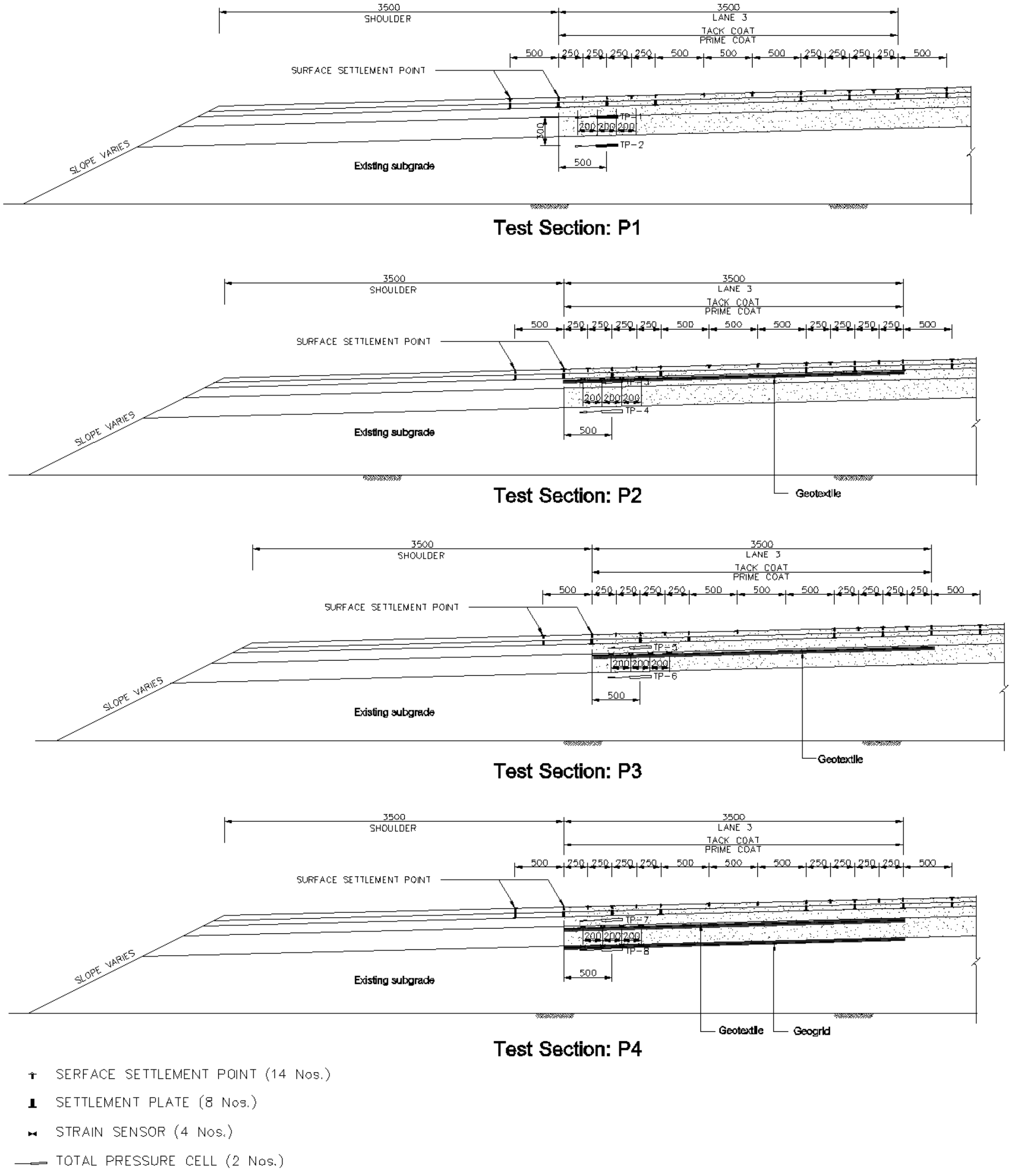

Figure 5. Instrumentation of test sections in the experimental program

3. RESULTS AND DISCUSSION

A series of tests has been carried out to verify the use of the Geosynthetics in the test sections since 2012 to 2014. Static load tests and rut depth measurement were performed on the test section to investigate the performance of reinforcing materials. Test results are presented as follows:

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3.1. RUTTING OBSERVATION

Comparison of rut depth measured from settlement points installed in AC layer (on the top surface of the pavement) is shown in Figure 6 in form of 3D contour plot. The rut depth measurement was continuously conducted after 3 years of service. As the result, the maximum surface settlement of pavement section P1, P2, P3, and P4 were 17, 17, 18, and 11 mm, respectively. This indicates the test section P4 shows a good rut resistant compared to other reinforced sections (P2 and P3) and the Geosynthetics in section P4 can reduce rutting distress significantly (see Figure 7) after 3 years of service. It is evident that geogrid reinforcement at bound base-subbase interface could increase the rutting resistance of the flexible pavement.

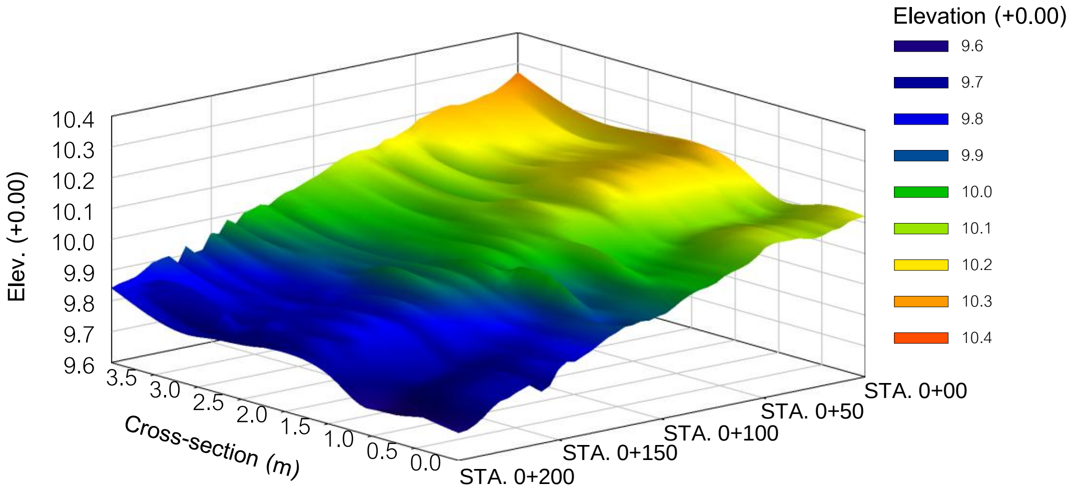

Figure 6. Contour plot of surface deformation after 3 years of construction

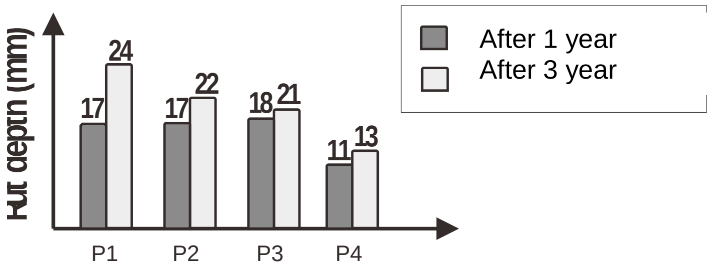

Figure 7. Rut depth from field measurement after construction completed (years)

3.2. VERTICAL STRESS MEASUREMENT

A series of load testing was conducted on the test section after 3 year of service (the test was performed every year for comparison purposes). Different truck loads were applied at the left wheel path of the test section. Due to space limitation, field data and comparison were shown only the test sections P1 and P4. Pavement responses of test sections P1 and P4 during the loading test such as pressure and transverse strain are shown in Figure 8. It indicates that both bound base and subbase pressures in section 4 (geosynthetic-reinforced pavement section) were significantly decreased, compared to section P1 (control section). However, the measured pressures in section 2 and 3, which were also geosynthetic-reinforced pavement section, were not significantly different from those in section P1 (not shown here due to space limit). However, it can imply that geogrid reinforcement at bound base-subbase interface could reduce the stress through the subbase layer and reduce rutting potential as shown in Figure 8. Due to the space limit, the result from this research is presented only for the static load test under the truck weight of 30 tons after 3 year of service. Full experimental result can be found in Imjai (2013)

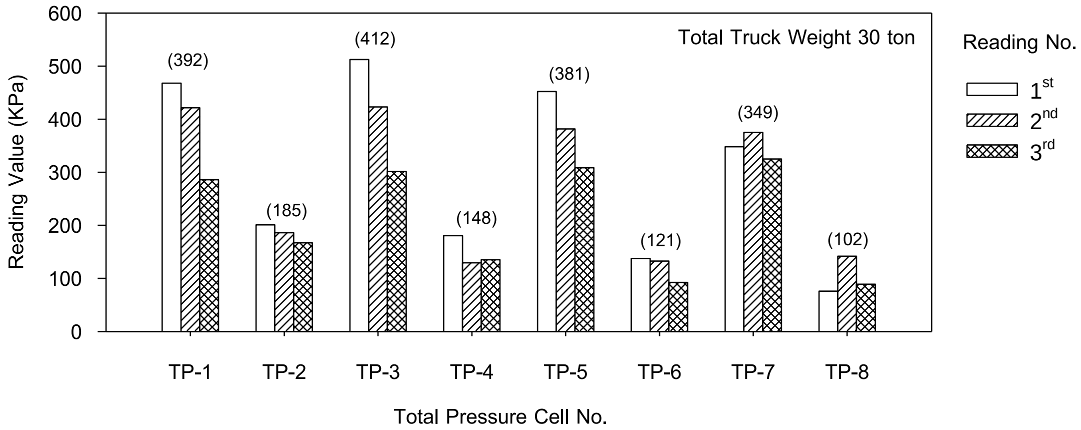

Figure 8. Vertical stress measurement from total pressure cell during station load test (30 tons truck)

4. CONCLUDING REMARKS

A series of long-term monitoring for the performance of geosynthetic-reinforced flexible pavement on full-scale test section. Field tests were conducted every years for comparison purposes. This paper presents the static load test and rut depth measurement after 3 year of service. Findings of recent study, it is concluded that the use of geosynthetic reinforced pavement sections significantly improved the resistance to rutting compared to the unreinforced section. From the experimental program, it is evident that geogrid reinforcement at bound base-subbase interface could increase the rutting resistance of the flexible pavement. The result of this research is a practical framework for developing extensive full-scale testing data base which is intended to use for long-term monitoring of the performance of geosynthetic reinforced material.

On-going research at Rajamangala University of Technology Tawan-Ok on various aspects include experimental and analytical investigations on the Geosynthetics-reinforced flexible pavement, and development of design methodologies. The research group participates to the activities on the use of Geosynthetics in flexible pavement and carries out collaborative research through Thai Government Research Grant.

5. ACKNOWLEDGEMENTS

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POLICIES AND MANAGEMENT

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THE DYNAMICS OF MANAGING COASTAL AREAS AT LOCAL LEVEL A CASE STUDY OF MELAKA, MALAYSIA

M.Z.MOHAMED[1] and S.A. BABATUNDE[2]

ABSTRACT: The paper focuses on the complexity in managing coastal areas at the local level in Melaka. It is based upon three main objectives namely to analyse the function of local agencies in coastal areas management, to determine the level of cooperation and integration among various local agencies and to identify challenges and constraints impeding the establishment of an effective coastal management system for Melaka. Five agencies involving in the management of coastal areas in Melaka are studied in terms of their legislation and perception towards the management of the coastal areas. A total of five interviews and forty two questionnaires are distributed. The result shows that the level of cooperation, awareness and understanding on management of the coastal areas are low and not integrated. Findings also indicate that there are overlapping of jurisdictions, lack of professional and man power, inadequate funding and difficulties in managing people in the coastal zones. Based on these findings, efforts must be made to enhance the level of awareness, cooperation and integration in the implementation of a more cohesive approach of coastal management. Laws to promote for integration, formation of coordinating body and programs to enhance cooperation and awareness should also be considered or put in place.

KEYWORDS: Coastal Management, Local Level, Awareness, Cooperation, Integration

1. INTRODUCTION

The rapid population growth, the effects of global warming and uncontrolled human activities has raised so much attention on the need to manage coastal areas in a sustainable way. Considered as most densely populated parts of the world, coastal areas are inhabited by the two-thirds of the world population. Past literatures indicate various terms given to define the coastal area or zone. Regardless of the definitions given, the coastal area or zone serves as point of convergence for various kinds of urban activities including shipping, forestry, agriculture and tourism. Through these activities, the coastal areas bring abundant economic opportunities and employment which in turn encouraged immigration, rapid urban growth and in many cases more reclamation of coastal land.

Despite the advantages highlighted, the development on the coastal areas has brought its owns set of challenges. The challenges vary from environmental depletion to poor or ineffective management of coastal areas and lack of enforcement of laws related to these areas. Tragedies of tsunami in Acheh, Sumatra, Sri Lanka and that of Fukushima, Japan have drawn the world population towards the environmental quality and the management of coastal areas. While public policy with regards to the implementation of coastal management is made at the national or federal level, those local agencies at the local level are instrumental in implementing the policy. Thus, the function of local agencies plays an important role in managing the global environmental and community in the coastal areas. Although there are various researches that have been done on the management of the coastal areas, but little has been done to examine into how effective are these agencies and how best they can be equipped at managing the coastal areas. The study focuses on the management of coastal areas because of several reasons;

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1.1. A LACK OF INTEGRATION AMONG LOCAL AGENCIES IN MANAGING COASTAL AREAS

Rapid urbanization and development in some cities and urban centres bordering the coast of Malaysia increase the need to provide an environmental friendly solution towards management of coastal areas. Environmental problems have expanded over the past two decades to include issues of pollution at local level to natural resources depletion and degradation and transnational environmental issues such as haze and marine pollution These problems pose to be major threats to human welfare and livelihood. In some of local areas, a number of local agencies are appointed to manage certain coastal area with unclear boundaries of responsibility. This contributes to a lack of integration among local authorities in managing these coastal areas.

1.2. INHERENT WEAKNESSES OR LIMITATION IN MANAGEMENT, IMPLEMENTATION AND ENFORCEMENT OF LAWS BY LOCAL AGENCIES IN COASTAL AREAS IN MALAYSIA

The existence of various local agencies at local level responsible directly or indirectly with the management of coastal areas based by an assortment of laws and regulations has in its own way generated its own set of problems. Imposition or enforcement of Federal and State laws, policies and regulations related directly or indirectly to coastal management can be a complicated job for those who are supposed to implement and enforce more so for the local communities who are going to be impacted by such policies, laws or regulations. This situation is made worse because some of these agencies lack the necessary human resources or professionals well-trained in this field.

1.3. POSSIBILITY OF OVERLAP OCCURS IN GOVERNANCE STRUCTURES AND JURISDICTION DUE TO LACK OF OPERATIONAL COORDINATION AT THE LOCAL LEVEL

In managing the environment, the integration among various tiers of government is crucial. According to Alan (n.d.), the governance structures commonly produce problems of jurisdictional overlap and lack of operational coordination at two levels - the horizontal, among different ministries or sectoral agencies, and the vertical, that is between central and provincial governments. In some cases, the occurrence of the overlapping leads to program failure.

1.4. A LACK OF STUDY ON THE ROLE OF LOCAL LEVEL AGENCIES IN THE IMPLEMENTATION AND ENFORCEMENT OF ENVIRONMENTAL MANAGEMENT

Past literatures indicate that implementation of land policy and environmental planning encountered many difficulties due to political, social and environmental influences. A good and successful environmental management exists when the organization is perfectly structured to accommodate the issues and problems. The concept of implementation and enforcement is thus related to good and successful environmental management.

Based on the highlighted problems, the study aims to analyse the complexity in managing coastal area at the local level. In order to achieve the aims, the study focuses on several objectives; i) to analyse the function of local level agencies in coastal areas management, ii) to determine the level of cooperation and integration among various local agencies in the study area, iii) to examine the challenges or constraints impeding effective the coastal management and iv) to outline recommendation to improve the role and functions of these local agencies in the management of coastal areas. The main research questions have been identified based on the aim and objectives set out for the study; a) what are the involvement of local agencies in managing coastal areas?, b) what type of cooperation exists and to what extent it is practiced among the stakeholders?, c) what are the constraints impeding successful coastal environmental programs?, and d) what are some of the recommendations that can be put forward to achieve a more effective coastal area management?

2. LITERATURE REVIEW

This section reviews some of the literatures that are cogent and important to the study. It delves into efforts and approaches to coastal environmental management in Malaysia and the steps that have been taken to incorporate environmental management at the local level. It starts by explaining the definition and meaning on related terms and issues related to coastal management.

2.1 THE DEFINITION AND SCOPE OF TERMINOLOGIES

Past literatures indicate that there is no universal accepted definition of Environmental Management (EM) due to ambiguity of the term (Barrow, 1999). In some literatures, EM is seen as a multi-layered process which involves different type of environmental managers. Others (Geoff and Raymond, 1997) characterized the term by a set of concepts and approaches that interrelate in a distinctive way and as the process of allocating natural and artificial resources to satisfy human needs at minimum and more for sustainable basis (Geoff and Raymond, 1997; Jolly, 1978; Barrow, 2006). Meanwhile, coastal area or zone is defined as 'the part of the land affected by its proximity to the sea and the part of the ocean affected by its proximity to the land' (Clark, 2002). The coastal area or zone also includes offshore waters, the coastline and the adjacent shores (Sorenson, 1997).

The concept of Coastal Areas Management (CM) is a proactive approach that is distinct from simply managing activities at the coast as it encompasses the management of everything and everyone on the coast within some form of a unified system and approach (Kay and Alder, 2005). CM can be seen as a process which covers the whole concept of protecting the coastline from damage and change from any activity (French, 2004). On the other hand, the Integrated Coastal (Areas/ Zone) Management (ICM) that was introduced in the 1970s was first given a clear definition at the Charleston Workshop in 1989 and entered the international political scene during the Rio Earth Summit in 1992 (Bille, 2008). The essence of ICM is to enhance sustainable coastal management through the involvement of stakeholders and through the comprehensive spatial planning (Glaeser, 2008). According to Cicin-Sain and Knecht (1998), the ICM also acknowledges the interrelationship that exist among coastal and ocean users and the need to overcome the fragmentation inherent in the sectoral management approach.

There are three important elements in regard to the Integrated Coastal (Areas/ Zone) Management (ICM); i) the concept of integration in ICM, ii) degree of policy integration in ICM and iii) the types of integration. The concept of integration refers to the implementation and monitoring of policies, investment strategies, administrative arrangements and the harmonization of standards as part of a unified program to ensure objectives are being met (Chua, 1996). However, the level of integration in most cases is determined by the type of policies which support the CM program that may range from relatively weak level of integration to a very strong integration one (refers Figure 1 below). Meanwhile, there are five types of integration which can inter-sectoral, intergovernmental, spatial integration or integration between land and ocean sides of the coastal zone, science management integration among different disciplines important in coastal and ocean management, and the international integration which involves participation of two or more countries.

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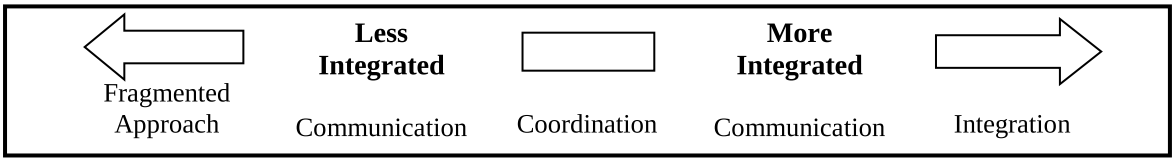

Figure 1. Degrees of integration in Coastal Management
Source: ***Kay and Adler (2005)***

2.2 THE THREATS/ ISSUES AND ENVIRONMENTAL PROBLEMS OF COASTAL ZONES

With the growth of coastal and marine parks, ports, tourism and industrial aquaculture, environmental problems have arisen. There are several threats associated with environmental problems in coastal zones including the coastal erosion particularly in urban coastline areas. This threat occurs due to extraction of sand, dredging, construction and development along the coast. Other threat is storm surge and flood risks. As one of the deadliest coastal hazards, the storm surge is the process where the water and the pressure caused damages to coastal structures and erode the coast.

The continuing urbanization process accompanied by rapid industrialization and transportation development put various pressures on the living and non-living resources of the coastal zone. Other threats that have been known to have a greater effect on the coastal zone include those from tourism activities to due to excessive influx of visitors and vehicles. In addition, natural disaster and man-made activities caused the biological components and structures of the coastal zone may deteriorate and disintegrate the coastal environments. Besides that, construction and coastal industrial development also pose threats that contribute to the alteration, and disturbance of the coastal ecosystem.

2.3 COASTAL MANAGEMENT: A CASE FOR LOCAL GOVERNMENT

Growing challenges and environmental problems at the local level call for effort to establish to establish a central body to facilitate a speedy response to overcome environmental issues and problems. However, the management of coastal zone involves a series of activities or actions as well as many stakeholders and this can create a lot of problems and difficulties in the implementation and coordination of measures to mitigate these environmental challenges among the participating agencies or actors. Based on past literature, several coastal management problems at the local level are identified as follows:

a) Jurisdictional overlap among agencies,
b) Lack of trained personnel
c) Lack of enforcement
d) Insufficient finance and lack of funding
e) Lack of integrated law and regulation
f) Lack of environmental awareness and public participation
g) Lack of coordination
h) Insufficient human resources

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2.4 GOVERNANCE/ MANAGEMENT TECHNIQUES IN ICM

One of the important aspects of ICM program is the process of management or the techniques used to carrying out the activities of the coast. According to Kay and Adler (2003), coordination or techniques used in the governance and management of the coastal area can be used individually to address specific problems and this can be combined to address complex issues or used as part of a coastal management planning process. Among the management techniques are the enforcement of policy and legislation that forms the basis of decision making process, or through the implementation of guidelines or a set of documents consisting of various objectives and procedures to manage the coastal area, zoning, regulation and enforcement techniques. The enforcement of regulation is considered as more flexible as a mechanism used by government to promote effective control in coastal area. Research has shown that enforcement used if combined with other management tools can realize long-term compliance.

2.5 EM AND LEGISLATION IN MALAYSIA

Several Environmental Management (EM) and laws has been introduced since the colonial era to protect environment in Malaysia. This started with the introduction of environmental legislation known as the Environmental Quality Act (EQA) 1974 to protect, guide and manage some of the important environmental sensitive areas in the country. The Act is seen as a very important tool used by the government to control industrial pollution, wastewater, air pollution from industries and solid waste problems. Due to increasing number of environmental issues and problems as well as rising global warming, the amendment on the Act was made and included in the Environmental Quality Act 1996 (Act 953).
Nevertheless, the need to address and control rapid development activities and urban sprawl problems has led to the introduction of Environmental Impact Assessment (EIA) regulation in 1987. This regulation aims to control and regulate the adverse effect of development from its inception through-out all stages involved in a project. Aside from EIA, the Malaysian government also introduced the Malaysia Plan (MP) that incorporated the environmental policy aimed at addressing environmental concerns and this important for its inclusion into the national development planning. This was introduced during the Third Malaysia Plan in 1976-1980. Currently, there are than 30 different environmental laws that are in place in managing, guiding and controlling environmental activities within the context of promoting sustainable environment.

2.6 INTEGRATED COASTAL MANAGEMENT (ICM) EXPERIENCE IN MALAYSIA

A report of study in 1987 on causes leading to loss of properties along the coastlines indicate that the country's coastline of 4,809km in which about 1,390km was subjected to constant erosion and this entails the need for proper implementation of long-term planning. As the result, the government has established the Coastal Engineering Centre (CEC) in the Department of Irrigation and Drainage (DID) in 1987. In the same year, Malaysia has witnessed the establishment of National Coastal Erosion Control Council (NCECC) that involves representatives from the economic Planning Unit; the Ministry of Finance; the Ministry of science, Technology and Environment (MOSTE); the Department of Drainage and Irrigation; the Public Works Department; the Town and Country Planning Department, the Forestry Department; representatives from Sabah, Sarawak and two other states (on the rotating basis); the professional institutes and universities (Cicin-Sain and Knecht, 1998).

Besides, Malaysia also established a comprehensive and multidisciplinary coastal resources management including the Coastal Resource Management Plan Southern Johor (CRMPSJ) which was established in 1992 and funded by the ASEAN-USAID Coastal Resources

Management Project (USCRMP) in collaboration with the Ministry of Science, Technology and Environment (MOSTE); the Implementation Coordination Unit (ICU) of the Prime Minister's Office; and the Department of Fisheries (DOF).

The most recent initiative towards integrated coastal zone management is the launching of a series of pilot projects being undertaken in Sabah, Sarawak and Pulau Pinang. This project is co-operation between the Government of Malaysia, represented by Economic Planning Unit and the government of Denmark represented by Danish Cooperation for Environment and Development. Another important coastal management that has been embarked in Malaysia is called Integrated Shoreline Management Plan. This program was set up under the Drainage and Irrigation Department aimed at addressing some of the major issues and problems along the coastal shoreline of Malaysia.

2.7 CONCEPTUAL FRAMEWORK

The review of literature helps to develop the conceptual framework (refer Figure 2), which was used as the guide and flow of the research. From there, several factors are identified to provide a general understanding on the variables, interdependent and interrelated factors that can form as guidance on how to manage the coastal area at local level and how to promote cooperation among local agencies.

2.8 STUDY AREA: A CASE STUDY OF MELAKA

Melaka also known as Malacca is one of the fast economically growing states in Malaysia and the third smallest state after Perlis and Penang. It is situated on the South-Western Coast of Peninsular Malaysia facing the Straits of Melaka, in-between the state of Negeri Sembilan to the north and Johor to the east. Melaka is rich with its cultural background and heritage preservation that it been listed as World Heritage site of UNESCO on 7th of July 2008.

Since the last 8 years, Melaka's economic performance has been unique and amazing as it has successfully generated a stimulating growth of economy with an average Gross Domestic Output (GPP) of 5.8 per cent. Some of the contributors to her successful economic performance include tourism and manufacturing sectors. As an entreport, Malacca used to be under the Portuguese, Dutch and British administration before Malaysia achieving its independence in 1857. Its rich colonial history and heritage is an important asset to its tourism sector. From a state with limited resources, Melaka has grown from a hollow state to be one of the most developed states in Malaysia maximizing on its assets and strengths such as its tourism sectors and its proximity to the Klang Valley facilitated by the construction of the North-South Highway which enhances its connectivity to both north, central and south part of Malaysia and as well as Singapore.

3. RESEARCH METHODOLOGY

The objective of the research is to investigate and understand the role and the level of cooperation among various local level agencies in the management of coastal environment. To achieve this objective , mixed methods of research are used based on literature reviews, structured interview and questionnaire with selected agencies.

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3.1 DATA COLLECTION METHODS AND SAMPLING

The mixed methods used constitute a qualitative and quantitative research technique. Mixed method research is the use of multiple approaches as this method does not restrict or constrain researchers' choices but allow researchers to answer research questions effectively (Maxwell and Loomis, 2003). It incorporates some form of triangulation in the discussion.

3.1.1 Literature Review

Literature review on some of the case studies related to this subject provides a general structure to the whole research. Besides, literature reviews also form a generalization of situation in the study area. The literature review explains the theories that support the research and explores other topics central to the research.

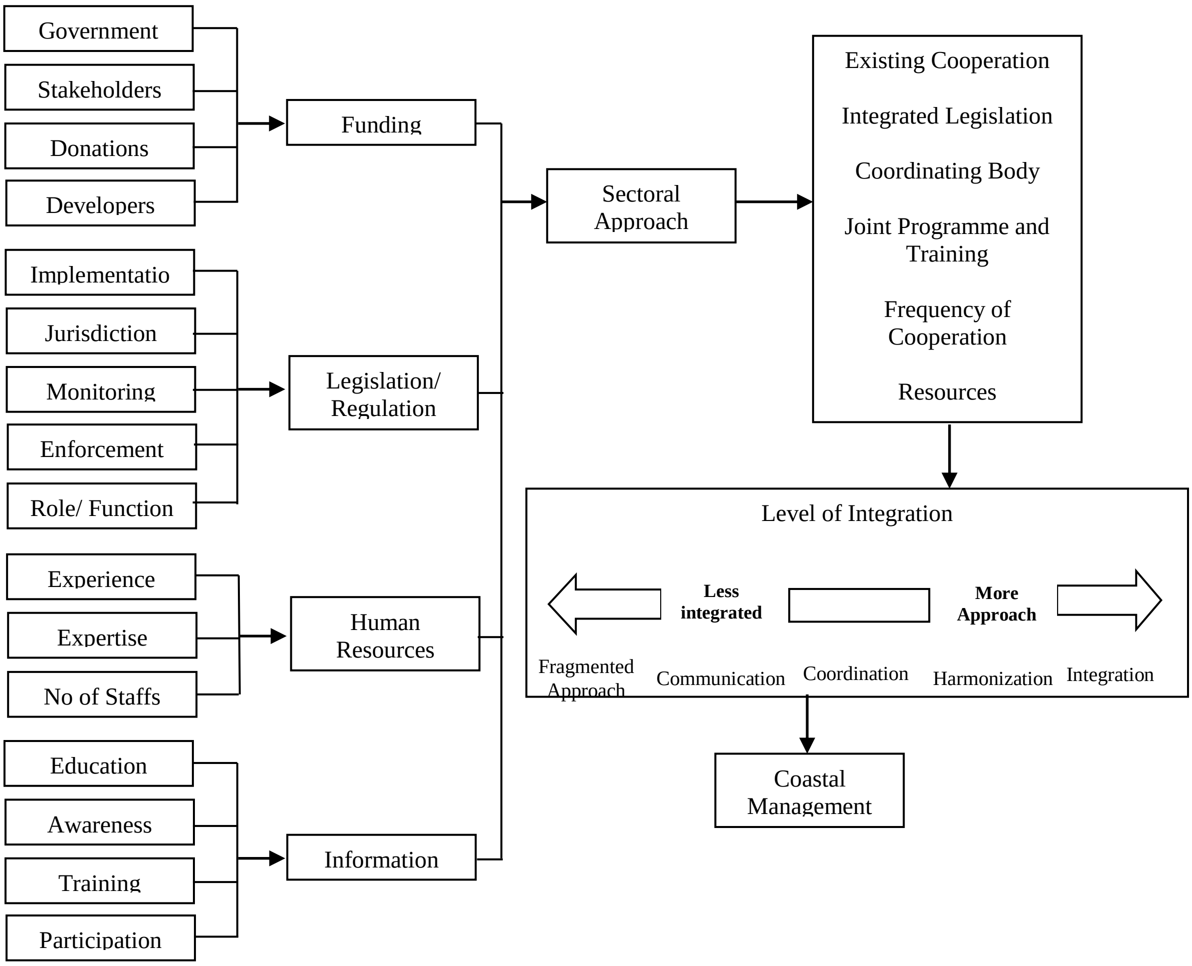

Figure 2. Conceptual Framework of Study
Source: *Field Survey (2009)*

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3.1.2 Structured Questionnaire

There are three data collection methods used in the study. The first method is the structured questionnaire (structured interview) is employed to access participants' commitment towards organization' management and involvement in the coastal area. The questionnaire designed with both open and close ended questions to obtain a comprehensive in-depth perception from the participants. There are two target population surveyed which are the senior officers of each local agencies and the staffs of the departments.

3.1.3 Questionnaire Survey

For the questionnaire survey, the method is administered by the researcher face to face with the assigned officer from each department visited. There are four parts of the questionnaire which include personal profile section, perception towards environment section related to types of environmental problems in the study area, the environmental laws, policies and regulation section and the last section is the questions on the existence of cooperation among various local agencies in dealing with coastal environmental management.

3.2 STUDY AREA

Melaka is selected as the study area for the research because of its uniqueness and its status in Malaysia as a part of United Nation heritage town. Apart from that, Melaka is one of the states in Malaysia with the largest of coastal known for its fast growing economy and development in terms of business, education, industry, coastal tourism and transportation. However, lack of clear role on the part of the local government close to the coast is a subject of great interest for those examining stakeholders' participation in the management of coastal areas. In view of this the researchers were interested in knowing the role and responsibility of the local level government in the environmental management in the coastal areas.

3.3 SAMPLING SELECTION

The target population sampling involved in the study is the government officers at related local agencies and departments that participate in environmental programme in the study area. The selected participants include the Director or Head of each department or their representative, various middle management staffs and officers from various sampled agencies. A total of 7 departments were selected; i) Melaka Historical City council, ii) Town and Country Planning Department, iii) Department of Agriculture, iv) Drainage and Irrigation Department (DID), v) Department of Environment (DOE), vi) Land Offices Department, vii) Forestry Department. However, only five departments responded. A total number of respondents participants involved in the questionnaire survey are 42 participants. In addition, five interviews were conducted from five different agencies. Although data collected came from two different methods of data collection, it has provided a good insight and greater understanding of issues arising in management and the study area.

3.4 DATA ANALYSIS

A system of coding is employed in the analysis of both interviews and questionnaire information. The coding system is based on the ideas and understanding derived from the literature review and other direct information that accessible in the process of the study. The descriptive method is also used in some analysis to present findings for the research.

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4. DATA ANALYSIS AND FINDINGS

After the analysis of the data which were done based on some of the indicators identified in the literature review, the authors were able to come out with some of the findings;

i. *Overlapping of management functions*

   Past literature indicates that problem of overlapping of management function caused a slow down the management process and encourage inefficiency in the management of the coastal area. The findings notice the functions and roles among various agencies are overlapping among agencies. Through the creation of unified and coordinating body, the function to oversee the management in the coastal area can be improved. Furthermore, amendment on legislation and policies to be more specific on the roles and empowerment on the management of coastal area should be included.

ii. *Legislation is disintegrated/piecemeal*

   From the analysis, it is found that no unified legislation and policy statement that encouraged for partnership among management agencies. Moreover, there is no integration of laws provided for management of coastal area in Melaka. However, the DID stated in their webpage to integrate some of their work with other department in the future plan.

iii. *Lack of viable cooperation*

   At present, only minor administrative cooperation in which advise are sought far from expert from other departments existing in the study area. This is however subjected to acceptance and rejection. This issue can be tackled through the improvement of provision of more technical cooperation and assistance along with the administrative advice.

iv. *No coordinating body*

   The finding shows major impediments to cooperation exist in the management of coastal area that contributed to difficulty in deciding who and where to report a case when instantly noticed. Thus, the creation of a coordinating body will bring coordination among stakeholders at better managing the coastal area.

v. *Poor and lack of cooperated programmes, training and awareness*

   There are lacks of awareness on coastal management among both staffs and communities. In addition, there is weak interagency training and programmes. Most of the programmes are in-house among the various departments in which most cases the programmes is design for their staffs. It is suggested to have awareness programme for both staffs and public, along with training to combat environmental problems together with sharing experiences and working as a team.

vi. *Insufficient of human resources, experiences and expertise*

   Other findings show there are lacks of well trained staff, insufficient man power and professional in the study area. This can be improved encouragement of management staff to participate in various management and professional programme. This also can be improved through recruiting more man power to manage the coastal area.

vii. *Lack of funding*

   There is also an issue on availability of funding for coastal management. This should be further looked into by the central government to help the local agencies in their management programme.

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viii. Lack of monitoring team

Insufficient in monitoring team is also found in the study area. The agencies should combine their resources at better making a task force to oversee the monitoring of coastal area. This can be assisted with the inauguration of a community based on coastal management which input will be provided by the local communities in the coastal area. The coastal management issue is very dynamic topic that concerns all level of governments.

4.1 SIGNIFICANCE OF THE STUDY

This study is significant for a number of reasons i) planning, ii) community and iii) local authorities or agencies. As more urban activities start to encroach into coastal areas, studying coastal management is important towards future planning to ensure a better living environmental condition. In creating a good environmental management development, it brings a more conducive atmosphere free pollution that can promote a more orderly social and economic development. A good of implementation and enforcement of environmental related programme can be one of the tools in creating the sustainable communities and development. Aside from that, the input of the study is important in helping local authority and other stakeholders in making decision on effective implementation and enforcement of environmental legislation and programme. Furthermore, findings and recommendation also can be used for other similar coastal areas encountering similar situation.. Other local authorities and agencies can also to consider of establishing 'an enabling body' dedicated and entrusted in enforcing environmental laws and programmes.

5. RECOMMENDATION AND CONCLUSION

Based on the findings, the literature review and experience from field study, several recommendations are highlighted to improve the performance and cooperation among various stakeholders. Six major recommendations suggested are;

i. The first recommendation is the establishment of coordinating body for controlling activities in the coast. It is recommended that the local authority should be responsible to take this task.

ii. Second, the formulation of a more integrated legislation to replace the existing ones. The integration of legislation will define what is required, permitted and forbidden by stakeholders and administrative actors in the coastal area. The local authority should be given the mandate to oversee the various coastal activities in partnership with others as part of the integrated approach.

iii. The research also suggests expanding the existing departments/ Local authority power to meet the increasing threats facing the coastal area. Both state and national government should delegate some functions to the local authority and various departments. This will help them to take a more directive measure at combating impact on the coastal problems.

iv. The fourth recommendation is to create a task force/ enforcement team and community based enforcement programme to encourage cooperation with local communities. The availability of on-site monitoring and enforcement officer coupled with local community based enforcement programme will help at curbing some activities that have impacts the coastal areas

v. Other recommendation is concerned with the issue of funding among local agencies. The central government should increase the budget for related departments and ministries to carry more effective roles in coastal management.

vi. The last recommendation is to increase level of environmental awareness, adoption of more rigorous training and programme on coastal management among staffs by having more lectures, training and symposium programme. Apart from that, there is also a need to educate the public on the coastal management and environmental awareness programme.

The increasing of global warming and sea level rise call for the need to actively integrate all level on management and increase level of awareness of local environmental issues. Findings of this study hopefully will contribute to better planning and management of coastal areas. It underlines the importance of the cooperation among stakeholders and participation of communities in the coastal management.

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THE AFFORDABILITY OF LOW INCOME SOCIETY IN BANDUNG CITY ON HAVING A HOUSE THROUGH THE SUBSIDIZED LOW PRICE HOUSING PROGRAM

Syarif Hidayatullah SANTIUS[1]

ABSTRACT: Based on data from the Department of Human Settlements and Housing of West Java, the number of households that do not have a decent house in Bandung until the year 2009 as many as 69.102 households. This study was conducted to understand the dynamics of the low income society capabilities in Bandung on having a house through mortgage by Housing Financing Liquidity Facility (FLPP). System Dynamics is used as the methodology in this study. The results of model simulations with base scenario show that the government's policy to increase the number of low income society who have a house in Bandung through mortgage program still can not reduce the number of low income families who do not have a house in the long term. FLPP mortgage program with an interest rate of 7.25 % per annum fixed for the tenor and tenor for 15 years did not result in increased capabilities of the low income society to access house ownership through the program. With the low income society family income conditions in Bandung today is assumed to be 2 million rupiah per month was not sufficient to pay down the mortgage or mortgage installments, moreover, the low income society family who earn under 2 million rupiah per month. Subsidized low-cost housing policy is implemented through FLPP mortgage program can have an impact on reducing the number of low income families who do not have a house if the level of family income of 3.9 million rupiah per month or more. The most urgent policy to be implemented based on the results of the simulation models, the addition of employment policy.

KEYWORDS: *low income society, low-cost housing, mortgage, housing finance liquidity facility, System Dynamics*

1 INTRODUCTION

The number of homeless low income families in Indonesia have been increasing every year. In 1998 the number of about 5,4 million, in 2004 increased to 7,4 million in 2007 increased to 11 million and in 2010 the number reached 13.6 million (Ministry of Housing, 2011). Base on Department of Human Settlements and Housing West Java Data shows, the cumulative amount of supply shortage of appropriate housing in the city of Bandung until the year 2009 as many as 69.102 units.

Based on the above background, the problems in this study are as follows.

1. The housing need for low income families in urban areas, especially in Bandung is always increasing, but the supply much lower.
2. The income allocation to repay the mortgage and make a down payment less than the amount to be paid.
3. The housing prices are higher because of the limited land can be used for housing.

The objective of this research is to understand the dynamics of the ability of low income family in having a house through the mortgage program by Housing Finance Liquidity Facility (FLPP).

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To achieve the research objective, there are several research questions that must be answered as follows.

1. How is the structure of cash of low income families in Bandung which is able to buy a house through FLPP scheme?
2. How is influence of the FLPP program in increasing the ability of low income families to have a house?
3. What are the right policies and the implications for increasing the ability of low income families to have a house?

2 METHODOLOGY

The research methodology used is System Dynamics. Selection of System Dynamics is based on its ability to recognize the elements of the systems and patterns of linkages between these elements and be able to show the inter-relationship that affects the behavior of the overall system in a model.

3 DISCUSSION

Models and sub models developed in this study refers to the global model that contains the flow of information and policy between the parties that involved in the phenomenon under this study. Global model in this study looks like in Figure 1.

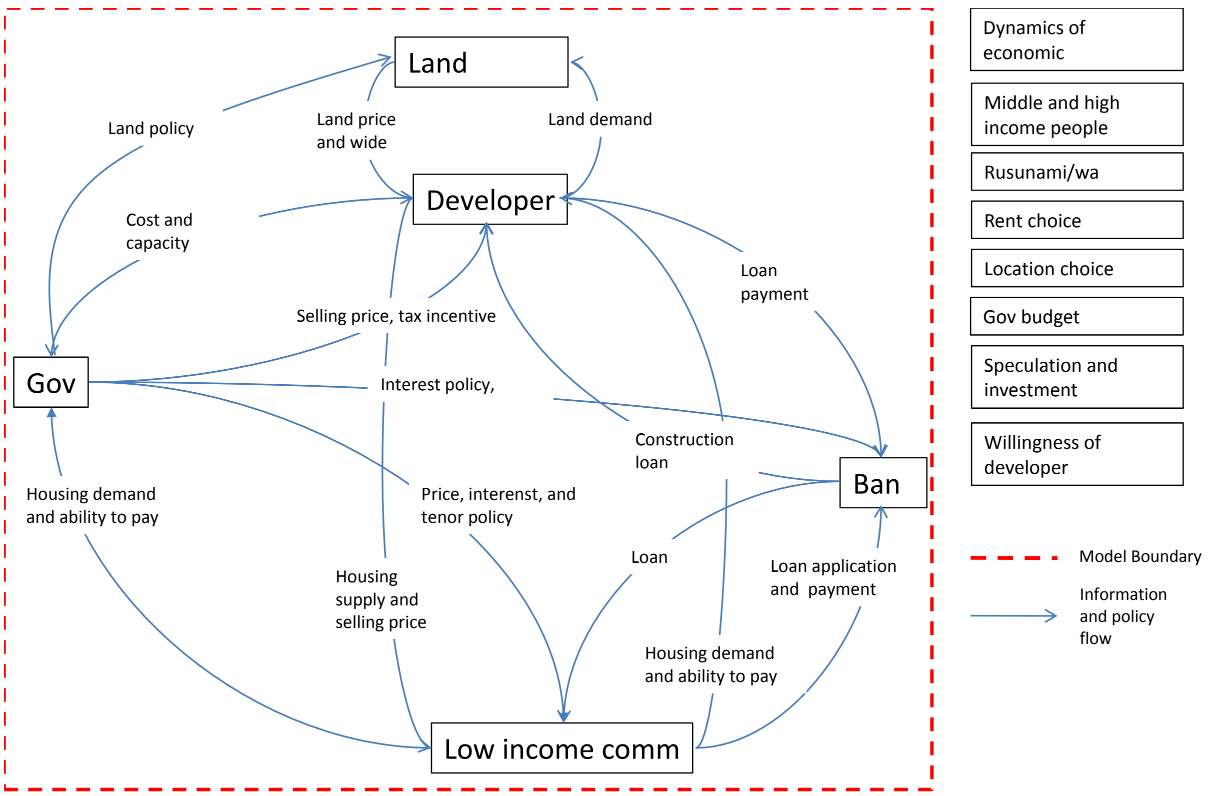

Figure 1 Model Overview

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3.1 SUB- MODEL OF LOW INCOME POPULATION

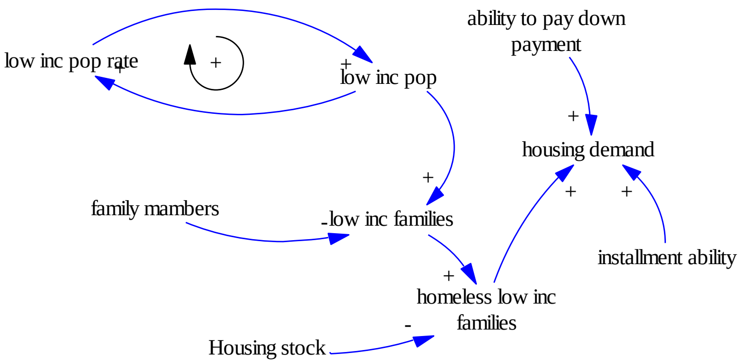

Figure 2. Causal Loop Diagram of Low Income Population

The aim of this sub model is to determine the number of homeless low income families. The number of homeless low income families is calculated from the number of low income family minus the number of houses that occupied by the low income family.

3.2 SUB MODEL OF LOW INCOME FAMILY CASH

This sub model is formed by cash income and cash expenses. Based on the author's personal observations and experiences, family expenditure consists of emergency expenditures, routine consumption expenditures or household expenses, and saving expenses. Saving expenses depending on the characteristics of each family, there can be also no saving policy. Because one of the goal of this model is to look at the ability of low income families in purchasing a home through FLPP facilities, then into cash sub models added one more expenses, namely housing installment expenditure. In FLPP scheme, customers are required to pay a down payment of 10 percent of the price of the home, therefore, low income families should have the savings to be able to pay the deposit.

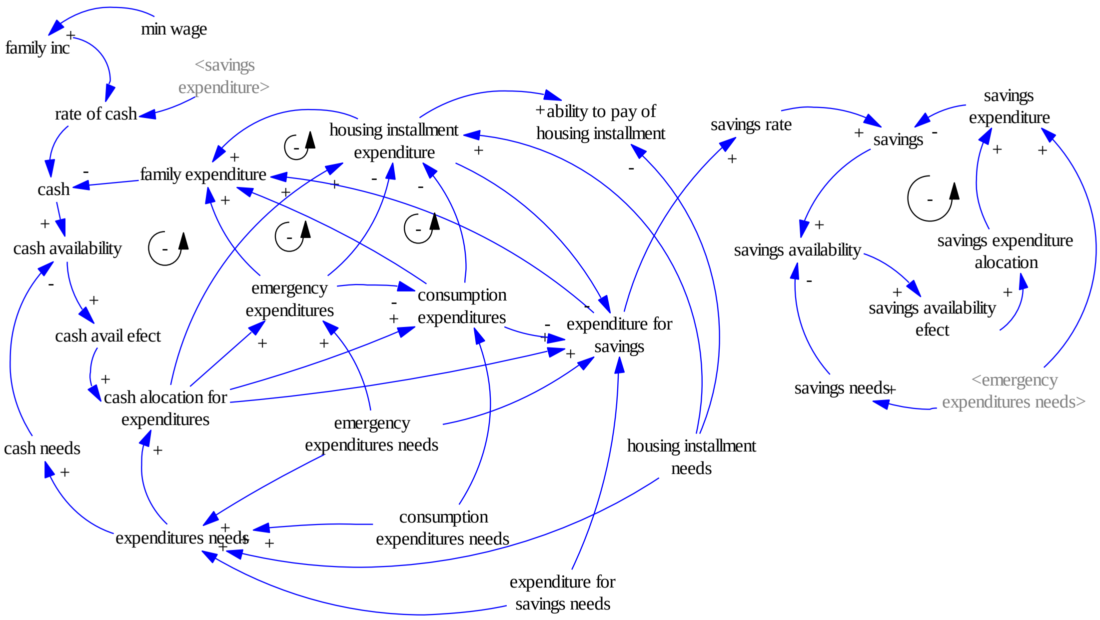

Figure 3. Causal Loop Diagram of Low Income Family Cash

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3.3 SUB MODEL OF DEVELOPER CASH

Sub model of developer cash is formed from developer cash income and expenditures. Developer cash income generated from the sale of the houses and the construction loan from the bank. Based on interview with developers and banks, construction loans granted to developers by 60 to 80 percent of the needs of the construction costs with interest rates of 12 to 13 percent and a maximum term of 3 years. For the purposes of land purchase, licensing and additional construction costs, developers must have a capital or initial investment first.

Cash expenses consist of expenses developer for bank loans and expenditure for the construction of houses. The first priority of allocation of developer expenses is to pay the loan. Cash availability will affect developer expenditures with a trend if the availability of cash is large then cash expenditures allocated is large as well.

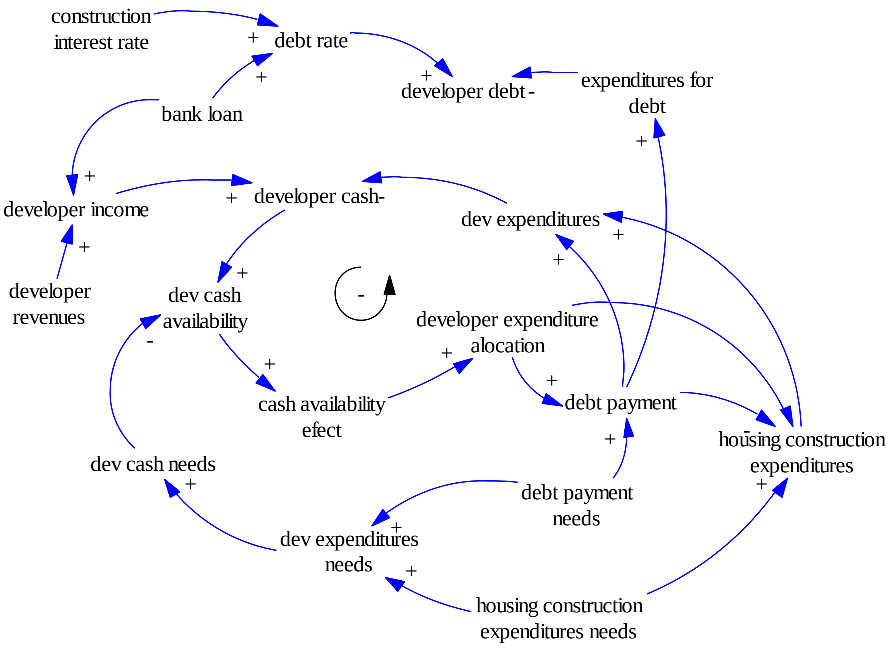

Figure 4. Causal Loop Diagram of Developers Cash

3.4 SUB MODEL OF HOUSING LAND

Sub models of housing land aimed to explain the mechanism of land provision for housing. In this model, the needs of land for housing is assumed to be obtained through a process of conversion of agricultural land. Why is agricultural land? Because based on the results of the interview, for the construction of housing at the subsidized price by 88 million rupiah per unit, the developer should be able to get the land at the price below 200,000 rupiah per m^2. If on top of that price, the house sale price will exceed the subsidized price. In Bandung City, certainly for this moment there is no longer the price of land under 200,000 rupiah per m^2. Therefore, developers have to acquire land for the location of subsidized housing outside the city of Bandung, as Soreang, Rancaekek, Cileunyi, Baleendah even to Sumedang.

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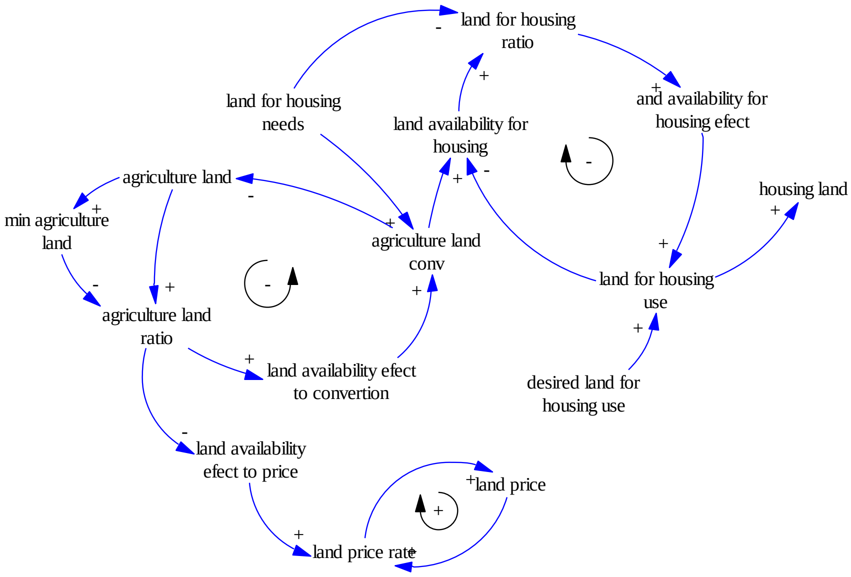

Figure 5. Causal Loop Diagram of Housing Land

From interviews with one of the developers, obtained information that to get lower price of land, usually developers buy land in the areas that have not developed especially the infrastructure, so the price will be cheap. Furthermore, the land is "saved" for some time till the construction of infrastructure or urban development in that area. With this strategy, the developer is still able to sell the house at the subsidized price even though the price of the land when the house is sold already high.

3.5 SUB MODEL OF HOUSE PRICE

Sub models of house price describing the structure that forming the house prices. Based on the results of interview with developers, the elements that forming the selling price such as: the acquisition cost of land, cost of construction per square meter, and other costs. Land acquisition cost has been described previously in the sub model of land. In this study, wide of the house land lot is 85 m^2.

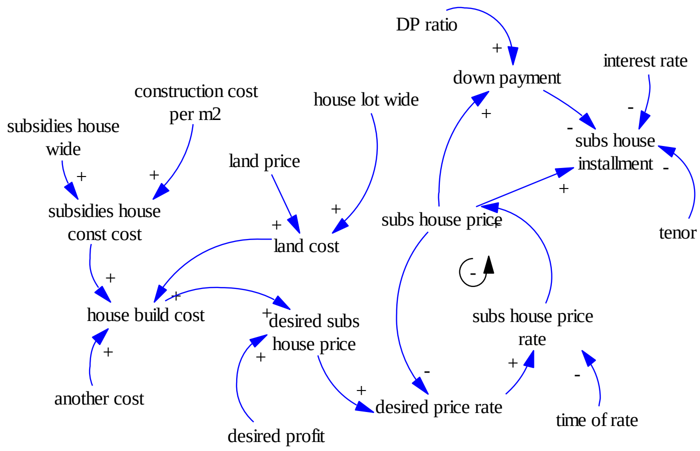

Figure 6. Causal Loop Diagram of House Prices Sub Model

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Construction cost per square meter is strongly influenced by the price of construction materials and worker wages. Normally, the cost of construction for a simple house around Rp. 1.000.000 - Rp. 1,500,000 per square meter. Meanwhile, other costs such as licensing fees like building permits (IMB) and the cost of land certificates when first purchased by the developer. Other costs are also included in this model such as developer routine expenses such as employee salaries and other office necessities.

All costs that expended by the developers to build the house added by the desired profit. Based on interviews, developers generally do not take profit more than 20 percent for a simple house. The selling price of the house is the sum of the cost of construction and desired profit.

3.6 SUB MODEL OF HOUSING SUPPLY

This sub model describes the structure of the provision of subsidized housing. Based on the interviews, there are three stages in the housing supply process. First, the planning process, usually carried by a developer to determine the amount of market or potential customers. Planning is in addition influenced by the potential of the market (demand), is also influenced by the condition of the developer cash. The greater availability of cash owned, it will affect the developers capacity of construction. The second process is the realization of development planning. Based on interviews, the development plan will be realized if there are existing buyers. It means new houses will be built when the loan agreement was made by the developer to the consumer. The third process is the completion of construction of the house. The time needed to complete the construction of a house is typically 3 months. When the house was completed, it's assumed that the house is inhabited by low income families.

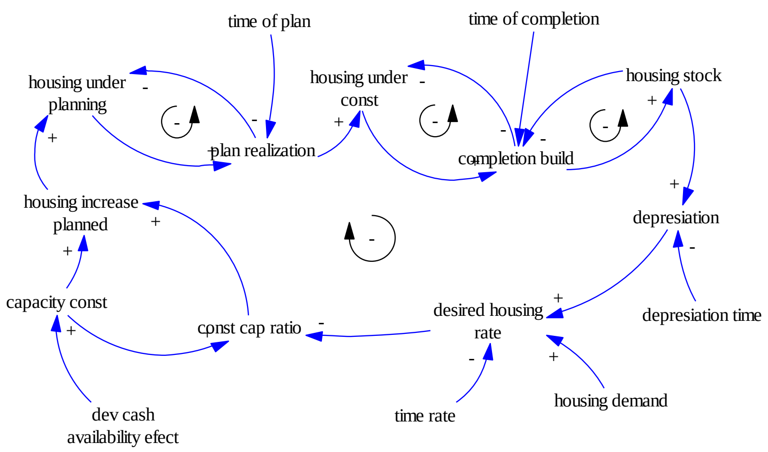

Figure 7. Causal Loop Diagram of Housing Supply Sub Model

3.7 BASIC SCENARIO SIMULATION

The model in the baseline scenario is a reference to make policy interventions. As in the baseline scenario, the value of the main variables as shown in Table 1 below.

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Table 1. Variable Value in Basic Scenario

Min wage	Rp. 2.000.000
Number of worker in family	1 person
savings fraction	0
Land price increases fraction	5 % per year
Down payment fraction	10%
Interest rate	7,25% per year
Tenor	15 years
Population increases rate	1,7%

The results of simulation models in the baseline scenario can be seen in Figure 8. The results show the inability of the low income family in paying mortgage installments and the down payment. Seen that the value of the ability to pay mortgage installments and the down payment is under 1.

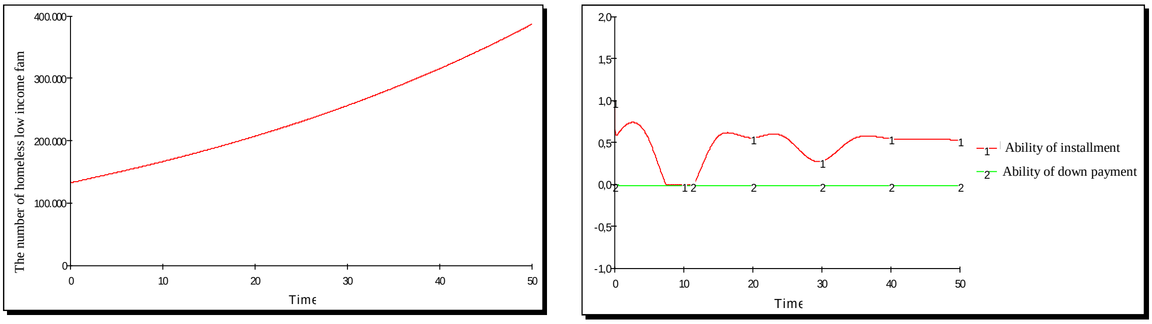
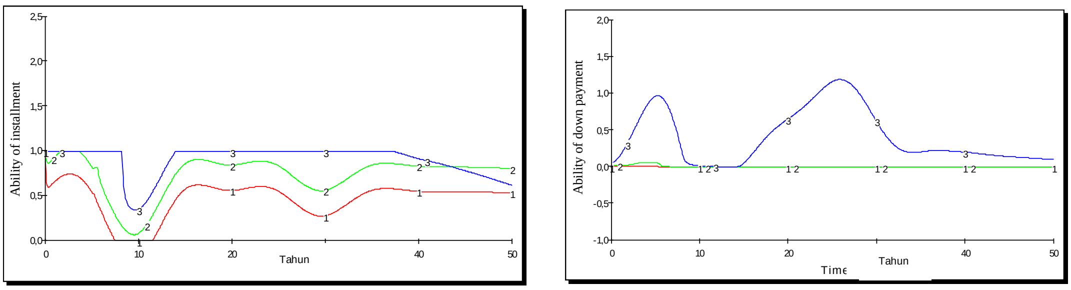


Figure 8. Simulation Results on Basic Scenario

The simulation results in Figure 9 below shows that the low income family will be able to pay the mortgage installment and down payment in scenario 3rd, if the family has income of Rp. 3,900,000 per month or more.



1 = family income Rp. 2,000,000 / mo
2 = family income Rp. 3.000.000 / mo
3 = family income Rp. 3.900.000 / mo

Figure 9. Simulation Results of Income Limits for Able to Pay the Mortgage Installment and Down Payment

3.8 POLICY INTERVENTION

Based on the simulation results of the baseline scenario, FLPP program has not been able to increase the ability of low income families to own a house. Therefore, there are several alternative policies proposed in this research. Alternative policies include: (1) the addition of new employments, (2) saving policy in the family, (3) the addition of tenor, (4) land subsidies, (5) controlling the rate of population growth, and (6) increase in the minimum wage

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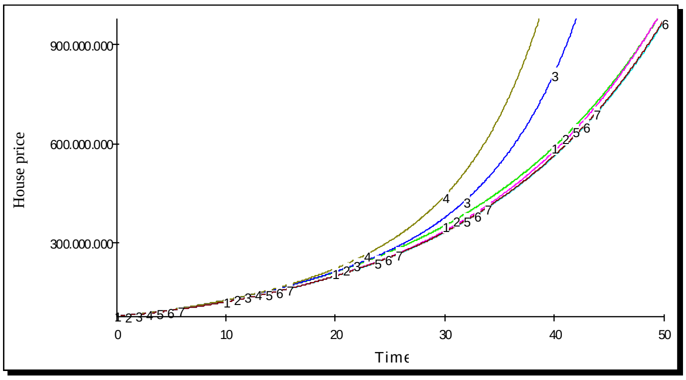
The alternative policies is implemented in the model by changing the values of certain variables. Several policy scenarios applied in this study can be seen in Table 2.

Table 2. Scenarios Used in the Model

Scenarios	Min Wages (Rp)	Number Of Worker In Family	Savings Fraction (%)	Land Price Increase Rate (% p.a)	Tenor (Years)	Population Increases Rate (%)
Scenario 1st (Basic)	2.000.000	1 person	0	5	15	1,7
Scenario 2nd (Savings)	2.000.000	1 person	10	5	15	1,7
Scenario 3rd (employment)	2.000.000	2 persons	10	5	15	1,7
Scenario 4th (Tenor)	2.000.000	2 persons	10	5	25	1,7
Scenario 5th (Land subs)	2.000.000	2 persons	10	2,5	25	1,7
Scenario 6th (Pop control)	2.000.000	2 persons	10	2,5	25	1
Scenario 7th (Wages)	2.500.000	2 persons	10	2,5	25	1

3.8.1 House Price

The simulation results in Figure 10 below shows the pattern of house price based on the seven scenarios. House price rise most likely in scenario 4th. This is on scenario 4th there is additional tenor from 15 years to 25 years. This addition cause the ability of low income families on mortgage installment increase. Growing on housing demand will cause developers build more housing to meet the demand. The consequence is the amount of land demand to be used as housing increasingly larger, thus significantly increasing the price of land. As explained at the beginning, that the largest cost component in the construction of the house is the cost of land purchase. Thus the higher selling price of land, the selling price of housing will be higher as well. In scenario 4th there is trade off, with the addition of employment will increase the ability of the low income family to pay mortgage installments and the down payment. This increased ability will have an effect on increasing the house selling price.



1=Scenario 1st (Basic)
2=Scenario 2nd (Savings)
3=Scenario 3rd (employment)
4=Scenario 4th (Tenor)
5=Scenario 5th (Land subs)
6=Scenario 6th (Pop control)
7=Scenario 7th (Wages)

Figure 10. Simulation Results of House Price in Scenario 1st - Scenario 7th

House prices start going down again on the scenario 5th. This is because in scenario 5th for first enacted land subsidy policy. Land subsidy policy in the model of reducing the extent of land price increases of 5 percent per year to 2.5 percent per year.

3.8.2 Land Price

Figure 11 below shows the selling price of land per square meter simulation results. The land price chart pattern identical to the pattern of home sales price chart of simulation results in

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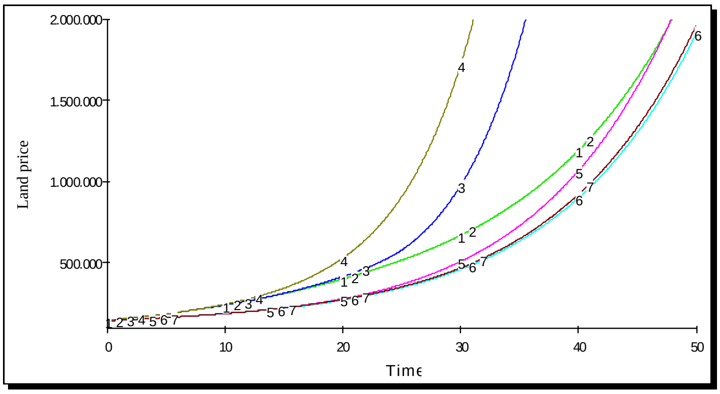
Figure 10. The highest land price is in scenario 4th and the land price start to decline in scenario 5th. The explanation is the same as in the case of the housing price, which is the high land price in scenario 4th is influenced by the addition of tenor from 15 years to 25 years. While the decline in land prices occurred in scenario 5th because in this scenario for the first time imposed land subsidy policy of reducing the extent of land price increases of 5 percent per year to 2.5 percent per year.



1=Scenario 1st (Basic)
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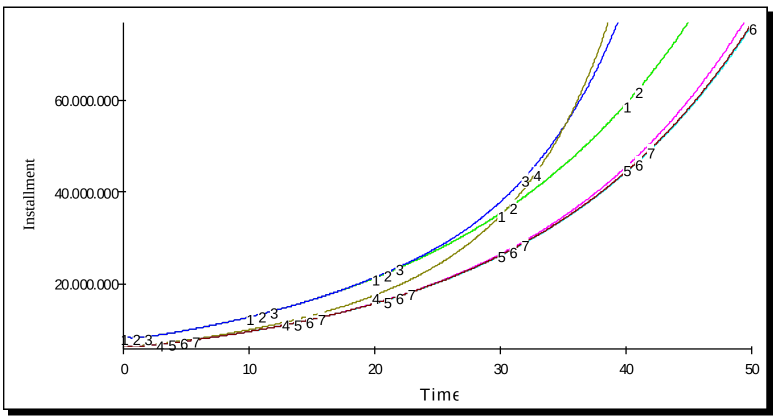
6=Scenario 6th (Pop control)
7=Scenario 7th (Wages)

Figure 11. Simulation Results of Land Prices in Scenario 1st - Scenario 7th

3.8.3 Mortgage Installment

Results of model simulation in Figure 12 below shows the number of mortgage installments to be paid every year. The highest mortgage repayments occur in scenarios 3rd and 4th. High mortgage repayments on scenarios 3rd caused by the policy of adding new employments. The addition of new employments lead to greater employment opportunities. Therefore, in Scenario 3rd assumed number of family members who work increased from1 person became 2 person. The increasing of family members who have a job is assumed to affect the increase in family income. With the increasing family income, the allocation of cash for mortgage payments and savings also increase as well. The increasing of the low income family cash ability will increase the housing demand and also would be increasing housing price as well. The increasing of housing prise will be increasing mortgage installment as well.



1=Scenario 1st (Basic)
2=Scenario 2nd (Savings)
3=Scenario 3rd (employment)
4=Scenario 4th (Tenor)
5=Scenario 5th (Land subs)
6=Scenario 6th (Pop control)
7=Scenario 7th (Wages)

Figure 12. Simulation Results of mortgage Installment in Scenario 1st - Scenario 7th

The increase in mortgage installment per year which is quite large also occur in the scenario 4th simulation results. In scenario 4th, conducted additional policy of tenor from 15 years to 25

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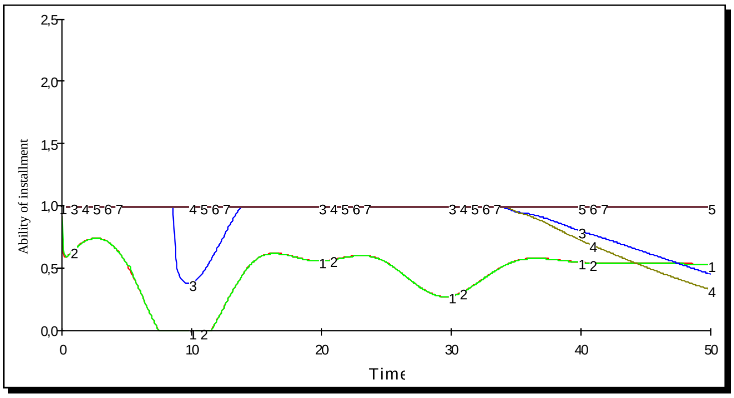
years. The addition caused a period of mortgage loan installment become cheaper thus increasing the amount of housing demand. The Increasing demand led to increase housing supply that ultimately led to the increasing in the selling price.

The decreasing of mortgage installment occure in scenario 5th, 6th and 7th. In scenario 5th land subsidy policy is started. In scenario 6th population growth control policy is started and the scenario 7th the increasing of minimum wage policy took effect as well.

3.8.4 The Ability of Mortgage Installments



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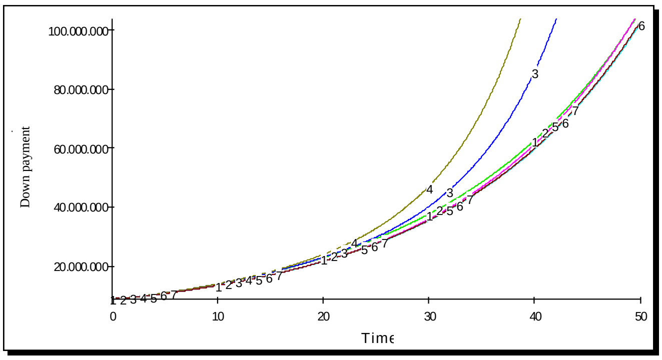
6=Scenario 6th (Pop control)
7=Scenario 7th (Wages)

Figure 13. Simulation Results of ability to repay the mortgage in Scenario 1st - Scenario 7th

Figure 13 above shows the low income family ability to repay the mortgage. The value of the highest ability is 1 and the lowest is 0. The value of 1 means that the low income family is able to repay the mortgage, while a value below 1 means that the MBR is not able to repay the mortgage. The lowest ability of mortgage installments occur in scenarios 1st and 2nd. In scenarios 1st and 2nd, the family income is depends on 1 person that have a job, so allocation of expenditure of cash to repay a home smaller than mortgage installments to be paid.

While, families were categorized able to pay the mortgage is on the scenario 5th, 6th and 7th. The leverage factor in this scenario is land price subsidies policy. Land price subsidies in the form of rate of land price increases below the rate of land price increases in the market.

3.8.5 Mortgage Down Payment



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7=Scenario 7th (Wages)

Figure 14 Simulation Results of mortgage down payment in Scenario 1st - Scenario 7th

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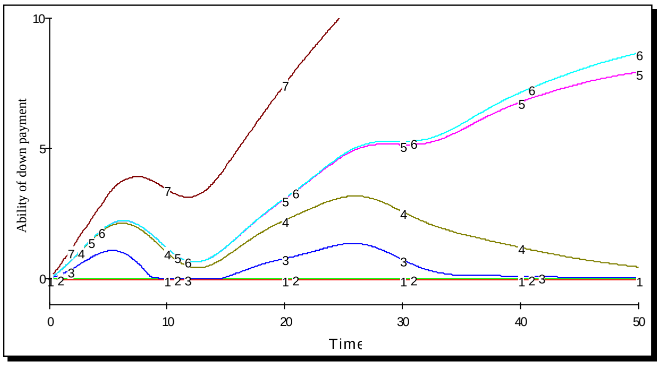
Figure 14 above shows the number of mortgage down payment from the model simulation results at 7 scenarios. The results of this simulation is identical to the graph of simulation results of the house price.

3.8.6 Ability to Pay The Mortgage Down Payment



1=Scenario 1st (Basic)
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5=Scenario 5th (Land subs)
6=Scenario 6th (Pop control)
7=Scenario 7th (Wages)

Figure 15. Simulation Results of Ability to Pay Down Payment in Scenario 1st - Scenario 7th

Results of model simulation in Figure 15 above shows the ability of low income families to pay the down payment. Down payment in this model by 10 percent of the sales price of the house. Value greater than or equal to 1 is considered able to pay the mortgage down payment and a value less than 1 means not being able to pay the mortgage down payment. The lowest ability to pay the down payment occur in scenarios 1st and 2nd. In scenario 1st, low income families do not have a saving policy. In scenario 2nd the same as scenario 1st in terms of family income derived from the 1 person working. The difference in scenario 2nd is starting to be a policy of saving 10 percent of family income. However, although there is a policy of saving, saving very little value because the cash allocation for saving the last priority after emergency expenditures, consumption and allocation of expenses to repay a home. The low income families can afford the down payment on scenario 3rd, when there is an increase in the family income with the addition of employment policy.

3.8.7 The Number of Homeless Low Income Families

Results of model simulation in Figure 16 below shows a graph of the number of low income families who do not have appropriate house (homeless). From the graph shows that in scenario 1st and 2nd, there is no influence of FLPP mortgage policy in reducing the amount of low income families who are homeless, even increasingly large numbers.

The Decreasing of number of homeless low income families started in scenario 3rd. Housing subsidy policy through FLPP program has an effect on the decline in the number of homeless families after the addition of other policies such as the addition of new employments. The addition of new employments will increase employment opportunities, resulting in a single family is assumed to have two people working. With the 2 people who work in a family, it will increase the income of low income families so that families are able to purchase a home through a mortgage program FLPP.

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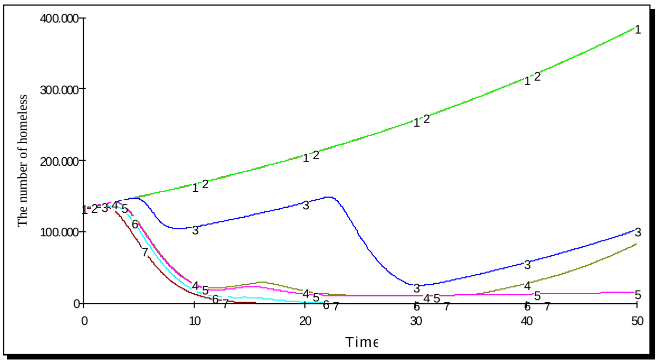

=Scenario 1^{st} (Basic)
2=Scenario 2^{nd} (Savings)
3=Scenario 3^{rd} (employment)
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5=Scenario 5^{th} (Land subs)
6=Scenario 6^{th} (Pop control)
7=Scenario 7^{th} (Wages)

Figure 16. Simulation Results of Number of Homeless Low Income Families in Scenario 1^{st} - Scenario 7^{th}

4 CONCLUSION

1. Very little opportunities for low income families in the City of Bandung at this time and in the next 50 years to own a home through the FLPP mortgage program especially for families whose income is below the 3.9 million dollars per month.
2. The structure of the low income family cash is the most important factor that affects the ability of low income families pay the mortgages installments and the down payment. Variables that significantly is the amount of the minimum wage and the number of working family members.
3. There is very significant decrease in the amount of installments for the FLPP mortgage scheme than regular mortgage scheme.

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POLICY IMPLEMENTATION ANALYSIS OF TSUNAMI RISK DISASTER REDUCTION IN THE COASTAL CITY OF PADANG – WEST SUMATERA PROVINCE

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ABSTRACT: To mitigate the earthquake and tsunami disaster in Mentawai Region, which also very likely to occur in the City of Padang, the Government of Indonesia implementing tsunami risk disaster reduction management as a precautionary measures along westward coastal of Sumatera Island. The management implementation in the City of Padang considered the second most advanced compared with the other cities along westward coastal Sumatera Island, after the city of Banda Aceh. The problems still persist, implementation of various policy to reduce tsunami risk disaster still long way to the expected goals, consequently the management's objective which is to reduce the loss of life and property if the tsunamigenic-earthquake occurred in the near future allegedly will not be reached. The indication portrayed when shallow earthquake occurred in the City of Padang in September 30, 2009 (7.6 Mw) and again during April 11, 2012 (8.5 SR), fortunately both are not accompanied with tsunami disaster, although the number of loss of life are thousands but comparatively far less than the number of victims in Aceh during tsunamigenic earthquake in 2004. From decision making rationale, the above portrayed events depicted as an indication that a gap between the expected goal and factual condition still persist. The paper aim to describe the implementation of tsunami risk disaster reduction management and the instrument used in the City of Padang using "Prevention and Mitigation of Tsunami Disaster" analytical-tool. As a lesson-learn from policy implementation's experience in Japan, description used in this paper by comparing the implementation of tsunami risk disaster reduction management and the instrument used in the eastern coastal cities in Japan, with factual condition in the City of Padang. Two obstacle in implementing tsunami risk disaster reduction management are identified, first lack of available funding prohibiting government to implement tsunami's structural countermeasure and second local culture aspect hampering government effort to convince people about the important of tsunami risk disaster reduction management.

KEYWORD: policy implementation, disaster risk reduction management, earthquake, tsunami disaster

1. INTRODUCTION

The picture of horrific event still haunted until now since terrifying an earthquake disaster accompanied by tsunami occurred in the tip of westward coastal Sumatera Island, Aceh Province (December 24, 2004). Then shortly thereafter, similar earthquake disaster accompanied by tsunami struck southward Java Island, Cilacap – Pangandaran area (July 17, 2006). Next, the same earthquake disaster accompanied by not-so-high of wave of tsunami hit back westward coastal Sumatera Island, this time in Mentawai Island – West Sumatera Province (October 25, 2010). Earthquake disaster accompanied by tsunami in Aceh Province (2004 – magnitude 9.0 in Richter scale)) is catastrophic tsunami disaster with the most fatalities and economic loss in modern history, the fatality estimated more than 200 thousand and one-and-half million people displaced or suffering economic losses (Carayannis 2014) (Murata, et al. 2011) (Borrero 2010) (Satake, Okal and Borrero 2007) (Yeh, et al. 2007). Three main factors allegedly contribute why earthquake disaster accompanied by tsunami inflict the most fatalities and economic loss in Aceh. First, no early warning system protecting those disaster area, second, only a few of local people know and understand the risk of tsunami disaster, third, no single tsunami building shelter or vertical evacuation refugee found along disaster area (Carayannis 2014) (Matsutomi, Sakakiyama and Nugroho 2006).

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Similar with the above disaster (magnitude 9.0 in Richter scale) with different result took place during "Great East Japan Earthquake – GEJE in short" (March 11, 2011). Fortunately, in eastward coastal of Japan since 1900 had been implemented Prevention and Mitigation of Tsunami Disaster (PMTD in short) Policy equipped with necessary instruments, include the above three tsunami mitigating factor, as a result the number of fatalities far less than Aceh tsunami disaster (although economic loss much higher than of Aceh). As comparison between pre and post PMTD implementation in eastward coastal of Japan, during pre-PMTD implementation, when earthquake accompanied by tsunami struck Sanriku region (July 15, 1896) the mortality number reach 20% of population. During GEJE (March 11, 2011), the PMTD policy effectively capable to reduce the mortality number to 3% of population (Murata, et al. 2011) (Shaw and Takeuchi 2012). Hypothetically, if PMTD policy with necessary instruments was implemented in westward coastal Sumatera Island (include Aceh Province) and also the whole coastal cities around Indian Ocean before the occurrence of earthquake accompanied by tsunami (December 24, 2004), then the fatality number apparently would be lower than 200 thousand (Murata, et al. 2011).

From historical and scientific-based assessment, four region inside Indonesia exposed by tsunamigenic earthquake, one of them inside Mentawai Megathrust. Considering the matter, all part of region inside Mentawai Megathrust declared as the most probable risk region which will struck by mega earthquake accompanied by tsunami in near future, include the City of Padang – Padang for short (BNPB 2012) (McClosky, et al. 2008). Learning from the past mistake, to reduce the impact of the will-be an earthquake-accompanied-by-tsunami disaster inside Mentawai Megathrust region, the government (this refer to local and central government or both alike) implementing various Tsunami Risk Disaster Reduction (TRDR in short) policy in the coastal cities along westward Sumatera Island with the main goal to reduce the number of fatality and economic losses. Comparatively, the TRDR policy implementation in Padang was seen as the second most advanced compared with the other cities along westward coastal Sumatera Island, after the city of Banda Aceh (BNPB 2012).

Even though TRDR implementation in Padang being implemented and will continue in several years to come, the problem related to the TRDR's goal still long way from the expected goals. These indication illustrated during earthquake occurrence (September 30, 2009 – 7.6 SR and April 11, 2012). All people panic by the strong earthquake's shake and run to higher ground in frantic and chaotic, no officer present to guide evacuation process (Figure 1), individual evacuation's orientation to higher ground did not follow Tsunami Evacuation Signage, tsunami building shelter or vertical evacuation refugee not present or properly functioning yet (BNPB 2012), and worst of all, the early-warning-system mistakenly informed the wrong information which multiply chaotic situation (Madlazim 2011). Fortunately both earthquake are not accompanied with tsunami. Nonetheless the number of loss of life are thousands but comparatively far less than the number of victims in Aceh during tsunamigenic earthquake 2004.

Figure 1. Panic, frantic and chaotic during evacuation when earthquake shake the City of Padang (credit Photo:

From decision making rationale, the above portrayed events depicted as an indication that a gap between the expected goal and factual condition still persist. Within development studies context, gap between the expected goal and factual condition is an indication of successful or failure an implementation of certain program or policy. The narrower the gap is an indication of successful implementation of a program and vice versa for the wider the gap. In academic context, this paper attempt to reveal the discrepancy between policy output (the formal actions that governments take to pursue) and policy outcomes (the effects such actions actually have on society). In more operable action, as a lesson-learn from policy implementation's experience in Japan, the paper attempt to describe the implementation of TRDR in Padang comparing with PMTD implementation in eastward coastal of Japan.

2. LITERATURE REVIEW

According to Anderson, in Kraft and Furlong, the term policy refers in general to a purposive course of action that an individual or group consistently follows in dealing with a problem. In a more formal definition, a policy is a "standing decision characterized by behavioral consistency and repetitiveness on the part of both those who make it and those who abide by it". Public policy is what public officials within government and by extension the citizens they represent, choose to do or not to do about public problems. Public problems refer to conditions the public widely perceives to be unacceptable and that therefore require intervention. In general, to deal with the public problem the government issued a policy with instrument (a) regulation, (b) government management, (c) spending and taxing, (d) market mechanism (e) education, information and persuasion. Policy was taken by many considerations, including the probability of natural disaster occurred in certain area. The rationale of the policy is to minimize the number of fatality and economic losses. Especially for certain area with historic occurrence of such natural disaster is highly considered. Effort to reduce disaster risk should be taken by the government based on scientific rationale or economic consideration especially within certain area which considered vulnerable for natural disaster occurrence (Kraft and Furlong 2013).

Indonesia has experienced thousands of earthquakes and hundreds of tsunami over the past hundred years, Sumatra and Java are two of the most vulnerable island to tsunami impact since they are located directly in front of Indo-Australian plate (Madlazim 2011). In Sumatera tsunamigenic earthquake frequently occurred inside Megathrust Mentawai (Schlurmann, Kongko, et al. n.d.) (Natawidjaja, et al. 2006). Considering many aspect in the afterward event of tsunami disaster in 2004, the government passing Law number 24, year 2007 on Disaster Management focusing disaster risk reduction. The mainstreaming of disaster risk reduction into development was translated by the government into a local disaster management plan (NDMA 2011). Some document used here and refer to as source of policy output for TRDR in Padang, i.e. National Guidelines on Tsunami Risk Assessment, Master plan of Tsunami Disaster Risk Reduction, Regulation Number 4 Year 2012 on Spatial Planning for the City of Padang. The above documents describe TRDR program in Padang and contain: tsunami risk map, temporary shelter, disaster management plan and INA-TEWS.

Susumu Murata and friends propose strategic disaster mitigation plan for tsunami. Plans consist of a goal, objective, target, policy and actions. First step before determine the objective and formulating the policy, an assessment need to be done. He divided assessment into three parts, (a) resources assessment to determine the extent of weaknesses, (b) risk assessment to understand the level of damage evaluation and administrative capabilities of local government and determine its risk management capabilities, (c) disaster prevention assessment to study the concrete content of countermeasures disaster mitigation implementation capabilities. Based on these three assessment, objective and targets are determined, policy are proposed and an action plan is drawn up and implemented, the actual degree of its implementation needs to be evaluated periodically.

3. RESULT AND DISCUSSION

3.1. ASSESSMENT OF TSUNAMIGENIC, TSUNAMI DISASTER AND THE VULNERABILITY OF PADANG

Padang located in Eurasian tectonic plate, and in close proximity with Eurasia-Indo-Australia tectonic plate subduction zone which moving relative into each other, also close with Great Sumatran Fault (*Sesar Semangko*) (Natawidjaja, et al. 2006). Those area, in Mentawai Megathrust region, are well known for high tectonic and seismic activity and considered prone to frequent earthquake occurrence, including the large tsunamigenic earthquake. Various recorded large earthquake accompanied with tsunami occurred nearby Padang with the epicenter not far from the above city (Natawidjaja, et al. 2006). From geological investigation of past tsunami and deducted using scientific analysis, large earthquake accompanied with destructive tsunami struck Padang twice, in 1797 (with Magnitude 8.5 – 8.7) and 1833 (Magnitude 8.9) with tsunami run-up reach 5 – 10 and 3 – 4 meter respectively (Natawidjaja, et al. 2006) (Schlurmann, et al. n.d.). Some geologist admitted that the above region until now hold huge seismic moment deficit which accumulated since the last large earthquake - in 1797 or in the more recent 1833 (Schlurmann, et al. n.d.). From scientific-based assessment and risk analysis of tsunamigenic earthquake mitigation, there is consensus among geologist that an increase of risk for tsunamigenic earthquake occurrence in southern part of continental plate which collide each other, and rupture will occur in the year to come. The big predicted-earthquake will generate destructive tsunami (Blaser, et al. 2012) (Igarashi, et al. 2011) (Lubkowsky, et al. 2009).

An earthquake with magnitude 8.9 SR predicted will struck Siberut, Padang and Mentawai Island Area. Such of an earthquake also predicted will be accompanied by tsunami. Padang, which laid within the above predicted area is the most probable city will hit by large earthquake accompanied by near-field destructive tsunami. Probable Occurrence prediction with maximum inundation 11 meter and minimum tsunami arrival time 31 minutes (BNPB 2012). By this earthquake likelihood and the accompanied tsunami, the possibility of fatality and economic losses certainly will huge and so with the affected region (Schlurmann, et al. n.d.)(BNPB 2012). Considering the possible risk to be faced and as a precautionary measure, the government implementing Tsunami Risk Disaster Reduction plan (TRDR) in the coastal cities along westward Sumatera Island (BNPB 2012).

The City of Padang directly adjacent to Indian Ocean. Although the city contour highly varied, from 0 up to 1833 meter above sea level, the most densely inhabited part of the city (694.96 km^2 or equal 40% of total city area) have elevation 0 up to 4 meter above sea level and become the most dynamic social economic activity and also the center of government activity (the remaining area are hills with the average slope mostly 40^0 and protected forest area). Worse, the above part of the city flanked by two big river and 16 small river which directly flowing water to Indian Ocean. No river embankment protecting the city, in case tsunami hit the city then the river will channeling the power of tsunami directly to the inland part of the city. With the number of inhabitants 871,534 (2012 data from Official Census Bureau) in sparsely 11 sub-district level (*kecamatan*), Padang become the most populated city in westward coastal Sumatera Island, almost half of that number lived along beach and so do with most social and economic activity of inhabitants.

3.2. DESCRIPTION OF TRDR POLICY OUTCOMES BASED ON PMTD ANALYTICAL-TOOL

3.2.1. Dissemination of tsunami knowledge

3.2.1.1. Earthquake and tsunami Research

In conducting research on tsunami hazard within certain area, precise numerical simulation are carry out. Precise numerical simulation require much work (set up earthquake model, prepare topographic data, collecting information on facilities and building) as a result these simulation are extremely expensive and time consuming. Because of those, in some cases a simplified tsunami hazard map is prepared based on the record of past inundation (Murata, et al. 2011, 201).

In Padang, Various foreign donor-agency in cooperation with certain ministries (include Ministry of Public Works) conducted research on earthquake and tsunami vulnerability. Basically all the research had similar conclusion and support the previous research result that Padang is prone to the earthquake & tsunami disaster and necessary action need to mitigate both disaster. Furthermore, tsunami risk modelling reveal some part of the most probable places inside Padang which will likely inundated by tsunami. This tsunami inundated map modelling, as a result from cooperation with GITEWS, was used by local government as base map in proposing spatial planning. Some research are accomplished by the cooperation among ministry and foreign-donor agency and local government, to date the local government unable to conduct research without the help of outside institution due to the lack of fund and expertise.

3.2.1.2. Dissemination of earthquake and tsunami disaster research

Conceptually, tsunami disaster awareness is undoubtedly very important, this is one of many non-structural countermeasure to reduce tsunami disaster risk by utilizing education, with the ultimate goal to enable inhabitant to self-survive when tsunami occur. In order to translate the knowledge learned into action, a process required as follow: (1) know the mechanism of tsunami, (2) know the weaknesses in tsunami disaster, (3) know the tsunami countermeasure, through “Learning”, “Drilling” and “Exercising”. Elaborating the first pointer, the best method is to study as a part of disaster preparedness education during science class in school. Whilst the second pointer stressing to know the weaknesses of structure and building to tsunami damage and the weaknesses the society (Murata, et al. 2011, 180). Supporting the importance of the above program, research revealed that most of victim in Sumatra Tsunami 2004 who felt the strong ground motion of the earthquake, did not even realize there was a threat of tsunami and did not run to higher ground because there had been no program of public education related to the hazard by the authority. Most of resident victims did not have fundamental understanding, did not react quickly when the water begun to withdraw along the beaches, were not aware of imminent danger and become quickly disoriented and overwhelmed as disaster unfolded (Carayannis 2014).

Despite the fact the instrument of “Dissemination of earthquake and tsunami disaster research”, as part of “Dissemination of tsunami knowledge” policy, adopted much earliest than any other instrument but the policy outcome still need more effort to raise tsunami awareness similar with what the school in Japan did. Problem found in implementing dissemination activity in school, first the extent of dissemination is limited in term of coverage and the number of participants, mostly took place in certain school and only certain student were invited to attend dissemination activity. Second, no follow-up in the afterward of dissemination activity, the student only know partial information about the topics, and it only cover the very basic of information. Although school used as a main tool to disseminate the earthquake and tsunami information (student and the building), but disaster preparedness education is not integral part of school curricula or even local-school curricula. Third, because dissemination of the above topics jointly conducted by local government (*BPBD*) in cooperation with related party such as Mercy-Corps, AUSAID, or GITEWS within a project framework, when the project terminated so do the dissemination activity. Other than school, dissemination took place in a hotel or government building with far more less participants and focused topic to be disseminate. The participants mostly policy holder, public official, educator and individual with their day-to-day job description directly with disaster management. Usually this had to do with strengthening the capacity of local government in tsunami preparedness and mitigation such as of those of join cooperation with German Indonesia Cooperation on Tsunami Early Warning System (GITEWS) project.

3.2.1.3. Tsunami evacuation drilling

After the student learning the tsunami knowledge during lecture-type, later on to gain practical knowledge the student must undergo tsunami drilling. In tsunami-prone region in japan, tsunami evacuation drilling are conducted periodically. Drilling are required to convert tsunami-knowledge learnt during school into effective action when needed, drilling also reflecting how far the student acquire tsunami-knowledge, the process of translating knowledge into action is only completed when participant are given education in school or other training. Periodic evacuation drilling also necessary to keep losing tsunami-knowledge (Murata, et al. 2011). In general, tsunami evacuation drill main goal is to acquire skill to survive in tsunami disaster emergency situation (Oikawa 2012).

Unlike in Japan, although evacuation drill have been performed several times in Padang since tsunami disaster in 2004 and it is usually integral part of dissemination of tsunami knowledge, in general the problem similar with dissemination program. During previous earthquake occurrence the knowledge gained from tsunami evacuation drill had slight correlation with the way the people evacuate.

3.2.2. Prevention of inundation of urban area

The main purpose of tsunami countermeasures is to mitigate human damage (death and injury) and physical damage. The human damage and physical damage occur when the external of tsunami exceeds the limits that person, object and the society can withstand (Murata, et al. 2011). Countermeasure significantly contributed to mitigate damages at GEJE and reduce mortality during tsunami disaster (Ishiwatari 2012). Tsunami countermeasure broadly divided into two function. First, as a measures that reduce external forces as far as possible and second, to create a “disaster proof” town which protect a city from tsunami inundation using fortress. All of tsunami countermeasure in Japan include in first category and all of these hardware facilities are constructed in the most vulnerable coastline.

Conceptually, tsunami seawall is a facility for the primary purpose preventing tsunami damage. Tsunami breakwater is a structure which is constructed at the mouth of harbor so to reduce entry of ordinary waves from the open sea and reducing the force of tsunami thereby to maintain a calm condition in the water inside harbors. Seawall and embankments are structure which prevent or reduce inundation of land by sea water resulting from tsunami. Water gate and inland-lock to stop tsunami from running up in the river, river embankment to avoid tsunami invasion (Murata, et al. 2011, 158, 163, 167, 193, 194). Learning from Japanese experiences and as acknowledged by the Government of Japan itself, developing any of the above tsunami countermeasure need many thing to consider and careful planning and financial support. Often, the development take years-long to finish and the project

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required political agreement among many parties before commencement. The number of victims (reported death or missing) during GEJE are 20.000, apparently the number of victim will higher if no tsunami countermeasure installed. Mortality ratio drastically decreased from over 20% of 76.000 population at the time of Meiji-Sanriku earthquake and tsunami (1896) to less than 3% of 274.000 population during GEJE (2011), while the latter magnitude of earthquake and tsunami is greater than the former and the population increase three fold since 1896. Countermeasure significantly contributed to mitigate loss of life and property damages (Ishiwatari 2012, 16).

Referring to the above PMTD policy, in Padang until now no man-made structure with the purpose similar or equal with tsunami countermeasure built along coastal line or main river embankment. Only pile of stone along partial coastline laid nearby city center with the purpose as breakwater just to protect inland area from sea wave exposure and abrasion but apparently the structure unable to withstand tsunami force and sea inundation because the pile of stone only fastened using wire mesh and the height merely 1 meter from average sea level. At present and apparently up to the next several years to come, policy to “Prevent inundation of urban area” still not yet an option either in Padang or anywhere else in the cities around Indonesia. Although scientific assessment and evident from GEJE occurrence proved the effectiveness of tsunami countermeasure but financial constrain and priority consideration prohibiting government (local or central government) to propose the above policy. For this case, because no formal actions governments take to pursue (no policy output) therefore no effects such actions actually have on society (no policy outcome).

3.2.3. Promotion of evacuation and safety countermeasure

3.2.3.1. Promoting inundation map

Promoting inundation map is one of many software measure taken to mitigate tsunami disaster. The key word for software measure is essentially “information”. This information must relate to the natural and social condition needed for evacuation. In particular, the communication and dissemination of information aimed at enhancing positive evacuation behavior are the main backbone of software measure (Suda, Shaw and Takeuchi 2012, 25).

Formal policy taken by local government of Padang, since the implementation of Regulation Number 4 Year 2012 (*Perda*) which integrate in it mitigation tsunami disaster (especially through planning and zoning). Based on *perda* the government divide Padang into two categories, first tsunami-vulnerable area and non-tsunami-vulnerable area. In line with *perda,* effort to mitigate tsunami disaster for both vulnerable and non-vulnerable area combine are as follow (a) restricting the residential development program adjacent by the coastal line, (b) developing infrastructure with the main function to reduce tsunami disaster impact, (c) spatial-controlling for urbanized area enabled as low socio-economic activity (d) developing coastal area into greenbelt (green open space) and low intensity fishery-related economy (*minapolitan*). According to *perda,* it was compulsory for local government to convert the red zone into trade and service zone. In contrast, the existing zone turning into the most dynamic and economically developed zone. However the above policy outcome still far from the expected goal. For instance, the red-zone in tsunami hazard map which indicate as the most tsunami high risk area, in fact are occupied by densely residential area packed with traditional housing. Evidence proved that mortality rate during 2004 Aceh Tsunami inundation are caused by water flow and building debris. Most of traditional building during tsunami disaster are completely washed away by water flow and the building component become debris which scattered and creating more danger. Every building inside red-zone area shall be built according construction’s minimum-standard-requirement, able to withstand tsunami force and systematically arranged.

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Even though the instrument of “Promoting inundation map” as part of “Promotion of evacuation and safety countermeasure” policy officially adopted but the outcome only partially implemented. The local government unable to fully implement *perda* to convert the red zone into trade and service zone mostly due to financial constrain. The people inside only willing to move from red zone if the government also agree to purchase land they lived on and the building above according with market price, the proposed alternative that the government hard to fulfill. The local government only able to enforce *perda* partially using building permit for prospective investor. Permission are issued for new construction inside red zone only if the prospective investor fulfill the construction’s minimum-standard-requirement which stipulated and in line with *perda.*

3.2.3.2. Promoting evacuation route

In general evacuation routes must be (1) clearly marked and well lit, (2) wide enough to accommodate the number of people evacuating, (3) unobstructed and clear of debris at all times and (4) unlikely to expose evacuating people to additional hazards (Suda, Shaw and Takeuchi 2012, 29).

As stipulated in *perda,* road networks in Padang are divided into 6 escaped road which can be used for tsunami evacuation route. According to the study done by BPBD and GITEZ, one of the research result is an identification that main bypass road can be used as connecting road between westward into eastward area. From main bypass road into westward defined as tsunami high risk since those area are prone to tsunami inundation. The government designated index I to IV for the above area. On the contrary, from main bypass road into eastward are safer for shelter area. Escaped road are road networks which connecting tsunami prone area into safer area (shelter) passing through bypass road. In some strategic point within escaped road huge billboard installed to inform bystander where the nearest shelter relative from certain position. 6 designated shelter are Indarung, Universitas Andalas Limau Manis, Kawasan Durian tarung, Kawasan Balai Baru, Kawasan Lubuk Minturun, Gadut, Indarung and Kawasan Sungai Bangek. Aside from the billboard, the escaped road also equipped with tsunami signage.

Whilst the “Evacuation route” billboard are clearly visible but as instrument of “Promotion of evacuation and safety countermeasure” policy, the outcome of this instrument yet failed to aware people the existence of escaped road and temporary shelter during emergency situation. The output of promoting evacuation route is well done but the outcome is far from accomplished. This policy implementation had persistent problem. From observation result, certain escaped road not fully equipped with billboard and tsunami signage yet. During normal condition, the traffic jammed everywhere and the capacity is limited and the road curvature is not straight line. In case tsunami emergency, the bottle-neck would be common situation and disrupt the traffic flow totally, although most part of the escaped road lead toward the nearest shelter but not in efficient time because some road circling farther before lead to shelter. Some road curvature had steeper angle which reduce the flow of vehicle. During earthquake occurrence all the road network, including the escaped road, congested by all means of transport mode.

3.2.3.3. Promoting temporary shelter

According to FEMA temporary shelter or vertical evacuation refugee is a building or earthen mound that has sufficient height to elevate evacuees above the level of tsunami inundation and is designed and constructed with the strength and resiliency needed to resist the effects of tsunami waves (FEMA 2008). Most schools in Japan, as stipulated by regulation, were designated as evacuation center by local government (60% of total public facilities and mostly are elementary and junior school). Therefore when disaster happen, community people evacuate to school, the reasons are school have huge ground and it is useful as temporary evacuation shelter and waiting place (Takeuchi and Shaw 2012, 145).

From tsunami disaster modelling, which calculate the number of inhabitants exposed in case tsunami struck the city, at least 100 temporary shelter are needed for the city of Padang alone. To date the city have 2 existing building which can be converted as temporary shelter, located in West Sumatra provincial governmental building and in Belanti High School (*SMU Negeri 1 Belanti*). The number is far less from the minimum number required to fulfill. To meet the least number required, the government in cooperation with Mercy Corps visually identify the private building which can be converted into temporary shelter. The scope of identification are limited, only to identify whether or not the building are sufficient enough to hold the large number of evacuee and structurally viable. The result of visual identification will be followed by the structural and construction study and the proximity calculation from the nearest escaped road. At least two private building fit to accommodate function as temporary shelter, Pangeran Beach Hotel and Bung Hatta University but structural and construction study are required.

Even though the instrument of “Promoting temporary shelter” as part of “Promotion of evacuation and safety countermeasure” policy officially adopted but the outcome only partially implemented. During earthquake occurrence the shelter is not available for evacuation. The main obstacle to materialize the minimum number of temporary shelter are land procurement and lack of available funding. Even though vacant or empty land relatively abundant in Padang but most of the land are belong to local clan (*kelompok adat*). Legally it is hard and complicated for local government to procure land from local clan, because procurement need approval from the whole family member of local clan (*ninik mamak*). In case single member of local clan oppose the procurement then the purchase agreement is annulled. Besides, the price of land in the city center of Padang relatively expensive, the average price of land far above the government ability to purchase. Moreover, the construction cost for standard temporary shelter such as in West Sumatra provincial governmental building beyond the local government annual budget capability. Single unit temporary shelter equipped with ramp can cost the government 51 billion rupiah – estimated price in year 2012 (kompas n.d.).

3.2.4. Countermeasure for person in coastal areas.

The tsunami early warning comprises (a) The detection of physical processes associated with the event, (b) The analysis of observations and interpretation, (c) Decision-making (Ruwanpura, et al. 2009). In Japan tsunami information can now be issued approximately three minutes after an earthquake, this information system is the most advanced of its type in the world (Murata, et al. 2011, 293).

Four year after 2004 Aceh tsunami, Indonesia have “Indonesian Tsunami Early Warning System (INA-TEWS)” which sensing tsunami occurrence in westward Sumatera Island. The system integrating various sensing device such as seismometer, Global positioning system, buoy and tide gauges (BNPB 2012) (Madlazim 2011). The system warn if earthquake occurred in Ocean, depth < 70 km and magnitude > 7, then Ina-TEWS announce early warning that the earthquake can generate tsunami. The tsunami warning will be broadcast by BMKG (*Badan Meteorologi dan Geofisika* – Atmospheric and Geophysics Agency) to BNPB (*Badan Nasional Penanggulangan Bencana* – National Disaster Agency) and BPBD (Local Disaster Agency) and local government through wireless and wired telecommunication system and also utilize radio and television station. Meanwhile the local government which

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their location adjacent with the source of earthquake and risked with tsunami ring the siren (Madlazim 2011).

In Padang, people know that their city are covered by INA-TEWS by the existence of networks of siren which visible in some places. To date Padang have 10 installed networks of siren along high risk zone but in the year to come the government plan to install 70 more networks of siren along the westward Sumatera coastal. Only some (three to five) out of the existing 10 siren which operated normally, the remaining are not functioning. The INA-TEWS as an instrument of “Countermeasure for person in coastal areas” policy is fully operable but the outcome is yet unable to improve sense of security and alert the inhabitant accurately. During earthquake occurrence the INA-TEWS failed for both the above aspect. The description related to the first point as follow, during earthquake occurrence in September 30, 2009 and April 11, 2012 only few siren properly function, to alert people of the tsunami occurrence minutes after earthquake. Although the sound of siren is loud enough but the network of siren only partially covered the vulnerable coastal area, not the whole vulnerable coastal city of Padang. Therefore lot of people decide to evacuate not because they receive warning from siren but they do because see others evacuating. Second, since the installation in 2008 the INA-TEWS has been twice inaccurately detecting whether or not the earthquake occurrence accompanied with the tsunami (Madlazim 2011), and networks of siren informed the incorrect early warning (BNPB 2012). During earthquake September 30, 2009 INA-TEWS sensor reported that tsunamigenic earthquake occurred, therefore the related institution relayed tsunami warning (“*Awas Tsunami*”) for people along westward coastal of Sumatera Island for the possibility of tsunami disaster. Indeed the earthquake is not tsunamigenic so that no tsunami followed on the afterward of earthquake (BNPB 2012). On the contrary, during earthquake October 25, 2010, the INA-TEWS sensor interpret that the earthquake occurred without tsunami, then the related institution relayed no tsunami warning to the affected people. Indeed tsunami followed minutes after the earthquake occurrence and struck Mentawai Island with the run up almost one meter (L. Blaser, et al. 2012) (Madlazim 2011).

4. CONCLUSION

In line with the research purpose, which is to describe the implementation of TRDR in Padang comparing with PMTD implementation in eastward coastal of Japan, all of the TRDR implementation description still long way to the expected goals, even for the least one. The main obstacle identified in relation with TRDR policy implementation in the city of Padang are financial constrain and local culture aspect. The description as follow:

a. From financial perspective, policies spectrum from the most to the less financially-need-policy, “Prevention of inundation of urban area” and “Promotion of evacuation and safety countermeasure” both are the policy that require the utmost financial support that government have to provide. The first policy clearly the government unable to implement whilst the second policy also still long way to accomplished. Even so, the remaining policy that required the less financial support, the government still rely on other party to materialize.

b. From the frequency of disaster occurrence, tsunami is not the imminent danger that local people perceived but earthquake disaster does. Even further, although geologic and scientific assessment undeniably show up strong evidence about the imminent danger of tsunami disaster, the inability of related institution to answer the main question on when tsunami disaster will struck the city of Padang, which could be a decade or hundred year to come, hampering government effort to implement TRDR policy. The inhabitant not so receptive with TRDR policy because the policy will benefit many years to come, possibly much longer than the average life span of local people. It imply that there are many prioritized policy other than TRDR policy.

Lesson learned from PTMD policy implementation revealed that similar problems with TRDR implementation also occurred, the government of Japan spent huge amount of time and money to implement PTMD policy incrementally and the benefit felt almost a hundred year later during GEJE.

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IMPLEMENTING INDONESIA'S NATIONAL CLIMATE CHANGE POLICY IN THE AMBON CITY GOVERNMENT AREA

Ronald Frans PATTIPAWAEY[1]

ABSTRACT: The Indonesian Government launched the National Action Plan Addressing Climate Change in 2007. One of the recommendations was to integrate climate change strategies into national development planning, as one of the steps to realise the national government's commitment to reducing GHG emissions by 26 per cent by 2020. However, it seems that the application of the national policy has not gone smoothly at the sub-national level, and especially at the local level which is an important level in carrying out the implementation of the national climate change policy.The research aim is to find out how the implementation of the national climate change policy is being achieved at the local government level. The object of the study is the city of Ambon, a city located in eastern Indonesia. Ambon City, like other medium-sized cities in Indonesia, faces common problems such as changes in urban land use, urban infrastructure and poverty and, again in common with other cities in Indonesia, has also suffered from the impacts of climate change. To achieve this goal, I collected data and documents related to the national policy on climate change and development plans at the national and at the local level, and conducted research into what policies, established by the Government of Indonesia, have implications for the implementation of climate change policy at Ambon City. A case study was then conducted to find out what other local governments in Indonesia have done to implement climate change policy in their areas. By analysing the strengths and weaknesses, the actors and outcomes in the process of implementing climate change policy in the cities of Semarang City and Tarakan City, I then created a recommendation for a new policy to be implemented for the Ambon City Government in implementing national climate change policy in the area.

KEYWORDS: National climate change policy, implementation, local government, Ambon city.

1. INTRODUCTION

For an archipelagic country like Indonesia with approximately 17,500 islands, the addressing of global climate change issues is not an easy task. The country, as part of the Southeast Asia region that is vulnerable to climate change (ADB 2009), has a coastline of 81,000 km, which constitutes a threat to the majority of settlements along its edge (MoE 2007). Realising the immediate threat of climate change effects on the population and vital sectors of the economy, the Government of Indonesia launched a national program in 2007: the National Action Plan Addressing Climate Change. Among the four recommendations contained in this document are recommendations for integrating climate change strategies into national development planning (MoE 2007).

The plan was launched as part of the commitment by Indonesia to achieve greenhouse gas (GHG) emission reduction targets by 26% by 2020, while at the same time addressing issues of national economic development, particularly the issue of poverty (MoE 2007). The national policy should be implemented at the national and sub-national level (i.e., the provincial and local levels).

At the national level, a roadmap has already been drawn that contains policies and program proposals that can be applied in both current medium term development plans and future

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medium term development plans (BAPPENAS 2009).[1] At the provincial level, although there has been no strategic document produced in several provinces regarding development planning weighted by climate change considerations, there have been reports submitted by 31 out of the 33 provinces for establishing a regional action plan to reduce carbon emissions (BAPPENAS 2013).

Implementation of a national climate change policy at the provincial level is likely to encounter a few problems in operation. The provincial government is facilitated directly by the national government. The provincial government's function is to ensure that the policies of the national government are implemented and run well at the local level. The provincial government, however, does not have the authority to control local governments who are autonomous, and have the right to manage all the natural and human resources that exist for the benefit of their citizens.

The research aim is to discover how the implementation of the national climate change policy is achieved at the local level. The object of study is the city of Ambon, located in eastern Indonesia. Ambon City has a population of 340,427 in 2011 (BPS Kota Ambon 2012), and, in common with other cities in Indonesia, has also suffered from the effects of climate change. The city experiences flooding and landslides almost yearly, with an economic loss estimated at US$22,400,000 in 2012 alone (BAPPEDA Kota Ambon 2013). Further, the city is the capital of the Maluku province, which is among the three poorest provinces of the 33 provinces in Indonesia (BPS Pusat 2010), and therefore faces huge problems of urban poverty. Issues of changing land use have also been a serious problem faced by the city, and the city underwent considerable social upheaval and conflict that lasted for nearly four years between 1999 and 2003.

From the picture emerging above, this research is important to stimulate the Ambon City Government to start implementing the national climate change policy in the region. In this way, the development priorities of Ambon City will continue according to existing plans, but will be equipped with climate change strategies. All communities, especially the poor who are directly affected by climate change, will consequently be better prepared to face the effects of climate change in the future.

2. NATIONAL DOCUMENTS RELATING TO THE IMPLEMENTATION OF THE CLIMATE CHANGE STRATEGY

2.1. NATIONAL DEVELOPMENT REGULATIONS

There are two types of regulations relating to development planning in Indonesia: non-spatial development planning and spatial development planning. The regulation relating to non-spatial development planning is Act 17/2007, which contains the National Long Term Development Plan 2005 to 2025, while the regulation relating to spatial planning development is Act 26/2007. Both of these regulations underpin all development planning at both the national and sub-national level.

[1] *The medium term development plan (RPJM) is a planning document that covers a period of five years. The document is a translation of the vision and mission of the elected President that includes the National Development Strategy, National Policy, National Priorities and programs and development activities undertaken by the Ministry/National Institutions. This document is a reference for the Ministry/National Institutions and Sub-national Governments (provincial and local governments).*

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2.1.1. Act 17/2007: National Long Term Development Plan 2005 to 2025

National RPJP has become *the* long term reference for planning development at the national and sub-national level, and it remains in force for 20 years. To ensure that the national development plan can be achieved within this timeframe, it has been divided into four medium term stages incorporated in the National Medium Term Development Plan (National RPJM): National RPJM I, National RPJM II, National RPJM III and National RPJM IV.

Each National RPJM remains in force for a period of five years. National RPJM I has already been completed (2005 to 2009). National RPJM II is currently in force (2010 to 2014), with National RPJM III to be implemented in 2015 to 2019, and National RPJM IV in 2020 to 2024. Each new National RPJM commences as the previous one expires. Each plan runs concurrently with the office of President, and the President is required to report on progress before laying the position down at the end of the term of office.

Government agencies and ministries at the national level are required to implement the strategic plan with reference to the National RPJM. The National RPJM is further broken down into a yearly national government work plan (National RKP). The National RKP is the reference for the formulation of the Draft State Budget. Further, the National RPJM is the source reference for the implementation of the Provincial Medium Term Development Plan (Provincial RPJM) and the Local or City Medium Term Development Plan (Local RPJM). The framework and the relationship between these documents apply to provincial and local level entities, and from these they make their own RPJM and RKP. The relationships between these documents in a local government context can be seen in Figure 2.1.

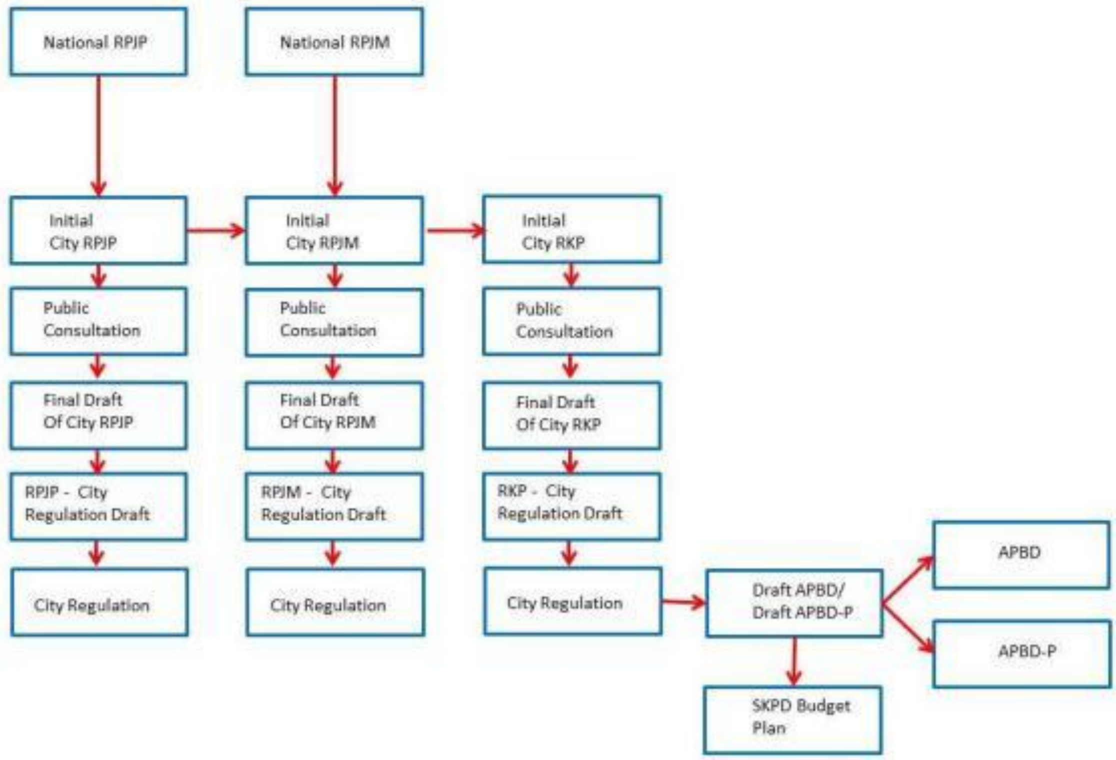

Figure 1. Relationship between national and city development plans (based on NLTDP Act 2007)

Figure 2.1 shows that before the final draft of the City RPJP, the City RPJM and the City RKP is released, it must be preceded by public consultation with local stakeholders. Moreover, the final RKP outlining proposed annual programs for the city must be referred to the city annual budget draft (draft APBD). The proposed budget for each City SKPD is also forwarded to the draft APBD. The draft APBD will then change its status after the draft is approved and endorsed by the City House of Representatives. Approval of the APBD for the next fiscal year is usually completed at least one month before the end of the current fiscal year, that is, in December of each year, while approval of the APBD revision (APBD-P) is completed in the middle of the fiscal year (in June or July of each year).

2.1.2. Act 26/2007: Spatial Planning

Act 26/2007 is a set of tools for spatial planning in Indonesia at the national and sub-national level. Article 17 states that the spatial planning charge includes the structure plan and spatial pattern of settlements and the plan for infrastructure systems. Subsequently, this plan generates other plans that encompass allocation of space for environmental preservation activities, social, cultural, economic, defence and security (Spatial Planning Act 2007).

This Act spawned two major products, namely, the general spatial plan (RTRW) and the detailed spatial plan (RDTR) at national and sub-national level. When referencing these products, both the RTRW and the RDTR should be mentioned together.

2.1.3. Act 32/2009: Environmental Management and Preservation Planning

The Indonesian Government-issued Act 32/2009 requires governments at all levels to carry out the Environmental Management and Preservation Planning (RPPLH) programs that include mitigation and adaptation to climate change. This Act also envisages assessment via the Strategic Environmental Assessment (KLHS), which can be implemented into all (both non-spatial and spatial development) planning documents. Until now, the RPPLH has not yet been available at the national and sub-national level. The government also has not provided guidance for the preparation of the KLHS to national and sub-national entities.

2.2. NATIONAL CLIMATE CHANGE POLICY DOCUMENTS

National climate change policy documents are developed by two ministries involved in climate change policy production: the Ministry of Environment and the Ministry of National Planning and Development (BAPPENAS). These policy documents set out the guidelines for the implementation of the climate change policy in Indonesia at both the national and sub-national level.

2.2.1. NAPACC

The National Action Plan Addressing Climate Change (NAPACC) was formulated in 2007 as the Indonesian Government's response to facing the effects of climate change, particularly in view of the vulnerability of the country. The Ministry of Environment was given the task of preparing a document to provide guidelines for all institutions at every level of government in relation to adaptation and mitigation of climate change planning. The document covers the integration of climate change mitigation and adaptation strategies in development programs designed by each institution, and establishes a permanent pattern of inter-agency coordination. There are four major recommendations contained in this document:

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a. The integrating of climate change adaptation into current National RPJP and future National RPJPs
b. The preparation of national financial resources and international support to optimise support adaptation plans
c. The building of information systems for climate risk management to optimise inter-institutional co-operation
d. Choosing of the appropriate adaptation options.

In addition, there are two recommendations that became the basis of vulnerability assessment:

a. The use of knowledge and information to reduce the risk of climate either occurring now or potentially occurring in the future
b. The implementing of climate risk into the development process as close as possible to autonomous local government areas, with the local government having the right to determine the policies that are considered useful for the region.

2.2.2. Yellow Book and ICCSR

The NAPACC was developed to enrich the National RPJP with regard to climate change adaptation, and the Yellow Book was designed to sharpen the National RPJM. The Yellow Book is the alternative name for the National Development Planning: Indonesia's Response to Climate Change put out by BAPPENAS in 2010. This document seeks to harmonise national issues concerning climate change faced within sectors and across sectors, and focuses on the priorities of fisheries, forestry and agriculture. The energy sector, small islands and coastal areas, therefore, are also a priority in relation to the need for adaptation and climate risk assessment. Along with the Yellow Book, BAPPENAS issued the Indonesia Climate Change Sectoral Roadmap (ICCSR). This document provides program proposals relating to climate change strategy that can be implemented in the current National RPJM II and future national RPJMs, with an emphasis on combining climate change mitigation with adaptation.

In conclusion, even though the national government has prepared a wide range of national policy on climate change, and allows for the integration of climate change strategies into the national or sub-national development plans and programs, there is no clear mechanism for ensuring they are implemented at the local level.

The next chapter will give an overview of Ambon City, including the strategic issues of urban development and climate change.

3. DESCRIPTION OF AMBON CITY

This chapter examines the lack of mechanisms in the implementation of climate change policy in Ambon City. Ambon City, like other medium-sized cities in Indonesia, faces problems confronting climate change effects that disrupt specific sectors: the water sector, coastal sector and health sector. Additionally, they face other problems such as changes in urban land use, urban infrastructure and poverty. In 2012, Ambon City Government spent US$337,310.46 to repair and rebuild infrastructure damaged by the floods and landslides (BAPPEDA Kota Ambon 2013). Spending is clearly still small compared with the estimated

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catastrophic losses in 2012 of US$22,400,000 (BAPPEDA Kota Ambon 2013). Although Ambon City Government has conducted several programs to anticipate the effect of natural disasters (BAPPEDA Kota Ambon 2013), the determination of these programs was not preceded by an assessment that ties into the characteristics of Ambon City in their effort to confront climate change.

3.1. POSITION, TOPOGRAPHY, DEMOGRAPHY AND ECONOMY

The Ambon City area is partly located in the region of Ambon Island in the eastern part of Indonesia. This administrative region geographically lies between: 3 to 4° Southern Latitude and 128 to 129° Eastern Longitude.

Ambon has a land area of 359.45 km^2, with a shoreline length of 98 km (BPS Kota Ambon 2012).

The topography of Ambon mostly consists of slopes and hilly areas of approximately 186.90 km^2 (73%) and elevated highlands (10%) and plains of approximately 55 km^2 (17%) Total river lengths are 81.75 km (BPS Kota Ambon 2012).

The population of the city of Ambon in 2012 was 390,825, with a growth rate in that year of 0.87% of the total population.

The population density of Ambon City (2012) is 1,087 persons/km^2 spread over five sub-districts containing 50 villages. A small proportion (7.67%) of the population is poor. Economic growth in 2011 increased by 0.12% compared to 2010, which amounted to 6.65%. The Gross Domestic Product (GDP) of Ambon City in real terms has reached US$192 million, with a per capita income of US$ 505 (BAPPEDA Kota Ambon 2013).

3.2. OVERVIEW OF NATURAL DISASTERS

During 2012, several natural disasters that caused loss of life and property in the city of Ambon occurred (BAPPEDA Kota Ambon 2013):

1. Water inundation occurred in three villages due to rising sea levels, and damage was caused to 78 houses.
2. Landslides occurred in five districts in the city of Ambon. Thirty-two people died, 20 were injured and one man was missing, and 405 houses were damaged. In addition, landslides have caused considerable damage to infrastructure, and even some city roads were damaged.
3. Due to high rainfall and the influence of global climate change, floods occurred, which peaked on 1 August 2012, in five sub-regions of the city. The floods damaged 790 houses, as well as public facilities. More than 5,000 houses were inundated, and some 7,328 inhabitants were displaced. The economic loss amounted to US$22,400,000.

General information about the local government of Ambon is given in the next section.

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3.3. AMBON CITY GOVERNMENT

Together with 10 other local governments, the City Government of Ambon is included within the administrative Province of Maluku, and is the provincial capital. Ambon City has had its own government since 2004 (Ambon City Government), and has become an autonomous region consisting of five sub-districts and 50 villages. As an autonomous region, the Ambon City Government has the right to manage all of its own resources, and is not under the jurisdiction of the Province of Maluku. The city government is headed by a mayor who is directly elected by the citizens of Ambon City for a term of five years.

In the next section, the documents that have been produced by the national government regarding mitigation strategy, and which can be used as guidelines for the local government of Ambon City, will be outlined.

3.4. REGIONAL ACTION PLAN FOR REDUCING GHG EMISSIONS

The guideline for the implementation of the national climate change policy at the provincial level is the Regional Action Plan for Reducing GHG Emissions (RAD-GRK). It was prepared by BAPPENAS and was completed in 2012. This guideline is intended to form part of a national mitigation strategy (RAN-GRK). In RAD-GRK, the defined role of the provincial government is to implement and supervise the activities of the mitigation of GHG emissions at the local level, in order to achieve the national target of reducing emissions by 26% to 41% by 2020. In the context of the Maluku province, the RAD-GRK was established by the Governor of Maluku Regulation, which sets out the steps to be taken in the Maluku province to reduce GHG emissions based on the capacity of the province. The Maluku provincial government needs to also calculate the GHG emissions at a provincial level, the reduction targets and the types of sectors in which emissions will be reduced across the seven counties and the city of Ambon.

Since the launch of the NAPACC in 2007 until 2013, there have been no documents relating to the implementation of the action plan report on the local government level for the city of Ambon. Even though the national government has set a national policy on *mitigation strategies* in the form of guidelines for provincial areas in 2012, there have not been the same guidelines for climate change *adaptation strategies*. Guidelines for the implementation of climate change adaptation action plans are only available at the national level (the RAN-API). The Ambon City Government currently does not have a strategic plan or any documentation to deal with climate change effects utilising either mitigation or adaptation strategies.

3.5. DOCUMENTS FOR SUPPORTING CLIMATE CHANGE POLICY IN AMBON CITY

Some of the documents that have been discussed in Chapter 5 show that the national government has realised that climate strategies have to be integrated into ongoing development. It can already be seen that there are several documents that must be provided to local governments to implement climate change into current and future development planning policy and development programs. The documents are:

1. City RPJP
2. City RPJM
3. City RTRW
4. City RDTR
5. City RKP.

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Understanding these documents is critical for further analysis related to the implementation of climate change policy at the local level. The Ambon City Government already has five primary documents: the City RPJP, City RPJM, City RTRW and City RDTR and City RKP.

3.5.1. Ambon City Long Term Development Plan (City RPJP)

The Ambon City Government has the City RPJP, which includes vision, mission, direction and development stages, and covers a period of 20 years. It runs from 2006 until 2026.

3.5.2. Ambon City Medium Term Development Plan (City RPJM) and Work Plan (City RKP)

The City RPJM has been established by the City Government of Ambon. It is a translation of the vision, mission and programs of the Mayor, which was prepared based on the City RPJP. The City RPJM is enhanced by mayoral decree, and includes city financial policy, city development strategies, public policies, city departments (City SKPs) programs, the city cross work unit and regional programs along with work plans within a regulatory and indicative funding framework. The City RPJM, then, is spelled out in the city department's strategic plan (City SKP Strategic Plan) and the City Government Work Plan (City RKP).

3.5.3. Ambon City Spatial Plan (City RTRW)

Mainstreaming climate change in the Spatial Planning Implementation System is a strategy in considering the potential risks of climate change, to avoid the effects of climate change, and to ensure that the implementation of spatial planning does not result in increased susceptibility to various types of hazard areas due to the effect of climate change in all sectors (BAPPENAS 2009). As a product based on Act 26/2007, the Ambon City RTRW is used as a guideline for accelerating regional economic development and utilisation of natural resources (BAPPEDA Kota Ambon 2010). This document is also used as a reference by local bodies for implementing development activities in the Ambon region, and as a reference for the control of land use. The City RTRW has a life of 20 years, that is, from 2011 to 2031. The spatial planning program is directed to:

1. Improving the organisation of effective spatial planning, transparency and participation
2. Developing the organisation of orderly land use plans
3. Improving space utilisation controls to ensure the effectiveness and efficiency of development activities on an ongoing basis.

Further, some disaster-prone areas such as areas prone to earthquakes and ground motion, landslide-prone areas, flood-prone areas and areas prone to tidal waves and tsunamis have been included in the City RTRW in anticipation of climate change. Most of the hilly regions are prone to landslides, and most flood-prone areas exist in the form of basins throughout the city of Ambon, so water could potentially collect at these points. With the establishment of zones prone to natural disasters in the city's spatial zones, there are some areas that should not be used for development to minimise casualties due to natural disasters. However, the determination of these areas has not been undertaken based on the results of a climate change risk assessment using specific methods or tools. In connection with the utilisation of natural resources, Ambon City Government has also set up a protected forest area of 6,115 hectares (dark green areas shown in Figure 3.5).

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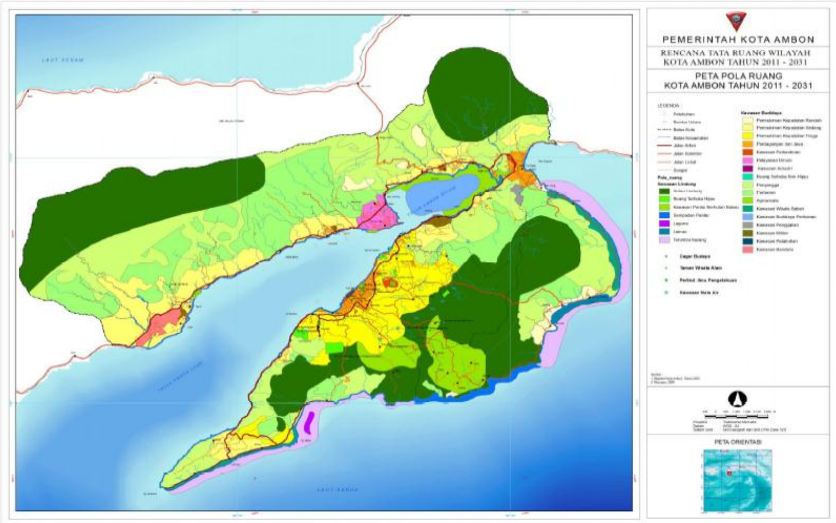

Figure 2. Protected forest area (BAPPEDA Kota Ambon 2010)

Efforts to control the use of land in the city of Ambon still face problems because there is no legal certainty that the spatial plan can be used as a guideline for local development. This leads to non-integrated developments and poor utilisation of space, and results in negative effects such as the emergence of regional slums, traffic jams, floods, landslides and forest encroachment (BAPPEDA Kota Ambon 2011, p. 1).

3.5.4. Ambon City Detailed Spatial Plan (City RDTR)

The City RDTR contains details of existing conditions and a detailed analysis of City RTRW. In addition, this document also establishes zoning regulations in the Ambon City region. The City RDTR gives guidance on:

1. Quality control of spatial land use by the city/districts
2. Detailed utilisation of space
3. Control of land use activities
4. The issuance of land use permits
5. The preparation of the Building and Environmental Management Plan.

4. IMPLEMENTATION OF CLIMATE CHANGE AT THE CITY LEVEL

From the data collected, it was found that some cities in Indonesia have made efforts to implement climate change policy in their regions, and are implementing similar methods, that is, assessing their vulnerability to climate change as part of adaptation strategy.

Furthermore, they have used the Indonesia Climate Change Sectoral Roadmap (ICCSR) as a national guideline to mainstream climate change strategies into their non-spatial and spatial development plans and city programs.

Semarang City and Tarakan City are two very different cities in terms of size and population. Semarang City has a population of nearly 1.5 million (2008), and Tarakan City has a population of only 193,069 (2010). In terms of area, Tarakan City is the larger with an area of

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657.33 km^2, while Semarang City has an area of 374 km^2 (ACCCRN 2010; MoE 2012). Based on population, Semarang City is categorised as a large city (cities with a population over 1 million), while Tarakan City is categorised as medium-sized (cities with a population between 100,000 to 500,000) (MoPW 1996). Although in different categories, it is appropriate for both to be compared in the context of their implementation of climate change strategies, since both sit at the same level in the Indonesian Government structure—that is, at the local government level—and have completed their CRS (for Semarang City) and Climate Change Risk Assessment and Adaptation (CCRAA) (for Tarakan City).

4.1. READINESS OF AMBON CITY TO BEGIN THE PROCESS OF IMPLEMENTING CLIMATE CHANGE IN THE REGION

From the description of Ambon City in Chapter 6, and from what has been done by other cities in Indonesia in implementing climate change in their areas, it appears that the city of Ambon has a number of documents that are suitable for being mainstreamed by climate change strategies. A number of documents concerning the development plan have been available (the Ambon City RPJM, Ambon City RTRW & RDTR and Ambon City RKP), and a number of programs have been detected within these documents that support addressing climate change issues. However, the Ambon City Government does not have risk assessments for a number of sectors that are directly affected by climate change.

Before outlining the next steps in a recommendation for the Ambon City Government to start implementing climate change in their area, a review of the Ambon City Non-spatial development Plan (RPJM), Ambon City Spatial Development Plan (RTRW and RDTR) and the Ambon City RKP, is undertaken to identify the strengths and weaknesses of these four documents in relation to climate change issues.

4.2. STRENGTHS, WEAKNESSESS, OPPORTUNITIES AND THREATS

There are several points that I have identified as strengths in the documents in terms of process and content related to spatial planning and environment.

In relation to spatial planning and urban infrastructure, the strengths of the documents are, among other things, identifying:

- Increasing transportation mobility in urban centres, which adds to congestion and air pollution levels
- A lack of public access to basic facilities and settlements, especially in the provision of clean water
- A still inadequate drainage system.

In relation to the environment, the following has been identified:

- Land grabs along the watershed still occur, especially in areas with steep topography which are unfit for settlement
- Many critical areas that are highly vulnerable to natural disaster
- Public awareness about the function of forests is low
- Rehabilitation and reforestation efforts have not succeeded significantly
- Village authorities are ineffective in curbing bad behaviour regarding using rivers as a garbage dump
- Lack of public awareness on waste management
- High air pollution in urban areas

- High levels of pollution in the waters of Ambon Bay.

These documents also contain weaknesses:

- Among the four documents, the Ambon City RPJM is not legally enforceable. Although it has been in established use for nearly three years (since 2011), this document has not been approved by the Ambon City House of Representatives as a local regulation.
- Although the Ambon RTRW established several program activities after thorough study and analysis, some programs (such as the determination of flood-prone areas in eight watersheds and landslide-prone areas in some 20 villages) have been established without any prior analysis.
- Similarly, water shortage is not a major issue to be addressed by the city, whereas, according to an analysis using the minimum standards set by the Ministry of Public Works (MoPW 1996) and based on statistical data held by the local government (BAPPEDA Kota Ambon 2010), the capacity of water sources provided by the local government of 132 litres/sec is still not sufficient to meet the minimum clean water standard of 314.78 litres/sec. Also, services provided by the Ambon City water company have not reached all residents of Ambon. Based on analysis, the service coverage is still low at 11.16% of the minimum standard set by the Government of Indonesia (55% to 75%). Water availability is therefore also vulnerable to climate change.

After analysing development documents and statistical data relating to Ambon City, there are several opportunities for the Ambon City Government to implement climate change policy:

- The Ambon City Government has been able to begin drafting the implementation plan using the documented development plans of several other cities in Indonesia as a guideline.
- The City of Ambon Government is still working with several international NGOs including Mercy Corps and USAID (until 2015) in community assistance programs to tackle the problem of sanitation and clean water. They have been working with the Ambon City Government since the post-riot period in 2003, and the relationship has been enhanced by the opportunity to be associated with the co-operative programs related to community assistance.
- The Ambon City Government still continues co-operation with two international sister cities, that is, Darwin (Australia) and Vlissingen (the Netherlands). Co-operation with Darwin focuses especially on the field of education, while co-operation with Vlissingen is in the field of waste management. In 2013, Ambon City also explored a sister city partnership with the City of Kyoto (Japan). The link with the sister cities also offers an opportunity to enhance knowledge in the field of climate change.
- Community and religious organisations create partnership opportunities in Ambon City that can be used by the local government in promotional campaigns. These organisations should be utilised, as the effects of climate change are faced by the whole society of Ambon City.

The threats to the implementation of these activities are:

- Coordination between the Government of the City of Ambon and the Maluku Provincial Government is sometimes hampered by rules of protocol. As a result, the national government policies are sometimes slow in being implemented at the city level, and the national guidance on mitigation strategies (RAD-GRK), passed on through the Maluku provincial government, could be a little difficult to implement quickly at the city level.

- The outcome of legal action against violators of the rules in the City of Ambon is still uncertain. This could be a threat if the approved development plans are not legally binding and do not have legal clout.
- The Ambon City RPJM is the outcome of the vision and mission of the Mayor, so the initiative to integrate climate change strategies depends on the initiative of the Mayor, particularly given the high status the Mayor enjoys as the ruler of the autonomous region.

The City's RPJM document will expire at the end of the year 2015 (BAPPEDA Kota Ambon 2011), so it is not recommended to mainstream the climate change strategy into it. The appropriate time for starting this process is at the end of October 2014, and it is expected to be completed by the end of 2015. The determination of the timeframe takes into consideration the usual term for establishment of local budgets (City APBD and City APBD-P). Further, the implementation process will be more complete because it can integrate an adaptation strategy used by the Semarang City and Tarakan City, with the appropriate mitigation strategy using RAD-GRK guidelines established by the central government and available to the Maluku provincial government.

In conclusion, the implementation of climate change policy in Semarang City and Tarakan City can be a strong foundation for Ambon City Government to immediately start implementing the national climate change policy in the region. Although the national government has not provided a clear mechanism to learn from the experiences of Semarang City and Tarakan City, the Ambon City Government has been able to start planning for the city's climate strategy. There are many alternatives to choose according to the conditions and needs of the city of Ambon.

The time for implementing climate change as a priority in the development agenda of Ambon City is now, and it cannot wait for the national government's initiative to start the process. Thus, the next chapter proposes recommendations for the Ambon City Government to start implementing national climate change policy in their area.

5. RECOMMENDATIONS

5.1. A NEW APPROACH: IMPLEMENTATION OF CLIMATE CHANGE POLICY IN AMBON CITY

The strengths of climate change implementation methods used by Semarang City and the methods used by Tarakan City have been applied into a new approach developed for implementing national climate change policy in Ambon City. Further, the new approach should be complemented by a mitigation strategy, absent in Semarang City and Tarakan City. The new approach also encourages decision makers to reference national policy on climate change and Ambon City's development priorities based on Ambon City RTRW & RDTR and Ambon City RKP.

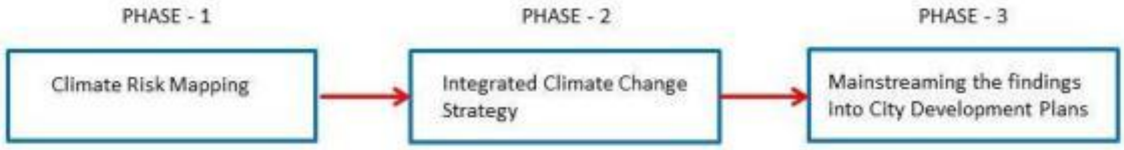

Figure 3. Three phases of climate change implementation

The process of climate change implementation in Ambon City is divided into three phases, namely, a climate risk mapping phase, an integrated climate change strategy phase and mainstreaming of the findings into the city's development plans (see Figure 5.1). Each stage will be discussed by highlighting the outputs, processes and actors.

5.1.1. Phase 1: Climate Risk Mapping

Ambon City climate risk maps are expected to be the final output documents in this phase. They contain a map of the city of Ambon that has been divided into sub-districts and villages that have been classified according to risk level. The types of hazard and vulnerability assessment that can be used for the city of Ambon are a combination of assessments used in Semarang City and Tarakan City. Figure 4 shows three types of suggested assessments, namely, risk assessment for the water sector, risk assessment for the health sector and risk assessment for the community-based sector.

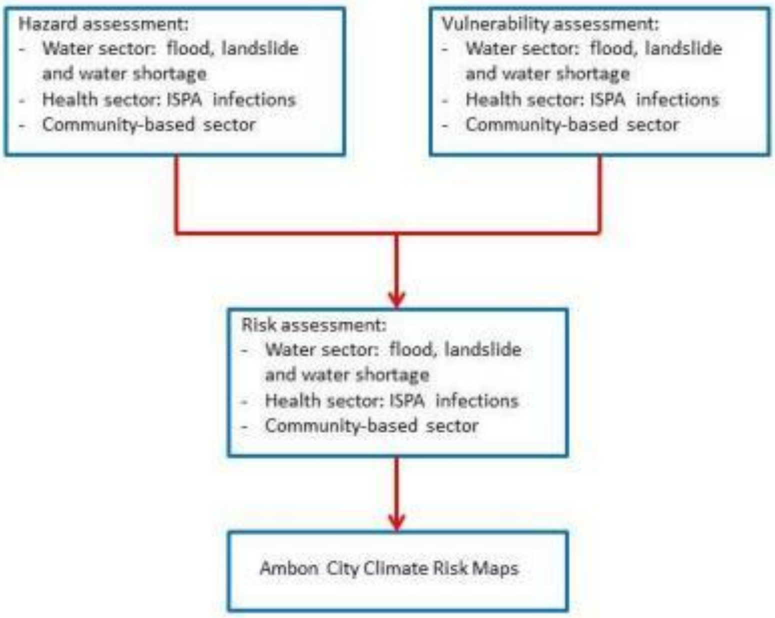

Figure 4. Three types of suggested assessments

Determination of the type of hazard and vulnerability assessment is performed after reviewing the suitability of the data provided by Ambon City, which supports program priorities in the local development plans (non-spatial development plan and spatial development plan). In the water sector, assessment was conducted of flood, landslides and water shortage in accordance with the priorities established for the development of Ambon City. Further, assessment of water shortage will be conducted, even though clean water availability for the community is not a priority on the development plans. However, as discussed in the previous chapter, there is strong evidence that water supplies and services to the city of Ambon are still not sufficient, so this sub-sector is also vulnerable to climate change.

Figure 4 also indicated that risk assessment is also necessary for the health sector. Tarakan City conducted a risk assessment for Malaria and DHF. Risk assessments for the city of Ambon focused on upper respiratory tract infections (ISPA), as these were ranked as the most widespread disease in Ambon City (BPS Kota Ambon 2012). Further, community-based assessments conducted in Semarang City were also included in this risk assessment. Direct and indirect effects, risk groups and sectors affected due to climate change can be identified by undertaking this assessment. Likewise, the economic losses caused by flooding and sea level rise can be calculated. Once the process is complete, the assessments will be included into the Ambon City climate risk maps.

To fund this program, BAPPEDA Kota Ambon can integrate these activities into their annual program, and be funded by the state budget revision (APBD-P) 2014, which is usually endorsed in June/July of each year. The actors who play a role in this process are the city government, local universities, local NGOs and external experts. A working group consisting of local government, local NGOs and local universities is set up before the process.

5.1.2. Phase 2: Integrated Climate Change Strategy

In this section, the implementation process, made after the city's climate risk is successfully mapped, is outlined. The purpose of the next process is to integrate two separate climate change strategy documents, that is, Ambon City's GHG Emission and the city's Climate Risk Profile, into an integrated climate change strategy. Figure 5 describes the process of rolling out the program by using the methods implemented by Tarakan City and Semarang City. At the same time, each strategy is discussed separately in three workshops held over approximately six to eight months.

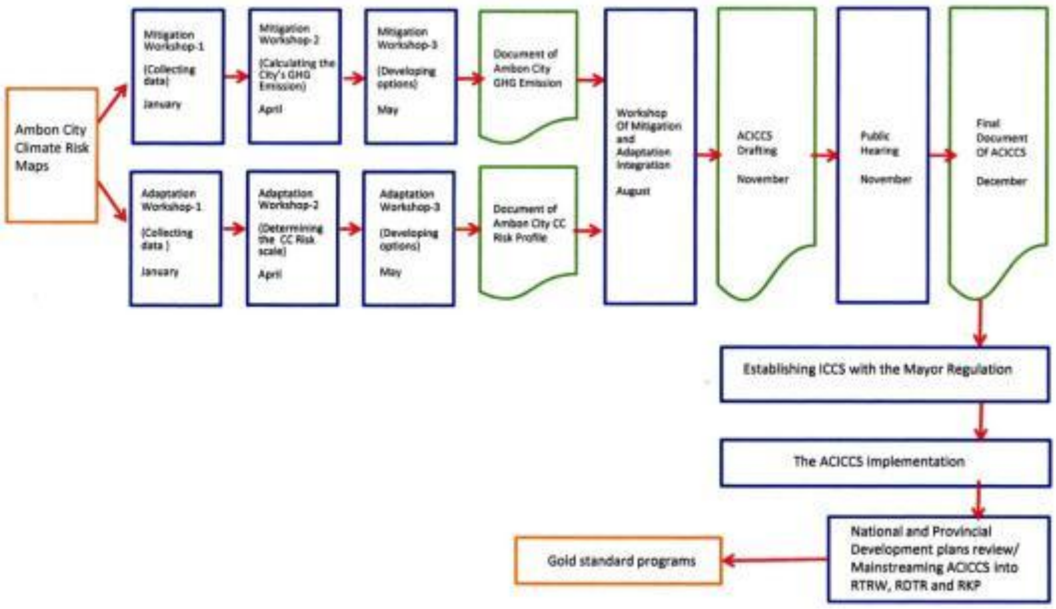

Figure 5. The process of Ambon City's Integrated Climate Change Strategy (ACICCS)

To fund this program, BAPPEDA Kota Ambon can integrate these activities into their annual budget for the period 2015, and it can be funded by the city-state budget (APBD) 2015. The ACICCS document should outline the major regulations before continuing the process of

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mainstreaming into the development planning system. Legislation is important because it will bind all the entities within its scope, and obligate local government to implement programs in a development plan with reference to the ACICCS.

The measurement of the city's GHG emission can be evaluated using the format outlined in the RAD-GRK guideline published by BAPPENAS and available from the Maluku provincial government. Components that can be used as an objective measure of CO_2 emissions are defined in accordance with regional needs and conditions. Components in Ambon City that can be used as a measure of likely CO_2 emissions are produced by the Ambon government and community groups and are shown in Figure 6.

CO_2 emissions by Government Sector

Sector	Total CO2 emission (t)
Building	
Fleet vehicles	
Lighting	
Water supply	
Waste water	

CO_2 emissions by source within Government Sector

Type of Energy	Total Use (GJ)	Total CO2 emission (t)
Electricity		
LPG		
Natural gas		
Diesel fuel		
Gasoline		
Kerosene		

CO_2 emissions by Community Sector

Sector	Total CO2 emission (t)
Settlement	
Commercial	
Industry	
Transportation	
Waste	

CO_2 emissions by source within Community Sector

Type of Energy	Total Use (GJ)	Total CO2 emission (t)
Electricity		
LPG		
Natural gas		
Diesel fuel		
Gasoline		
Kerosene		

Figure 6. Indicators of CO_2 Emissions

CO_2 emissions indicators are divided into two groups to facilitate the calculation of GHG emissions in choosing mitigation activities, as shown in Table 5.1. The following factors to be considered are:

- Sectors: which consume a lot of fossil energy, especially with high GHG emissions, and are used in general in the city of Ambon, such as electricity, LPG, natural gas, diesel fuel, gasoline and kerosene.
- Groupings: based on users (i.e., government groups and community groups).

Measurements for determining CO_2 emissions by the government group are gas emissions produced by the government building sector, fleet vehicles, lighting, water supply and waste water, while community groups use the residential, commercial, industrial, transportation and waste sectors as factors. Table 5.1 also describes CO_2 emissions by source from both government and the community groups. Compiling CO_2 emissions calculated by these two groups will produce an output of CO_2 emissions generated by the city.

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After the Ambon City's GHG Emission and the Ambon City's Climate Risk Profile documentation is completed, the next step is to integrate these two documents into the ACICCS. This process takes four to five months (see Figure 5.2). Before the ACICCS is established, a process of public consultation would be set up to ensure that the resulting document contains feedback and comments from the public, so that the implementation of the climate change strategy in the local context will have the full support of the people of Ambon.

5.1.3. ACICCS Mainstreaming into Development, Spatial and RKP Plans

The next step is to conduct a review in order to ensure that the Ambon City RTRW&RDTR and Ambon City RKP do not contradict similar documents at the provincial and national level. This review is necessary because the climate change policy at the national level and provincial level allows for revision of the development plans. Recent changes in provincial and national development documents must be updated to avoid conflicts with the national and provincial development plans.

5.1.4. Gold Standard Program

The process of mainstreaming the ACICCS findings into the development plans then results in a gold standard program. The gold standard program is designed based on the recommendations made in mitigation and adaptation prioritisation. The program is then submitted by the local government to the national government for funding assistance. The national government can provide funds that can be sourced from non-state or state budgets, including international finances. The gold standard programs that should be implemented in the city of Ambon are programs that are not project-oriented, because project-oriented programs would not provide much benefit to the learning community. An example of a gold standard project that might suit Ambon City is a community settlement improvement program, which integrates climate change issues, such as has been established in Tarakan City.

5.2. RECOMMENDATION FOR FUTURE ACTIONS

In addition to the recommendations made in the previous section, there are three additional recommendations regarding implementation of climate change for the city of Ambon:

1. Information systems and coordination on national climate change policy that are tiered from the central level to the local level should be reviewed again by the central government, since the system is still hampered by the determination of mitigation strategy at the local level. Preparation of mitigation strategy at the level of regencies or cities is still very dependent on the readiness of the provincial government to establish guidelines for the implementation of CO_2 emissions at the city level. For this process, the national government should make the system effective in the provision of information on national policies on climate change with regard to the hierarchy of government, but not make the system a barrier for implementing national climate change policy at the local level.
2. The Ambon City Non-Spatial Development Plan (RPJM) is still valid to the end of the year 2015, but, to date, it has not yet been approved by the City House of Representatives. The Ambon City Government and City House of Representatives need to be more serious in legislating and upholding the legal aspects of the documents for future development, especially the future RPJM of 2016 to 2021. By

not having permanent legal force, it is feared that there will be abuses, particularly in the area of larger spatial land use.

3. The vision, mission and programs for urban development that are contained in the development plan are dependent upon the Mayor. Leaders of political parties and the public in Ambon City should therefore have a good knowledge of a mayoral candidate's commitment to, and concern about, the effects of climate change on the city and its community.

6. CONCLUSION

Even though the NAPACC was launched in 2007, and had as its target the mainstreaming of climate change strategies into national long term development, as at 2014 the evidence is that not many local governments have implemented the national policy in their area. Several local governments have, however, completed strategic planning documents related to climate change, performed risk assessments in sectors affected by climate change and have then mainstreamed the findings into the development plans. However, the approaches undertaken and tools used have been different. With the support of an international donor and assistance from NGOs and external experts, Semarang City, using the approach and tools provided by the ACCCRN, produced outcomes that reflect a synergistic co-operation between local government (as the key actor) and local stakeholders. The experience of Semarang City also provided an understanding that planning policies that will give effect to the social life of the community should involve local stakeholders, so that the full potential of human resources and local knowledge can be utilised as inputs for their own planning.

The experience gained in Tarakan City shows that the role of national governments also remains important in local planning and implementation of climate change outcomes when trying to mainstream the findings of risk assessments into the development plans. In this case, the national government should continue to assist local governments by providing the right tools to be used to ensure that national policy implementation at the local level area is going well. This is an important consideration, because national climate change policy is a part of the national government commitment to the global community, who have contributed to the reduction of global GHG emissions.

What has been achieved in Semarang City and Tarakan City serves as a valuable lesson for the city of Ambon, which has no climate change planning program, to start the process immediately. Notwithstanding the weaknesses in the system of governance, and the threats to be faced in the implementation of climate change policy, Ambon City is in a position to undertake the process without having to wait for an initiative from the provincial government as the representative of the central government. The local government should take the initiative to start this process, since their autonomous status allows them the freedom to do so. Planning climate change is already seen as an urgent matter because the citizens of Ambon City have already felt the direct effects of natural disasters caused by climate change, which have resulted in loss of life and property, along with enormous economic loss. The Ambon City Government has also experienced economic loss due to damage of their assets and infrastructure, and also damage to urban areas built as a public facility for the community.

The potential human resources of the city of Ambon should be mobilised to develop programs that implement national policies, both at the planning stage and in the undertaking of real action in the city, so that action on climate change is not just on the part of the local authorities but of the whole population. More than this, it is expected that local government programs will act as a trigger to change the everyday behaviour of citizens and government officials, so that the people of Ambon City will be better prepared to face both the predictable and unpredictable effects of climate change in the future.

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DYNAMIC EKISTICS; AN ADAPTED METHOD DEVELOPED FOR LAMONGAN COASTAL SETTLEMENTS STUDY

Ivan AGUSTA[1], Fery IRFAN[2] and Dian RAHMAWATI[3]

ABSRACT: Ekistics dynamic is a method used for settlement study is to analyse the characteristics of settlements amenities that forming ekistics elements. Each settlement with certain characteristics have its strength of each part which depends on its location in the system as a whole ekistics. Settlements can be figured through settlements value that related to the services provided and the number of inhabitants. This article is part of a research about *minapolis* coastal settlements concept development in Brondong, Lamongan. The purpose of this article is to formulate the factors that determine the coastal settlement's strength in study area. The discussions in this article consist of morphology study, spatial planning, and development trend. The method used in the analysis is scoring method related to the affordability of residential location variable observations (facilities, utilities, accessibility, social interactions are formed) by considering the morphology of settlement (settlement formation process). The method above are adapted to the principal method of finding ekistics elements that found bay C.A. Doxiadis. The findings of this research are visual mapping of the settlement's strength that formed by attitude-related developmental trends.

KEYWORDS: Dynamic Ekistics, Coastal Settlements

1. INTRODUCTION

Indonesia is a maritime country dominated by marine region and well known as the largest archipelago country in the world. This indicates the potential abundance of fishery resources owned by Indonesia, amounting to 6.4 million tonnes per year (Sunoto, 2010). But of the many potential fishery resources, to gross domestic product in Asian countries, Indonesia still remain inferior compared to other countries, such as Japan, the PRC, and South Korea (Riyadi, 2004). East Java Province as part of the regions in Indonesia is the areas with natural resources richness, but the level of poverty shows that coastal inhabitants are mos of it. Marginal Fishing Community Development Program Pilot (MFCDP) has helped coastal communities and fishermen in addressing root causes of poverty (Bappenas, 2004). Next coastal development focused by the Ministerial Regulation No.12 / 2010 regarding Minapolitan Program. This program aims to accelerate economic development of marine and fishery management system approach and a fast-growing region like a city (Sunoto, 2010).

Based on Ministerial Regulation No. 12/2010, there are three principles that became the basis for the concept Minapolitan:

1. Economic Democratization marine and fisheries pro-communnity.
2. Community empowerment and alignment with the intervention of the state is limited (limited state intervention).
3. Strengthening the principle areas: the strong - strong state and nation.

From the above, it can be said that the community is one of the aspects highlighted. Good settlement will provide a good quality of life as well. To realize good community life it is necessary to use the right approach process of settlement development.

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Minapolitan is the area of marine and fisheries-based economy consists of centers of production and trade, services, housing, and other activities that are interrelated. In accordance with Decree MenKP 39 / Men / 2011 Date July 21, 2011 on the Determination Minapolitan area, Kab. Lamongan became centers of sea-fisheries and aquaculture. The presence of marine resources has the most dominant influence to the coastal settlements.

Each settlement has individual characteristics and ekistics study is the approach taken in order to see the characteristics of the settlement based on the elements - elements that ekistics forming settlements; nature, human, community, housing, and network. Dynamic ekistics approach is the development of a general ekistics method with certain treatment n its stage. Ekistics dynamic approach in determining the strength of settlements is the basis of the application of the concept of settlement minapolis. By identifying the strength of each settlements based on indicators that have been determined, it will be mapped to the character of each point clearly within the scope of the overall residential areas. Mapping process needs each point since it should be specific and unique according to the physical and non-physical characteristics in each region.

2. RESEARCH METHODS

2.1. DATA COLLECTING METHOD

The data used in this study is secondary data that contains information related to the area of study used as the basis for the generalization of the characteristics of the neighborhoods for ekistics study-based approach. Observation as primary data is also used for enhanced the and specified the mapping process for the ekistics elements.

2.2. ANALYSIS METHOD

Settlement's strength determined factors are analyzed after the settlement characteristics of coastal settlements in the study area are known. Generalization of the characteristics and strengths of this settlement is basically done by using adaptation methods of ekistics studies which is one way to scientifically study the settlement. ekistics study has the principle of integration in the field of settlement. The aim of the study was to synthesize ekistics based development of the planning and design of settlements as a physical artifact. The main object of ekistics are insights in a settlement to then be developed in the direction of physical distribution, shape, and structure of settlements. This method is considered as a method that is able to organize information and map the relationship between the results of field observations to theory. There are many varieties in this method is adapted to the purpose of the study such as the classification of settlements by size, the analysis of the quality of housing, and morphogenesis. While in this study the main objective to be achieved is the mapper's strength is based on the combined settlement conditions ekistics each element - each of which describes the characteristics of the settlement as a whole. The method used in this study ekistics analysis is basically to see how the current condition of the settlement, it was compared with the pattern formation (morphology) and spatial historical shaper settlement will affect the projection of future housing developments. To study adaptation procedure is done as follows. :

- The first step is to analyze the pattern of settlement formation (morphology) based on a hierarchy of settlements, the shape and direction of development of the settlement. The unit of observation is needed is data associated with spatial indication of settlements in the study area. The analysis was performed by descriptive of the appropriate units of observation are the visually examine the patterns formed in the study area.

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- The second stage is to analyze the strength of each - each unit ekistics through a scoring process based on criteria that describes the elements ekistics accessibility. Availability facilities. Availability of infrastructure, as well as the social interaction that describes the quality of the community. Analysis of the scoring is done through an overlay process using fuzzy logic. Overlay analysis is a method that is applied in suitability modeling or other spatial analysis. This technique is used to implement the scale of values common to the diverse and different inputs in order to create an integrated analysis. The aim is to build relationships overlay analysis of all input factors together to identify desired outcomes that meet the objectives of the model. In some cases, overlay analysis can be referred to as an analysis that combines a wide variety of different factors. Whereas fuzzy logic is a technique to overcome the inaccuracies in the attributes and geometry spatial data. Fuzzy logic, related to the overlay analysis focuses on the inaccuracies in the data attribute. In general, Fuzzy Overlay analysis is based on set theory. Humpunan theory is a mathematical science that measures the relationship phenomenon of membership in a particular set. In Fuzzy Overlay, set customizable and generally referred to as a class. Fuzzy models used in this study to provide a snapshot that is not massive / rigid delineation of how the power of a settlement in an area spread criteria force settlements that formed the basis in determining the delineation of powers settlements can be seen in Table 1 that contains each - each criterion for each component and their observations of its score range.

Table 1. Criteria Settlements Strength

No.	Components	*Score*	Criteria
1	*Accessibility*	1	The settlement's location has two criteria from all criteria mentioned
	Settlements location criteria based on :	2	The settlement's location has three criteria from all criteria mentioned
	• Proximity to workplace • Proximity to school	3	The settlement's location has four criteria from all criteria mentioned
	• Proximity to trade area • Proximity to tourism area • Proximity with clinic/hospital • Provision of transportation facilities	4	The settlement's location has all of the criteria mentioned
2	*Provision of facilities criteria* : • Education facilities	1	Two facilities criteria are available and accessible
	• Health facilities • Religious facilities	2	Three facilities criteria are available and accessible
	• Commerce and trade facilities • Recreational and park facilities	3	Four facilities criteria are available and accessible
	• Security	4	All facilities criteria are available and accessible
3	*Provision of infrastructure criteria:* • Transportation network	1	Two infrastructure criteria are available and accessible
	• Clean Water • Sanitation and Drainage	2	Three infrastructure criteria are available and accessible
	• Waste • Wastewater	3	Four infrastructure criteria are available and accessible
	• Electricity • Telecommunication network	4	All infrastructure criteria are available and accessible

No.	Components	*Score*	Criteria
4	*Social Interaction* Criteria: • The form of social interaction • The availability/agenda of social interaction • The social interaction's facility • Comfortness	1 2 3 4	Social interaction are unavailable Social interaction are available but unscheduled Social interaction are available and scheduled but the facilities/physical space are unavailable Social interaction are available and scheduled also the facilities/physical space are available

Source : Analysis, 2014

There are three (3) steps in overlay analysis to interpret the criteria determined in this article using fuzzy overlay:

1. Classification or data change in layer;
2. Addition and combination of layer;
3. Analysis and interpretation.

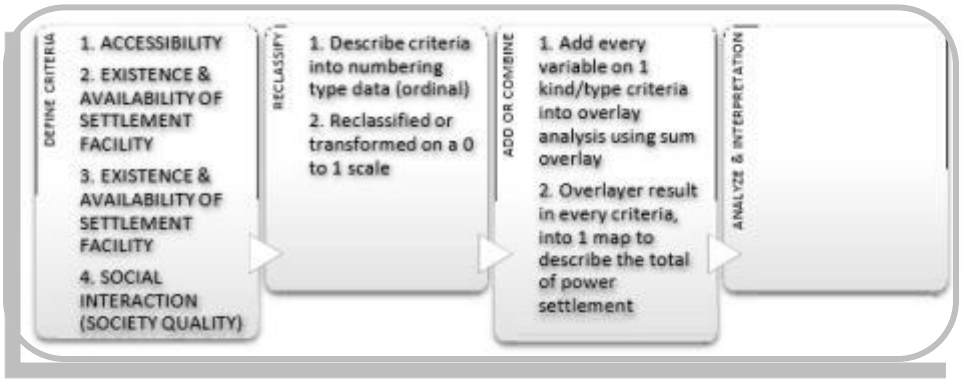

Figure 1. Fuzzy Overlay Diagram Procces

a. Reclassification
The input data is reclassified or transformed on a 0 to 1 scale, identifying the possibility of belonging to a specified set. This reclassification or fuzzification process is implemented through Fuzzy Membership tool. A series of membership functions have been developed to aid in this transformation process. The available functions are FuzzyGaussian, FuzzyLarge, FuzzyLinear, FuzzyMSLarge, FuzzyMSSmall, FuzzyNear, and FuzzySmall. Each membership function transforms the data in a specific way to capture the interaction of the phenomenon.

b. Add and Combine Layer
This study using fuzzy sum The Fuzzy Sum overlay type will add the fuzzy values of each set the cell location belongs to. The resulting sum is an increasing linear combination function that is based on the number of criteria entered into the analysis. Fuzzy Sum is not an algebraic sum and should not be confused with the additive approach used in the Weighted Overlay and Weighted Sum tools. These two overlay approaches assume that the more favorable input, the better. To add all the membership values in a Fuzzy Sum analysis does not necessarily mean the location is more suitable.

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c. Analyze and interpretation
   As in any overlay analysis, it is up to you to analyze and interpret the results. However, because of the different meanings of the reclassified values and of the overlay techniques underlying each overlay approach, different mechanisms may need to be employed to measure the validity of the results.

3. FINDINGS AND DISCUSSIONS

3.1. EKISTICS ELEMENTS IN SETTLEMENTS MORPHOLOGY

Morphology approach is a study of spatial expression in urban/town. Includes both the physical and non-physical aspects (historical, cultural, social, and economic) of the population that can affect changes in the shape of urban space. Through an understanding of the morphology of the city, will get a physical picture associated with the architectural history of the formation and development of an area ranging from the beginning to the present form and will also obtain an understanding of the condition of the society. Settlements in the study area grew by following the development of road infrastructure. The area closest to the main road is the first stage of settlement area that developed in ribbon pattern; a physical development pattern of space that tends to follow the road infrastructure (Rapoport, 1977). Blimbing-Brondong settlement areas concentrated in the southern main road (jln. Daendels) which also provincial road along the northern coast of Java (Pantura), which is caused by the pull of fishing activities and all major facilities and support centered on the northern main road. Coastal fishing village Brondong Gang centered on Jl. Pemuda.

Figure 2. The architecture of old buildings in the first period of coastal settlements grow in North Coastal Area / Pantura

While the second growth occurs in the area around the growth of early settlements by establishing the physical organization of space that tends patterned clusters, which is a simple combination of elements dwellings adjacent to each other and do not necessarily express a form of geometry or symmetry properties (Norberg-Schulz, 1984).

Figure 3. The architecture of old buildings in the second period of coastal settlements grow in outer North Coastal Area / Pantura

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Two characteristics of the above blend in the region but has a different characteristic functions. In order organization ribbon settlements settlement function is dominated by the function of the means of settlement. Pattern Shaped Ribbon (ribbon) is influenced by transportation lines and hamper the expansion area to the side. In the settlement conditions Blimbing-Brondong, settlements grew rapidly following the northern trails because it is the area around the main line is the distribution point - the center point of activity / human activity. Brondong coastal settlements in the area of transportation lines (north) is functionally fused to the coastal settlements in Blimbing establish upstream-downstream systems. In this condition the upstream system is Brondong while the downstream system is Brondong and Blimbing for inclusion.

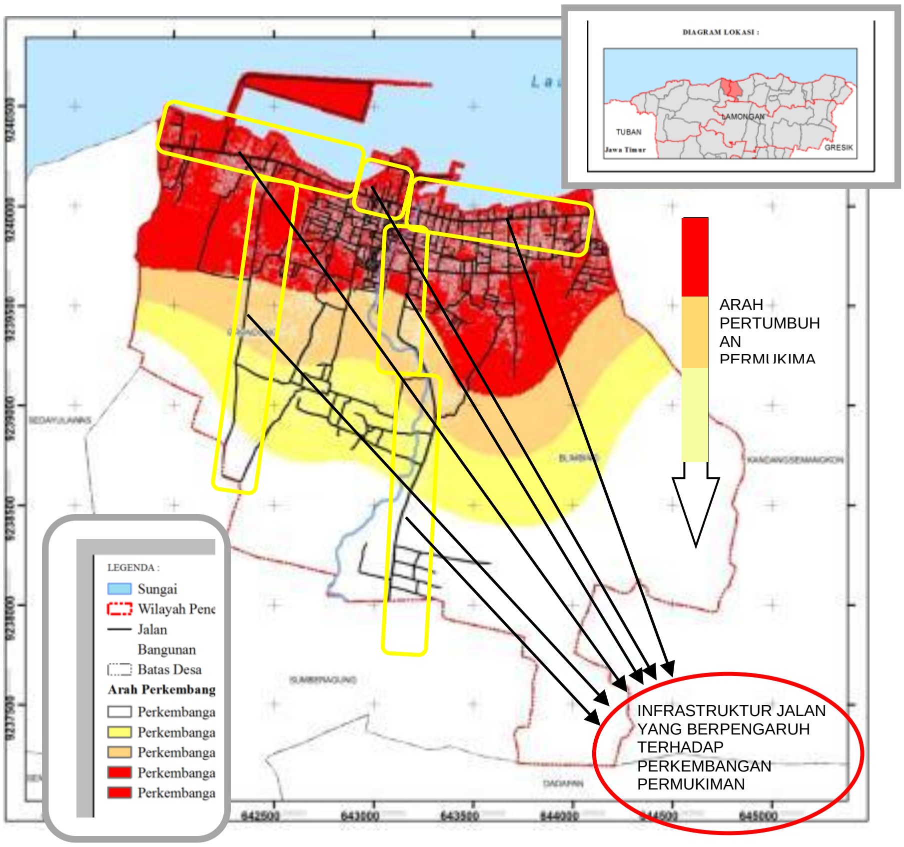

Figure 4. Visual Mapping of Settlements Growth Orientation based on average house building activities in the last ten years

3.2 SETTLEMENTS STRENGTH FACTOR DETERMINATION BASED ON EKISTICS METHOD

Fuzzy Overlay process obtained settlements strength according to the criteria of the four components have been determined. The results of the analysis performed on each criteria gradual component. Fuzzy Overlay results for each component based observations predetermined scoring criteria can be viewed on Picture 5a, 5b, 6a, and 6b.

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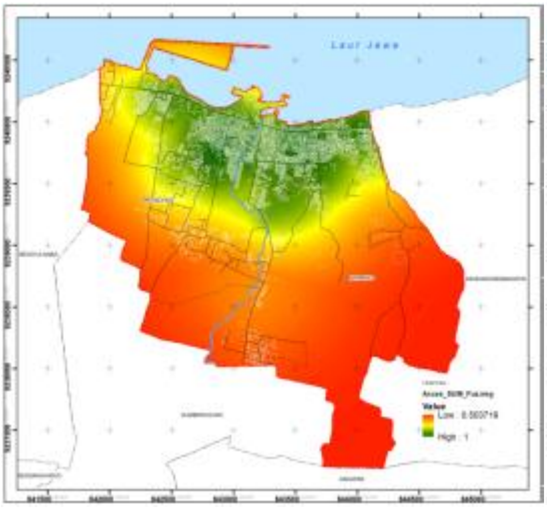

Figure 5. Settlements strength according to accessibility

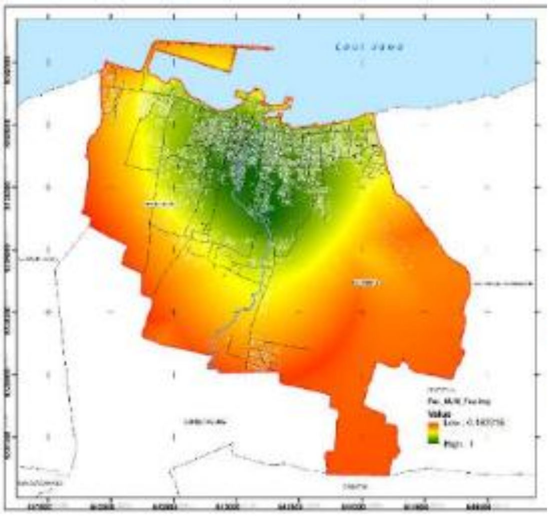

Figure 6. Settlements strength according to accessibility

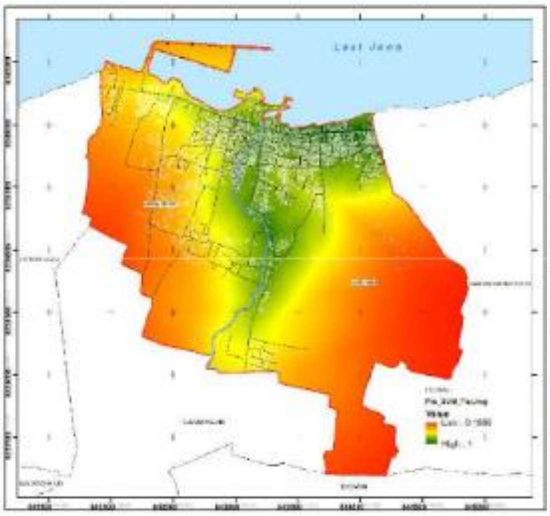

Figure 7. Settlements strength according to facilities provision

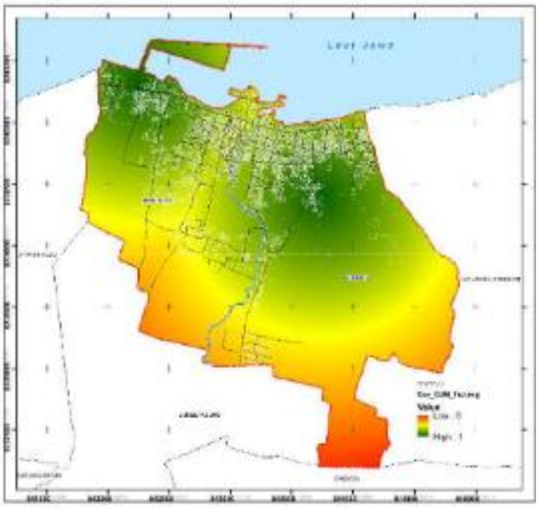

Figure 8. Settlements strength according to social interaction

Settlement based on the strength of each picture and component is described range from green into red shades. The more green shades in a residential area, the stronger the position of the settlements be seen based on the criteria of observation component. In reverse, the red shades of the residential areas increasingly weak position / location of the settlement based on the criteria of observation component. The strength of the overall settlement of the overall results obtained from the overlay each component based on a predetermined scoring criteria (accessibility, presence and availability of facilities, the existence and availability of infrastructure, and social interaction. Outcome of settlement strength visualized in Picture 7. From the Fuzzy Overlay process result shows settlements located in the northern region (coastal area) has the highest level of strength and become weaker in the south.

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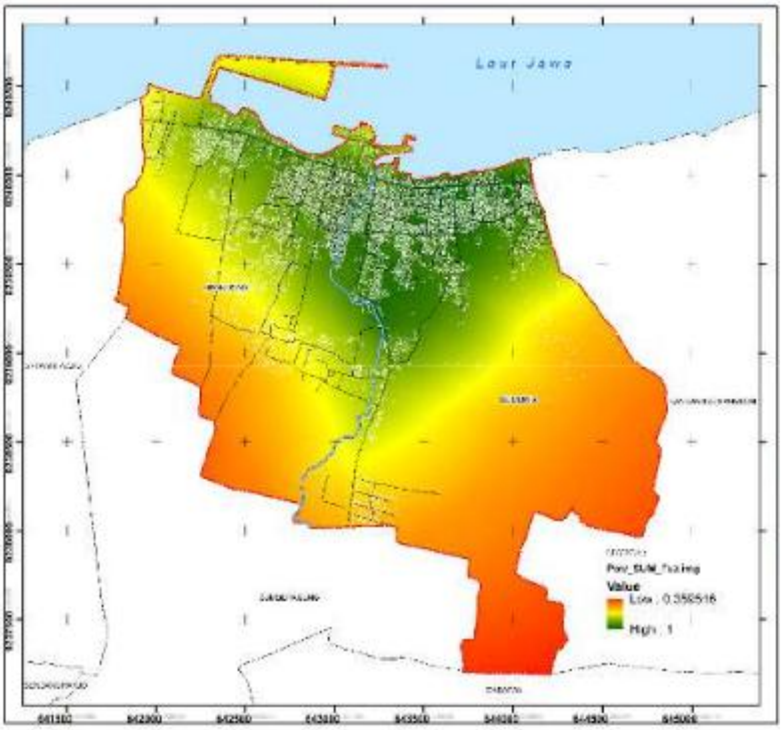

Figure 9. Visual Mapping of Settlements's strength factor

4. CONCLUSIONS

The results obtained by the analysis of settlement form (morphology), the direction of development of the settlement strength factors are:

1. The development of settlements occur leading from the area that has the highest strength to the settlements in the region with the lowest level of force settlements
2. There was restriction / delineation of powers existing settlements to form a triangular shape which leads to the path of the road infrastructure connecting Blimbing-Brondong with other villages. For the record this is generally triangular shape does not have a direction of development where, because of the nature of the resulting overlay is delineation.
3. Form of settlement strength indicated by the delineation is strongly influenced by access roads in accordance with the settlement morphology formed (ribbon settlement)
4. There is a vacant area located within the triangle (undeveloped areas). It can be interpreted that the vacant area has the potential to be a viable location for a settlement in terms of the study based on the strength ekistics settlements.
5. Range yield strength of each category indicates the value below which there is no 0 (zero). This suggests that each region / point location / red dots) still has the strength settlements. Highest settlement strength hypothesis (1) was able to / has an influence on the surrounding area.

The total overlay result in this study that describe the power of settlement in the study area and delineated alongside the spread of building and street.

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THE APPLICATION OF EARTHQUAKE RESISTANT PRINCIPLES IN 2006 EARTHQUAKE VICTIM'S HOUSES IN YOGYAKARTA - A STUDY ON 18 APBN FUND BENEFICIARY HOUSES

Johanita A. RINI[1], Sugeng TRIYADI[2] and Tri YUWONO[3]

ABSTRACT: Soon after the 2006 earthquake in Yogyakarta, the victims have begun reconstructing their damaged houses, assisted by various donors. One of them was national government funding, known as Anggaran Pendapatan dan Belanja Negara (APBN). The funding was given along with the assistance on constructing earthquake-resistant houses with reinforced concrete frame structure. On the reconstruction process, the owners were guided and supervised in order to enabling them practicing earthquake-resistant principles for the future development. After the funding ended, the houses then have been developed independently by the owners to fulfill their needs. Focusing on the implementation of earthquake-resistant principles, this paper examines how well the application of the principles is, and which principles applied well and applied badly, in the development of 18 APBN funded house pre- and post-aid. The aim is to determine the sustainability of the autonomous application of earthquake-resistant principles, and to see the changes of the local behavior in construction process. The result shows that the earthquake-resistant principles were applied badly on the reconstruction with APBN funding and supervising, and getting worse when the owners develop their houses independently. This might be caused by the relatively new reinforced concrete frame structure, which the house owners find difficult to construct, and was never been constructed before by them because they used to lived in their ancestor vernacular bearing wall houses. The expensive cost is another reason why they chose not to sustain the application of earthquake-resistant principles once taught to them, although they seems to be aware of the threat.

KEYWORDS: House, reconstruction, earthquake-resistant principles, reinforced concrete frame structure.

1. INTRODUCTION

Nowadays, the victims of 2006 earthquake in Yogyakarta have begun reconstructing their damaged houses. The reconstruction projects officially started in July 3rd 2006, under the control of Tim Koordinasi Rehabilitasi dan Rekonstruksi Wilayah Pasca Bencana Gempa Bumi di Provinsi DIY dan Jawa Tengah (Hadiwigeno, 2007).

There were a lot of funding and assistances in this reconstruction program, both from government and private sector. One of them was national government funding or known as Anggaran Pendapatan dan Belanja Negara (APBN). The APBN reconstruction program did not provide funding only, but also give guidance on how to reconstruct houses according to earthquake-resistant principles. The program involved some architecture/civil college students and experienced natives to supervise the reconstruction. However, the reconstruction process must be done by the homeowners or local artisans. The aim is enabling the homeowner to practice earthquake-resistant principles for the future development.

Some problems emerge in this program, including the various degrees of homeowners' and artisans' abilities to understand earthquake-resistant principles. In the other hand, the socialization and supervision intensity was various too in each location. In the end, the

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application of earthquake-resistant principles was not at the same level between one house and another. This phenomenon continues after the APBN program ended and the homeowners decide to further develop their houses without government supervision and without financial help, while the application of earthquake-resistant principles in houses is still not mandatory. It means that they would get no punishment if they did not applied it.

This research aims to examine the percentage of application of earthquake-resistant principles in houses built with APBN program fund, and the addition parts of the same houses developed independently later. Each earthquake-resistant principle was listed and checked in every part of the houses. The results then were compared so we can see the sustainability of earthquake-resistant principles applications after the program ended. The result also compared with the way the homeowner used to construct vernacular house before earthquake. From the comparison, we can see if there is any change in the way they construct the house responding to earthquake threat.

Figure 1. A devastated house documented by an organization for owner

1.1. BASIC PRINCIPLES OF EARTHQUAKE-RESISTANT BUILDING

There are 9 basic principles of earthquake-resistant building according to Boen et.al (2006, 2009, 2010) and Dirjen Cipta Karya (1993) that have been checked in 18 sample houses. These principles were similar with the one that has been socialized to APBN fund beneficiary. These 9 principles are:

1.1.1. The Soil Type Choice and Contour Stability

Some type of soil must be avoided from being chosen as building site, such as sand, water-drenched clay, and soil with unstable contour. Nonetheless, soil type and contour stability didn’t included as variables in this study, since all the examined area have good soil quality and are in stable contour.

1.1.2. Building Mass Configuration and Layout

An earthquake-resistant building should have a simple and symmetric plan to both building axis to prevent torsion. A big-sized mass should be divided into some smaller masses, their structure separated.

Before 2006 earthquake, the homeowner’s old houses were vernacular houses, and they already had simple and symmetric plans. The old houses also had flat façades, and had courtyards between separated masses.

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1.1.3. Fenestration Design

The smaller the fenestrations size, the safer the buildings from damages caused by earthquake. It is also important to place the fenestrations as close as possible to the building axis.

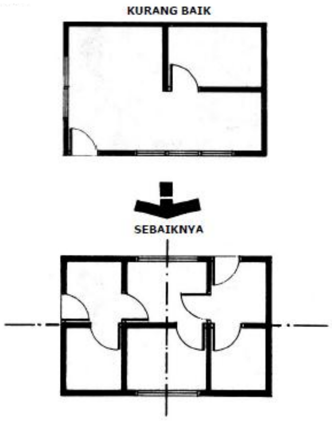

Figure 2. Fenestration placement to building axis; not good (top) and good (bottom)

(Source: Dirjen Cipta Karya, 1993)

The homeowners used to made small size fenestrations in the old houses, but they put it randomly according to their needs without consideration on building axis.

1.1.4. Building Weight

The heavier the building, the bigger the force happened to it on earthquake (Charleson, 1988). Built as thick brick-bearing wall systems, the homeowner's old houses were heavy-weighted masses. Its roofs also had large surfaces and high-pitched forms, so they needed large amount of roofing to cover them, hence the heavy-weight roofing.

1.1.5. Stiffness

Stiffness is the ability of structure to deform, to bear the forces of earthquake. To increase stiffness, the houses' walls should be fully attached one to another, and should be at identical heights so they will act as stiff boxes.

The homeowners' old vernacular houses usually were open planed one, with wooden non-structural partitions. This design made the house weaker and less stiff.

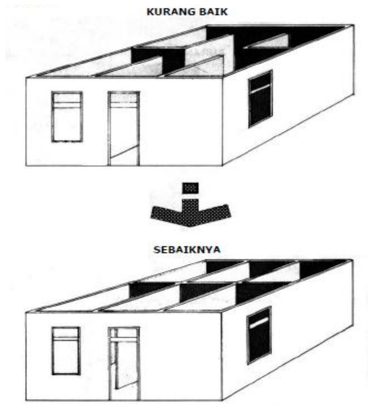

Figure 3. Examlple of bad wall configuration (top) and good wall configuration (bottom) (Source: Dirjen Cipta Karya, 1993)

1.1.6. Strength

Building strength is related to connectivity among building components, so the whole building can oscillate together at the very time of earthquake. Connectivity can be achieved by e.g. placing the building foundation deep enough, or making a continuous foundation along all wall. It is also important to place anchors to tighten the gap between foundation and beams, beams and columns, walls and columns, walls and fenestration frames, and also walls and trusses.

Another requisite for building strength is the attachment between all building frames to form a closed portal, including prolonging the steel rebar inside the columns into the beams and ring balks.

In the past time, the owners only put anchors between wooden columns and pedestals (Jv. umpak). Closed portal system was uncommon, and the homeowners familiar to bearing wall system only.

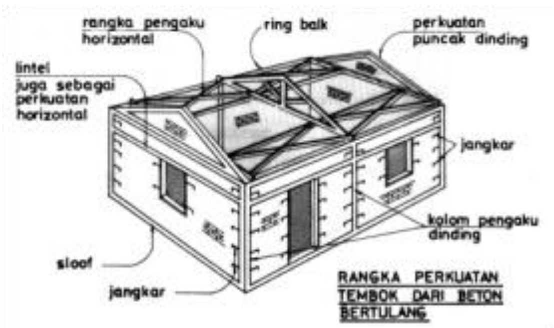

Figure 4. Connectivity among building components
(Source: Dirjen Cipta Karya, 1993)

1.1.7. Structural Components' Dimensions

The dimension of column, beam, and ring balk must be sufficient for its span. For example, for a simple house with 3 meters width span, the minimum dimension for the beam is 150 x 200 mm, for the column is 150 x 150 mm, and for the ring balk is 150 x 120 mm.

In the old vernacular houses, there were no reinforced concrete frames at all. The main structure was bearing wall, and the thicker the wall, the stronger it considered.

1.1.8. Structural Components' Materials' Quality

Structural components' materials must be in a good quality, in the right size, and combined with precise proportions. For structural concrete, the mixture proportions of cement : sand : pebble must be 1 : 2 : 3. The stones used for foundation must be the hard one taken from mountain or river. The wood for roofing must be a hard wood.

Steel rebar and stirrups for concrete frame have to meet the minimum dimension for its span. For example, for a simple house with 3 meters width span, the minimum diameter for steel rebar is 10 mm, and for the stirrups is 8 mm. The distance between stirrups or anchors must not be too far.

In the old vernacular houses, there were no concrete framing so the concrete's quality and steel's dimensions can't be measured.

1.1.9. Construction process of primary structure

Earthquake-resistant houses must be constructed in a correct way, as well as using the good materials and applying a good seismic-resistant design. Column casting must be done in several steps, each in every 1 meter. In the casting process, concrete must be pushed with stick several times to avoid air trap. The wooden cast can be removed within 3 days for column and beam, and within 14 days for hanging beam.

In the old vernacular houses, there were no concrete casting process so the primary structure construction process can't be measured.

2. METHOD

Data collecting for this study was done in two ways. To collect physical data about the house, a direct observation was held. The undetectable data like concrete mixture proportion or construction process are collected by arranging open interviews with homeowners. The questions for interviews were based on 9 principles of earthquake-resistant building explained above, which is the same principles that had been socialized to the homeowners on the APBN program.

The next step is quantifying the data with distribution method, to see the percentage of application of earthquake-resistant principles in each house. A comparison was made between parts of the house built with APBN program fund, and the addition parts of the house developed independently later.

To conclude the finding, a descriptive analysis was accomplished to compare the way the owners build their houses before and after the earthquake, essentially the way they built the houses independently after APBN program ended.

Variables of this study are: building masses' configuration and layout, fenestrations design, building weight, stiffness, strength, structural components' dimension, structural components' materials' quality, and construction process of primary structure. The main variables then detailed into smaller assessment points.

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The location chosen for observation are Kelurahan Banguntapan, Kelurahan Potorono, and Kelurahan Jambidan, part of Kecamatan Banguntapan, Kabupaten Bantul. All of them were the victims of 2006 earthquake. 18 houses were chosen as the objects. They were the beneficiary of APBN reconstruction program. The object limited to a single floor, concrete framed house that has been developed again independently by the owner after the program.

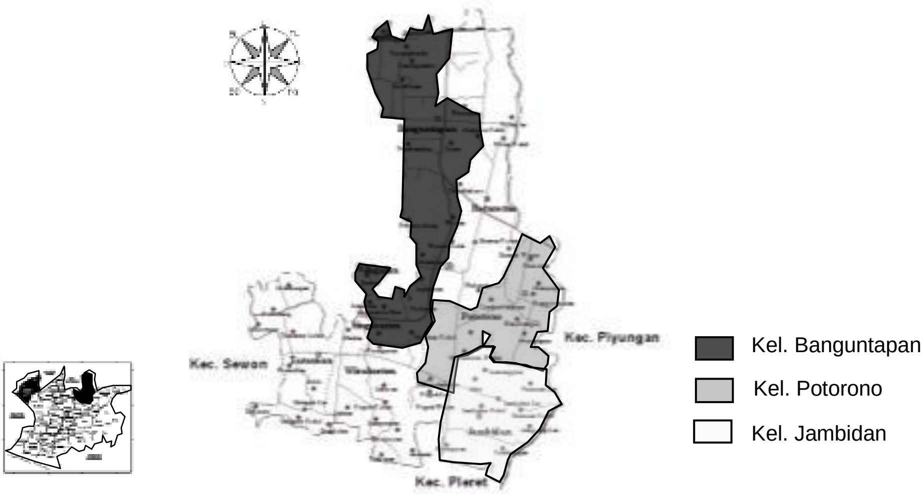

Figure 5. Location
(Source: APPL, 2012 and LP3Y, 2007)

3. DISCUSSION

3.1. APPLICATION OF EARTHQUAKE-RESISTANCE PRINCIPLES

First, parts of the house built with funding and supervision from APBN program were observed. There were only 5 of 18 houses that reach a high percentage (more than 70%) in applying earthquake-resistant principles. The highest one is house number 7 in Kelurahan Potorono (78.85%). The lowest one is house number 6 in Kelurahan Banguntapan (38.46 %).

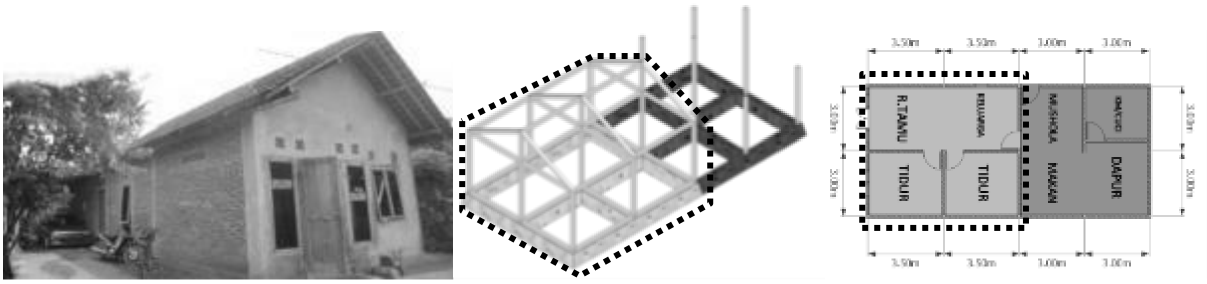

Figure 6. Exterior (left), structure (middle), and plan (right) of house number 7

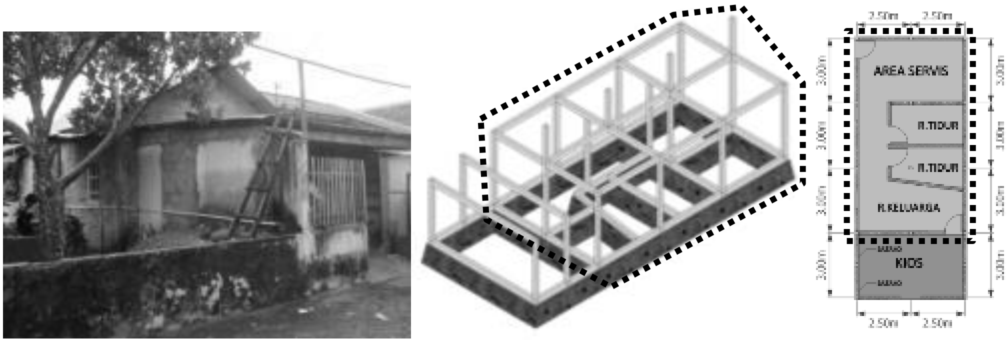

Figure 7. Exterior (left), structure (middle), and plan (right) of house number 6

Second, parts of the house built independently later without funding and supervision from APBN program were observed. The result was quite worse. There were only 2 of 18 houses that reach a high percentage (more than 70%) in applying earthquake-resistant principles. The highest one is house number 18 in kelurahan Jambidan (90.20 %). The lowest one is house number 15 in Kelurahan Jambidan (25.53 %).

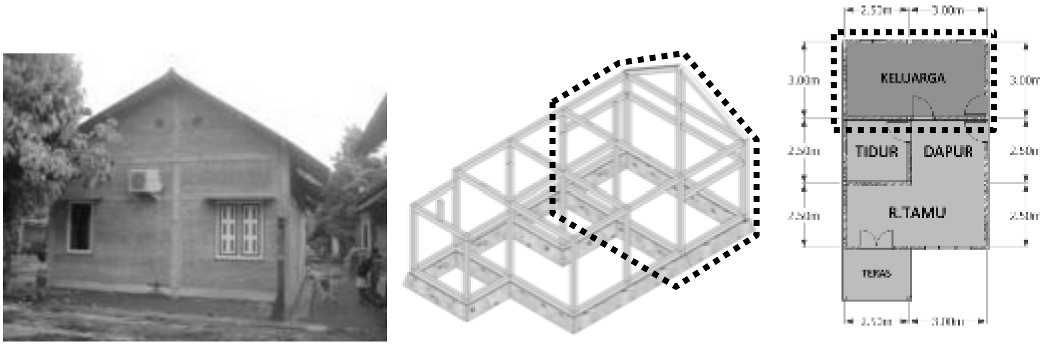

Figure 8. Exterior (left), structure (middle), and plan (right) of house number 18

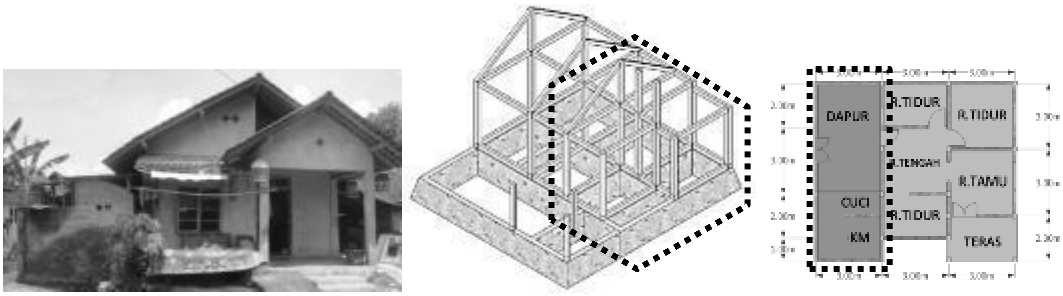

Figure 9. Exterior (left), structure (middle), and plan (right) of house number 15

Overall, the percentage of earthquake-resistant principles application was lower when the homeowners developed their houses independently later, and it show the unsustainability of the application. The APBN reconstruction program was not successful enough to motivate the 18 homeowners to change the way they construct their houses, even though the program had already given funding, socialized the earthquake-resistant principles, and supervised the construction process.

Four principles most ignored were: fenestration design, strength, structural components' materials' quality, and construction process of primary structure. Four other principles that

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widely applied were: building masses configuration and layout, building weight, stiffness, and structural components' dimension.

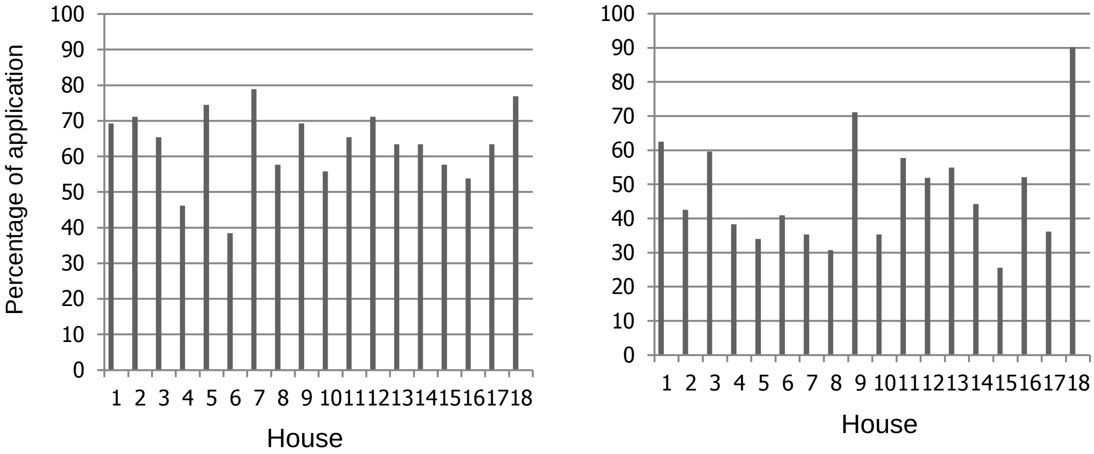

Figure 10. Percentage of earthquake-resistant principles application in APBN program (left) and after APBN program (right)

3.2. COMPARISON BETWEEN PRE AND POST EARTHQUAKE HOUSE

3.2.1. Building Masses Configuration and Layout

The post-earthquake building masses were relatively smaller than the big pre-earthquake houses. This considered positive change because smaller and stiffer mass perform better in earthquake. In the other hand, this change occur not only because of the increase of earthquake awareness, but also because smaller mass is cheaper to built in short term after they lost their old house.

3.2.2. Fenestration Design

The homeowners made small size fenestrations in their post-earthquake houses, just like the old one. However, the placement of fenestrations according to building axis is still out of their consideration. They still continued their old habit because it was still too complicated to them to understand building axis concept.

3.2.3. Building Weight

The post-earthquake house still used same materials as the old houses, like brick and clay roof tile, but the brick wall in the new house was way thinner with support from reinforced concrete frame. The new two-pitched roof (*kampung*) was way simpler than *joglo* or *limasan* roof in the old houses, so the roofing weight can be reduced. This change made the overall building lighter. However, this change widely applied because they were easy to do and demanded less material, so it can cut the budget too.

3.2.4. Stiffness

For the post-earthquake house, the homeowners left the wide open plan design and moved to smaller plan with rigid separation and permanent partition to form smaller rooms. This new plan made the building stiffer. It was easy for them to adapt to the new plan, moreover their financial limitation didn't allow them to build a wider house.

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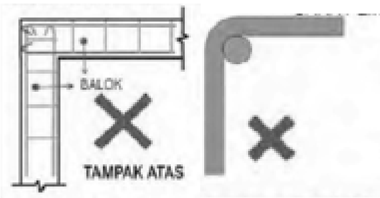
3.2.5. Strength

The strength principle was ignored in many ways, but commonly the homeowner didn't connect all building components precisely. In the parts of the house that were developed independently, there were no application of prolonging steel rebar inside the column into the beam and ring balk, all in the 18 houses.

Most of them also didn't place anchors between sloof beams and foundation. Some homeowners placed anchors between wall and fenestration frames, but the placement gap was still too big. The ends of the stirrups also mostly weren't bended 45° inward.



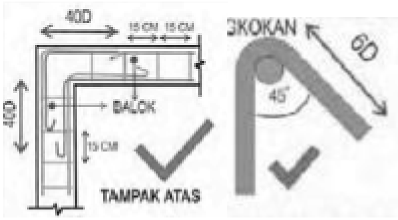


Figure 11. Mistake in not prolonging steel rebar and not bending the stirrup 45 ° inward (left) and the correct one (right)
(Source : Boen 2009, 2010)

In the parts of the house that were developed independently, many of them still had no continuous ring balk so the frame was not closed. There are also a lot of unframed *ampig* or brick pediment (see Figure 7 and Figure 9). These mistakes happened because reinforced concrete structure was a new thing for the homeowners. Many of them said that this was the first time they built reinforced concrete structure, considered that their old houses were bearing wall structures.

3.2.6. Structural Components' Dimension

Mostly, post-earthquake houses have fulfilled the minimum dimension standard for beam, column, and sloof beam. The spans in new houses were narrow, so no need for big structural components and casting process with regular casting was easy.

3.2.7. Structural Components' Materials' Quality

The homeowners have applied correct proportion of cement, sand, and pebble for concrete. However, they still ignored the steel rebar dimensions standard. They used smaller-than-10 mm-diameter steel for rebar, and smaller-than-8 mm steel for stirrups. The distance between stirrups was too far. This mistake was caused by the expensive price of the steel, so the homeowners tried to eliminate the size for cheaper price. In the other hand, this steel reinforcement technique was relatively new for them.

3.2.8. Construction Process of Primary Structure

In the construction process, common mistake was that the column casting wasn't divided in some phases, but casted in straight one phase from top to bottom. Other mistake is that the homeowners removed the casting of hanging beam too soon before 14 days. This mistake was caused by their unfamiliarity to casting process.

4. CONCLUSSION

The application of earthquake-resistant principles was still low in 18 APBN program beneficiary houses, both in the parts of house built with APBN fund and the additional parts of the house built independently later. This finding show that 18 homeowners were not successfully motivated to apply earthquake-resistant principles and to sustain it, even after the APBN reconstruction program had given funding, socialized the principles, and supervised the construction process.

The unapplied principles mostly related to the use of reinforced concrete structure, which was new for homeowners considering that their old houses were bearing wall structures. The homeowners found difficulties in applying this new technology, such as steel connection detailing, casting, and understanding the building axis. Furthermore, it costs a lot of money for them to apply the correct steel reinforcing.

Some widely applied principles were also new for the homeowners, but those principles were easy to understand, and their application can eliminate materials and construction cost, such as building masses configuration and layout, building weight, and structural component's dimensions.

Nevertheless, this study use 18 houses only as objects, considering the large number of details needs to be examined in each house to check the application of earthquake-resistant principles. The finding can't be generalized for every APBN program beneficiary house or furthermore for every earthquake victim's reconstructed house. The next study can involve more objects, or can lead to the alternative structure that might be easier to apply.

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COASTAL CITIES

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MITIGATION OF ABRASION IMPACT TO FARMER POND COMMUNITY (*A CASE STUDY OF MANGROVE CULTIVATION IN URBAN DISTRICT)*

LIANAH[1], Amin FATAH[2], Joko Budi POERNOMO[3]

ABSTRACT: Mangunharjo beach is one of the areas affected by sea erosion, the cause is a tidal wave. Other areas such as Mangkang wetan, Karanganyar and Mangkang kulon also damaged due to abrasion, other factors beside global warming, greenhouse effect, melting of polar ice, tidal flooding, as well as the rising temperature of the earth's surface which causes the tides, caused unstable waves and coastal erosion that damages resulted plains and farming areas in the Mangunharjo Village. Then the farmers to take steps to reduce the impact of seawater abrasion by mangrove planting. The purpose of this research is to figure out how to cope with the impact of sea erosion and management through mangrove cultivation. Data collection is done by the method of observation, interviews, and a review of documentations. The result showed that mangrove cultivation in Sub Mangunharjo is very influential in overcoming the effects of abrasion, mangrove species diversity in the Mangunharjo Village numbering about 11 species, namely *Avicennia lanata*, *Avicennia marina, Bruguiera cylindrica, Bruguiera gymnorrhiza, sexangula Bruguiera, Rhizophora apiculata, Rhizophora mucronata, Rhizophora stylosa, Rhizophora lamarcki, Sonneratia alba, Sonneratia casoelaris.* but the type of cultivated types *Bruguiera* sp. and *Rhizophora sp*. While developed for planting there are three types are used, namely *Bruguiera sp*, *Rhizophora sp* and *Avicennia sp*. This is caused of the three species has its own advantages and large strong roots that can grip the soil / sand which is on the coast of the influence of sea water abrasion.

KEYWORDS: Mitigation, impact, abration, community farmers.

1. INTRODUCTION

The coastal area is a meeting between marine and terrestrial regions, this area is an area where the interactions between terrestrial ecosystems and marine ecosystems are very dynamic and influential, this region was intensively exploited for human activities such as: central government, residential, industrial, ports, aquaculture, agriculture and tourism. The beach has a dynamic equilibrium which tends to adjust the shape of the profile so that it is able to destroy incoming wave energy. Normal waves that will come easily destroyed by coastal mechanism, while the big wave / storm that has great energy though short will cause erosion (Sumbago Pranoto, 2007).

Abrasion is one of the problems that threaten coastal conditions, which threaten the coastline so moved backward, damaging farms and rice fields location on the beach, as well as threaten the moder-nan directly adjacent to the sea water. Coastal erosion is defined as the pullback of the coastline from its original position (Triatmojo, 1999). The problem of coastal erosion is likely to increase in many areas not least in Semarang coast. One of the areas experiencing quite severe abrasion is Semarang Coastal western part of the monument, which includes District and Western District of Semarang. In the area quite severe problems that occur in regards to reducing land use in because of coastal erosion and inundation in the pond. Damage that occurs along the coast approximately 2:25 miles in the District includes the Village Mangunharjo monument, Wetan Mangkang Village, Village Randugarut, Karanganyar Village, Village Tugurejo and approximately 0.5 miles in the District of West Semarang, Village Tambakharjo (Department of Marine and Fisheries Semarang, 2009).

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Various activities or development on the mainland and the coast, such as deforestation, land clearing, dredging on the coast, and so on, which causes soil erosion and sand will cause sedimentation or siltation. Sedimentation is one form of pollution that is not toxic. The sediment will enter the river or water body and eventually empties into the ocean or coastal areas. Major natural disasters, such as volcanic eruptions, tsunamis, and hurricanes can cause damage to the mangrove ecosystem. Large amounts of ash from eruptions can cover the mangrove ecosystem, both carried by the wind to the coast and transported by the flooding of the river. Similarly tsunami and hurricanes can also cause damage to mangrove ecosystems, although naturally protective coastal mangrove ecosystem is.

Global climate change (global climate change) can cause damage to coastal ecosystems, including mangrove ecosystem. Global climate change is mainly caused by the increased production of CO2 and other greenhouse gases. Continuing impact of global warming is melting the ice at the poles, so that the sea level rise, changes in rainfall, salinity decreased, and increased sedimentation in coastal and marine areas (Ghufron, 2012). In order for the widespread effects of abrasion, it must be done with reference to the handling of spatial planning of coastal areas. As one of the coastal ecosystem, mangrove forest is a unique and fragile ecosystem. This ecosystem has ecological and economic functions. Ecological functions of mangrove forests include: shoreline protection, prevent the s

ea water intrusion, habitat (residence), foraging (feeding ground), the care and rearing (nursery grounds), where pemijakan (spawing ground) for a variety of aquatic biota, as well as a regulator of the micro-climate, while the economical function of industrial use, and producing seeds. Mangrove plants have unique adaptability to the environment. Bengen (2001), describes the adaptation of the form: adaptation to low oxygen levels, causing mangrove roots has a typical power: 1 Type scrawl has pneumatofora (eg: Avecennia spp., Xylocapus) to take oxygen from the air; and Type 2 buffer / wand that has lenticels (example: Rhyzopora spp.), adaptation to high salinity, adaptation to unstable soil and the presence of tides (Bengen, 2001).

2. PROBLEMS AND EXPERIMENTAL METHOD

This research was a case study using qualitative methods and methods desriptif. Sugiyono (2009) explained that based on the degree of naturalness (natural setting), the qualitative method is also referred to as naturalistic method, the method of research carried out at the place and do not make a natural treatment. Descriptive method in this study aims to provide an overview of mitigation impact abrasion sea water with mangrove cultivation in Sub Mangunharjo. This study was conducted for one month, the month of May 2014, the material scope of this study is to mitigate the impact abrasion sea water with mangrove cultivation in Sub Mangunharjo monument that includes the number of farmers cultivating crops and livelihoods mangrove p. While the scope of this research is the area of the Forest Area Mangrove Village Mangunharjo which is administratively located in the region Mangunharjo village, Semarang, with consideration of these locations have the potential to support the mitigation of the impact of coastal erosion. The data used include primary data and secondary data based on the scope of the study. Primary data is the main data required in this study. Sources of data in qualitative research is the words, and actions (interview or observation), the written record through video / audio tapes, photographs, statistical data (Lexy J. Moleong, 2012). Secondary data in the form of a general overview of the condition of the Village Forest Area Mangrove Mangunharjo which include flora and fauna, landscapes, livelihoods, education level, and the institutional system of the Village Forest Area Mangrove Mangunharjo.

Selection of speakers using nonprobability sampling technique with mentode purposive

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sampling. Informants in this study include fish farmers, agencies, and experts / academics, amounting to 6 speakers. Determination of the number of sources is not based on statistical calculations (Lincoln and Guba, 1985 in Sugiyono, 2009), but sources are considered adequate if the data has reached the redundancy (data sources has been saturated and no new information), it means that by using the next speaker is virtually no longer obtained new information that is meaningful (Nasution, 1988) in Sugiyono, 2009).

Data analysis was done by finding and compiling research data systematically, including organizing the data into categories, stripped in units, do sistensis, develop into a pattern, choose a name that is important and will be studied, and making conclusions, so it is easy to understand by myself and others (Sugiyono, 2009).

3. RESULTS AND DISCUSSION

The general condition of the Village Mangunharjo monument.

3.1 The total area of the village approximately: 482.370 ha with borders North Java Sea, East Mangkangwetan, Southern District of Ngaliyan, and West Mangkangkulon. Geographic height of 4 m above sea level, amount of rainfall is 2,000 m / year, as the hilly topography of the lowlands, the average temperature is 31 0C. High Orbisitas government center region of the sea surface temperature Minimum / Maximum: 28/32 0C, the distance from the sub-district administrative center distance of 9 km, 20 km Semarang city, province 24 km.

3.2 The area of paddy land: 0.00 Ha technical irrigated rice, irrigated fields of technical half 50.00 ha, 30.00 ha of rainfed lowland rice fields tidal 0.00 Ha. While the number of people this year for the 2793 male, 2814 female person, last year the population of 2711 people men, women 2741 people, the percentage of male development of approximately 3.02% and 2.66% of women.

Table 1. Population Village Livelihood Mangunharjo

NO	Livelihood	Population
1.	Farmers	99
2.	Farmers Mangrove	6
3.	Peasants	161
4.	Fishermen	163
5.	Entrepreneur	13
6.	Industrial Workers	266
7.	Labor Building	122
8.	Merchants 142	142
9.	Transportation 59	59
10.	Employees (Civil, Military and Police)	103
11.	Retired	23
12.	Farmer	688
13.	Other	133617
	Total	**5607**

Source: Monograph Village Mangunharjo, May 2014

In terms of quantity, with a small number of residents who work as farmers mangrove, then it becomes an obstacle for the mitigation of the impact of sea erosion, but in quality to see the enthusiasm of the population, especially those with coastal environmental concerns, a group of farmers who are members of Sustainable Mangrove, Mangrove farmer groups times pesantren, as well as the awareness of the various government agencies, private foundations and NGOs concerned about the environment such as mangrove biota, green comunity, etc., then this factor can be a force to support the mitigation of the impact of coastal erosion Mangunharjo village.

Physical Condition and Landscape Mangunharjo Mangrove Forest Areas. Mangunharjo mangrove forest there is a river flowing in Mangunharjo, this river ecosystems associated with coastal brackish waters Mangunharjo, physically mainland coast consists of a collection of land Mangunharjo and sedimentation of rivers Mangunharjo results. Ecologically, the area consists of mangrove trees, aquaculture areas, and habitats of flora and fauna. From the hydrological aspect, Mangunharjo mangrove forest directly adjacent to coastal waters, various environmental components above interact to form a unique ecosystem and has great potential.

4. FLORA AND FAUNA OF MANGROVE FOREST AREAS MANGUNHARJO

Flora and Fauna role in improving farm productivity. Therefore, the existence of the flora species must still be considered to maintain the ecological sustainability of mangrove forests, taking into account its ecological function in the short term and long term.

Mangrove species diversity in the Village Mangunharjo numbering about 11 species, namely Lanata Avicennia, Avicennia marina, Bruguiera cylindrical, Bruguiera gymnorrhiza, sexangula Bruguiera, Rhizophora apiculata, Rhizophora mucronata, Rhizophora stylosa, Rhizophora lamarcki, Sonneratia alba, Sonneratia casoelaris. but the kind that is cultivated or nursery that is kind of Bruguiera sp. and Rhizophora sp. While developed for pleanting Mangunharjo mangrove on the beach there are three types that are used, namely Bruguiera sp, sp Rhizophora and Avicennia sp.

Mangrove cultivation in the Village Mangunharjo
Mangrove cultivation by the farmers monument Mangunharjo ponds, mangrove nursery trick as follows:

- Drying nurseries
- Structuring beds set up a distance of 15 cm straight line.
- If the dry season waring / net / black nets to reduce the temperature of the heat.
- Structuring or recharging ground white or black color dipolibackplastik content of the soil, poliback diameter of 15 cm length 10 cm width.
- When all was given manure. If no fertilizer then we let stand for 1 week.
- Then we fill the new 6 / plugs in good seed Rhizopora, Avicennia, and Bruguiera.
- Fill the water at the location of the nursery until poliback sink, if not sink into a double work should water the seedlings.

Figure 1. Seed while still in polybags.

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- Within the emerging 1.5 months, age 2 months leaved 2, age 3 months leaved 4, new 4 months old ready for harvest.

- Yields later partly sold and partly transferred into the sea to reduce the effects of abrasion.

Figure 2. Plant already 4 months old.

5. KINDS OF MANGROVE BEACH IN MANGUNHARJO VILLAGE

5.1. RHIZHOPORA MUCRONATA

Tree reaching 25 m height, root tunjang, the single composition, cross, elliptical shape, a tapered tip, a length of 15-20 cm, seeds vivipari, Phenology: year-round flowering and fruiting in October-Des.Bunga: 4-8 interest groups arranged two by two, the crown: 4, white, hairy, petals 4 strands stamens 8, the size of 3-4 cm, short stamen pistil very pendek.Buah: 2.0 to 2.3 cm diameter, yellowish green color, neck cotyledons, fruit cylindrical, can float.

5.2. RHIZHOPORASTYLOSA

Height of trees up to 6 cm, akar tunjang, the single composition, cross, elliptical shape, sharp tip, a length of 10-18 cm, seeds vivipari. Flowers: 8-16 or more, arranged two by two, dependent, 4 crowns, white, petals 4 strands, hijau kuning, benangsari8, 2.5-3.5 cm in diameter. Stamen long and thin.

Fruit: diameter of 1.5-2.0 cm, length> 30 cm. Color: green hypocotyl

5.3. RHIZHOPORA APICULATA.

Height of trees up to 15 m tall, roots tunjang, the single composition, cross, elliptical.

5.4. AVICENNIA ALBA

Height of trees reaching 15 m tall trees, the roots of breath, such as a pencil, the single composition, cross, shape lanceolate to elliptical, pointed tip, 10-18 cm long. Kriptovivipari seeds, leaves have salt glands.

5.5. AVICENNIA MARINA.

Tree / shrub, up to 8 m, the roots of breath, the single composition, cross, elliptical shape rounded up to the pointy end, a length of 5-9 cm, kriptovivipari seed type.

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5.6. SONNERATIA ALBA

Shrub tree height reaches 12 cm, roots breath, the single composition, cross, elliptical shape, runcinghingga rounded tip, 5-11 cm length, type kriptovivipari seeds, leaves have salt glands.

5.7. SONNERATIA CASEOLARIS.

Trees shrubs, up to 16 m, the roots of breath, single shaped arrangement, cross, tee up a round shape, egg breech, rounded ends, 5-10 cm size, year-round flowering phenology, fruiting May-June.

5.8. BRUEGUIERAGYMNORRHIZA

The tree reaches 20 m height, knee and banir small roots, single stack, intersects the tapered tip of the ellipse, shape, size 8-15 cm long, phenology, seed type vivipara: flowering fruiting all year round, in July-August. Flowers: flower arrangement Crown width, single, white to Tan, petals 10-14 strands, red, size 3-5 cm long.

5.9. BRUEGUIERA CYLINDRICA

The tree reaches 20 m height, knee and banir small roots, single stack, intersects the tapered tip of the ellipse, shape, size 8-15 cm long, phenology, seed type vivipara: flowering fruiting all year round, in July-August. Flowers: flower arrangement Crown width, single, white to Tan, petals 10-14 strands, red, size 3-5 cm long, the ends of each Crown-shaped tapered.Fruit: diameter of 1.7 to 2.0 cm, length 20-30 cm, dark green to purple with brown blotches, slippery surface, cylindrical fruits.

5.10. BRUEGUIERA GYMNORRHIZA

Its a form of high trees reach 15 cm, root root benir knee and minor, single stack, cross, eliptical, tapered tip, size 6-9 cm, type seed vivipara. Flowers: large, single flower, leaf, underarm white Crown, until brown, petals 10-14 strands, greenish yellow, 3-4 cm size, the ends of the strands of the Crown are blunt. Fruit: size of 1.5-2 cm diameter, green to purple, with streaks of Brown, slippery surface, a short cylindrical fruits.

5.11. BRUEGUIERASEXANGULA.

Height of trees reach 15 cm, root root benir knee and minor, single stack, cross, eliptical, tapered tip, size 6-9 cm, type seed vivipara. Flower: width, single flower, leaf, underarm white Crown, until brown, petals 10-14 strands, greenish yellow, size 3-4 cm, tip blunt Crown strands.Fruit: 1.5-2 cm diameter, green to purple, with streaks of Brown, slippery surface, a short cylindrical fruits.

Based on the results of research conducted, mangrove cultivation led to the first plateau damaged by erosion, sedimentation and silting are now experiencing and the distance to the beach can be returned settlement about 500 m, so calculated annually coastal areas experiencing sedimentation or silting of 33 m per year, ranging 1999 fish farmers began planting mangroves to promote the cultivation of his own, until now in 2014 about 0.5 km farmers have to take back the plain seawater abrasion affected.

Mangrove species diversity in the Village Mangunharjo numbering about 11 species, namely Lanata Avicennia, Avicennia marina, Bruguiera cylindrical, Bruguiera gymnorrhiza, sexangula Bruguiera, Rhizophora apiculata, Rhizophora mucronata, Rhizophora stylosa, Rhizophora lamarcki, Sonneratia alba, Sonneratia casoelaris. but the kind that is cultivated or nursery that is kind of Bruguiera sp. and Rhizophora sp. While developed for pleanting Mangunharjo mangrove on the beach there are three types that are used, namely *Bruguiera sp, sp Rhizophora* and *Avicennia sp*. This is because the three species has its own advantages and strong roots so that it can grip the soil / sand which is on the coast of the influence of sea water gelombak abrasion.

Mangrove plant species diversity in the Village Manguharjo because of donations and sponsorship roles farmer sets up a mangrove nursery ponds to perform, so as to achieve 15 species, but amounts there is little or uneven. Analisisbudidaya mangroves to mitigate the effects of coastal erosion. Based on the image 1.There are three elemenpenelitianatau called social situations / events of nature in the form of a tidal wave abrasion, including: first sebagaiaktor fish farmers, both the cultivation and breeding activities are carried out by fish farmers Mangunharjo, third place of cultivation and planting of mangroves in the area of the pond and Mangunharjo beach.

6. CONCLUSION

1. Mangrove cultivation in Sub Mangunharjo very influential in overcoming the effects of abrasion, Based on the research conducted, mangrove cultivation led to the first plateau damaged by abrasion, is now experiencing sedimentation or silting and distance to the beach can be returned settlement about 500 m, so the calculated per year experiencing coastal sedimentation or silting of 33 m per year, from 1999 fish farmers began planting mangroves to promote the cultivation of his own, until now in 2014 about 0.5 km farmer has taken back the plain seawater abrasion affected.
2. Diversity of mangrove species in the Village Mangunharjo numbering about 11 species, *namely Lanata Avicennia, Avicennia marina, Bruguiera cylindrical, Bruguiera gymnorrhiza, sexangula Bruguiera, Rhizophora apiculata, Rhizophora mucronata, Rhizophora stylosa, Rhizophora lamarcki, Sonneratia alba, Sonneratia casoelaris. but the kind that is cultivated or nursery that is kind of Bruguiera sp.* and *Rhizophora sp*. While developed for pleanting Mangunharjo mangrove on the beach there are three types that are used, namely Bruguiera sp, sp Rhizophora and Avicennia sp. This is because the three species has its own advantages and strong roots so that it can grip the soil / sand which is on the coast of the influence of sea water gelombak abrasion.

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MANAGING AMBON FOR A SUSTAINABLE COASTAL CITY

Adi MULYANTO[1], Arie HERLAMBANG[2] and Ahmad GUSYAIRI[3]

ABSTRACT: As a coastal city, Ambon gets environmental pressures that threaten its sustainability. Various needs of the community come from the utilization of natural resources, mainly marine and land. However, with the increasing number of population and lifestyle changes that tends to be consumptive, this causes the limited of the natural resources so that it becomes increasingly difficult to obtain. The most environmental stress derived from the upper area of the city. The environmental pressures include land clearing for settlement purpose and the presence of domestic wastes both solid and liquid those are not properly managed. In managing Ambon for a sustainable coastal city, it is necessary to improve the water quality in coastal areas and its waters through four elements of strategy, they are: (1) pollution prevention strategy, (2) pollution minimization strategy, (3) improvement of water resources strategy, and (4) pollution handling strategy. The research used a descriptive method by utilizing primary and secondary data. Benefits gained from this study are the identification of pollutant sources based on both primary and secondary data so that methods and problem solving of obtaining the pollution prevention can be clearly identified and solved. Another benefit is used as reference material for the improvement of domestic solid waste and wastewater management systems in inland areas of Ambon as well as efforts the improvement of active community participation in that of waste management.

KEYWORDS: managing, sustainable, coastal city, environmental, strategy.

1. INTRODUCTION

Ambon as the capital city of Maluku province has a land area of 359.45 km2dan sea area of 17.55 km2, consisting of five districts namely Nusaniwe, Sirimau, Teluk Ambon (T.A) Baguala, Laitimur Selatan and Teluk Ambon. Geographically, the position of the city of Ambon is located between 3^o – 4^o south latitude and 128^o – 129^o east longitude. Distribution of the population in Maluku province remains uneven.

Ambon is located on the island of Ambon which is part of the Maluku islands and is surrounded by the sea. Several rivers empty into Ambon bay, they are such as Batu Merah, Waitomu, Galala, Lateri and Pokka rivers. In general, Ambon has an area consisting mostly of hilly region and slope. The topography of Ambon about 73% of the land area can be classified as hilly to steep slope, with the slope in above 20%. While 17% of the rest can be classified as flat or gently sloping with a slope of less than 20%.

Activities of the residents in the Gulf region Ambon contribute significantly to the pollution of the bay. Population activities that generate wastewater and solid waste if it is not managed properly will carry over into the bay through the rivers or waterways. Residents who live along the river generally utilize the river as a place to dispose of domestic waste water and garbage as well. Population growth resulted in an increased need for housing that is procured by opening new land originally forested and groundwater recharge areas. Land clearing activities lead to soil erosion, especially in the rainy season and resulting

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sedimentation in Ambon bay. In addition the increasing of sea transportation has potential to pollute the bay.

With that in mind, there are several important issues related to the environmental management of coastal areas and waters in Ambon, namely:

a. The development of settlements in watershed and coastal area.

   The development of human settlements on the banks of the river carries consequences of which increase pollution, such as domestic waste water that enters the waste stream and also carried away by the flow of the river to the coast.

b. Uncontrolled of development and distribution of population.

   The development of the population carries consequences of increasing water demand and consumption. The amount of waste water produced is also increased, as well as the waste generated. Spreading distribution of population complicate the handling of waste water and garbage, therefore the intervention of appropriate technology is needed.

c. Increasing of sea transportation.

   Marine pollution may occur due to lack of awareness of ship owners, operators and passengers. Ship owners should provide adequate sanitation facility in the ship, so there is no disposal of liquid and solid wastes into the ocean. Operators should implement good management practices to all existing facilities. Other problems related to the shipping are discharging of ballast water and spilling of fuel oil when refueling, or when washing the vessel.

d. Large number of piers.

   Large number of piers has risk of increasing pollution, in terms of becoming a multi-point pollution source, and if not controlled it will be difficult to handle. Spatial arrangement needs to be done.

e. Not feasible of the treatment system of industrial wastewater.

   The quality of wastewater treatment discharged by the industries should meet the quality standards and required to obtain a wastewater disposal permit from the Environment Agency (Dinas Lingkungan Hidup / DLH), and periodically must be reported to the DLH and DLH on their own initiative are required monitoring without being asked by the proponent. If the result of industrial waste treatment is not able to meet the quality standards, then carried the admonition, ranging from administrative level to legal process.

f. Wastes from households and markets.

   Garbage from households and markets, especially those located at the coastal area, should receive priority in the provision of facilities and handling of its garbage. Trash if not managed properly will worsen the aesthetics. Disposal of waste on beaches should be discontinued and waste management in coastal needs to be improved.

g. Waste oil from the ferry, fishing vessels and others.

   Oil pollution is easily observed, both visually and from satellite image. This condition can be avoided if there is high awareness of ship owners and operators. However, inspection of the ship should also be executed.

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h. Sedimentation from upland clearing.

   Land clearing increase the rate of run-off, increasing the run-off led to increase soil erosion, so that the water turbidity increased, and sediment will be deposited on the beach.

i. Low public awareness of solid waste management.

   Public participation in solid waste management in general is very low. It can be said that only 1% of 100 people who think about how waste should be managed. To increase public awareness, it is necessary to conduct socialization, education and training to increase understanding of the dangers of litter and to change public attitudes, so that government programs can be supported.

j. Lack of law enforcement (related to sanctions).

   Law enforcement is often constrained by the lack of evidence and the lack of environmental monitoring which is conducted regularly by competent parties. Completion of regulation is still done, especially concerning the control of wastewater and solid waste problems.

k. Lack of cross-sector coordination.

   Any activities that emit wastes to exceeding quality standards in an area of activity, must be followed up within 24 hours, if within 3 days could not be overcome, the activities must be stopped. In fact, the time required is often longer. Therefore, cross-sector coordination within the governmental body should be strengthened.

l. Lack of facilities and infrastructures provided by local government.

   The facilities and infrastructures mean of transporter to transfer the solid waste, garbage collection facilities, and centralized waste treatment facilities.

m. Optimization Kewang Society at the city level.

   Kewang society is traditional institutions that play an important role in the control of marine pollution, the socialization and training on Kewang leaders can effectively accelerate the delivery of information regarding the management of waste water as well as domestic waste.

n. Potential development opportunities on tourism and nautical sports.

   Development of tourism and nautical sports requires a clean and comfortable marine environment. Tourists visiting the beach are usually very sensitive to the cleanliness of the beach.

2. IMPROVING THE WATER QUALITY

The activities in improving water quality in coastal area and its waters are very crucial in managing Ambon for a sustainable coastal city. The activities can be done through four elements of strategy, namely: pollution prevention, pollution minimization, improvement of water resources, and pollution handling strategies.

2.1. POLLUTION PREVENTION STRATEGY

Pollution prevention strategies can be done through public education programs on environmental management, waste water management, solid waste management, sanitation management of ports and shipyards, and watershed management.

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The public education is an introductory program aimed at increasing public understanding and participation on environmental management in Ambon that will be done by the stakeholders, the goal is to understand and support community environmental management program that will be conducted in Ambon by the stakeholders. Counseling is done through various media (local TV, radio, local newspaper and dissemination of brochures as well as leaflets), to perform this socialization, it is necessary to increase the quality of human resources who is competent to issue public communications. To succeed this program, it requires commitment from decision makers to increase the socialization budget.

The target of these programs is the achievement of a good understanding in the community regarding the importance of environmental sustainability in Ambon, which is characterized by increased public support for the running program. Socialization programs include the management subjects of wastewaters, municipal solid wastes, ports and shipyards sanitation, traditional markets, residential, tourist area, hotels, offices, and watershed.

2.2. POLLUTION MINIMIZATION STRATEGY

Pollution minimization strategies can be implemented through regulatory improvement program. Strengthening and improvement of regulation needs to be done to support the implementation in the field as a legal basis. The purpose of this program is to improve the control and supervision of pollutant discharge into public waters, with the goal of requiring polluters to manage its waste before entering into public waters. The strategy will be carried out starting from the evaluation of the existing problems that need regulation improvement. Further step is doing improvements and coordinate with stakeholders, focusing on problems that may arise in the implementation phase. Policy directives aimed at improvement of quality standards, with the involvement of stakeholders, experts, and using references from the regulation of other big cities, such as Jakarta, Surabaya, and others.

2.3. IMPROVEMENT OF WATER RESOURCES STRATEGY

Water is a natural resource that there should be and need to be maintained and preserved so that its presence can be sustained until the next generation. This water source improvement program involves many sectors and should be carried out simultaneously and continuously.

The goal is to get the information of potential raw water, preserving water quality in water sources, repairing damaged forests in the upstream region with a reforestation using local plants which are have rapid growth characteristic and good effects on aquatic systems.

The main target of this program is to obtain quantitative and qualitative data of potential water sources that guarantee the availability for drinking water and agriculture. Reforestation is more focused on the area of potential water sources and has a strategic role for the community and development.

2.4. POLLUTION HANDLING STRATEGY

This program aims to determine the suitable individual and communal WWTP with the result that the treated water has already meet the quality standards. It is necessary to give examples of the application of wastewater and solid waste treatment technology for domestic or the small scale one, offices, health centers, hospitals, hotels, restaurants and markets.

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3. MATERIALS AND METHODS

The research used a descriptive method by utilizing primary and secondary data. Data collected is the basis for determining the appropriate method or technology, so that existing problems are expected to be solved.

3.1. PRIMARY DATA COLLECTION

Primary data collection was conducted by a survey in Ambon landfill and water sampling in 5 estuaries and analyzed at the laboratory of Engineering Center for Environmental Health and Communicable Disease Class II Ambon with the parameters of pH, temperature, TSS, BOD5, COD Ammonia , nitrates, phosphates, surfactants, oil and grease, sulfide, Cd, Cu, Pb, Zn, Cr, and Coliform.

3.2. SECONDARY DATA COLLECTION

The secondary data was obtained from Dinas Lingkungan Hidup Ambon to get the information on population and the activities on municipal solid waste handling.

3.3. CALCULATION OF POLLUTION LOAD

Pollution load is calculated based on population, the waste produced per capita and the concentration of waste generated. The pollution load calculation is applied for domestic wastewater and domestic solid waste.

4. RESULT AND DISCUSSION

Table 1 shows the results of water quality analysis of some estuaries in Ambon. TSS is suspended solids derived from organic and inorganic materials that can be separated using a filter paper having pores um 0.45 µm. This suspended material has adverse impact on water because it prevents the penetration of sunlight into the water body. The presence of the TSS will increase water turbidity. In general, TSS form colloidal surface for the attachment of potentially pathogenic bacteria.

Table 1. Results of water quality analysis in some estuaries of the river

No	Parameter	Unit	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Seawater Quality Standard
I.	**Physical**							
1.	TSS	mg/l	**38**	**34**	**34**	**25**	**33**	20
II.	**Chemical**							
1.	pH	mg/l	7.2	7.5	7.74	6.71	6.71	7 – 8.5
2.	COD	mg/l	28	15	16.8	9.4	8.6	-
3.	BOD	mg/l	8.2	5.3	7.4	3.2	4.2	10
4.	NH_3-N	mg/l	**1.4846**	0.0123	0.0143	0.0181	**0.571**	0.3
5.	PO_4^{3-}	mg/l	**0.3431**	**0.0608**	**0.0608**	**0.0262**	**0.0501**	0.015
6.	NO_3^{1-}	mg/l	**2.8208**	0.001	**0.9326**	**3.9818**	**0.7564**	0.008
7.	H_2S	mg/l	0.002	0.002	0.002	0.002	0.002	0.05
8.	Oil and Grease	mg/l	0.036	0.029	0.092	0.014	0.1864	1
9.	SO_4^{2-}	mg/l	560	420	348	389	412	-
10.	Cr^{6+}	mg/l	**0.05**	**0.02**	**0.04**	**0.02**	**0.02**	0.005
11.	Cd	mg/l	**0.01**	**0.008**	0.008	**0.007**	**0.007**	0.001
12.	Cu	mg/l	0.007	0.007	0.006	**0.012**	**0.012**	0.008
13.	Pb	mg/l	**0.165**	**0.114**	0.088	**0.11**	**0.133**	0.008

No	Parameter	Unit	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Seawater Quality Standard
14.	Zn	mg/l	0.03	0.03	0.013	0.02	0.011	0.05
III.	**Microbiological**							
1.	Coliform	MPN/ 100 ml	**54x10^3**	**42x10^3**	**35x10^3**	**47x10^3**	**48x10^3**	1x10^3

Remarks:

Sample 1 was taken from the estuary of the Batu Merah river.
Sample 2 was taken from the estuary of the Waitomu river.
Sample 3 was taken from the estuary of the Galala river.
Sample 4 was taken from the estuary of the Lateri river.
Sample 5 was taken from the estuary of the Pokka river.

Ammonia in the river comes from urine, feces, and the results of the microbiological decomposition of organic matter derived from natural water, waste water, industrial waste water and domestic sewage. The presence of ammonia can cause toxic conditions for aquatic life. Level of free ammonia in water will increases with increasing of pH and temperature. Aquatic life affected by ammonia at a concentration of 1 mg/l and can cause suffocation because it can reduce the concentration of oxygen in the water (Barnes and Blisse, 1980). Ammonia in water can be microbiologically processed by heterotropic and autotropic bacteria through the nitrification process to form nitrite and nitrate. The nitrification process takes place under aerobic conditions, necessitating the addition of oxygen through aeration (Bitton, 1994).

The concentration of phosphate compounds also exceeded the sea water quality standard. Phosphate indicates nutrient status of the waters. High phosphorus content indicates that the water is fertile. As a result of what happens is the potential for uncontrolled growth of algae (algal bloom). Phosphate in estuaries is generally derived from the use of detergents by residents who directly discharging it into the river.

The main sources of heavy metals contained in the waters derived from agricultural and industrial activities (Mallick and Rai, 1993). The use of pesticides and fertilizers that contain heavy metals excessively, sludge from the wastewater treatment industry (especially the physico-chemically treated) could potentially increase the concentrations of heavy metals in the waters. Heavy metals have properties that are difficult to degrade, so when entering into the food chain, the heavy metals will accumulate (Hart and Scaife, 1977).

Secondary data collection includes the population, the amount of solid waste generated per capita (2.75 l/capita/day, SNI S-04-1993-03) and waste management activities in Ambon (Dinas Kebersihan dan Pertamanan Kota Ambon, 2012). The water usage in residential amounting to 120 l/capita/day (SNI 03-7065-2005) and 80% of water usage has potential to be wastewater with the average BOD concentration amounting to 400 mg/l. For weight calculation of solid waste, the bulk density data used is 0.229 kg/l (Mulyanto and Titiresmi, 2009). Composition of plastic waste in the city of Ambon is very high, ie 15.05% of the total solid waste generated. While big cities such as Bandung, Semarang and Jakarta generate the plastic waste with composition of 8.58%; 14.15% and 13.25% respectively (Damanhuri and Padmi, 2010).

If the domestic wastewater is not treated, then Ambon will be burdened pollution by organic matter amounting to 15,006.64 kgBOD/day (Table 2).

Table 2. Potential domestic wastewater pollution load per district based on population data in 2012

District	Population	Water consumption (l/cap/day)	Total water consumption (l/day)	Potential of wastewater (l/day)	BOD concentration (mg/l)	Wastewater load (kgBOD/day)
Nusaniwe	113,142	120	13,577,040	10,861,632	400	4,344.65
Sirimau	160,808	120	19,296,960	15,437,568	400	6,175.03
T.A. Baguala	56,921	120	6,830,520	5,464,416	400	2,185.77
Teluk Ambon	49,647	120	5,957,640	4,766,112	400	1,906.44
Leitimur Selatan	10,280	120	1,233,600	986,880	400	394.75
Total	390,798	120	46,895,760	37,516,608	400	15,006.64

Indonesian Government Regulation number 81year 2012 on the management of household waste and similar household garbage set the community-based waste management (communal scale) based on the principles of reduce, reuse and recycle. Communal scale waste management is very suitable to be done in Indonesia, because it can extend the service life of the landfill (Mulyanto, 2008). Communal scale facilitates the sorting process which is alleged as the principle of waste management (Tchobanoglous, et al, 1993).

Waste management activities undertaken by the public and the government of Ambon city can be described as follows:

- Performed by the individual directly.

  This activity is carried out by people to bring their solid waste directly into the garbage truck that comes to the area of service daily, and then the garbage truck transported the waste directly to the landfill.

- Performed by individual indirectly.

  This activity has involved the temporary shelters in the form of a container or bin. People bring their trash directly into the temporary shelters, and then the garbage truck pick up and transport it to the landfill.

- Carried out by communal directly.

  Garbage is collected by officers using a garbage cart and then carries the waste directly into the garbage truck. The garbage truck then throws it into the landfill.

- Carried out by communal indirectly.

  Community served by the garbage collectors use a garbage cart and took it to a temporary shelter in the form of a container or bin. From temporary shelter then the garbage is transported by truck to landfill.

Table 3. Potential domestic solid waste load per district based on population data in 2012

District	Population	Solid waste generated (l/cap/day)	Bulk density (kg/l)	Potential solid waste generated (ton/day)
Nusaniwe	113,142	2.75	0.229	71.25
Sirimau	160,808	2.75	0.229	101.27
T.A. Baguala	56,921	2.75	0.229	35.85
Teluk Ambon	49,647	2.75	0.229	31.27
Leitimur Selatan	10,280	2.75	0.229	6.47
Total	390,798	2.75	0.229	246.11

In term of solid waste, Ambonese produce garbage for 246.11 ton/day which is a burden for the existing landfill.

5. CONCLUSIONS

Community and the government of Ambon have not fully perform the processing of domestic waste water and garbage. This is indicated by the high chemical and physical parameters of the sample analysis results from several river estuaries in Ambon. Parameter that exceeds the quality standard for seawater is TSS, total ammonia, phosphate, nitrate, chromium, cadmium, lead, and coliform bacteria.

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PRINCIPLES OF LOCATION DEVELOPMENT FOR HOUSING AND SEAWEED PROCESSING INDUSTRIAL

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ABSTRACT: Currently, the development of seaweed grows rapidly in Indonesia, such as in South Sulawesi. The activity is an economic potency for the low-income community. However, two issues arise: 1) the growth of unlivable informal houses along the coast (Baubau & Bantaeng), or along the river (Wajo), 2) the drying container, constructed as needed (along the road, beach/river) without considering the safety and direct access between the houses and the location of cultivation, especially in the transport process after seed binding and post harvest for drying. In the case of Bantaeng District, seaweed cultivation occurs on the side of the arterial road along the coast. *Para para*/drying container is constructed along the coast (32 km), and about 14 km of it is part of Bantaeng city center. This condition is vulnerable to traffic accidents, waves and sea breeze. Thus, production centers grow according to the working group of fishermen along the coast. The risk of traffic accidents is a result of carrying the seeds and products while crossing the arterial road. Therefore, this discussion is necessary to analyze the needs of the location/space for livable houses, seed binding, and seaweed drying development with proper access based on community approach (Case: Banteng watershed region).Data collection was done through surveys, direct observation and interviews with the farmers and fishermen using random sampling. Besides, the research method used Focus Group Discussion. The method of analysis is descriptive-quantitative and comparative to the standards and related policies. The result shows that the principle of location development for housing seaweed processing industry must: 1) separate the housing zone and seaweed drying zone with north-south orientation to avoid the wind; 2) Both zones should be developed in the watershed that has a direct access between the local road network and water transport (boat dock).

KEYWORD: Housing, watershed area, seaweed processing, community

1. INTRODUCTION

Currently, seaweed processing activity grows rapidly in Indonesia. The same condition also occurred in the region of South Sulawesi. The activity is an economic potency for low-income community (MBR). In the last five years in Bantaeng regency, most of fishermen focused in seaweed processing activity than fishing. This condition is a good turn for more income for the fishermen. Especially for fisherman who have double job in seaweed processing and fishing.

However, in relation to those economic activity there are two issues which arise in the City of Bantaeng: 1) informal housing, unlivable grow strong on the artery road side along the coast and in the coastal border, 2) *para para* / drying container built along the coast (32 km), and ±14 km of it is part of Bantaeng city center.

Informal housing constructions are built without considering the user's security toward the strong sea breeze and the safety of the fisherman (seed bonding/Seaweed product). There is a risk when fisherman carried the product and crossed the arterial road from the house to the beach, or vice versa. The product is carried by two people who need to cross the road. That is why it high risks to traffic accidents.

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Seaweed processing activities such as binding seed, harvest and drying seaweed can be found on strategic vacant land along the coast. Currently, there are huts/houses, *para para*/drying containers constructed along coastal border that should be used for public activity. This condition is contrary with spatial planning policy.

Figure 1. Road side condition that used for seaweed processing activity along the coast (± 32 km), High risk of accident

Another problem for farmers/fishermen in seaweed processing who develop housing and drying area is creating land use conflicts (residential and drying container). The housing became dense, slum, puddles around the seaweed drying container, resulting unlivable environment (Figure 2, andFigure 3).

Figure 2. Housing and Settlement conditions of seaweed fishermen growing along the river(Case Study Bantaeng)

The condition of the infrastructure for processing/drying seaweed, and the quality of the environment is one of the factors that affects the sale value/quality from seaweed (http://www.trobos.com/ Access December 20th, 2013). This value highly related to post harvest treatment, such as dryness and water substance. The high value, associated with post-harvest handling, depending on the drying process and water content contained in seaweed.

Figure 3. Housing conditions and Seaweed fishermen settlements on the waterfront (Case:Baubau)

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Base on previous description the interesting point to be discussed is to analyze the needs of the location/space to develop livable housing for seaweed fisherman, which is equipped with the infrastructure to support its activities.

2. REVIEW OF LITERATURE AND EXPERIENCE

2.1. COASTAL REGION CHARACTERISTIC

Subandono (2007) describes that the coastal region consist of complex system, requiring integrated management. There are 3components that must be planned in a balanced way: existing ecosystems, coastal pace used and prevention/mitigation.

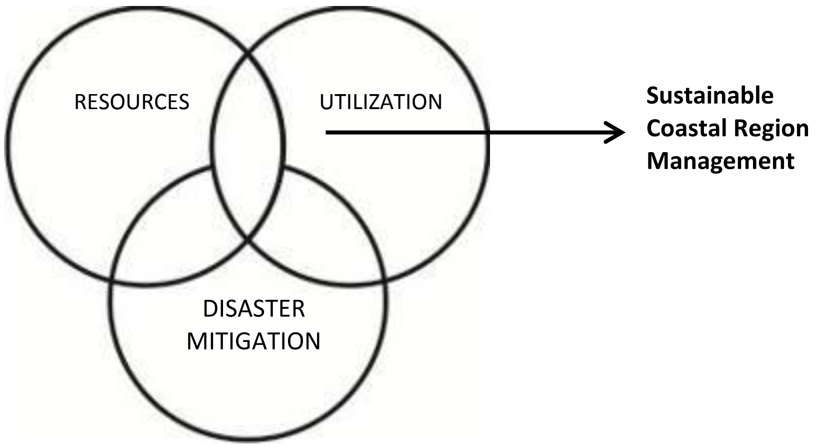


Figure 4. Component in sustainable of Coastal Region Management (Diposaptono, 2007)

Based on Wunas (2013), the use of public space coast has led to conflicts between residential land and fishery activities (Drying and selling fish, boat building and boat moorings). Housing form generally follows the local wisdom. Maintain the shape, structure and construction material of local traditional house in coastal areas. Infrastructure and facilities needed to attract residents to live/work in coastal areas/watershed.

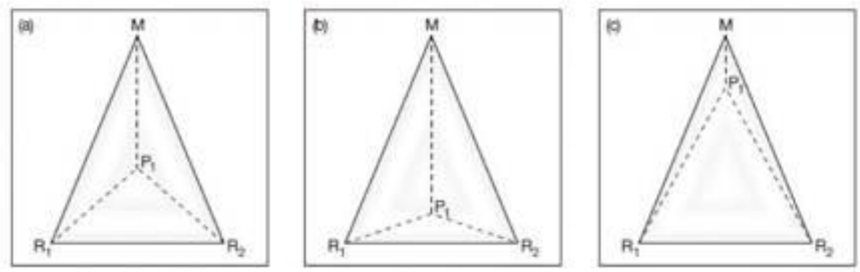
Coastal community group has a very strong togetherness in fishing and farming. Participation form that can be applied in the implementation of development is based on the respective strengths that exist in the society.

3. APPROACH IN LOCATION THEORY/CONCEPT

Regional developments should consider space, distance, and time, in order to determine a location may consider aspects of workers and economic efficiency.

According to Weber in Rustiadi et al (2011), the location selection by smallest cost, in which businesses and consumers are concentrated in certain centers. Each of these groups can enter the various markets to compete. Some labor stay in business location. The approaches in regional marketing are:

1) There is no distance difference in raw material distribution, labour and capital in the plains region of homogeneous
2) Population density is equal
3) Public taste is constant. Population preferences are the same. Does not depend on corporate locations.



M = Market R_1R_2= Raw Materials P1= Lowest cost Location

Figure 5. Industrial location Determine Illustrations base on market analysis of Weber Model.

Weber models for basic analysis of market areas:
Model 1: The cost of production and transport is similar
Model 2: Production costs is different, while the transport costs is similar
Model 3: The cost of producing is Similar, while the transport costs is different

Some point need to think about in the approach of industrial agglomeration (Weber in Rustiadi et all, 2011):

1) The transport cost in location determine
2) Two primary location strengths, namely: the orientation of manpower and export
3) The market area
4) The advantages of localization economy, ie external benefits for company but internal for the industry

Determination of the optimum location based on the cost of distribution (delivery costs) which is the cost of production plus transportation costs, is described using the market area.

4. COMMUNITY PARTICIPATIONANDTHE ROLE OFFORMAL ANDNON FORMALINSTITUTIONS

The lower strata of society will not easily participate in the implementation of the procurement organization, because they are afraid of government officials and their distrust to outsiders (Oscar Lewis, in Panudju1999). In terms of funding, according Turner(1976) special housing procurement system is needed in the form of loans to buy land, to build a home also subsidies other outside assistance so that coastal communities can build their house. Limited education and knowledge also led to community participation in implementing the development plan that does not meet the standards. External parties are needed in the drafting of the house and the building permit.

Some basic procedure that should be followed in community participation implementation are (in URDIParwoto1997):

1) All parties have an equal opportunity to express their opinions. Decide things that are directly related to his fate and responsible for all the decisions that have been agreed.
2) Each attending party must be received by the other party for what it is and inequality.
3) All parties must be willing and able to communicate themselves to allow coordination and synergy. Each party is willing to merge into a single entity or collaboration.
4) Each party is required to be welcome/open minded.
5) All parties must be prepared to give their opinions and accep to ther people's opinions/criticism.

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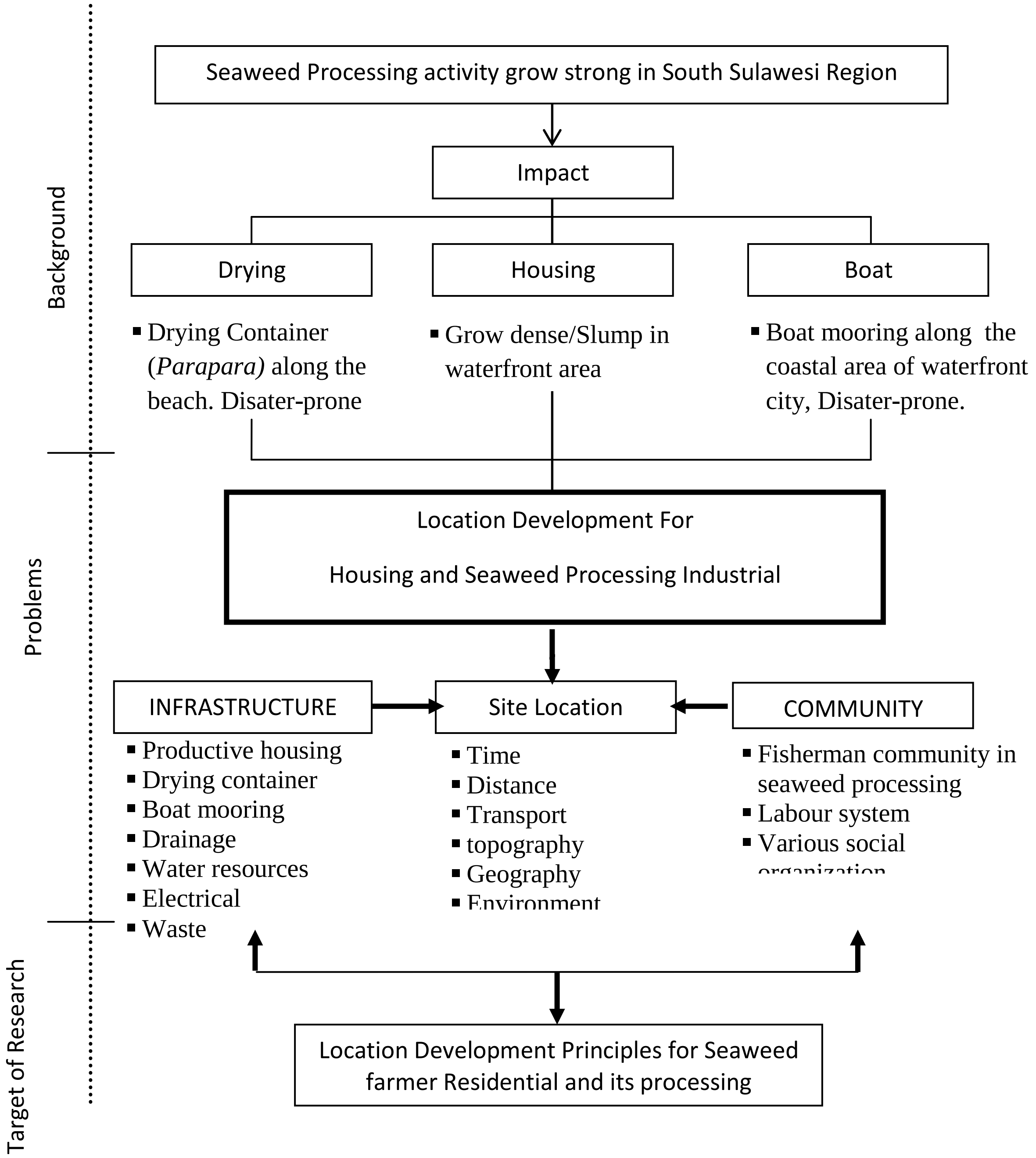

Figure 6. Research Framework

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5. RESEARCH APPROACH

This research is non-experimental and descriptive exploratory. The location of the research is conducted in the coastal and watershed of Bantaeng, including Byangloe, Pajukukang, Lamalaka.

Figure 7. Map of Research Location in Panaikang, Tangtanga and Calendu Watershed

Basic considerations in the determination of the research location in Bantaeng are1) Fishermen activities grow strong in coastal areas. High risk to traffic accident and wind and wave disaster;2) Three districts out of eight has70-80% of population whose work is a seaweed fisherman, 3) *para-para/*drying container and boat moorings in the coastal areas place in public space, 4) Seaweed processing activity has been secured by the efforts of economic production(UEP) and business groups(KUBE).

Data were obtained through multiple data collection techniques, such as:

a. Direct observation to the object ofstudyinclude1) space availability in the water front area, 2) land suitability to slope for the construction,3) condition of infrastructure in traditional sailing, road network, water piping systems, electricity and telecommunications.
b. Interview. Conduct a discussion on the problemsof1) residential space and seaweed processing activity space, 2) transportation, 3) processing industry, 4) community issues.
c. Discussions with the various local government agencies that deal with housing and industrial development. Explore the location possibility for local and national investment.
d. Field note. Write down overall record/things that are found in the field and during the process of discussion with stakeholders.
e. Logbook. Describes the entire process of the research activities

The population of this study was all seaweed farmers/fishermen throughout the working population in the seaweed processing activities that live in Bantaeng Regency. Respondents in the study are determined by purposive/incidentally sample, consists of the head of the family and seaweed businesses, the actors that are related to the activities such as: seed binder, drying, boat owner, motor boat's driver).

Analysis of space requirements in terms of land suitability (land suitability analysis, analysis of solar orientation, wind direction, extensive analysis of space) for productive housing development and seaweed processing industry, using a comparative analysis of the various standards and policies, water depth analysis in traditional sailing need. Analysis of water and land transport mobility.

Analysis of regional infrastructure networks (transport) covering assessed on transport mode that used and owned by seaweed fishermen, patterns of mobility and type of cargo/freight. Utility assessed by availability and the needs of water, electrical and telecommunication from one community of retainer/*punggawa* of seaweed fisherman to their seaweed processing activities. Sanitary sewage system assessed from liquid and solid waste to the regulations of the Ministry of Environment.

Social systems assessed from the amount of households for each seaweed community, skipper systems, cooperative systems, systems that are managed in integrated effort from upstream to downstream, or partially. Organization system analysis assessed of formal and non-formal systems, business systems that have been conducted, and business system that can be developed, approach by Focused Group Discussion (FGD) method.

6. DISSCUSSION

6.1. SITE LOCATION ANALYSIS

Seaweed processing activities consist of 1) the binding of new seedlings in rope, 2) cultivation in the sea, 3) harvesting seaweed, 4) release of the seaweed from rope and cleaning dirt from sand, rock, etc., 5) drying, 6) washing with fresh water and draining, 7) bleaching and 8) sieving.

The location in the 8 stage of seaweed processing is choose as close as possible (short) with the location of cultivation in the sea, ie along the coast, or at the mouth of the river Bantaeng (Figure 9).

Figure 9. Seaweed Fisherman/Farmers Illustration along the coastal area (a. Housing, Boat mooring, and b. Drying along the beach c. Housing/ gazebo and drying above the sea)

Housing pattern and site layout in coastal areas are generally developed in a linear pattern, following the coast geographic, or follow the arterial road along the coast, as well as the binding activity of seeds and drying. Drying container or buildings constructed on the beach side or on the side of the road. The pattern of housing development is in accordance to Alibasyah (1989), that describes the characteristic pattern of housing in coastal areas, developing elongated following the coastal geography.

Similar things show in the pattern and layout of there sidential site at the mouth of the river. Housing developed following the mouth of river geographic shape. However, the housing formed in a concentric pattern in Bantaeng Regency(Figure 10).

Figure 10. Seaweed Fisherman/Farmers housing Illustration that grow dense and slump in estuaries Area of Bantaeng Regency

The development of housing and supporting infrastructure in coastal areas or on the river banks is also affected by land availability as a public space and the location is very strategic(in the city center and along the arterial road).

The condition of the three site locations(coastal, road side and estuaries) showed that seaweed farmers/fishermen try to get closer between residential location, seeding/planting(ocean) location and seaweed processing location(residential distance to the container processing ≤800m. This indicates that factors of distance accessibility are more preferred. In other words, they ignore the risk/disaster factors such as sea breezes and abrasion(Figure 10).

Distance between building and beach is one of the regulations in coastal housing development. This regulation made to preserve ecology/environment in the coastal area. However, the regulations mostly ignore, as the result buildings develop in shoreline/beach side or above the water and leads to building risk and beach ecological destruction.

Building distance from beach is one of the requirements in housing development. This requirement is to maintain the sustainability/ecology of coastal environments. This requirement is ignore by the community. Most building developed on the shoreline/river or on the water, without considering the building safety, and ecological destruction.

7. INFRASTRUCTURE ANALYSIS OF SEAWEED PROCESSING AREA

7.1. PRODUCTIVE HOUSING

Seaweed Fishermen/Farmer's House is generally shaped as elevated houses. This house can be categorized as a productive house, because the ground floor is used for economic activity such as: binding the seed (±10-15m rope length), cleaning the harvest. Second Floor is used as a residential area. There is 60% of seaweed fishermen/farmers who stay in unlivable housing (without sanitation, drainage and waste facility. As well as no sewage treatment from seaweed processing (washing and drying). Air flow contaminated with dust and smell come from seaweed processing under the elevated houses (Figure 11).

Figure 11. Illustration of Seaweed Farmer/fisherman residential as productive housing

The conventional way is still used in seaweed drying process. Drying container (*Para-para)*, is built on vacant land around the house (in the flatland, on the water, on the road side), with an average area 24-60 square meter. Generally, by used 6m modules size, according to the length of bamboo or wood. This condition cause the housing area becomes dense and slum (60-70% was a built area) and also low quality of life. For the Seaweed Fisherman/Farmer, safety is not a concern yet (Figure 12).

Figure 12. Conventional Drying Container Illustration

7.2. TRANSPORT INFRASTRUCTURE NETWORK

Boat is the main mode of transport that is used by Seaweed Fishermen/Farmers. This mode is a woodboat, measuring±1,00 x 3,00m. Generally, the type of mode tha tis used is a paddle boat to carry seed or harvest. Planting seed distance location is relatively short(<500 m from the shoreline). There are 40% of seaweed entrepreneurs who have their own boat and mooring around their house. (at the mouth of the river or along the coast) which is a place for public. The need of boat mooring area must be integrated with land use planning to accommodate dock and housing also an area for cleaning, drying, pilling up in seaweed activity. Distance, time and easy access are factors, so the seaweed activity area needs to be close to planting area.

Seaweed fishermen/farmer's housing already served with road network, both located in coastal areas, or in estuaries. Problems arise when drying the seaweeds occur on the road side. Also when the fishermen/farmer carriage the product from coastal area to drying location/housing. Due to the way transport seaweed carry or push the cart, then crossed the arterial road, high risk of traffic accident. (Figure13).

Figure 13. Seed and Product carriage Ilustration, from coastal area to housing or vice versa

7.3. ENVIRONMENTAL SANITATION

Most of the Seaweed Farmers/Fisherman residences are not equipped with toilets(80%) yet, especially people who lived in coastal areas and estuaries. Most of the population is still throwing feces around their houses, mainly in the river or in the sea. Most of them dumped on the shoreline or in the river. They are not concerned about the health and the quality of the environment.

Seaweed washing/cleaning and drying facility built in ±50-100 square meter of the flatland, with a simple and conventional construction, without drainage. Under the drying container(para-para) becomes muddy, humid, because the people do not understand the drying technic that can affect the seaweed quality. As well as affecting the health and environmental quality.

7.4. ENVIRONMENT UTILITY

Water and electricity infrastructure have reached all housing site locations. Utilization of renewable energy has not become a public concern or a concern for the local government yet.

A conventional drying seaweed activity, which requires a wide space, a lot of time (3-5days), requires thinking for space efficiency and improving the quality of production, primarily in the drying phase.

Farmers approved (100%) that the drying container can be used together with all the community member. The opinion indicates that Seaweed Fishermen/farmers realize that drying space need rearrangement.

7.5. ANALYSIS OF SEAWEED PROCESSING ACTORS ACTIVITIES/COMMUNITY

Processing activities are generally carried out on government land (70%). Generally, they used the space that is designated for public space, particularly in coastal area sand estuaries.

Figure 14.Condition of Conventional Gazebo and Non Formal on Bank/Local Government Sponsor.

Seaweed processing actor communities has been formed by the fisheries department in the Village of Pajukukang and Kaili. Each group consists mostly of 10 actors.The labors mostly come from the family system.

Gazebo for seed binding is the facility that is constructed by the local government or banks sponsorship. But most of it did not function optimally because the construction was not in accordance with the demands of behavior in the seed binding process, such as wind direction and solar radiation. Figure15 shows the construction of the gazebo roof slope which should be able to reduce wind and heat.

The idea is arise on FGD process. Community suggests to unite resident area and seaweed Processing area. That is why the seaweed processing location should be move in appropriate area around the river side. Apparently 80% of them approve in rearrange the residential and seaweed processing area in the watershed of Bantaeng. Rearrangement should be complete with boat (35%) and easy access to cultivating area.

8. CONCLUSION

The result of analysis shows the planning concept needs to consider; 1) the physical aspects of the land, topography/slope is relatively flat, 2) geography, watersheds that can support easy access and connectivity to the sea and the land. and3) behavior in seaweed processing, such as wind direction and thermal radiation, 4) land use, bring a variety of activities, such as residential, the binding of seed, cleaning and drying also industry activity in seaweed processing.

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POTENTIAL OF NEW LAND AS A RESULT OF COMMUNITY EMPOWERMENT ON MANGROVE PLANTING IN BEDONO COASTAL AREA

Widiyana RIASASI[1], Muhammad C. SATRIAGASA[2], Faizal RACHMAN[3]

ABSTRACT: Bedono coastal area is vulnerable to climate change impact. Accresion occured in the coastal area since 1998 due to coastal dynamics triggered by development of Tanjung Mas Harbour and Terboyo industrial area. Accresion, which is compounded by tidal flood, land subsidence and sea level rise, causes loss of a number of local communities' asset and property i.e. settlement, infrastructure, farm land, and fish pond. NGO and government response to this phenomenon by empowering local community to cultivate and plant mangrove along Bedono Coastal Area. Now, the mangrove ecosystem has been fairly dense. Mangrove ecosystem can provide various benefit, some of them are economic benefit and ecologic benefit e.g. supporting on formation of new land due to sedimentation on mangrove root system. Aim of this research is to measure and to map the potential of new land of sedimentation induced by mangrove in Bedono Coastal Area. Visual analysis on multi temporal landsat imagery of year 2000-2014 by geographic information system is used to detect the rise of new land from sedimentation on mangrove root system. Potential of new land is generated by scoring and weighting analysis. From this study, it can be predict that at least 58.868 to 558.159 m^2 area were risen in Bedono Coastal Area due to mangrove sedimentation with classification into very high to very low classes.

KEYWORD : Mangrove, Sedimentation, Satelite imagery, Community empowerment, Tide

1. BACKGROUND

Java northern coast is directly adjacent to Java sea. Characteristic of the coast is low slope and its surface elevation is not higher than the lowest tide. Bedono is one of villages in Demak district which located at the interface between sea and land. Bedono coastal area is vulnerable to accretion and tidal inundation. Sea water tide leads to tidal inundation routinely occurs in Bedono every tide cycle times.

IPCC (2001) stated global warming effects to sea level rise, and it proves on Java Northern coastal. Tidal flood in Bedono coastal area is also triggered by sea level rise besides tide cycle which routinely occurred. In 2007, two hamlets in Bedono, which are Senik and Tambaksari hamlets, were sunk by great tidal flood. 228 households were evacuated to near hamlets. The great tidal flood did not leave even one undamaged building because whole area of the two hamlets were inundated by sea water. Inundated area in Senik and Tambaksari hamlet can be seen on Figure 1.

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Figure 1. Former Building in Sinking Hamlet, Senik and Tambaksari; (A) House; (B) Mosque

The disaster automatically ruined community welfare because their livelihood before was ponds farming. The sinking ponds were not productive anymore as sinking hamlets caused by the tidal flood. Since the disaster destroyed two hamlets in their village, the coastal community created idea to reduce accretion and tidal flood hazard and disaster risk on mainland of Bedono village.

Together with government and NGO (non-government organization), the coastal community began to promote mangrove plantation in the coast area. The aims of mangrove plantation are retaining sea waves, to reduce erosion, and to increase sedimentation. Government and NGO gave mangrove seed to be planted on coast area, included on former area of sinking hamlets, Senik and Tambaksari. Government and NGO support in form of the mangrove planting program. The program was a kind of community empowerment in tidal flood risk reduction. To increase the spirit of participation, government rewards IDR 100 per stem mangrove for those who plant mangroves surrounding their living area. The method excites community to plant more mangroves, beside their own awareness due to accretion and tidal flood hazard.

Formation of mangrove ecosystem provides many positive impacts, either to ecological aspect or economic aspect. For economic aspect, mangrove stem can be used for building material or other uses, but must be under controlled utilization. Besides mangrove plant logging, other benefit comes from the ecosystem, which its area can be used for crab farming. The crab farming method also gives economic benefit for coastal community.

For ecological aspect, mangrove ecosystem creates new land formed by the sediment trapped. The more dense mangrove plants, the more material can be trapped by magrove root system. By the time, the sediment trapped by mangrove plants can form new land. Local people calls the new land formation as *tirah*. The sediment consists of mud and sand which are filtered by root system. Former research regarding to sediment on mangrove area has been held by Santen et. al (2006) in La Lat estuarine, Red River, Vietnam. The research compared sedimentation rate between dry season and wet season. The result shows sedimentation rate in mangrove area in dry season is 2.94 g cm^{-2} $year^{-1}$. Meanwhile sedimentation rate in wet season is 3.46 g cm^{-2} $year^{-1}$. Sedimentation rate in mangrove area is influenced by current and wave because sediment distribution is determined by direction of current.

Environment benefit also comes from the density of mangrove plants, which is it can be habitat for birds, snake, and other wild animals to complete the balance ecosystem.

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Generally, mangrove ecosystem has benefits for many aspects, either physic, chemical, biology, economic, or tourism. The aim of this research is to measure and to map the potential of new land of sedimentation induced by mangrove in Bedono Coastal Area.

2. RESEARCH METHOD

Prediction of new land formation of magrove sedimentation is visual analysed by Geographic Informatio System (GIS) using medium scale sattelite imagery (30 m). This research uses multitemporal landsat imagery (Landsat 4 to 8) from year 2000 to 2014. Those satellite imageries is used to identify the dynamic of mangrove ecosystem. Composite 542 for Landsat 4, 5, 7 , and also composite 753 for Landsat 8 are particularly to identify vegetation, in this case is mangrove. Those composites are also can differentiate between turbid water and clear water.

Band 4 for Landsat 4, 5, 7, and band 5 for Landsat 8 are included in near infrared band (0.7-1.1 μm) which sensitive to detect vegetation, therefore the object looks bright. By the composite, mangrove object is characterized by colored bright green, patterned clumped, located on coastal area, associated with sea. Turbid and clear water can be identified by band 3 (Landsat 4, 5, 7) with wave lenght 0.6-0.7 μm on blue channel with composite 543. Turbid water shows bright blue color as impact of red spectrum reflection by sediment particles, while clear water looks in dark blue because the most radiance cannot be reflected back to censor. Turbid water indicates the high total suspended solid (TSS). Suspended level in coastal area is influenced by various sediment supply from land according to season. In wet season, total sediment which transported to water is higher than in dry season.

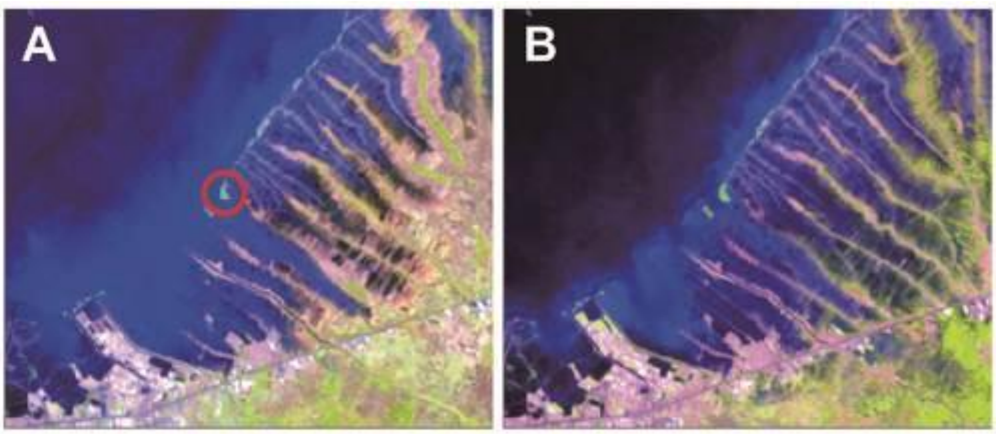

Figure 2. Mangrove object on Landsat (in red circle) and sediment on water in different season, (A) wet season in September 2002; (B) dry season in May 2003

Prediction of new land formation is based on the ability of mangrove ecosystem to reduce sea current rate therefore the sediment in water on coastal area can be deposited in the bottom and bounded by mangrove root system. Total of mangrove ecosystem and its spatial distribution have positive correlation to new land formation. It is also considered that age of mangrove plants has positive correlation to thickness of sediment deposited. However, in the prediction of the land formation is assumed there is not sediment decreasing along year 2000 to 2014 on the mangrove area.

Based on the imagery interpretation, it shows mangrove ecosystem with various thickness, thick mangrove scape is scored 2, while thin one is scored 1. Particularly for mangrove map in year 2014, scoring factor is 2 because it is assumed that the sediment that has been deposited years before is still exist until now. Mangrove maps per year are overlaid and gave score then be calculated for total value of land formation potential. The value is classified by equal step classification divided into 5 class (very low to very high).

3. RESULT AND CONCLUSION

Various types of mangrove growing in Indonesian coastal area are Avicenia, Bruguiera, Rhizopora, and Nypha. Each type has specific species. Mostly, species growing in Bedono coastal area is Avicenia and Rhizopora, but species Bruguiera and Nypha area also can be found in small population.

Every year, mangrove ecosystem in Bedono coastal area is getting wider. In 2000, wide of mangrove area is 20,514 m^2, while in 2014 its area is 1,438,247 m^2 (Table x). However, there is condition which wide area of mangroves in 2005 and 2009 is lesser than years before. The lost mangroves is predicted as new mangroves which is crushed by wave and sea current or it can be caused by mangrove wood illegal logging in the study area.

Table 1. Mangrove Land Cover in Bedono Coastal Area in 2000-2014

Year	Area of Mangrove (m^2)		Total (m^2)
	Thin	Thick	
2000	20,514	0	20,514
2001	14,618	28,983	43,601
2002	32,162	32,264	64,426
2003	53,631	51,783	105,414
2005	38,333	58,500	96,833
2007	89,113	103,870	192,983
2008	98,753	168,167	266,920
2009	56,936	147,555	204,491
2010	224,546	396,278	620,824
2012	344,829	606.414	951,243
2014	398,942	1,039,305	1,438,247

Source : Primary data analysis

The significant increas of mangrove area from year to year cannot be separated from local community intervention. In Bedono village, there is marine mangrove community (*kelompok mangrove bahari*) which takes active role in planting and conservation of mangrove ecosystem. Based on mangrove planting data of the community in 2013, at least 814,370 mangrove seeds were planted on 344.4 hectare area. The detail data of mangrove plantation in Bedono coastal area can be seen on Table 2.

Table 2. Area and Mangrove Seeds Planted in Bedono Coastal Area in 2004-2013

Year	Area (Ha)	Mangrove Seeds
2004	11	13.750
2005	63	79.000
2006	82	115.000
2007	82	122.000
2008	41	93.120
2009	15	45.000
2010	10	25.000
2011	23,5	83.250
2012	16,5	141.250
2013	0,4	97.000

Source : Mangrove Planted Data of Bedono Marine Mangrove Community 2013

Result of multitemporal mangrove imagery overlay shows some location grown by mangrove all the time, therefore it indicates thick sediment deposited in the area as the result of sedimentation on mangrove root system. Zonation of sediment thickness potential is divided into 5 classes, very low to very high which is symbolized by gradation color of dark green to red. Total area of very high potency is 58,868 m^2 and symbolized by red color. Mangrove has been grown for seven or nine years, and still exist until now (Figure x). While very low potency of land formation is symbolized by dark green and its area is 558,159 m^2 for one to three years mangroves growth.

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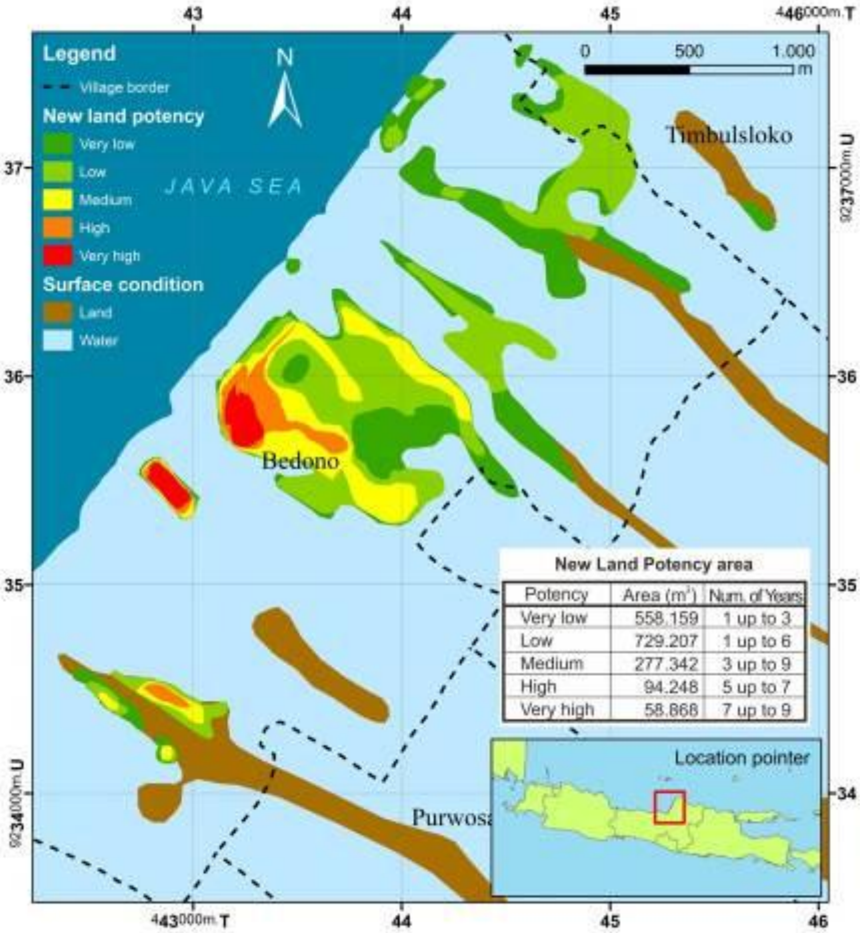

Figure 3. Land Formation Zone Map

Santen (2006) said sedimentation rate in high density mangrove is moreless 2.94 g cm^{-2} year^{-1} up to 3.46 g cm^{-2} year^{-1}. Sea current and wave influence total sediment deposited in mangrove ecosystem. Based on the same assumption, high density of mangrove in Bedono coastal area has almost same sedimentation rate as Santen's research (2006). Bedono coastal area has lower current and wave compared to Java southern coastal area. Regarding to the low process, the sediment distribution is slower as well.

4. CONCLUSION

Based on the result, conclusion of the research is :

1. Mangrove distribution in Bedono coastal area is clumped pattern.
2. Area of land formation by sedimentation in mangrove root system is predicted moreless 58.868 m^2 hingga 558.159 m^2.

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FLOATING SANITATION IN TIDAL AREA

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ABSTRACT: Water such as: surface water in rivers, flood plains and tertiary channels are an easy means to spread a variety of diseases, diseases spread through water (water borne deseases). Highly population living at or above the banks and river/tertiary channel, causing the amount of domestic waste water entering into water body, will result in increased pollution of surface water for the general population is still used daily activities. In addition, the handling of sanitation in the settlement system in general has not been entirely done well, let alone specifically for settlements located on the banks or floating on the river. Toilets often discharge untreated or partially treated into open drains, canals, rivers, or ponds. Toilet facilities in flood plains need to to prevent water pollution when the water level rises.

The aim of this study is to improve health and prevent disease that is caused by the bad habit in defecate to the water body directly. This condition can be changed by build healthy water closet which is simple in making, using and maintenance.This study intended to measure the efficiency of the processing system of floating sanitation which built in residential areas along the river or floating settlements consisting of (i) latrines, (ii) Bio-filter , and sanita garden (planting media and the local water plant). Conducted experimental study method was laboratory testing of floating sanitation effluent results of this study showed that floating sanitation is a model of a floating sanitation technology that can process domestic waste water in tidal areas and the banks of the river and its banks to take advantage of the growing media and the local water plant, so further facilitate the operation and maintenance. Efficiency of wastewater quality of floating sanitation unit has reached 86.50 to 89.64% for BOD, COD reached 86.48 to 89.74%, Total Suspended Solid (TSS) reached 70.59 to 72%, and the mean efficiency of pH is 6.74. The concentration of oil and grease is 0.38 mg / L. The results of the effluent quality meets the quality standard of waste water according to the Decree of the Minister of the Environment of Indonesia No. 112 of 2003.

1. INTRODUCTION

The high population of residents who live along or above the river, then the amount of household waste water that enters water bodies will increase as well, which will result in increased pollution of surface water. In general, residents living on the water, still use the river water for daily activities, among others, for the purpose of bathing, washing clothes, washing dishes, washing rice and ablution.The river is one of the means that is easy to spread a variety of diseases, such as diseases spread through water (water borne deseases) namely diarrhea, filariasis, diseases due to worms.

The study results showed 46.1% of mild to severe polluted for big rivers in Indonesia. When only seen in rivers "important" alone, approximately 80% had very severe polluted. generally contaminated ammonia, phenol, detergents, coli bacteria, metals, and solid waste such as trash (Sobirin and Putuhena, 2008 dalam Yudiarti, 2011).

Pollution from domestic waste water disposal is the largest contribution sebanyak 85% go into water bodies (DGHS-PU, 2009). Previous assessments conducted by Rahmadi [1] yield that the disposal of feces directly into the river, approximately 42% and 7% dump sludge directly into the drainage channel. So the lack of wastewater infrastructure would reduce the value of the city government's efforts to improve the health community of the city. Most people who reside there or the house floating on the river and laid on the boat/barge small shop trade equivalent, up on the day boats are crossing or passing over the river, where the

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waste water generated will be directly discharged into the river without prior treatment first. For people living in the riverside/river basin generally do not have adequate sanitation facilities, as household wastewater directly discharged into the river without treatment.

Whatever the reason needs to be setting an urban waste water is increasingly urgent and household waste water must be managed properly and correctly. Late completion of the system, then future generations will pay a very expensive consequences. Various reasons can be given why the effort of handling the problem of domestic waste water in urban areas like in tidal area city is currently done by the city government and the community both individual and communal, as well as the private sector has a role in the handling of these sub-problems. In handling this, the role of city government conducted by specialized institutions like the board of supervisors or operators environmental conservation efforts and the institution performing the functions of the technical regulator in charge of formulating policies in the form of technical management of waste water treatment, as well as operator functions in the management of waste water treatment. However, waste water management in multiple locations, such as the case has not been handled in the villages of Tanjung Baru, Kelayan B, Banjarmasin City, the location of this model is placed. Banjarmasin city with special natural characteristics that many river and its geographical park is ± 16 cm are below sea level, resulting in a rapid spread of water pollution [2].

Activity model of floating sanitation latter as BIOSANTER (Bio Sanitation Floating), a physical model consisting of floating sanitation toilet unit, using the form of waste water treatment installation namely BIOFIL and is equipped with a floating sanitation garden planted with ornamental plants, in the form of jasmine water (Rechinodorus Paleafolius) with planting media purports galam wood, coir and fishing nets from plastic materials.

Installation BIOFIL initially constrained in the selection of areas where tidal wet because the water bodies in the form of channel primier, secondary and tertiary channels, there is a section at the bottom of the channel covered a large plant roots are strong enough and complicated, making it difficult to cut/felled. As a result, the roots are left alone, but at the place of installation BIOFIL, very annoying because when the water is in a state of low tide, the water pressure is great enough and threw BIOFIL tank, so the tank base BIOFIL, cracked. This tank repairs done by using resin fillings and need to replace it with a special type BIOFIL.

BIOSANTER model placed at the edge of the water, so choose Banjarmasin City as the city with special natural characteristics that many river and its geographical park is ± 16 cm are below sea level, resulting in a rapid spread of water pollution [2].

Planting media using local ingredients combined with three kinds of local water plant, but it can increase the removal of organic substances and inorganic substances desired and the availability of water plants around the retreat location, making it easier in terms of maintenance and operation of the BIOSANTER.

In connection with the foregoing, this study aimed to measure the efficiency of the treatment system built in the area BIOSANTER bantaran retreat river or floating retreat consisting of (i) toilet, (ii) Biofil, and Sanita garden (planting media and the local water plant). Sanita floating garden as an extension of the treatment plant for removal of organic and inorganic substances desired and the availability of water plants floating around the location of the local settlement.

Associated with an increase in the quality of these settlements, the need for the development of sanitation models that can adapt to the physical condition of settlement, culture and local resources. Research models of floating sanitation, using simple technology that consists of three parts: the elimination of waste, waste collection and waste treatment. In the processing

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of waste, use of media from local materials such as fibers, coconut shell charcoal and sand. This floating sanitation models, equipped road or stairs (maximum 20 º) are made from local wood, so that the model can be placed in such a way and can adapt to the tidal river.

2. DESK STUDY

2.1 APPLICATION OF WASTEWATER TREATMENT IN TIDAL AREA

Tidal area is the part of the shoreline that is submerged at high tide and exposed at low tide. [definition source: UNEP. 2001. Protecting the oceans from land-based activities.]

2.1.1 Floating Wetland

Urban wetlands in Bega, Australia, has an area of 60 hectares and as a recipient of rainwater runoff. Aside from being flood plains, wetlands also receives wastewater effluent discharges. Aqua bio-filter /floating wetland is one solution to reduce the content of pollutants at lower costs and minimal land, which has been applied to the treatment area of 200 m2, the allowance of 40 kg of nitrogen, which is equivalent to 1 ha of conventional treatment wetlands. Further processing with these bio-filters, also has been applied in China for 30 years, which shows the feasibility in the treatment of domestic and industrial wastewater and to recycle the water. Floating wetland can be designed wider and deeper, to provide more capacity and HRT, so effective in the reduction of TN, TP, TSS and heavy metals. Example settlement equipped with a floating toilet hole separation of urine and feces (urine diversion UDD- dissecting toilet) can be seen in Figure 1.

Figure 1. Settlements and Floating Toilet

2.1.2 Floating Technology

Results of research on the "Floating Home", Christanto et al is as follows, technology 'floating' rely on a balance between the mass of water displaced by the building of the foundation of the building mass itself (Figure 2). When building mass equal to the mass of the displaced water can float building, the use of foundation 'air space' under the building.

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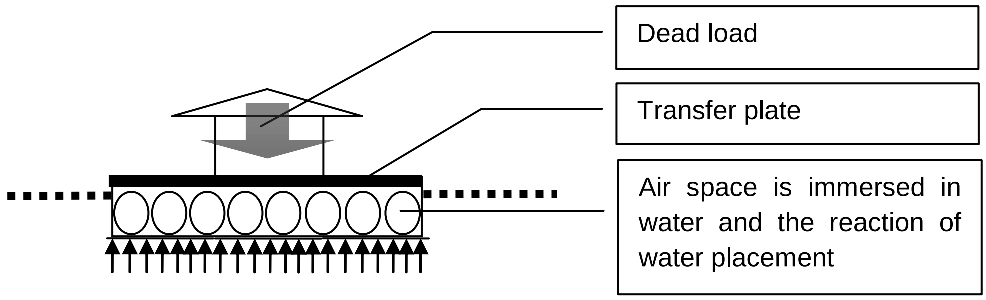

Figure 2. Floating Technology

According to the Law of Archimedes, buoyant force acting on an object that is partially or completely immersed in a fluid is equal to the weight of the fluid displaced by the object. Or buoyant force = weight of object in air - weight of object in water / liquid.

A floating object is determined by the average density of the object and the density of the liquid. If the density is smaller than the density of the fluid, the object will float on the liquid surface. Float calculation formula is as follows:

Archimedes equation, Fa = mf g

$$W = \rho f V b f\, g \tag{1}$$

$$W = Fa \tag{2}$$

where:

W = weight of the object

Fa = buoyant force

ρf = density of fluid / fluid

VBF g = mf g = weight of fluid displaced by the object

In computing applications, there should be additional safety factor of 10%.

2.1.3 Anaerobic-Aerobic Bio-filter

The bio-filter system was developed from locally available materials, consisting of 3 modules namely equalization tank, sedimentation, and bio-filters. The module consists of drums, each 55 gallons, and tank for 10 gallons and 5 gallons, piping and fittings. The function of each part are described as follows [3]: equalization tank: This tank for flow equalization so as not to disturb the settled solids, peak flow can reach 25 gallon/day with a total tank capacity of 40 gallons. Up-flow sedimentation tank: an anaerobic contact zone, the formation of sludge blanket with ultra low velocity. Tank Bio-filter: a contact zone and the aerobic bio-film layer formed on the bio-filter media.

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2.2 BIO-FILM WASTEWATER TREATMENT SYSTEM (FIXED BED MOVIE)

2.2.1 Processing

One of the wastewater treatment process that is widely used is a biological process with inherent stationary submerged cultures (both Film Fixed Bed anaerobic process and aerobic process). The process is often used the bio-filter. Bio-filter is a biological reactor with a fixed bed / attached stationary submerged cultures in which microorganisms grow and grow attached to the surface of the rigid media such as plastic or stone. Influent wastewater fed into the reactor in which the media is filled with buffer (bio-filter media) where microorganisms will grow attached to the surface of the media. With the layer of microorganisms that grow attached to the surface of the medium, the organic pollutants in the waste water will be decomposed into a product of respiration namely CO2 and H20.

Wastewater treatment process with bio-film systems or bio-filters or media contactors can be performed under aerobic conditions, anaerobic or a combination of an-aerobic and aerobic. Aerobic process carried out by the condition of the presence of dissolved oxygen in the wastewater reactor, and anaerobic process carried out in the absence of oxygen in the reactor wastewater. While the combination of anaerobic aerobic process is a combination of anaerobic and aerobic processes. Wastewater treatment process with aerobic bio-film process is done by means of wastewater flow into the biological reactor in which the media is filled with a buffer for breeding microorganisms with additional aeration. In the bio-filter media with aerobic systems, pollutant compounds present in wastewater, such as organic compounds (BOD, COD), ammonia, phosphorus and others will diffuse into layers or films attached to the surface of the biological media. At the same time, using oxygen dissolved in the waste water, pollutant compound will be broken down by microorganisms present in the bio-film layer and the energy generated is converted into biomass. If the layer is thick enough microbiological, then the outer layer will be microbiologcal under aerobic conditions, while on the inside of the bio-film attached to the media will be in anaerobic conditions. In anaerobic conditions will form H_2S gas, and if the concentration of dissolved oxygen is large enough, then the formed H_2S gas is converted to sulfate. In addition, this process is normally used to remove nitrogen content in wastewater. In aerobic conditin, nitrification process occurs which ammonium is converted to nitrate nitrogen (NH_4^+ - NO_3) and anaerobic conditions occur in the denitrification process nitrate formed is converted to nitrogen gas (NO_3-N_2) (Hikami, 1992).

According to Lim and Grady (1980) the mechanisms involved in the biological reactor attached to stationary submerged cultures are as follows:

1. Transport and adsorption of organic substances and nutrients from the liquid phase to the bio-film phase.
2. Transport of microorganisms from the liquid phase to the bio-film phase.
3. Adsorption of microorganisms that occur in the bio-film.
4. Metabolic reactions of microorganisms that occur in bio-fim layer, allowing the mechanism of growth, maintenance, death and cell lysis.
5. Attachment of the cell, when the bio-film begins to form and accumulate continuously and gradually (gradual) on bio-film layer.
6. Release mechanism (bio-film detachment) and other products (byproduct).

Wastewater treatment with aerobic bio-film system can simply be described as in Figure 2 which shows a bio-film system consisting of buffer medium, bio-film attached to the medium, and the waste flow coating layer that lies outside air. Compounds of pollutants present in the wastewater include volatile organic compounds (BOD, COD), ammonia, and other phosfor

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will diffuse into layers or films attached to the surface of the biological medium. At the same time, using oxygen dissolved in the wastewater pollutant compounds will be broken down by microorganisms in the bio-film.

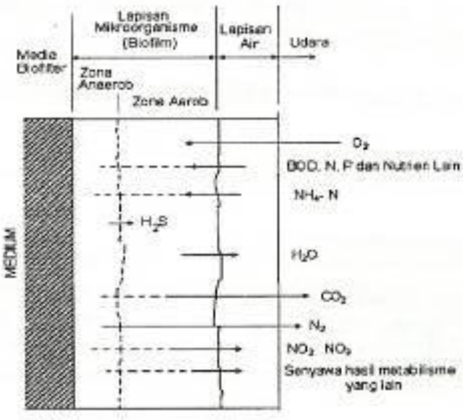

Figure 3. Mechanism of metabolic processes in the process of bio-film systems (Nusa Idaman, 2006)

2.2.2 Design Filters Facility

Factors that should be considered for designing a bio-filter wastewater treatment system includes [4]:

1. The type and physical characteristics of the filter packing is used;
2. Dosing rate;
3. Type and dosing characteristics of the distribution system;
4. Underdrain system;
5. Adequate air flow system (such as ventilation) is also naturally or accidentally discharged air;
6. Sedimentation Tank Design.

2.2.3. The filter is packed (Filter Packing) / Media Bio-filter

Packaging is the ideal filter material having an area of high surface area per unit volume, cheap price, durability and power has seeped high enough, so that clogging can be minimized and there is good air circulation, such as the shape of the plastic packaging sieve (Figure 3). Printed plastic packaging materials, corrugated consolidated in the form of module-square mud to enhance the growth and retention time. Each module layer upside down on the top right corner of the patch to the previous layer to improve the distribution of waste water to flow vertically and perpendicular flow, Figure 3 plastic packaging type is reported to be very effective in reducing BOD and TSS in a wide range (Harrison and Daigger, 1987; Aryan and Johnson, 1987). The advantage of this plastic filter packing is to put its construction requires a smaller area than other systems, filter rock and also the ability to be used at high rates of loading and higher sieve. Grady.et al. (1999) noted that when given the same low organic load (less than 1.0 kg BOD/m^{3}day), then the performance of the

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filter and the filter stone plastic packaging that, together. At higher organic content, the performance of the filter stone and packaging plastic filters, very good. With higher porosity, can lead to better air circulation and peeled bio-film is an attempt to improve performance.

Figure 4. Media contact plastic packaging

Bio-filter media of many organic materials are made by way of printed materials such as stainless and PVC and other lightweight, with a large specific surface area and volume of voids (porosity) is large, so that micro-organisms can attach in large numbers with the risk of deadlock is very small, making it possible to treat wastewater with high concentration load as well as the efficiency of processing large enough.

2.2.4. Water Quality.

Water treated with the system of local or centralized processing technology should produce effluent that meets the quality standards of domestic waste water in accordance with the Indonesian Ministerial Decree of Environment No. 112 year 2003, as shown in Table 1 below.

Table 1. Quality Standards Of Domestic Waste Water

Parameter	Magnitude
pH	6 – 9
BOD, mg/L	100
TSS, mg/L	100
Oil & grease, mg/L	10

Raw sewage coming from households in general often contain oils and grease, that can interfere with the treatment process, especially in the biological treatment as it can hinder contact with the microorganisms for pollutants in wastewater. In order to avoid interference or reduce the oil and grease, need to set aside time ago, one of the simple types such as the grease trap.

The resulting treated water from BIOSANTER must already meet environmental quality standards according to Minister of Environment Decree No. 112 Year 2003 on Domestic Wastewater Quality Standard and / or meet the Standard of Waste Water by South Kalimantan Governor Regulation No. 04 Year 2007.

3. METHODS

The study is held in two places, namely, at RT 16 and RT 17 RW 02, Village of Tanjung Pagar, Banjarmasin City, Indonesia. This location was chosen because of the unavailability

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of latrines and processing of stool, is located at the edge of the settlement of riverside/riverbanks and the area is tidally influenced.

In a pilot study using the materials and equipment as follows: Material BIOSANTER: latrines of ironwood; BIOFIL with a volume of 2,260 m^3, FRP materials and sanitation garden consists of material Ø 4 inch PVC pipe and planting medium are coconut fiber, wood charcoal Galam and plastic fishing nets. Aquatic plants used in the sanitation garden as local productive crop plants.

The study used an experimental method, in which the results will be tested the validity of the model development and the difficulty (validity test, difficulty index) field conditions were identified according to tidal conditions wet.

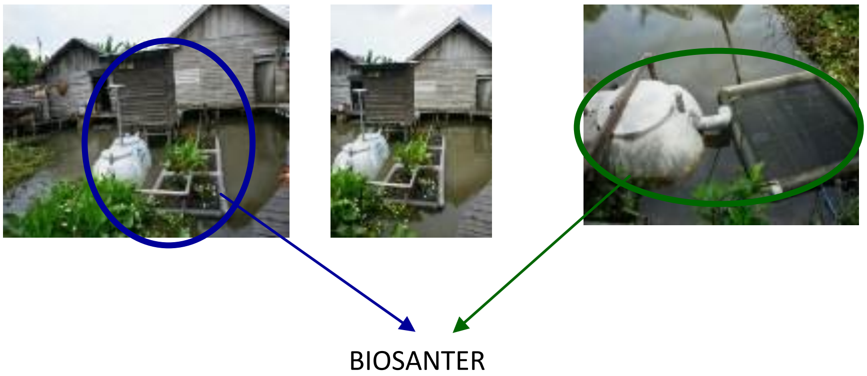

Figure 4. BIOSANTER at two locations

Parameters to be tested in this activity, including BOD, TSS, pH and oil and grease. The parameter selection is based on Ministry of Environment No. 112 of 2003 concerning the quality standard of domestic waste water and of the Governor Regulation No. 04 Year 2007 on the Quality Standard.

Data analysis will be conducted to support the development of a quantitative descriptive model for field conditions, community, and environmental quality standards-compliant.

The scope of analysis includes:

1. Completion and Requirements Volume and Mass BIOSANTER Model
2. Characteristics media local parks and aquatic plants
3. The water quality of the raw wastewater and effluent of BIOSANTER floating sanitation garden and processing efficiency.

Maximum load correlation Archimedes style: heavy tank processing depending on the BIOSANTER unit, users, water in the tank at the processing BIOSANTER unit, a variety of media, and complementary equipment

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4. RESULTS AND DISCUSSION

4.1. COMPLETION AND REQUIREMENTS VOLUME AND MASS BIOSANTER MODEL

RT 16 and RT 17 RW 02 Village Tanjung Pagar is located in the south of the city of Banjarmasin as the city water's edge at a height of 16 meters below sea level, was selected as a model where the placement and relocation BIOSANTER.

This is in accordance with the regulation on management of domestic waste water, according to the Governor Regulation No. 04 Year 2007 article 6 paragraph 5 which states must fulfill the health requirements for making buildings environmentally excreta disposal. Completion Model BIOSANTER as a model of communal wastewater treatment on the water in the of Banjarmasin city.

BIOSANTER models or models enhanced with the addition of water to the plant variation planting medium that uses local materials to support the development of models to suit field conditions, the public, appropriate environmental quality standards.

Implementation of monitoring and evaluation carried out on the model to examine the long BIOSANTER fixed processing could take place, although old BIOFIL-08 had improved because of the crack (Figure 5), hit a tree root at the bottom of the river at the time of the channel water was receding.

At a minimum tidal conditions, at the bottom of the creek looks much larger tree roots overlap between the types of trees with other trees. There is a section at the bottom of the channel covered a large plant roots are strong enough and complicated, making it difficult to cut / cut. As a result, the roots are left alone, but at

Figure 5. Cracking of BIOFIL bottom tank

the place of installation BIOFIL, very annoying because when the water is in a state of low tide, the water pressure is great enough, so that the filling is done using fiberglass resin. There is a section at the bottom of the channel covered a large plant roots are strong enough and complicated, making it difficult to cut. So the installation BIOFIL unit must be supported by wood construction, because it can not be installed directly over the water. Cracking of the bottom of the tank BIOFIL in BIOSANTER can be improved by using glue and fiberglass fibers. Then the tank leak test with raw sewage entering the water as much as 250 Liters and the water comes from the Tertiary Channel in BIOSANTER Unit located. After it was left for 3 (three) days and no leak, there was a relocation BIOFIL again located in the village of Tanjung Pagar.

4.1.1. Requirements BIOSANTER Septic Tank Volume and Mass

The new BIOFIL which used on BIOSANTER have the following specifications:

1. User Capacity: 8 -12 people
2. BIOFIL Dimensions: 2,0 m x 1,0 m x 1,50 m
3. Total Volume: 2,260 m3
4. The inlet pipe: Ø 4 inch, PVC material
5. Pipe outlet: Ø 4 inch, PVC material

Tank capacity for BIOSANTER is in conformity with the plan where the user two adult heads of families numbered 6 and 8 people, children. Based on the calculation, that the long draining of the sludge tank and tank BIOFIL -08 BIOFIL HD-08 on long BIOSANTER models planned for each, each 5.50 to 6 years.

Sludge dewatering can be done by Wastewater Management Enterprise (PD PAL) in Banjarmasin or private service providers engaged in the services of the suction and discharge sludge. Results sludging accommodated in PD.PAL and processed through the WWTP.

4.2. CHARACTERISTICS MEDIA LOCAL PARKS AND AQUATIC PLANTS

In the model BIOSANMTER, media park mounted on a 4-inch PVC pipe Ø 4 formed a rectangle measuring 3 x 1 m and is divided into 3 compartments (Figure 11) with the following characteristics:

1. The materials used to accommodate media park, from plastic mesh material is perforated with a hole size of 0.70 x 0.70 cm, a fishing net;
2. Materials Materials planting medium local / local:
    a. Waste oil, and fibers such as coir are easily obtained
    b. Charcoal Galam with a length of 4-6 cm

Figure 6. Media park consist of 4-inch PVC pipe Ø 4 rectangular shape (3 x 1 m) in 3-compartment.

While the models Original BIOSANTER, also mounted a media park of material Ø 4 inch PVC pipe 4 rectangle shaped, 1 x 1 m only in one compartment (Figure 12)

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Figure 7. Media garden consist of 4-inch PVC pipe Ø 4 rectangular shape measuring 1 x 1 m and coconut fiber for growing media

At sanitation garden units on ornamental plants grown BIOSANTER Plus, Water Jasmine; productive crops, rice; vegetable crops. Plants that are installed on BIOSANTER Lama, only one type of the Water Jasmine Plants only. The unit is also designed so that sanitation park floating, so it can go up and down to follow the local tides.

In this model application of BIOSANTER, consists of two parts, namely the processing of the bio-filter tank and planting medium layer floating (floating sanitation garden). Density of 4-inch PVC pipe Ø 4 rectangular shaped and divided into 3 compartments complete with growing medium and plants, the mass of water in the Tertiary Channel location. PVC pipe is not filled with water and the volume of water displaced tertiary channels so very large, so that the sanitation garden float (Law of Archimedes). According to the Law of Archimedes, buoyant force acting on an object that is partially or completely immersed in a fluid is equal to the weight of the fluid displaced by the object. Or buoyant force = weight of object in air - weight of object in water / liquid.

In the bio-filter tank unit consists of a fiber tanks, piping and plastic media with a total mass = 7770 kg + 10% safety factor, so that the total float = 8547 kg

$$Fa = mf = \rho f\ VBF\ g\ W\ g \tag{3}$$

With Archimedes equation, $W = FA$

$W = \rho f V b f g$, mg = ρ V g □Vbf = m / 1000 kg / m 3 = 8547/1000 = 8.55 m3

If using BIOFIL HD BF - 08 with a total volume of 2260 L size, then the tank will not float so it will be necessary Galam wood (special for contruction) and iron wood boards for installation.

In the sanitation unit floating gardens, which consist of 4-inch PVC pipe Ø, fishing nets coconut fiber, Galam wood charcoal and three kinds of plants with a total mass = 22 kg + 10% safety factor, so that the total float = 24.20 kg.

W = ρ Vg, mg = ρ V g □ V = m / 1000 kg / m 3 = 24.2 / 1000 = 0.242 m3

The volume of water displaced around 0,242 m^3 of growing media so 2 layers applied with a diameter of 1 m will float and rise when there is high tide.

4.3. WATER QUALITY OF RAW WASTEWATER INFLUENT, EFFLUENT SEPTIC TANK EFFLUENT BIOSANTER AND SANITATION FLOATING GARDEN AND PROCESSING EFFICIENCY

Wastewater samples from two houses inhabited by 14 people. Domestic wastewater is from the toilet unit which is then processed through the form BIOSANTER BIOFIL water then flowed into the sanitation garden.

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Sampling of waste water from the three-point decision at BIOSANTER model unit, at Village of Tanjung Pagar. Sampling consisted of raw wastewater, effluent water BIOFIL and water after passing through the sanitation garden for three time sampling. Waste water quality test results can be elaborated upon below, Table 2 and in graphical form as in Figure 8 with the following results:

1. BOD (Biochemical Oxygen Demand) removal 86.50 to 89.64%;
2. COD (Chemical Oxygen Demand) removal 86.48 to 89.74%;
3. TSS (Total Disolved Solid) removal 70.59 to 72%;
4. Mean pH of 6.74 in accordance with the quality standard for pH 6-9;
5. Oil and grease removal efficiency of 65-70%.

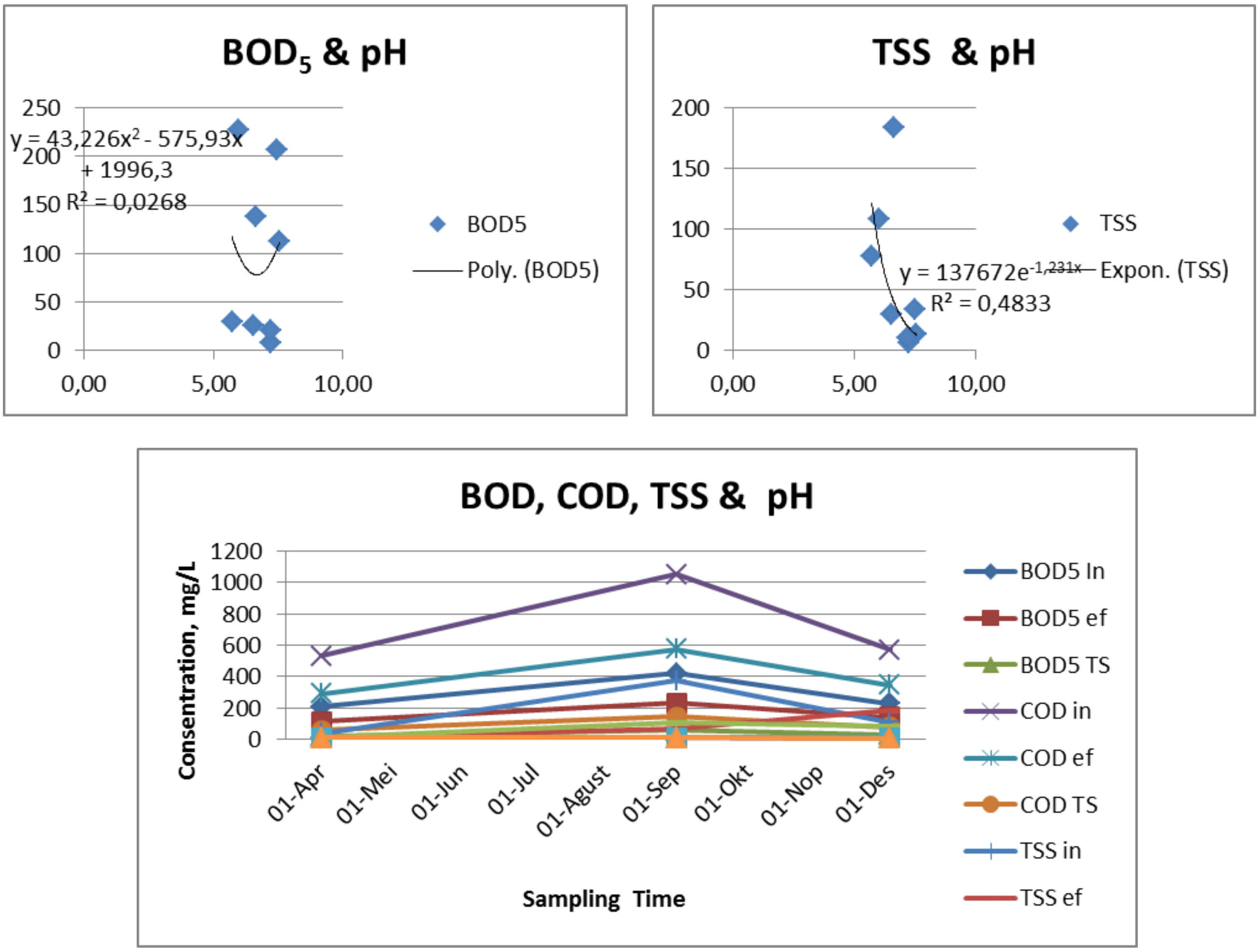

Figure 8. Concentration of BOD, COD, TSS and pH of the BIOSANTER model

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Table 2. Water Waste Quality on BIOSANTER

Parameter	06-Des	15-Sep	30-Apr	Quality Standards Regulation South Kalimantan Governor No.04 year 2007	Quality Standards Standards of the Minister of the Environment No. 112 year 2003
$BOD_{5\ In}$, mg/L	227,49	419,6	207,4		
$BOD_{5\ ef}$, mg/L	137,61	228,6	112,8		
$BOD_{5\ TS,}$ mg/L	29,89	56,63	21,28	30 mg/L	100 mg/L
$COD_{\ in,}$ mg/L	570,97	1053	528,8		
$COD_{\ ef,}$ mg/L	345,39	573,7	287,6		
$COD_{\ TS,}$ mg/L	75,09	142,7	54,27	80 mg/L	-
$TSS_{\ in,}$ mg/L	108	371	34		
$TSS_{\ ef,}$ mg/L	184	69	13		
$TSS_{\ TS,}$ mg/L	78	104	10	30 mg/L	100 mg/L
$pH_{\ in}$	5,99	7,25	7,47		
$pH_{\ ef}$	6,62	8,06	7,54		
$pH_{\ TS}$	5,71	7,76	7,2	6 - 9	6 - 9
Oil & $Grease_{in,}$mg/L	0.134	<0,005	<0,005		
Minyak & Lemak $_{ef,}$ mg/L	0,016	<0,005	<0,005		10
Minyak & Lemak $_{TS,}$ mg/L	0,038	<0,005	<0,005		10

Source: Lab. Health, Public Health Service Prov. South Kalimantan, Banjarmasin 2011 in = influent; ef = effluent; TS = Sanitation garden

5. CONCLUSIONS AND RECOMMENDATIONS

5.1. CONCLUSION

The results of the above description can be summarized as follows:

1. BIOSANTER Model located at Tanjung Pagar Village, Banjarmasin or model enhanced with the increased variety of aquatic plants with planting medium that uses local materials to support the development of models to suit field conditions, easy to obtain, easy to be imitated by community, environmental quality standards-compliant, so it can eliminate or at least reduce water pollution caused by domestic waste water in the receiving body, tertiary channel at that location.

2. The results of monitoring and evaluation BIOSANTER models to examine the treatment process still could take place as long BIOFIL broken/cracked at the bottom and fillings done and tested, and then reused at Village Tanjung Pagar;

3. BIOSANTER Model using BIOFIL Heavy Duty type with the volume of 2,260 m3, the user 14 and the sludge dewatering every 5.50 to 6 years .

4. Sanitaion floating gardens that can go up and down to follow the local tides. On BIOSANTER there is the addition of the three components of the three types of growing media and plants (Water Jasmine and rice), so that the effluent can be utilized more optimally BIOFIL.

5. Components of floating garden sanitation. Archimedes is calculated based on the formula that the Sanitaion floating gardens submerged depth of the building and load mass media media container gardens and parks in the form of PVC pipes and accessories, covering an area of 0,242 m^3 .

6. The quality of the waste water from the old unit from the unit BIOFIL BIOSANTER BF-08, already dperiksa Laboratory of Provincial Health Office in South Kalimantan. The results are the average meets the standard of waste water according to the Decree No. 112 2003 LH BOD efficiency reaches 86.50 to 89.64%, COD reached 86.48 to 89.74%, and the Suspended Solid (TSS) to 70 , 59-72%. For pH parameters diprosentasekan not yet scale figure, with a mean of 6.74 and oil and grease content of 0.38 mg / L has met the standard for the Environment No. 112 of 2003.

7. Unit BIOSANTER which has been applied in RT 16 & Rt 17, RW 02, Village of Tanjung Pagar, Banjarmasin, showed his ability to set aside contaminants as shown by effisienasi allowance ranged from 70.59 to 89.74%.

5.2. RECOMMENDATION

Recommendations from this activity are as follows:

1. Research on BIOSANTER requires special attention to the sanitation component floating sanitation gardens. So the unit BIOSANTER need assistance in planning, construction, and operation. Care, particularly for the riverside/riverbank areas affected by tidal cycles.

2. Before applying BIOSANTER units need to recognize the characteristics of the location of its application, particularly in the use of local materials as growing media and plant selection for the floating sanitation garden ;

3. Further research is needed for the planting medium on floating sanitation gardens units in order to keep afloat, but safe from the huge tidal influence. Advanced studies for placement of planting media and alternative growing media types that can be combined in order to optimize the quality of effluent water.

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