ISSN 2541-223X

DEFORMATION ANALYSIS OF PILE FOUNDATION AT SOFT SOIL USING SOFT SOIL CREEP MODEL

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ABSTRACT

A pile foundation was installed on reclaimed land with a thickness of 7-10 meters, where the reclaimed land had been in preloading beforehand. Preloading was done by giving a heap on the west side of the building as thick as 2, 5 - 3,5 meters. To speed up the process of consolidation of the reclaimed land, we could attach the drain vertically to a depth of 24 meters at a distance of 1.5 meters. Preloading lifted after the degree of consolidation in the area was estimated to have reached 70%. After preloading was complete, the structure of the foundation was built on the area of ex-preloading system in the form of pile foundation.

During the development process progresses, the observation / monitoring of lateral and vertical ground motion using inclinometer and settlement plate was performed. The observation was made by measuring the elevation and coordinate of the top base plate. From the observations, it was revealed that deformation occurred laterally and vertically. The movement in the lateral direction was expected due to differences in settlement rates between ex-preloading area to area non-preloading using vertical drain. In addition to lateral movement, vertical movement was also thought to occur due to the deformation of the pole and negative skin friction on a pole along a layer of very soft clay.

When the process of building chlorine reached 90%, a significant decrease was detected with cracks in the foundation pile. The decline in the pole was followed by the collapse of land on the west side of the embankment. As a result of this it may have been a secondary consolidation that leads to creep on soft ground. In order that the condition does not continue and lead to the collapse of buildings, it is necessary to further analyze the relation to the mechanism of soft soil behavior. The analysis is carried out by modeling the loading mechanism that is already well underway as well as to predict what kind of deformation will happen next. The analysis was conducted using modeling of soft soil creep.To analyze the process, the analysis was performed using PLAXIS 8.2 which uses finite element formulation related and integration rules for different types of elements used in PLAXIS.

The research leads to results which deform on the average of 330 - 1025 mm day was 1812.47 - 2215.26 mm and the amount of excess pore pressure of 115.06 kN / m2. It is possible to conclude that the soft ground will still continue to experience vertical direction and lateral movement during secondary consolidation and that the creep is still ongoing. It would be very dangerous for the stability of the building structure chlorine thereon. Having conducted an in-depth analysis using a model of soft soil creep on the decline pile on soft soil, it is expected that this research will shed some lights and provide an alternative treatment solution in the future.

Keywords: Creep model; Deformation; Pile foundation; Preloading; Reclamation; Soft Soil.

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1. INTRODUCTION

The foundation is a major part of the building structure to continue the work load to the ground. The less stable soil condition will lead to deformation that would endanger the buildings on it. Thus, a case in one of the buildings of PT. Pupuk Kaltim has been identified a significant decline in the building foundation. (Hanin, 2003). For the purposes of analysis, we need to identify both the initial conditions of soil at the site before the building is built and certainly the cause of its deformation. The soil condition at the building site is a reclamation area with a thickness of about 7-10 m after stripping the original ground first. Then a preloading was conducted on the west side of the building site by giving the pile as high as 2.5-3.5 m. in the area under preloading. Afterwards, vertical drain was installed to a depth of 24 m with a distance of 1.5 m. Preloading was lifted after the degree of consolidation in the area was estimated to have reached 70% at the end. At the time of preloading, once the collapse of the land east embankment preloading occurred, the counterweight to the east must be added along the 35 m towards the sea. After preloading was complete, the structure was built in the east area of ex-preloading in the form of pile foundation system.

To observe the soil movement er installed a settlement tool plate, inclinometer around the area as well as the measurements of elevation and coordinates of the top base plate foundation. From recording over the last six months after the construction of pile cap, deformation in the lateral and vertical directions has been performed. The initial assumption is that the deformation mechanisms occur not due to the burden borne by the ground but lateral movement in settlement rate is expected due to differences between the ex-preloading area by area in a location that is not given preloading and vertical drain. In general, the lateral movements occur to the north and the west. On the other hand, the movement of the vertical direction is expected to occur due to the deformation of the pole caused by the lateral movement of the pole and negative skin friction along a layer of a very soft clay. In the vertical direction, the greater deformation was to the north and to the south. The enlarged deformation toward the north is expected as the result of sizeable structural loads which was concentrated in the northern part of the building and a consolidated layer thickening to the north.

To know the exact mechanism, it is necessary to analyze the finite element method to model the loading mechanism that is already well under ways as well as to predict what deformation will happen next to obtain the appropriate counter measures.

2. RESEARCH PURPOSE

In general, the purpose of this research is to demonstrate the movement phenomenon occurring in the field and at the same time handling what takes place in the field by using a soil model of Soft Soil Creep. In detail, the research purpose includes:

1. To learn the mechanisms that causes the sizeable decrease occurring in the field to performa finite element of modeling method.
2. To predict the great and the time of the downturn, especially in the field based on the finite element analysis results which were verified with field observations.

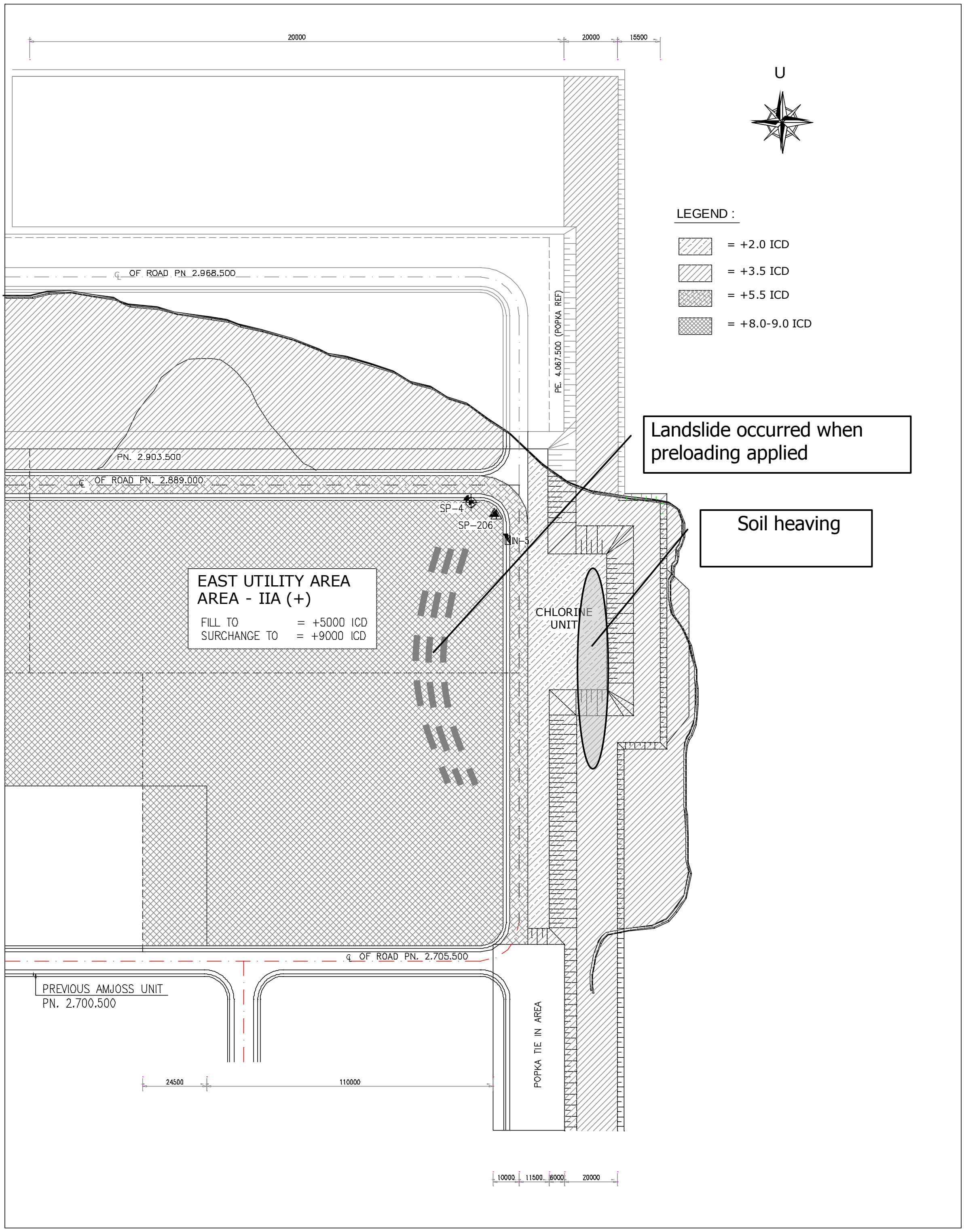


Figure 1. Preloading location and points observation around the chlorine unit

3. RESEARCH MODEL

The mechanical behavior of a soil can be modeled with variations in some levels of accuracy. Hooke's law of linear, isotropic elasticity can be exemplified as stress-stain simple relationship, which is influenced by two parameters, namely Young's modulus

(E) and Poisson ratio (ν). Generally it is still too early to determine the importance behavior of the soil. Modeling of the structural elements and the layer of rock bed is important eventhough the linear elastic models tend to be more precise.
Basically all ground experience and primary creep compression is followed by secondary compression. Secondary dominant compression occurs on soft soil, among others in the normally consolidated clay, silt and peat and usually is modeled as Soft Soil Creep. Plaids version 7 is the first to introduce the Soft Soil Creep Model. This initial version has been developed for application problems of foundation settlement, pile, etc. For unloading such problems in tunnels and other excavation work, the Soft Soil Creep model can hardly replace Mohr- Coloumb Model. As in Mohr Coloumb determination model of initial soil conditions is also essential for the Soft Soil Creep Model. The Soft Soil Creep model also enters data when pre-consolidation stress, such as this model takes into account the effects of over consolidation. To analyze this conditions we usually used a finite element method (FEM).
The limit equilibrium method by assuming the failure happened at the points along the surface failure. The Shear strength is needed to maintain the limit equilibrium conditions compared with the shear strength at the soil and will give the average safety factors along 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)).
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 of 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.

4. GEOTECHNICAL DATA

Stratography of land around the site based on the chlorine unit Boring log BHM-2 can be seen in Figure 4.

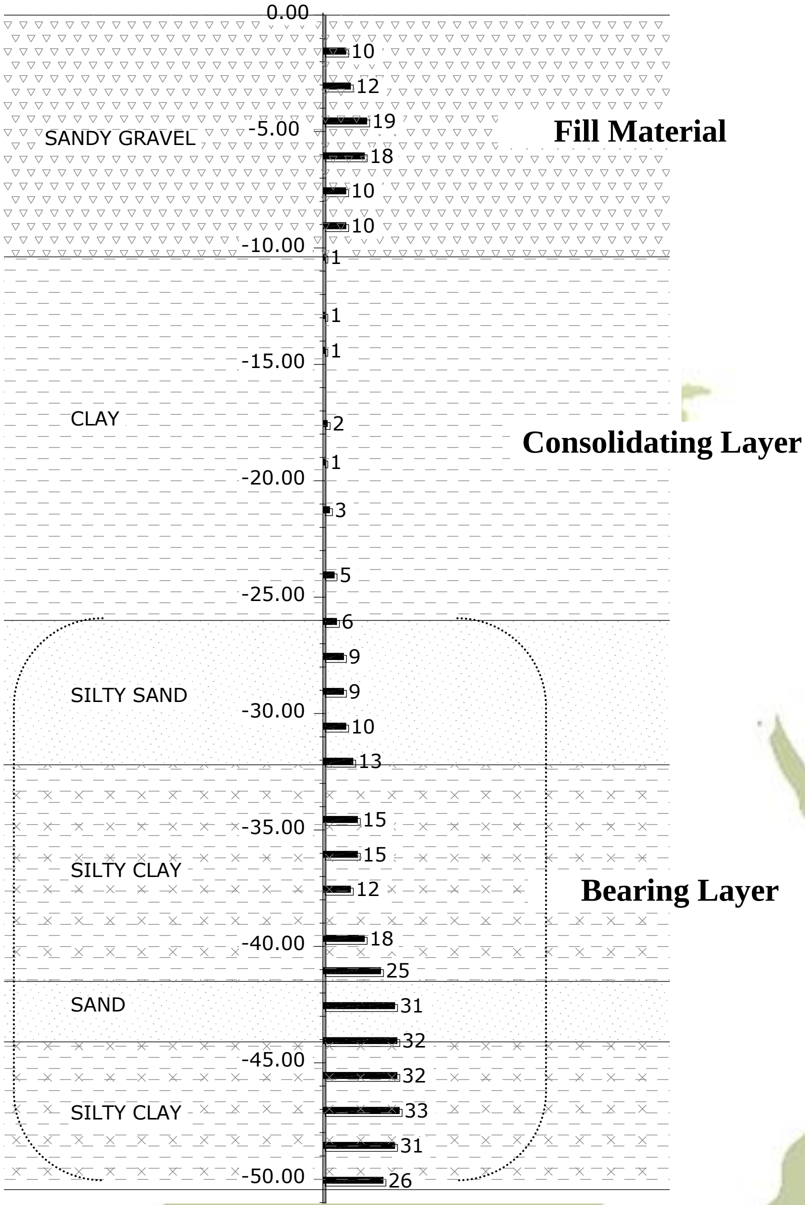


Figure 4. Stratography of land around the Chlorine unit (BHX-2)

5. RESEARCH RESULTS

The location of observation instruments around the area of analysis used to verify the results of finite element modeling is as shown in Figure 1. The instrument including field observations settlement plate and inclinometer are presented in Figure 2 , Figure 3, Figure 4 and Figure 5.

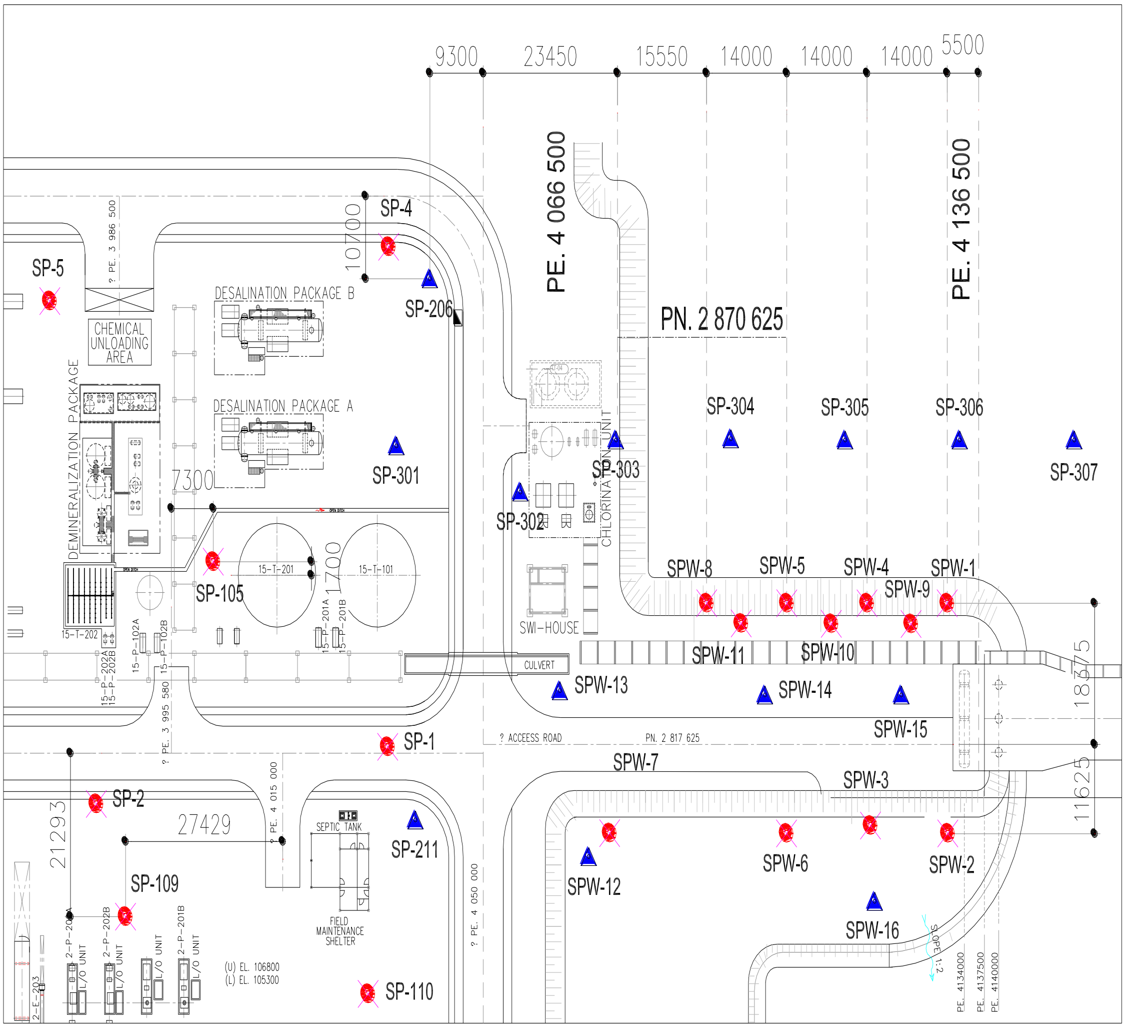


Figure 5. The Possition of the Observation Instruments in the Field

5.1. Time Rate Prediction and Final Settlement

Based on the data of soil parameters and observations in the field, the final settlement can be predicted by various methods. In this case, the calculation results is analytically verified by recording the results of Settlement Plate-4. Based on observations in the field, the ccurrence of big final settlement was predictable. The observation and the estimated settlement made by PT. Soilens during preloading is as shown in Figure 6, 7 and 8.

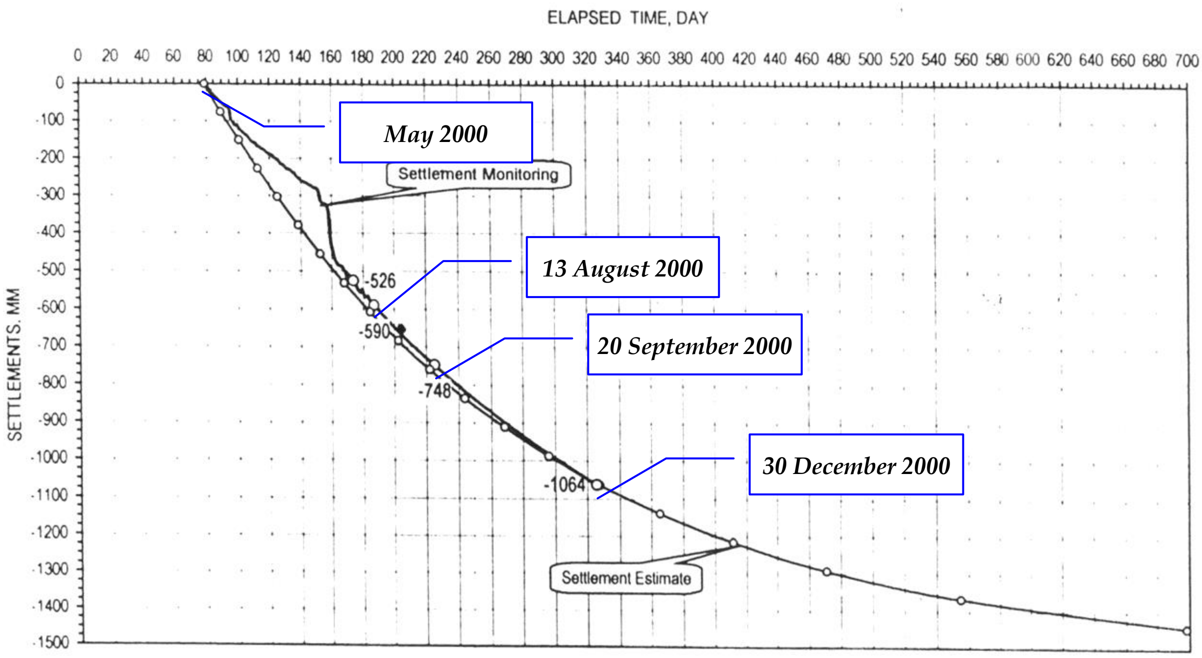


Figure 6. Results of Measurement Plate SP4 Settlement During Preloading

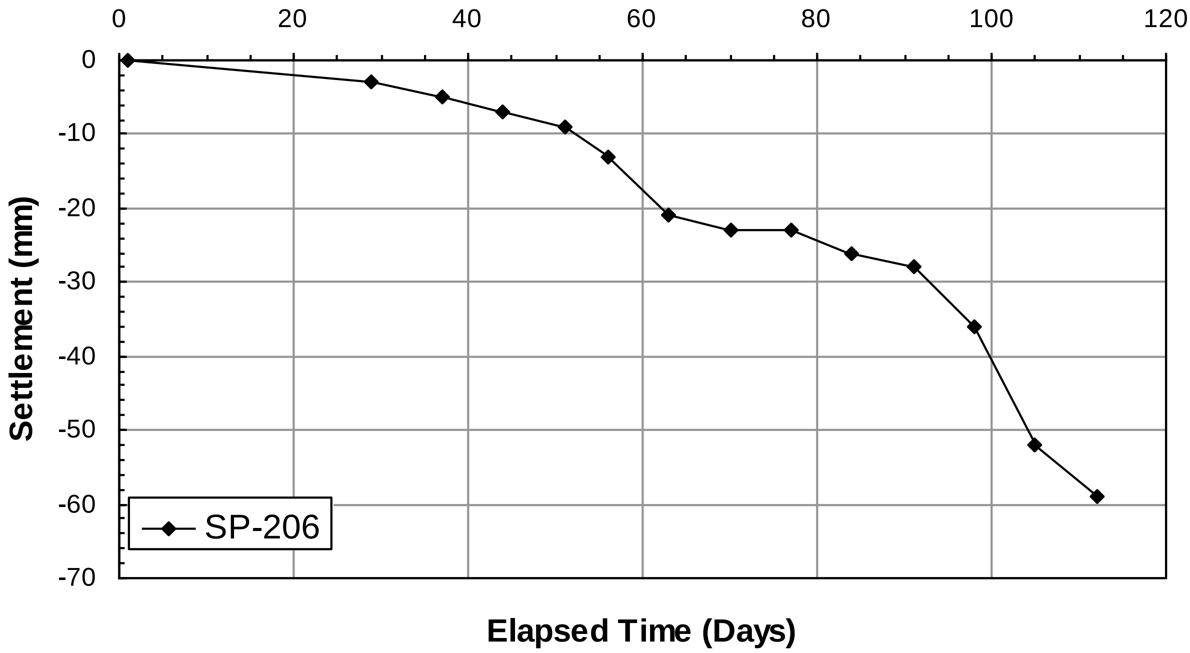


Figure 7. Observations Settlement Plate SP-206

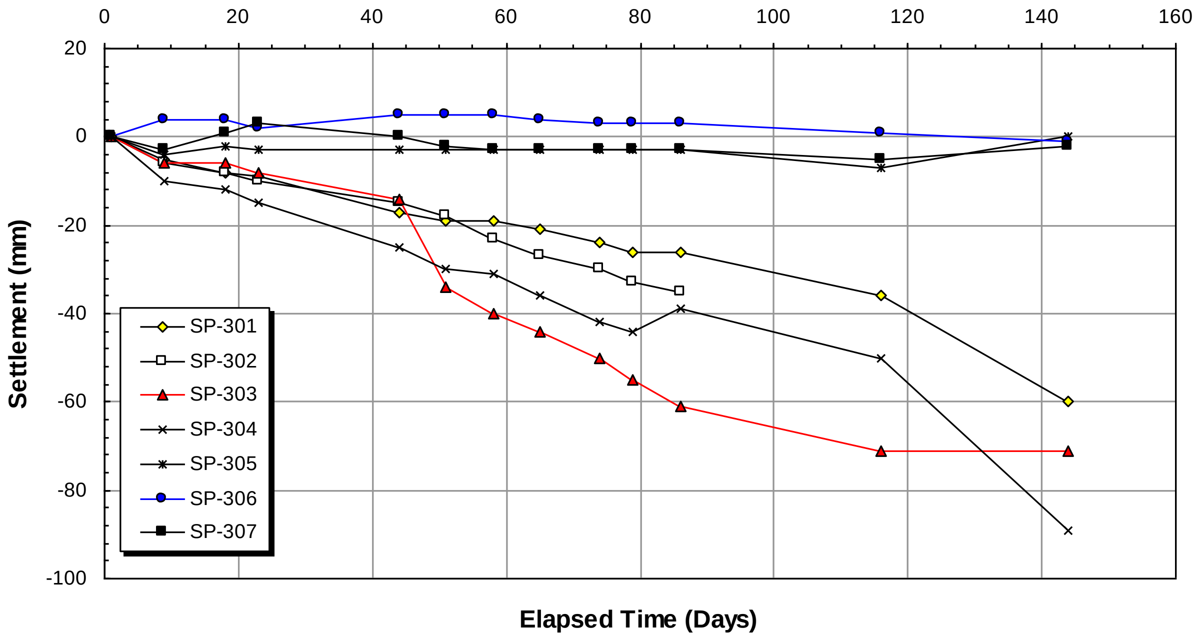


Figure 8. Observations Settlement SP301- plate SP 307

5.2. Lateral movement Directions

During preloading, great lateral movement was measured at some point as shown in Figure 9. In this analysis, what is used as a reference is the closest observation point on the west location chlorine unit which is the point IN-5.

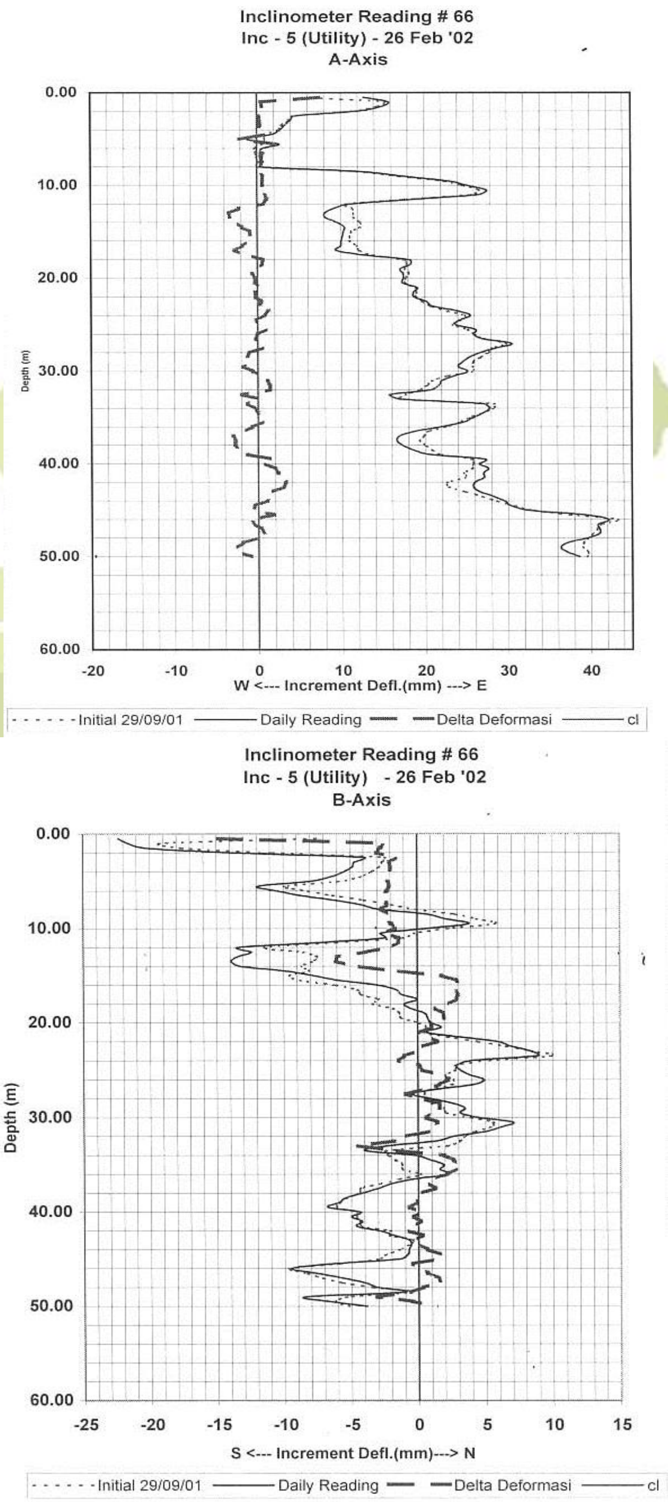


Figure 9. Observations of the Inclinometer IN-5 at the time of Preloading

5.3. Vertical Deformation

The measurement of the vertical deformation in the field is presented in Figure 6 and the results of the measurement is presented in Figures 10 and 11.

ISSN 2541-223X

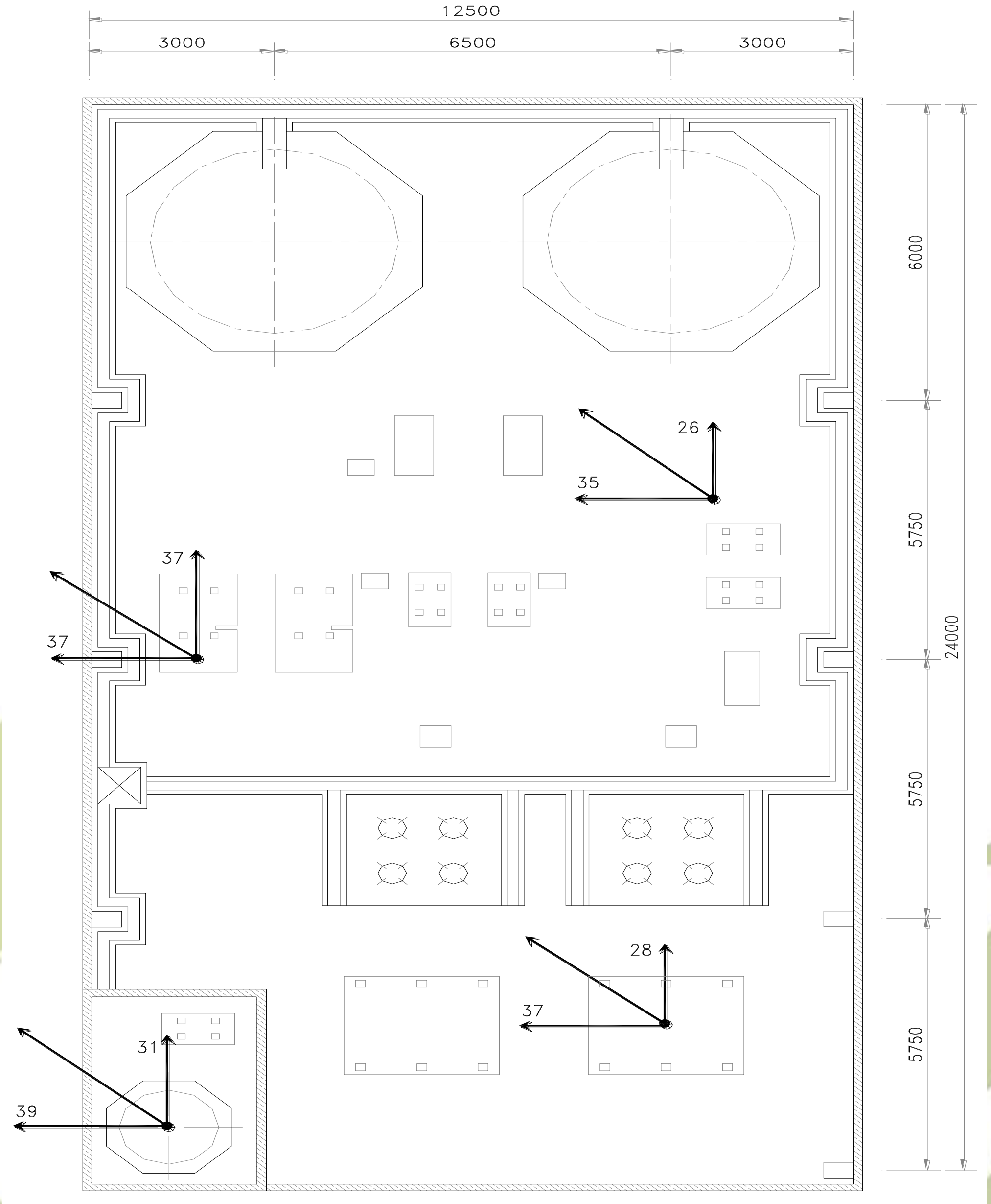


Figure 10. Location/Points of the Horizontal Deformation Measurements

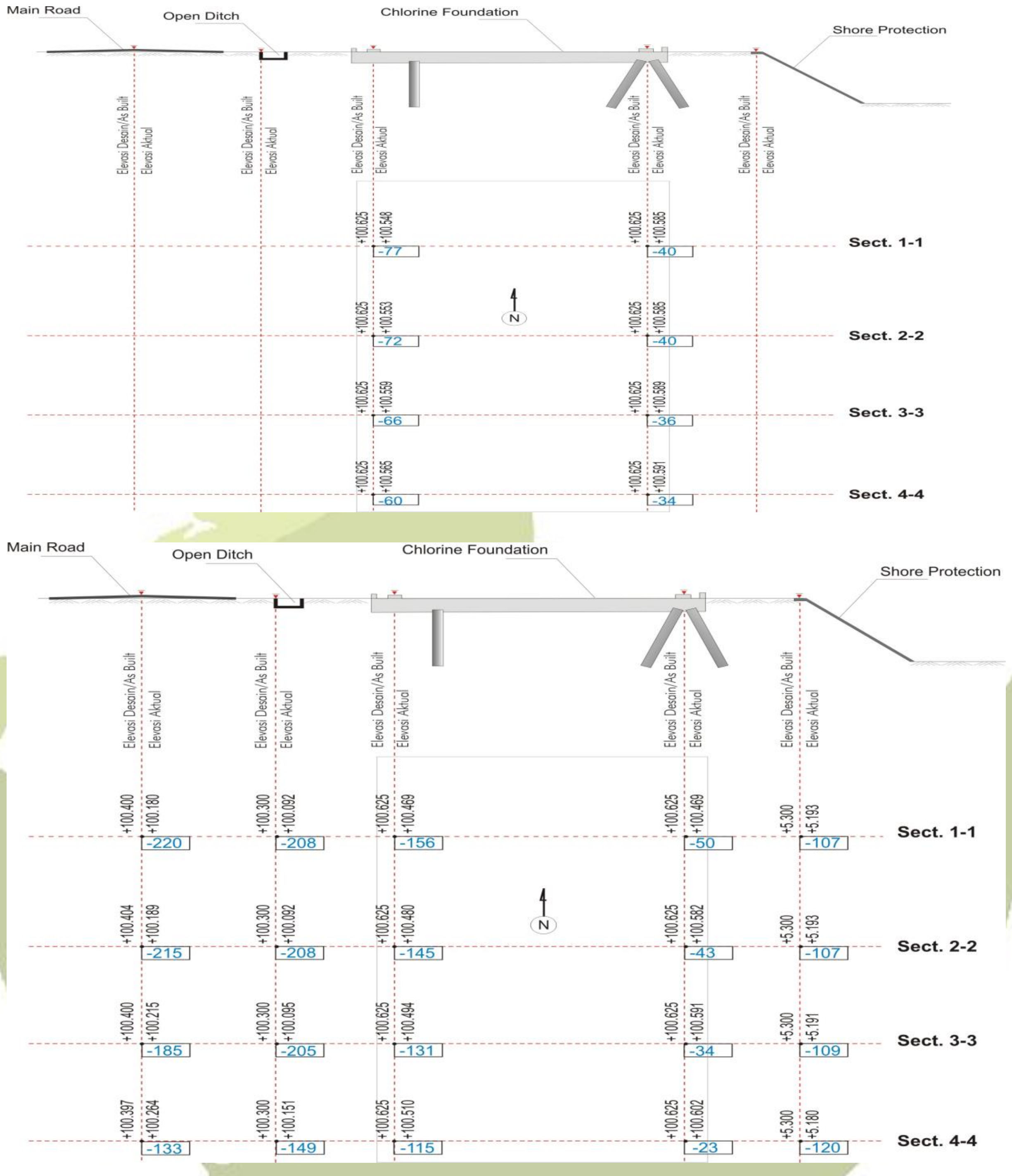
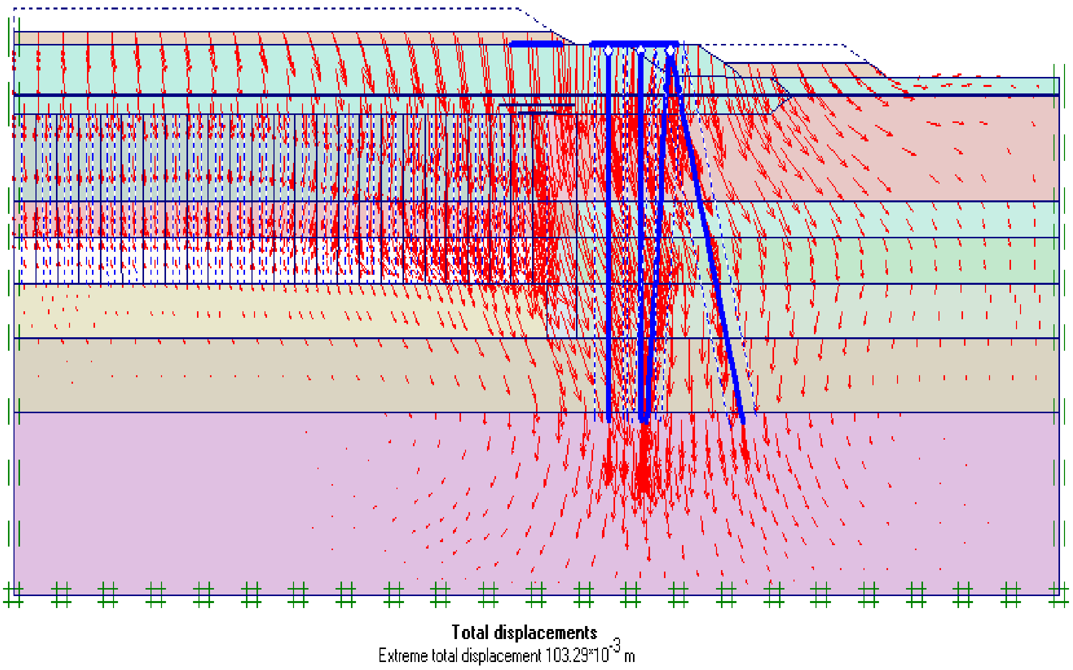


Figure 11. The results of Measurements of the Vertical Deformation around Chlorine Unit

5.4. Soil movement and horizontal deformation

The results of the soil movement and horizontal deformation using Plaxis programme is presented in Figure 12 above.



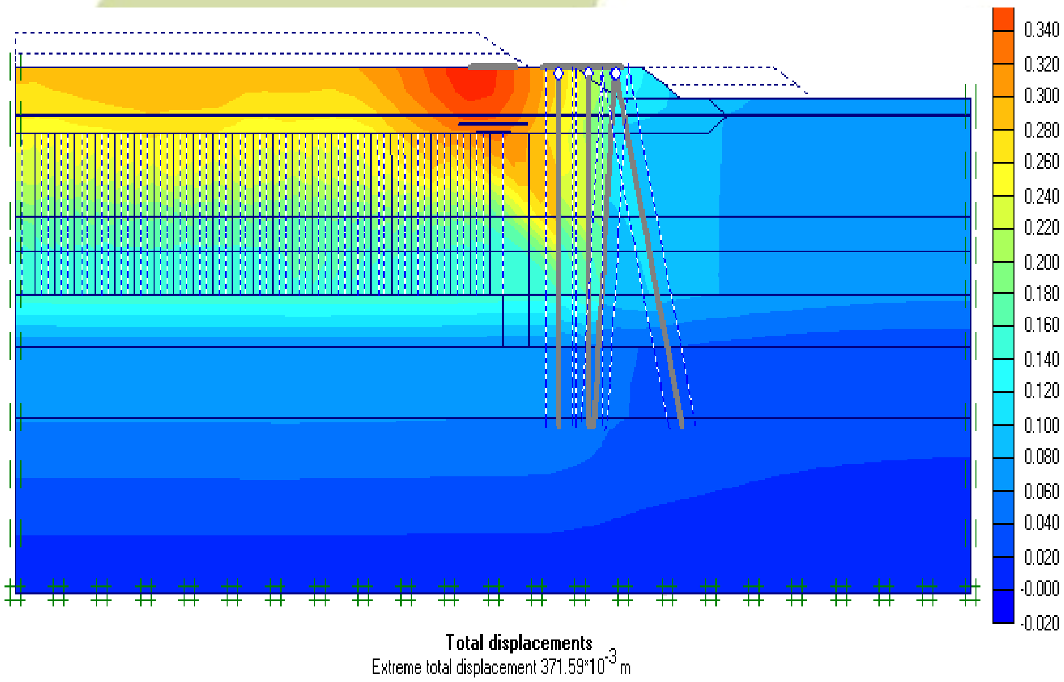


Figure 12. The Results of Total Displacement around Chlorine Unit

6. CONCLUSION

Data obtained from the modeling of soft soil consolidation model using parameter value is very sensitive so that care should be taken to match the real conditions in the field. The amount of deformation at the time of 330 - 1025 mm day was 1812.47 - 2215.26 mm and the amount of excess pore pressure was of 115.06 kN / m2. The field observations occurred at 1025 mm ground movement towards the west for settlement rate differences that occurred in the area of vertical drain and area without vertical drain.

ISSN 2541-223X

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