The 2nd International Conference :
Integrated Solution to Overcome the Climate Change Impact on Coastal Area
Semarang, Indonesia – November 19th, 2015
Paper No. A-V-102

The Improvement Of Soft Soil Layer For Toll Road Embankment On Java North Shore A Study Case On Jalan Tol Pejagan Pemalang

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***Abstract*-** To deal with soft soil, of Prefabricated Vertical Drain (PVD), Prefabricated Horizontal Drain (PHD) and geotextile were carrying out at Pejagan-Pemalang Toll Road Project. On construction, to monitor the settlement of embankment occurring due to the consolidation of soft soil, a set of settlement plates, piezometer and inclinometer were used. Settlement plate was used to monitor vertical settlement, piezometer was used to monitoring the change of excess pore pressure, and inclinometer was used to monitor the horizontally shifting embankment toe. All the monitoring instrumentations can then explain the PVD performance to accelerate the embankment consolidation.

***Keywords*:** prefabricated vertical drain, settlement plate, embankment consolidation

1. Introduction

Soft soil has characteristics which are high in compressibility, and low in shear strength, as low as less than 25 kPa. Because of those characteristics, embankment on soft soil is susceptible to slide and could produce an excessive settlement. After embankment begin, an immediate settlement will occurred and will continue with settlement due to consolidation. Consolidation process will occurred in weeks or years, depend on the depth of the soft soil layer and also depend on the ability of the soft soil to dissipate the pore water pressure occurred during embankment process. The most importance factor due to the consolidation settlement is the level of ground water, soil permeability, drain to generate pore water pressure and load. The strength of soil will increase as the consolidation process take place.

In recent, the use of Prefabricated Vertical Drain (PVD) and Prefabricated Horizontal Drain (PHD) are become ordinary because they function in significantly reduce the time for consolidation from years to month and consequently accelerate the settlement. This is because the vertical drain can accelerate the dissipated of pore water pressure during consolidation, and horizontal drain can accelerate the horizontal movement of the pressure to the side of embankment.

2. Model

2 Bor Hole equipped with soil sample for laboratory test and SPT test, and also a number of CPT test were done to investigate the base soil condition. From those soil investigation a design parameter were derived.

From the results of the soil investigation, the soil profile is obtained as in the table below:

Table 1. Soil parameters

Depth (m)	Consistency	N-SPT	E (kN/m^2)	Cc	Cs	C (kN/m^2)	Ø (°)	Ksat (m/day)	e_{init}	Cr
0 – 3	Soft Clay	3	-	0.499	0.049	16	9	5.249E-04	1.60	0.2
3 – 8.5	Medium Clay	6	4800	-	-	14	15	5.250E-04	1.10	-
8.5 – 10	Soft Clay	3	-	0.499	0.049	16	9	5.249E-04	1.60	0.2
10 – 16	Medium Clay	6	4800	-	-	14	15	5.250E-04	1.10	-
16 – 30.5	Stiff Clay	10	10000	-	-	26	14	3.900E-04	1.40	-
30.5 – 40	Very Stiff Clay	25	25000	-	-	39	23	2.200E-04	1.25	-

Based on numerical calculations using Plaxis program, the results obtained were presented in Figures 1 and 2 below:

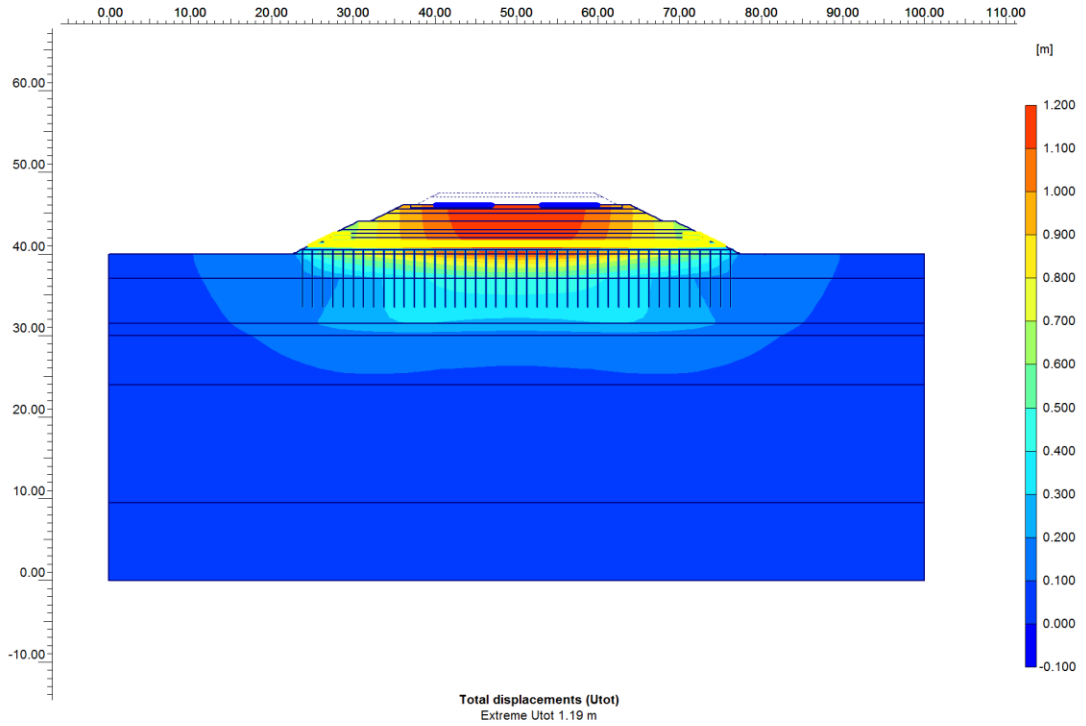

Figure 1. Total displacement as a results on consolidation process

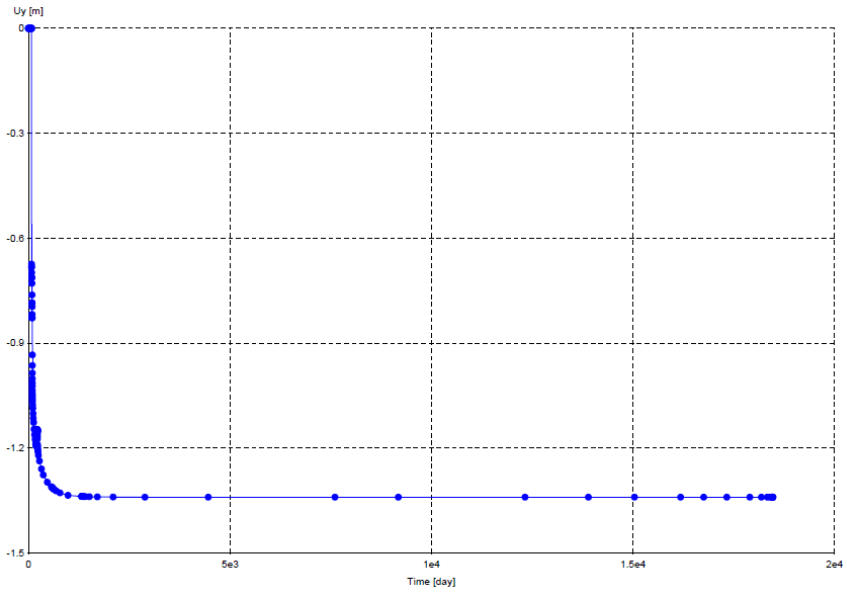

Figure 2. The prediction of consolidation settlement using numerical methods

In the construction process first it was start with clearing then continued with the installation of PVD as deep as 7 m with a distance of 1.25 m (center to center) with a triangular pattern. After PVD have been installed it were continued with the installation of PHD and then followed by the installation of geotextile (Figure 3). After all the material correctly installed next is the installation of settlement plate at elevation + 45,500 (Figure 4) and covered with embankment accordance with the final elevation plan and aggregate material as preloading (Figure 5).

For monitoring the occurred performance of embankment, it was performed by installation of instrumentation equipment in the form of 4 settlement plates (for settlement monitoring), 2 inclinometers (for lateral deformation monitoring), 2 piezometers(for monitoring the pore water pressure).

Figure 3. Installation of PVD and PHD

Figure 4. Installation of settlement plate instrument

Figure 5. Installing the preload

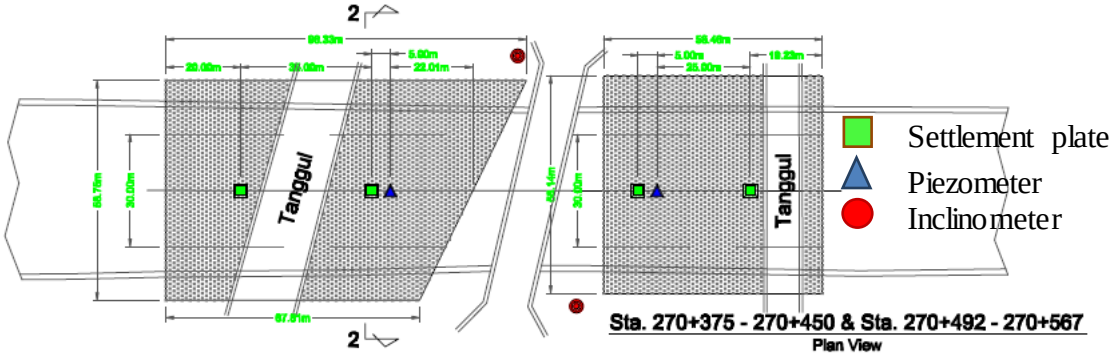

Figure 6. Configuration of instrumentation

3. Monitoring

The results of settlement plate reading to measurethe consolidation settlement according to the rise of embankment are presented in the following figure (Figure 8). While for the inclinometer results and the piezometer results are presented in the Figure 9 and 11.

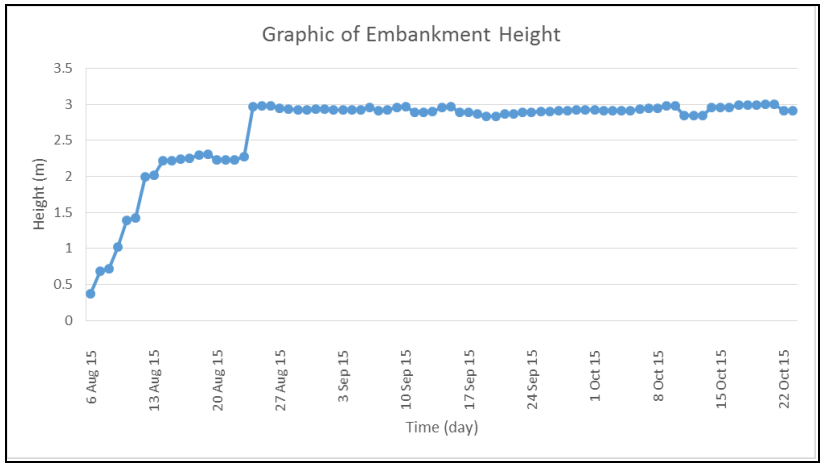

Figure 7. Gradually rise of embankment preload

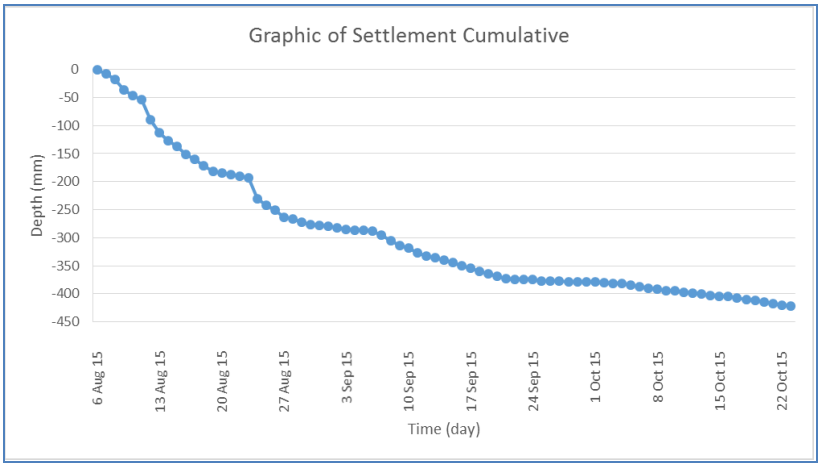

Figure 8. The results of settlement plate reading

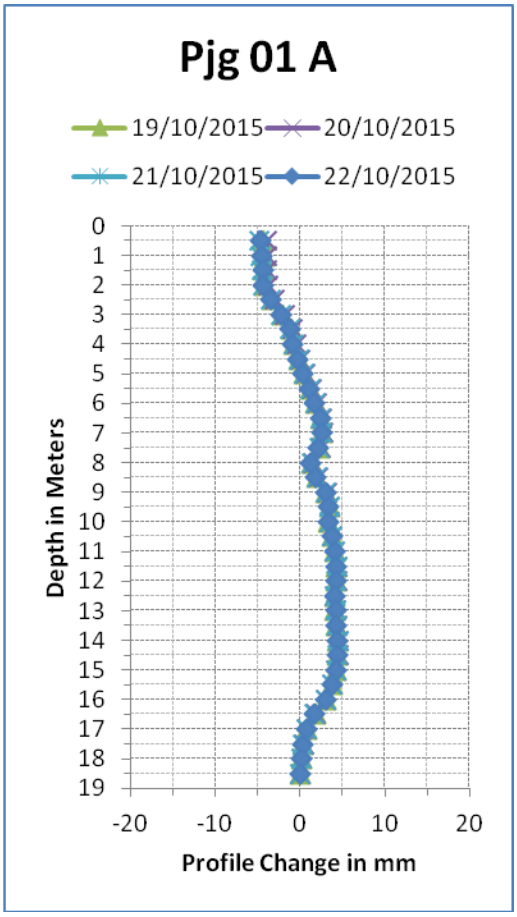

Figure 9. The results of inclinometer reading

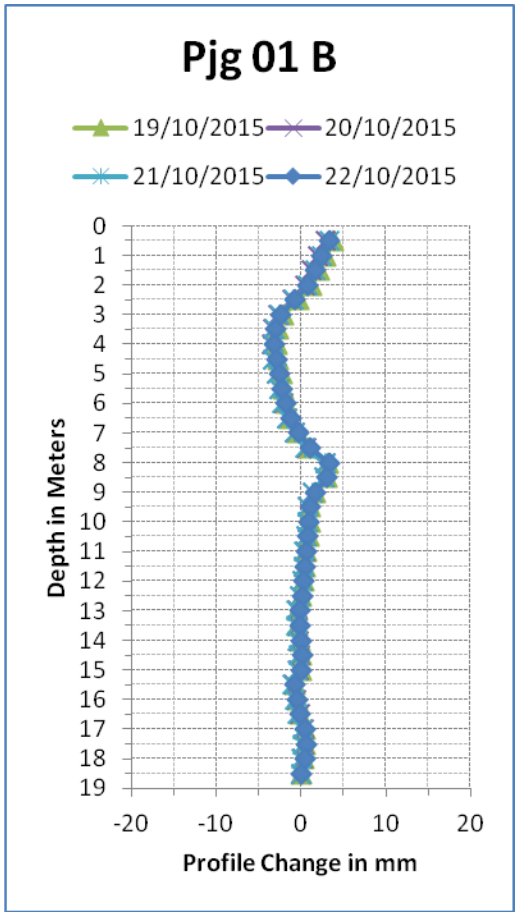

Figure 10. The results of inclinometer reading

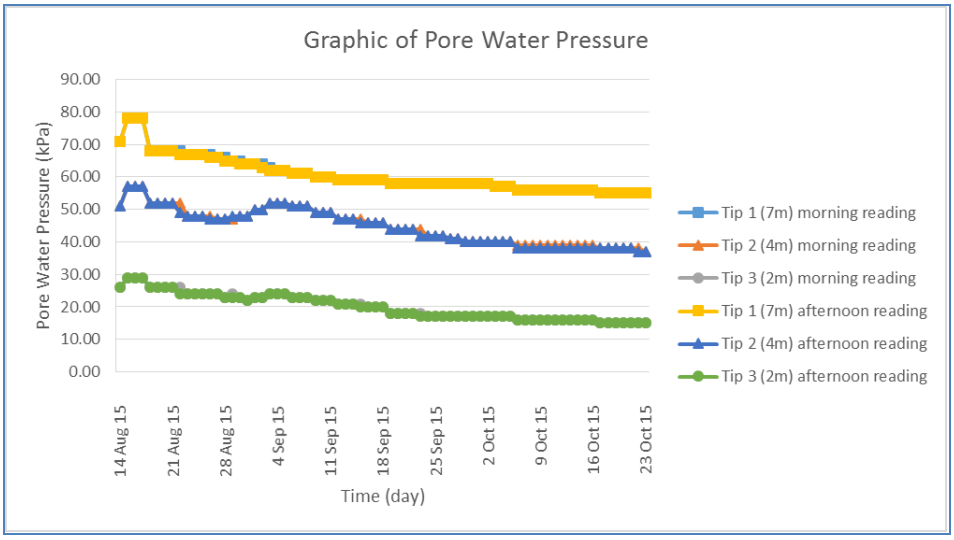

Figure 11. The results of piezometers reading

4. Comparison to Real Measurement

From the results of settlement plate reading, then back analysis were performedto estimate the consolidation settlement by the use of Asaoka Method (1978) with the resultas in the following figure (Figure 13).

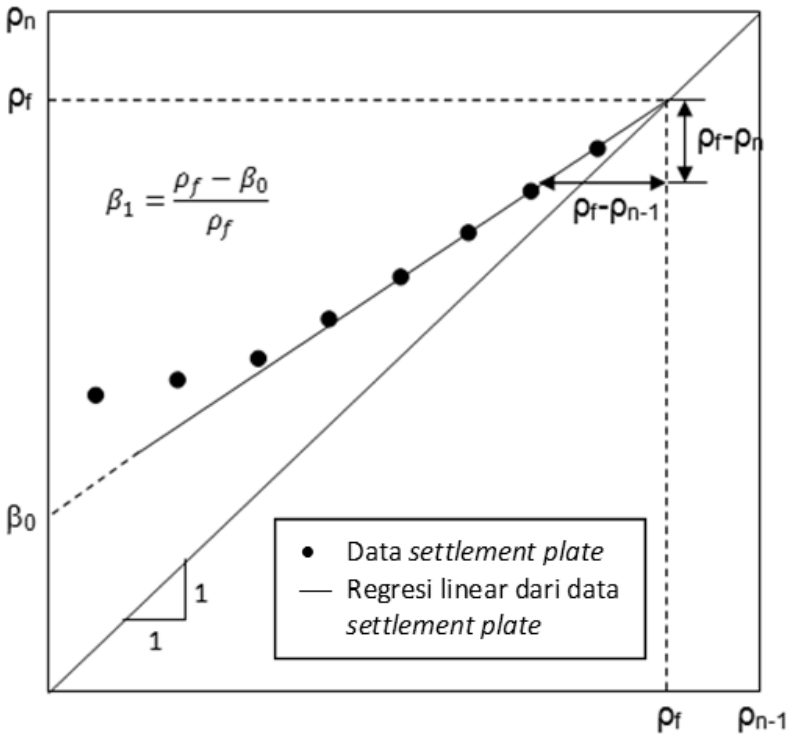

Figure 12. An Estimate of Total Consolidation Settlement According to Asaoka Method

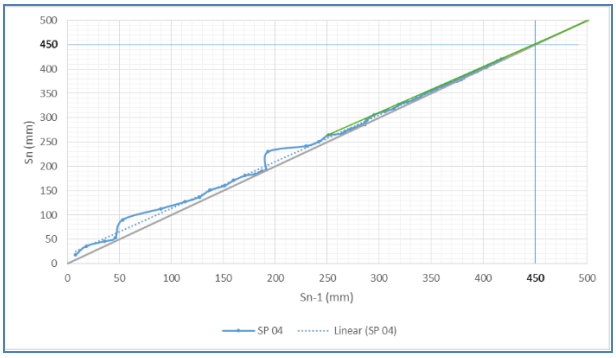

Figure 13. An estimate of consolidation settlement according to Asaoka Method

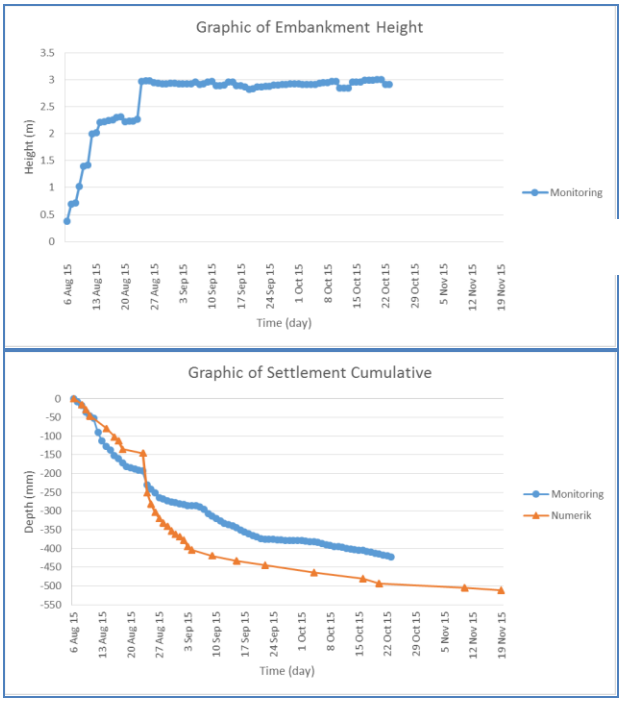

Figure 14. Comparison of numerically settlement and the results of monitoring by instrument

5. Conclusion

With the use of numerical model the value of embankment settlement accelerated by PVD were examined and compared. Base on the calculation and monitoring at site during construction, the soil improvement method shown good performance and could become an alternative solution to improve soft soil on road embankment construction.

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