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Soil Improvement and Embankment Stability Using Combination of Preloading and Prefabricated Vertical Drain (PVD)

Study Case: Double Track Railway Sepanjang-Mojokerto Km. 48+800 To Km. 48+950

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ABSTRACT

The construction of Double Track Sepanjang-Mojokerto KM 48 + 800 to KM.48 + 950 passes through an area with soft and compressible subgrade soil known from field testing data. After analyzing and calculating the settlement value, high settlement value is obtained for a long period. Efforts to solve the settlement problem in this study are to accelerate the settlement time using the Prefabricated Vertical Drain combined with Preloading. The use of this method aims to accelerate the process of settlement in the soil and increase the value of the soil shear strength (Cu) so that the subgrade becomes more stable also utilizes the pressure from the embankment, which also functions as a load (surcharge) that has been adjusted to traffic and construction loads. PVDs were installed with different patterns and spacing variations in order to calculate the efficiency of installation. Based on consideration of the number and time of PVDs to achieve 90% consolidation, a rectangular installation pattern with a spacing of 1.5 meters was selected, which was installed as thick as compressible soil layer at each point. The PVD calculation used settlement data obtained from the sum of consolidation settlement (SC) and immediate settlement (SI) from variations in the height of the embankment depicted in graphical form, which resulted in a polynomial equation. From this equation, the backfill requirement used to achieve the planned elevation of the embankment after the subgrade was installed with PVDs was obtained. Subgrade backfilling was carried out with a planned embankment height of 9-10 meters. The calculation was continued to find the increase in Cu of the subgrade and then analyzed for stability using the Geoslope program. The results of the final stability analysis after the soil improvement method at the point under review ranged from 1.8 to 1.98 and it was safe.

1. Introduction

Railway tracks are built on soil that must be strong enough to withstand the loads and forces generated during construction and post-construction, expressed by a safety factor (SF) [1]. The problem that often occurs in road and railway embankments is the occurrence of landslides or construction instability on soft soil without reinforcement [2]. Based on the data from the soil layer testing conducted on KM. 48+800 to KM. 48+950, planning for a double-track railway (KA) Sepanjang-Mojokerto was passing through areas with very soft and compressible soil conditions. Soft and compressible soils have low carrying capacity, large settlement values, and long consolidation times [3]. Therefore it is necessary to improve the soil to increase its carrying capacity and eliminate its settlement.

Soil improvement using Prefabricated Vertical Drains combined with Preloading aims to speed up the settlement process and increase the shear strength of the soil, which has an impact on more stable soil [4], [5]. The preloading method utilizes the pressure from the embankment, which also functions as a surcharge. The design stockpiles are exaggerated by calculating the traffic load which is intended as a substitute for the traffic load. After a very

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small settlement, the traffic load was unloaded to obtain the design elevation [4], [5].

Based on the problems mentioned above, a study was conducted to determine the bearing capacity and stability of the embankment using a combination of soil improvement using the Prefabricated Vertical Drain (PVD) and Preloading methods (Case Study: Double Track Long-Mojokerto Railway KM. 48+800 to KM. .48+950).

2. Method

2.1 Research Location

This research is included in the Sepanjang-Mojokerto double-track railway construction project KM. 43+800 to KM. 49+500. However, in this final project, the kilometre reviewed is 150 meters long, KM. 48+800 to KM. 48+950 located in Tarik Village, Tarik District, Mojokerto, East Java. The purpose of this research reviewing the site because this area is categorized as the softest soil zone based on the construction planning module of this project. The location of the research area can be seen in Figure 1.

2.2 Data Collection

At this stage, the data collection needed for research is carried out. The data include soil characteristics, embankment specifications, embankment design drawings, soil improvement and strengthening. In this study, some of the data needed include:

1. Soil Test Data
2. Embankment Design
3. Shop Drawing

2.3 Calculation of Load and Settlement

Before carrying out the calculation, it is necessary to know the load distribution based on the axial load regulated according to Peraturan Menteri No. 60 [1] and . The load, which is initially axial, is distributed into a uniform load using several methods. The load will later be replaced with embankment soil which is useful as a preloading load that is added up to the design embankment height [6].

The settlement that occurs is the sum of the immediate settlement (Si) and the consolidation settlement (Sc). Immediate settlement usually occurs in soils with coarse grains. The amount of immediate settlement (Si), is determined by equation (1) [4].

$$Si = \frac{q_n}{E} Ip^B \tag{1}$$

$$Ip = (1-\mu^2)F_1 + (1-\mu-2\mu^2)F_2 \tag{2}$$

Where *Si* is the immediate settlement, *qn* is pressure due to load, *B* is the width of the embankment, *L* is the length of the embankment μ is the Poisson ratio, *I* is the influence factor and *F1*, *F2* is Steinbenner coefficient

Figure 1. Research Location

Settlement of consolidation occurs in fine-grained soils where the volume changes as a result of the release of water that occupies the soil pores [3]. The soil at the study site is normally consolidated soil. The value of the decrease in consolidation with normally consolidated conditions uses equation (3) [4].

$$Sc = C_c \frac{H}{1+e_0} \log \frac{P'_0 + \Delta P}{P'_0} \quad (3)$$

where H is compressible layer thickness, eo is the void ratio, Cc is compression index, ΔP is stress due to embankment, and $P'o$ is vertical effective soil pressure from a point in the middle of the layer caused by the weight of the soil itself (effective overburden pressure)

2.4 Calculation of Embankment Height

The initial construction embankment height is not the same as the planned embankment. This is because at the time of construction, the embankment height has been added to the traffic load, and the thickness of the decline has been calculated as Hinitial by the equation (4).

$$\text{Hinitial} = \frac{\text{q final} + (\text{Stot x } \gamma_{emb} + \gamma_w - \gamma_{sat-emb})}{\gamma_{emb}} \quad (4)$$

where:

$$q = (H_{initial} - \text{Stot}) \text{ x } \gamma_{emb} + \text{Stot x } \gamma_{sat-emb} \quad (5)$$

Then, Hfinal can be found with the equation (6)

$$H_{final} = H_{initial} - H_{traffic} - \text{Stot} \quad (6)$$

where *Hinitial* is the initial height of the embankment, *Hfinal* is the final height of the embankment, *Stot* is the total settlement, *γemb* is the bulk density of the embankment, and *γsat-emb* is the bulk density effective of the embankment (γemb - γwater)

2.5 Settlement Time

Clay soil takes time to consolidate, which can be said to be relatively long. This happens because the layers of clay are very dense and tend to be watertight. Consolidation time (t) is calculated using equation (7) according to Terzaghi [3] :

$$t = T_v \cdot \left(\frac{H_{dr}}{Cv}\right)^2 \quad (7)$$

where t is consolidation time, Tv is Terzaghi time factor, Hdr is the longest distance the soil pore water can flow out, and Cv is vertical consolidation coefficient

2.6 PVD calculation

Spacing Factor of PVD

The value of the spacing factor (*Fn*), according to Hansbo, simplified by Christiady [4], can be calculated by equation (8).

$$Fn = \ln\left(\frac{D}{dw}\right) - 0{,}75 \quad (8)$$

where *Fn* represent the spacing factor, *D* is diameter of an influence/drainage zone surrounding a PVD, D = 1.13 S for triangle pattern, and D = 1.05 S for square pattern, and Dw = (2(a+b))/π.

Degree of Consolidation

The average degree of consolidation is calculated using an equation by Carillo (equation 9) [4]:

$$U_{total} = \left(1 - (1 - u_h) \cdot (1 - U_v)\right) 100\% \quad (9)$$

with :

$$Uv = \left(2\sqrt{\frac{Tv}{\pi}}\right) \times 100\% \quad (10)$$

$$Uh = \left(1 - \left\{\frac{1}{e^{\left(\frac{t \times 8 \times Ch}{D^2 \times 2 \times F(n)}\right)}}\right\}\right) \quad (11)$$

where *Utotal* is the total degree of consolidation, *Uv* is the degree of vertical consolidation, *Uh* is the degree of horizontal consolidation, *Ch* is the coefficient of consolidation due to horizontal pore flow, *Hdr* is the distance of soil pore water to flow from the longest point,

2.7 Increase in Cu Values

The increase in Cu value occurs due to the increased stress received by the soil before receiving the embankment load. The new Cu calculation uses the equation according to Ardana and Mochtar (1999) [4], which can be seen in equation (12)

$$\text{Cu (kg/cm}^2) = (0{,}0737 + (0{,}1899 - 0{,}0016\ \text{PI})\sigma'_p \quad (12)$$

where PI is plasticity index (%), and $\sigma p'$ is vertical soil stress (kg/cm2)

2.8 Final Stability Check

The final stability analysis is used to re-examine whether the soil and embankment's stability is safe according to SNI Geotechnical planning 2860:2017 [7] where minimum SF > 1.5. Stability analysis in this study uses the Geoslope auxiliary program.

3. Results

3.1 Soil Data

The soil data used in this study used data from the Cone Penetration Test, which was correlated based on the correlation of soil types [8], and then continued with the correlation to obtain the soil parameters used for analysis and calculations. Correlation of soil parameters using the relationship that has been determined by Mayerhoff [9], Terzaghi and Peck [10], Burt Look [11], Biarez and Favre [12]. The results of the correlation of soil data from Cone Penetration Test are then used to create soil stratigraphy (Figure 2) with the aim of facilitating soil classification from several observation points.

Based on the soil stratigraphy (Figure 2), it can be seen that the top layer of soil from KM.48+800 to KM.48+950 is a clay-type soil with a depth range of 1 to 4 meters which, based on soil investigations, is said to be soft clay. The layer after the clay is a layer of silty clay which is found at all points with a depth range of 4 meters to 8 meters

3.2 Loading

The load used in this study is the load that is distributed over the embankment soil. This load has been through the calculation of distribution on the embankment structure in the form of rails, bearings, ballast, and sub-ballast with consideration of dead load and dynamic load based on PM 60 of 2012 [6]. The load distribution value for the embankment is 45.689 kN/m^2.

3.3 Calculation of Derivation, Hfinal, and Initial

Settlement due to expenses is the sum of consolidation settlements and immediate settlements. Calculation of consolidation settlement (Sc) is carried out by dividing the compressible layer with a thickness of 1 meter with the aim of obtaining a more accurate settlement value. Variations of the embankment are made with a total height of H, 7 m, 8 m, 9 m, up to 12 meters, where the embankment height is made higher than the final H, which will later decrease. Calculation of Sc value based on equation (3). The recapitulation of Sc values for all locations can be seen in Table 1.

Table 1. Recapitulation of Sc values for each embankment variation

H	q_o kN/m^2	Stot m	H initials m	H-Traffic m	H Final m
7	121,590	1,995	7,877	2,630	3,252
8	138,960	2,182	8,960	2,630	4,147
9	156,330	2,352	10,034	2,630	5,052
10	173,700	2,507	11,103	2,630	5,965
11	191,070	2,650	12,165	2,630	6,886
12	208,440	2,782	13,224	2,630	7,811

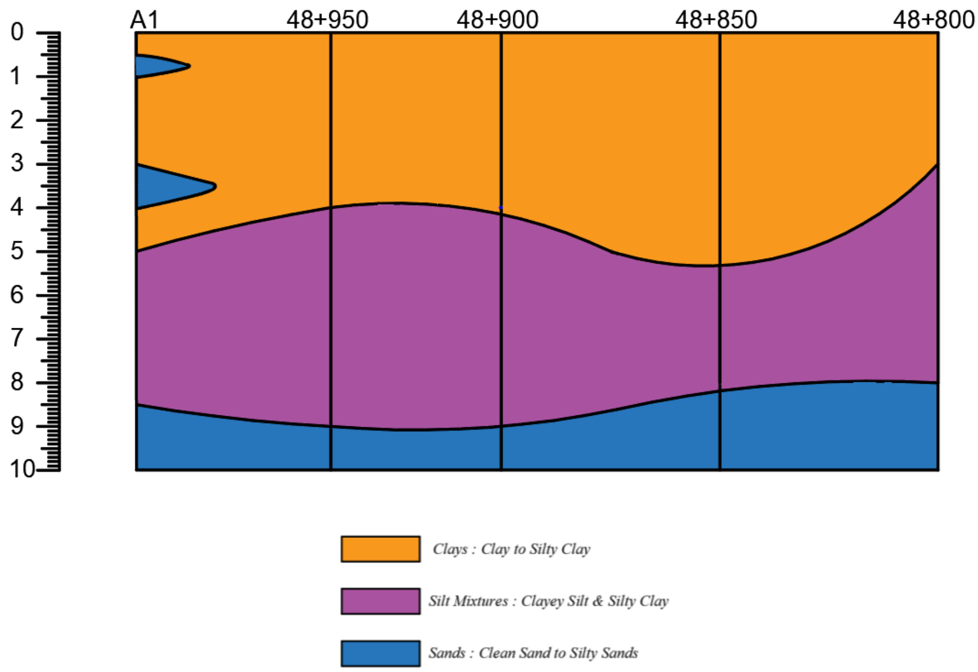

Figure 2. Soil Stratigraphy

The calculation of immediate settlement is taken into account because there is a layer of unsaturated clay at each point. This was also stated by Hardiyatmo HC [4], who estimated the immediate settlement that occurred due to the suppression of air coming out of the soil pores. The recapitulation of the calculation value of immediate decline (Si) in this study uses the equation according to Steinbenner in Hardiyatmo HC [4], whose results can be seen in Table 2.

Table 2. Recapitulation of Si values for each point

KM.	Si (meters)
48+800	0.0577
48+850	0.0597
48+900	0.0684
48+950	0.0897

After calculating the magnitude of consolidation settlement (Sc) and immediate settlement (Si), the settlement results are added up to continue calculating the initial embankment height, namely the embankment whose height is adjusted to settlement and load (Initial) and the planned embankment height (Hfinal). The initial is calculated from the total load due to traffic, embankment, and settlement divided by the volume weight of the embankment. The calculation of initial and Hfinal values at KM.48+800 can be seen in Table 3.

Table 3. Initial and Hfinal calculations at KM 48 + 800

H	q o	Stot	H initials	H-Traffic	H Final
	kN/m2	m	m	m	m
7	121,590	1995	7,877	2,630	3,252
8	138,960	2,182	8,960	2,630	4.147
9	156,330	2,352	10034	2,630	5052
10	173,700	2,507	11.103	2,630	5,965
11	191,070	2,650	12.165	2,630	6,886
12	208,440	2,782	13,224	2,630	7,811

Calculation results of Hfinal with several variations of embankment height in KM. 48+800, which are summarized in Table 3, then a graph of the relationship between the Hinitial and the Hfinal (Figure 3) and a graph of the relationship between the Hfinal and the settlement (Stot) (Figure 4) produce an equation that will be used to calculate the design height and settlement (Table 4). and Table 5).

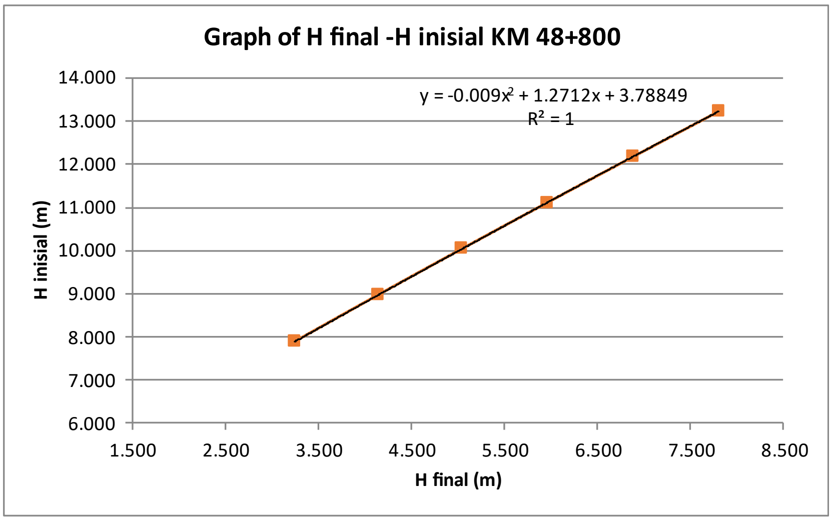

Figure 3. Graph of Hfinal-Initial KM.48+800

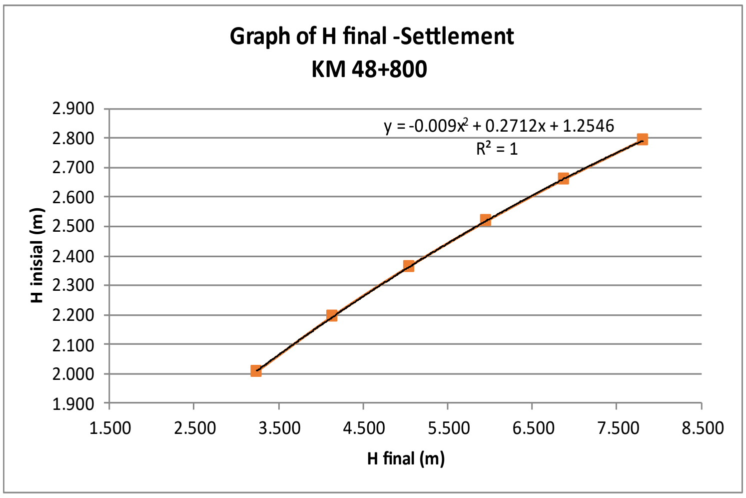

Figure 4. Graph of Hfinal-Settlement in KM.48+800

Table 4. Recapitulation of Hfinal-Hinitial calculations for all points

KM	H Final m	Equation of the final H with the initial H	H initials m
48+800	5.04	$y = -0.009\ x^2 + 1.2712\ x + 3.78849$	10.00
48+850	4.90	$y = -0.009\ x^2 + 1.262\ x + 3.6987$	9.67
48+900	4.72	$y = -0.0109\ x^2 + 1.3238\ x + 3.8304$	9.83
48+950	4.28	$y = -0.0104\ x^2 + 1.312\ x + 3.6997$	9.13

Table 5. Recapitulation of Hfinal-Settlement points calculations

KM	H Final m	The final H Equation with Derivation	Decline m
48+800	5.04	$y = -0.009\ x^2 + 0.2712\ x + 1.2546$	2.39
48+850	4.90	$y = -0.0085\ x^2 + 0.262\ x + 1.0684$	2.15
48+900	4.72	$y = -0.0109\ x^2 + 0.3238\ x + 1.2001$	2.49
48+950	4.28	$y = -0.0104\ x^2 + 0.312\ x + 1.0694$	2.22

Table 6. Calculation of descent time without acceleration

KM.	Cv gab m2 / day	T(90%)	Hdr m	Stot m	t year
48+800	0.01036971	0.85	8	2.39	14,339
48+850	0.008146341	0.85	8	2.15	18,252
48+900	0.008579325	0.85	9	2.49	21,935
48+950	0.009620043	0.85	9	2.22	19,562

3.4 Settlement Without Acceleration

Calculation of the length of time for the descent without acceleration is carried out by equation (7). Calculation of the time for the descent without acceleration (t) uses the table of variations of the time factor on the degree of consolidation 90%[13] obtained a T value of 0.85. The Hdr value is the longest distance for the pore water to flow, with a different layer of clay at each point, and without a layer of sand in between or within it, the pore water only flows to the surface or what is commonly called (single drained). The results of calculating the lead time without acceleration are shown in Table 6.

Based on the results of the settlement calculation time, it can be seen that each point takes a very long time to reach a degree of consolidation of 90%, which ranges from 14 to 21 years. The cause of the difference in the descent time for each point is the distance of the Hdr at each point. The greater the Hdr, the longer the required settling time. In addition, the Cv value is also a factor in the length of time it takes to decrease. The greater the Cv value, the faster it takes. Therefore it is necessary to plan to accelerate the settlement by installing a Prefabricated vertical drain (PVD) combined with preloading so that the consolidation process can run faster.

3.5 Settlement Time with PVD

The PVD used for planning in this study was installed along the compressible layer of each layer of KM. 48+800 - KM.48+950 with a rectangular (square) and triangular installation pattern. The PVD used is the CeTeau-Drain CT-D822 type with thickness (a) of 100 mm, width (b) of 4 mm, and weight of 75 g/m

The reason for using this type of PVD is the large supply on the market, as evidenced by the wide circulation of literature using this type of PVD. Siahaan L.P.[14] one of the researchers who used this type of PVD in his research.

PVD Spacing Factor

Calculation of the spacing factor in PVD is calculated using equation (8). The value of the reach diameter (D) for the triangular pattern is 1.13S, and for the rectangular pattern is 1.05 S. The following summarizes the calculation of the PVD resistance factor due to the triangular and rectangular patterns, which can be seen in Table 7.

The results of calculating the PVD resistance factor (Fn) with variations in patterns and distances get different F(n) values. This F(n) value is then used to consider how long it will take for land with PVD to consolidate 90%. [4]

Table 7. Calculation of the PVD Spacing Factor

Pattern	distance	D	a	b	Dw	F(n)
	m	M	mm	mm	mm	
Triangle	1.00	1.05	100	5	66.8	2.00
	1.50	1.57	100	5	66.8	2.40
Rectangular	1.00	1.13	100	5	66.8	2.08
	1.50	1.7	100	5	66.8	2.48

Total Consolidation Degree (Utotal)

Calculation of the total degree of consolidation using equation (9). The recapitulation of the Utotal calculation with variations in PVD patterns and spacing can be seen in Figure 5. Table 8 show the recapitulation of variations and time needed to consolidate 90%.

Based on the calculation results (Table 3), it can be considered variations in the use of PVD will be used for planning in this study. Taking into account the time and amount of PVD used [15], a rectangular installation pattern was chosen with a distance of 1.5 meters selected on the grounds that the least number of PVDs was required and the time allowed during construction.

Table 8. Recapitulation of time with variations of PVD KM.48+800

Pattern Installation	PVD distance (m)	T 90 % (weeks)	PVD Every 50 meters
Triangle	1	5	1731
	1.5	12	799
Rectangular	1	6	1580
	1.5	14	667

3.6 Calculation of Critical Height (Hcr)

H-Critical is the maximum embankment height that the subgrade can support. Critical calculations in this study use the GeoSlope assist program at each point. The results of critical analysis using the GeoSlope assist program for each point can be seen in Table 9.

Table 9. Recapitulation of Hcr Modeling

km	SF	Initial (m)
48+800	1.3301	9,987
48+850	1.3025	9,997
48+900	1.3873	9,833
48+950	1.4584	9.129

Based on the results of the analysis using the Geoslope (Table 9), the initial SF value at each point ranges from 1.3 to 1.45. Initial Safety Factor (SF) is said to be safe according to SNI 8460:2017 [7], where the minimum SF for temporary construction is 1.3. Therefore, the stockpiling process may be carried out without having to go through a delayed process.

3.7 Soil Cu Improvement

The increase in Cu value occurs due to the increased stress received by the soil before receiving the embankment load. The new Cu calculation uses equation (12), where the PI value is obtained from the correlation of soil types based on Skempton [4]. Calculation results of New Cu on KM. 48+800 can be seen in Table 10.

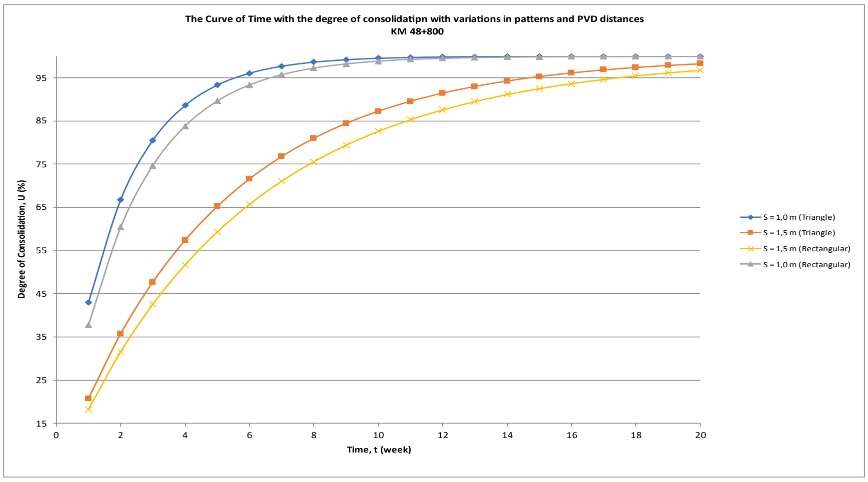

Figure 5. The Curve of time relationship with the degree of consolidation with variations in patterns and PVD distances in KM. 48+800

Table 10. Recapitulation of Cu values

Depth m	PI %	ΔP1 + Po kN/m²	Old Cu Kpa	New Cu Kpa
1	15	188.3892	10	38.48977
2	15	202.6383	10	40.85435
3	15	204.6536	12	41.18877
4	6	205.5748	25	44.30272
5	6	205.5942	25	44.30623
6	6	206.3839	25	44.44865
7	6	206.765	25	44.51738
8	6	206.0865	25	44.39501

Based on the calculations in Table 10, it can be seen that the increase in Cu value is quite large. This is due to the applied stress from the large embankment. The result of this new Cu calculation is used for stability analysis after soil improvement [16].

3.8 Final Stability Check

Check the stability of the embankment and subgrade using the Geoslope assist program using the new Cu value have been calculated in the previous sub-chapter. The results of the Stability Check can be seen in Figure 7, and the recapitulation of each point is in Table 11.

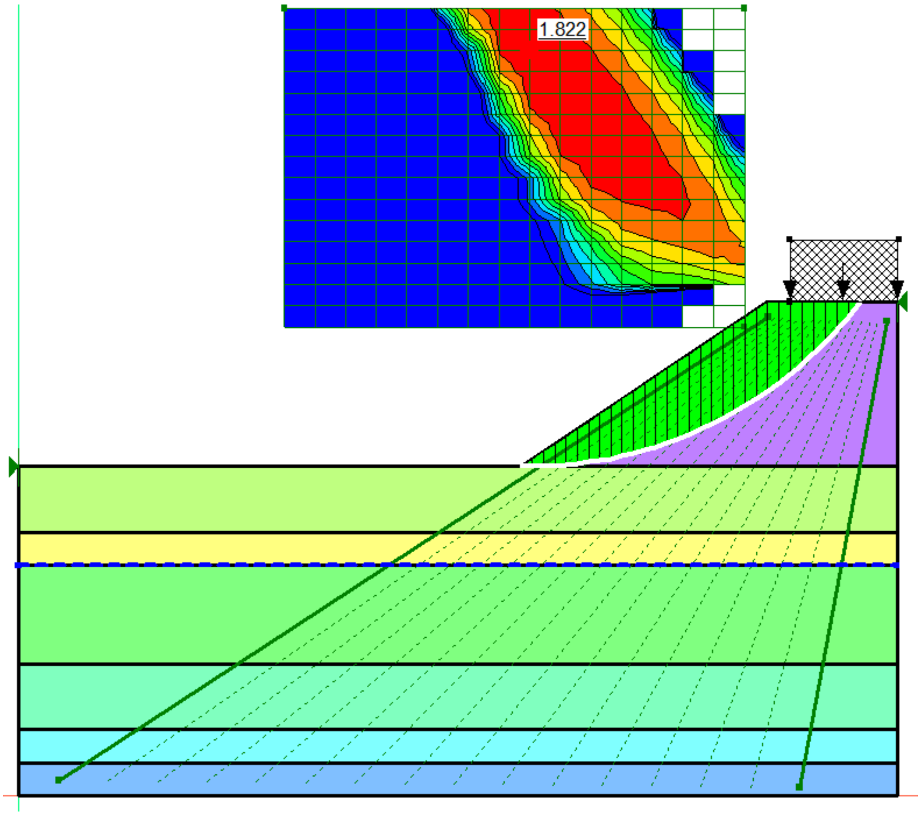

Figure 7. Stability Check with New Cu Values at KM.48+800

Based on the results of the Stability check (Figure 7) and recapitulation (Table 11), it can be seen that the SF Stability value is > 1.5, which means it is safe [7]. It can be ensured that the soil construction and embankment conditions are safe from sliding [7].

Table 11. Final SF recapitulation

KM.	SF
48+800	1.822
48+850	1.888
48+900	1.974
48+950	1.977

4. Conclusions

Based on the results of the analysis that has been carried out, it can be concluded that the effective PVD (Prefabricated Vertical Drain) is adjusted to the least amount, namely a rectangular pattern with a distance of 1.5 meters which is installed along the compressible soil at each point. Taking into account the ease of work in the field with the least amount of PVD, a rectangular pattern was chosen.

Stability checks due to changes in Cu values carried out using the Geoslope assist program showed that the planned embankments were considered safe because the SF values for all points ranged from 1.822 to 1.97 and were declared safe.

References

[1] Menteri Perhubungan, "Persyaratan Teknis Jalur Kereta Api," 2012 Accessed: Jun. 16, 2022. [Online]. Available: https://djka.dephub.go.id/uploads/201908/pm_no._60_tahun_2012.pdf

[2] B. Ready, Krisnamurti, and I. Nurtjahjaningtyas, "Analysis of slope stability in soft soil using hardening soil modeling and strengthening of bamboo mattress," *International Journal of GEOMATE*, vol. 19, no. 73, pp. 226–234, 2020, doi: 10.21660/2020.73.58422.

[3] B. M. Das, *Principle of Geotechnical Engineering*, 10th ed. USA: Cengage Learning, 2021.

[4] H. C. Hardiyatmo, *Mekanika Tanah II*, VI. Yogyakarta: Gadjah Mada University Press, 2018. Accessed: Jan. 27, 2023. [Online]. Available: https://ugmpress.ugm.ac.id/id/product/sains-teknologi/mekanika-tanah-2-edisi-keenam

[5] J. J. Muhammed, P. W. Jayawickrama, A. Teferra, and M. A. Özer, "Settlement of a railway embankment on PVD-improved Karakore soft alluvial soil," *Engineering Science and Technology, an International Journal*, vol. 23, no. 5, pp. 1015–1027, Oct. 2020, doi: 10.1016/j.jestch.2020.03.004.

[6] A. Mia Aulia *et al.*, "Perencanaan Jalan Rel Kereta Api Di Atas Tanah Lunak", Accessed: Sep. 06, 2022. [Online]. Available: http://jurnal.unissula.ac.id/index.php/kimueng/article/view/20565

[7] Badan Standardisasi Nasional (BSN), "Persyaratan perancangan geoteknik," 2017 [Online]. Available: www.bsn.go.id

[8] P. Arya Pranantya, E. Sukiyah,) Edi Prasetyo Utomo,) Hendarmawan, P. Litbang, and S. Daya, "Korelasi Nilai Sondir Terhadap Parameter Geoteknik Dan Rembesan Pada Pondasi Tanggul Fase E, Kalibaru, Jakarta Utara," 2018. doi: https://doi.org/10.32679/jsda.v14i2.177.

[9] B. J.E., *Analisis dan Desain Pondasi*, 4th ed. Jakarta: Erlangga, 1991.

[10] Karl Terzaghi, P. R.P., and Gholamreza Mesri, *Soil Mechanics in Engineering Practice*, 3rd ed. 1996.

[11] B. G. Look, "Handbook of Geotechnical Investigation and Design Tables," 2007.

[12] B. J and F. J, "Parameters filing and statistical analysis of data in soils mechanics," vol. 2, 1975.

[13] B. Das, *Principles of Foundation Engineering* , 9th ed. 2018.

[14] L. P. Siahaan, "Alternatif Perbaikan Tanah Dasar dan Perkuatan Timbunan Pada Jalan Tol Palembang-Indralaya (STA 8+750 s/d STA 10+750)," Institut Teknologi Sepuluh November, Surabaya, 2017. Accessed: Jul. 28, 2022. [Online]. Available: https://repository.its.ac.id/2766/1/3113106042-Undergraduate_Theses.pdf

[15] M. I. M. Bachtiar, I. Nurtjahjaningtyas, and P. P. Putra, "Perbaikan Tanah Lunak Dengan Metode Preloading Kombinasi PVD dan PHD Berdasarkan Data Analisa Balik (Studi Kasus: Proyek PPKA 4, Sumatera Selatan)," 2019, Accessed: Jan. 27, 2023. [Online]. Available: http://repository.unej.ac.id/handle/123456789/103337

[16] Mochtar and E. Noor, *Modul Ajar Metode Perbaikan Tanah*. Surabaya: Jurusan Teknik Sipil FTSP-ITS, 2012.