STABILITY ANALYSIS OF GRAVITY WALL USING PLAXIS 2D v-8.6
(Study Case in Piyungan Road-Batas Gunung Kidul, Yogyakarta)

Prepared as a condition of completing Study Program of Bachelor Degree at the Department Of Civil Engineering

By

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Penulis

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ABSTRACT

STABILITY ANALYISI OF GRAVITY WALL

USING PLAXIS 2D v-8.6

(CASE STUDY Piyungan- Road Gunung Kidul, YOGYAKARTA)

The technological development is growing up fast, and it is going to talk about the geotechnical development on constructions. The software (program) is urgently needed to simplify calculation and the analysis of slopes and structures. In this study, the authorsearched how to analyze the slope stability computationally and got Plaxis program, to analyze the Piyungan slope stability case at Yogyakarta to determine the safety factor. The result has been analyzed manually and computationally and it got a safety factor less than required. The safety factor manually was 0.95085 <1.5 and with Plaxis the safety factor was 0.9522 <1.5. So the alternative treatment is needed by providing concrete gravity wall structure, andreanalyze the slope with both methods using the soil data such as soil density (γ) 15.186 kN / m^3,specific gravity (SG) 2.66, cohesion (c) 15.984 kN / m^2, friction angel (φ) 30.44^o,average moisture content 44.82%,So after the treatment with gravity wall, the safety factor manually (fellenius) became 1.76506 >1.5 and computationally with Plaxis became 1.76601 >1.5 So the slope became safer.

Keywords: fellenius, PLAXIS, gravity wall, slope stability.

ABSTRAKSI

Sejarah perkembangan teknologi dewasa ini terus berkembang pesat. Salah satu dampaknya adalah perkembangan teknologi dibidang pembangunan atau konstruksi, khususnya dalam bidang geoteknik. Untuk mempermudah efisiensi kinerja perencanaan dan perhitungan konstruksi, penggunaan perangkat lunak (program) sangat dibutuhkan. Dalam penelitian ini, penulis ingin mengetahui bagaimana penggunaan program untuk menganalisis stabilitas lereng dengan menggunakan program *Plaxis*. Analisis dilakukan dengan melakukan kontrol stabilitas lereng di Piyungan, Yogyakarta untuk mengetahui angka keamanannya. Setelah dianalisis dan hasil menunjukkan angka keamanan kurang dari yang disyaratkan, maka diperlukan alternatif penanganan. Penulis merencanakan alternatif penanganan dengan memberikan dinding penahan tanah tipe kantilever dengan struktur beton. Metode perhitungan untuk mendapatkan angka keamanan dilakukan dengan dua metode, yaitu perhitungan manual dengan metode *Fellenius* dan perhitungan dengan program *Plaxis*. Adapun parameter tanah yang digunakan: volume tanah (γ) 15,186 kN/m3; berat jenis (GS) 2,66; kohesi (c) 15,984 kN/m2; sudut gesek dalam (φ) 30,44o; kadar air rata-rata 44,82%, untuk kondisi geologi lapisan di lapangan berupa pasir kelempungan dengan tinggi tanah yang ditahan 15,2 m. Hasil perhitungan stabilitas lereng, sebelum dilakukan alternatif penanganan didapatkan angka keamanan metode *Fellenius* 0,95085<1,5 (tidak aman), sedangkan program *Plaxis* 0,9522<1,5 (tidak aman). Setelah dilakukan alternatif penanganan didapatkan angka keamanan metode *Fellenius* 1,744>1,5 (aman), sedangkan program *Plaxis* 1,7413>1,5 (aman). Dengan menggunakan dinding penahan tanah, faktor keamanan lereng menjadi meningkat.

Kata kunci: dinding penahan tanah, *fellenius*, longsoran. *plaxis*, stabilitas lereng

1. INTRODUCTION

The development of the modern future technology has a great impact in various fields, such as education, economy, industry, and construction, etc. In this case, it is going to talk about construction and how does technology effect on it. Geotechnicalis a science that is applied by civil engineering in reviewingIssues related to the mechanical properties of soil and rock.

Soil and rock plays an important role in geological processes onearth. Slopes are a scientific form of geological processes, for examplehillsides or riverbanks. Besides on the slope can also be made by humanssuch as embankments, excavation heap for highways or railroads, dams,and others. Things to consider in the assessment of slope arean collapse can occur at any time slowlyand suddenly.

The gravity wall is construction that needed, because it can beused to stabilize soils on the slopes / cliffs to preventthe sliding and collapse of the soil that may happened.

Construction of gravity retaining wall should be completely based onthe calculation of stability and safety factor of the soil and the wall itself, and these calculations can be done manually and by some programs such as, geo 5, oasis, Plaxis, etc.

Plaxis program is a series of program designed to solve various geotechnical problems, it can analyze the stability in geotechnical issues so it needed to design many constructions such as foundation, retaining wall, etc.

Indonesia has many mountainous area and it is considered as dangerous area, such as Piyungan road that located in Yogyakarta city, this road is a crowded road that leads to many beaches, so it has to be protected to reduce the risk.

The gravity wall is one of retaining structure that suggested to retain and prevent any sliding that may occur in the road like Piyungan road Yogyakarta.

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2 RESEARCH METHODS

Boring logstest is a test to get the soil parameter data that considered as the research datawhich carried in(PiyunganYogyakarta) then the processing is carried out by the Soil Mechanics Laboratory of Civil Engineering Department inuniversitas sebelas maret. Drill Hole test at the site is done by two holes, first is to a depth of 8 meters, second is to a depth of 10 meters.With a different stages.

Planning made consisting the calculation of thesafety factor of the slope with manual methods and simulation calculations using Plaxis program.

Computational equipment that used in this research is *PLAXIS Software V 8.6, Software Autocad 2007, and Software Microsoft Office 2010.*

Six stages of research is including:

1. Stage 1

   The first step isbegan with studying the Piyungan case very carefullyand looking for theories related to the research problem.

2. Stage 2

   Collecting the secondary data value: γ, Gs, c, φ, *w*. which is taken from the *Sheer Direct Test* results *(DST)* (Ramdhani 2017).

3. Stage 3

   The slope stability analyzed by two steps of calculations, namely:

   a. Calculation of slope stability manually with*Fellenius*method

   b. Calculationof slope stability by using *PLAXIS*2D v-8.6

4. Stage 4

   the safety factor rate (SF) can be seen as follow:

   a. If SF> 1.5 is stable.

   b. If SF <1.5 is not stable and need a treatment.

5. Stage 5

   The slope stability analysis after treatment consists of two ways, namely:

   a. Slope stability calculation after treatment with manually method(*Fellenius).*

   b. Slope stability calculation after treatment using program*PLAXIS2D.v-8.6.*

6. Stage 6

Discussion the results of the tests that have been done at the side and also talk about theconclusion that can be made of the results obtained and providing advice if necessary.

3 RESULTS AND DISCUSSION

Boring log data calculations that has been done at the site and laboratory tested to determine the data of soil mechanical test, that used as calculation parameters manually andcomputationally

3.1 **Handling Before sliding Slope Analysis**

3.1.1 **Manual Calculation Using*Fellenius*Method**

Theslope stability analysis calculation was done manually using Fellenius method.

Table 1. The *Drill Hole* I values of soil parameters is:

Table *Properties Land*				
No.	Properties	Symbo l	silty sand	Unit
	Depth		from 2.50 to 3.00	m
1.	Model material	*model*	*Mohr-Coulomb*	-
2.	Material *behavior*	*Type*	*Drained*	-
3.	Unit weight of dry soil	$\gamma_{cleaning}$	10.486	kN / m^3
4.	Unit weight of wet soil	γ_{wet}	15.186	kN / m^3
5.	Permeability horizontal direction	K_x	0	m / day
6.	Permeability vertical direction	K_y	0	m / day
7.	The elastic modulus	E_{ref}	15000	kN / m^2
8.	Poisson's ratio	v	0.30	-
9.	Cohesion	c	15.984	kN / m^2
10.	friction angle	φ	30.44	^{o}
11.	angle of dilation	ψ	0.44	^{o}

The safety factor in Piyungan land sliding without treatment, when R = 27.090 m safety factor is equal to (SF) = 0.95085. with the known the minimum safety factor must be (SF) <1.5

3.1.2 Calculation of program*PLAXIS*2D *V-8.6*

Computational calculations of slope stability analysis using *Plaxis* program. the calculations results of program *output*,showed in *figures.1* as well as in can see the*gravity loading* is equal to 0.9522 and slope deformed is by 6.675 cmso the slopes will experience *failure* with it own weight load due to the result of the safety factor that less than the minimum limit that is equal to 1.5.

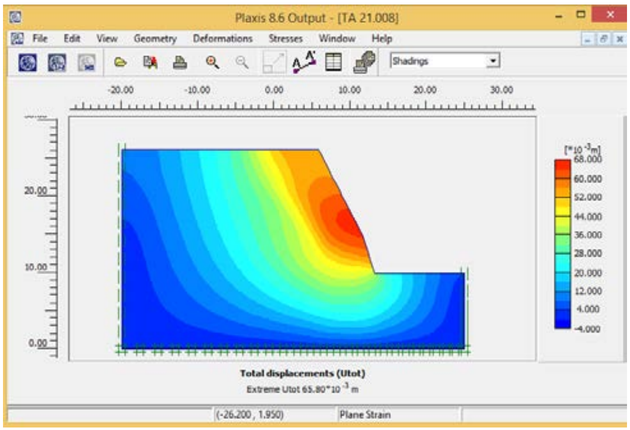

Figure 1. The direction of movement of land and a decline due to *Gravity Loading*

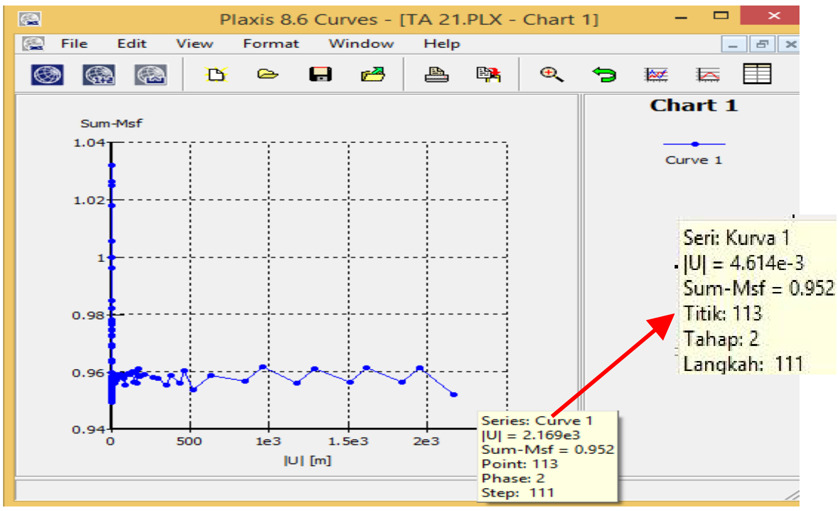

Figure 2. The safety factor due to*GravityLoading* and *Vertical Loading.*

3.2 Slope Stability Analysis After Treatment

The calculations result of the safety factor that has been done, manually and computationally, obtain the safety factor is (SF)<1.5 which is manually result is equal to 0.95085 while the program result is equal to 0.9522. Due to these results we can considerthe slopes is not safe, because it does not comply with the minimum safety factor which is equal to 1.5. The planned alternative treatment is to use a gravityretaining wall to improve the safety factor.

3.2.1 Materials Modeling

Table 2. Parameter Design of Soil retaining Walls

No.	Properties	Symbol	Value	Unit
1.	material model	*model*	*Linear Elastic*	-
2.	Material *behavior*	*Type*	*Non Porous*	kN / m
3.	Heavy Volume dry	$\gamma_{cleaning}$	25	kN / m^3
4.	Modulus of Elasticity	E_{ref}	2.574 x 10^7	kN / m^2
	Poisson's ratio	*v*	0.15	-

3.2.2 Manual Calculation Using*Fellenius* Method

The safety factorcalculations (*Trial Error)* using manualmethod *Fellenius*for the slope stability analysis of reinforcement soil retaining walls shown in Table 3.

Table 3. Manual results of analysis with Soil retaining walls

No.	analysis stage	The radius of the slop Sector (R)	Safety factor (SF)	Note
1.	Due to it own weight	R = 15.115 m	FK = 1.74441	Safe

In the study area the safety factor baseline before the treatment was equal to 0.95085 and after treatment the safety factor is increased to become 1.74441.

3.2.3 *Plaixs*Program Calculation.

The computationally calculations results of *output* plaxis program of the slope stability analysis can showed in figures.3 that the Security settings for *gravity loading* is equal to 1.7413 and slope deformed by 7.747 cm. so the slope is stable due to the result of safety factor is >1.5

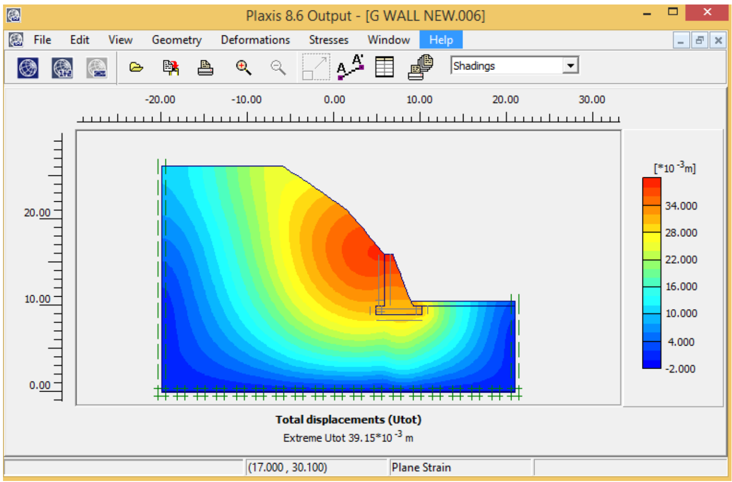

Figure 3. Direction movement of soil and a decline due to *Gravity Loading*

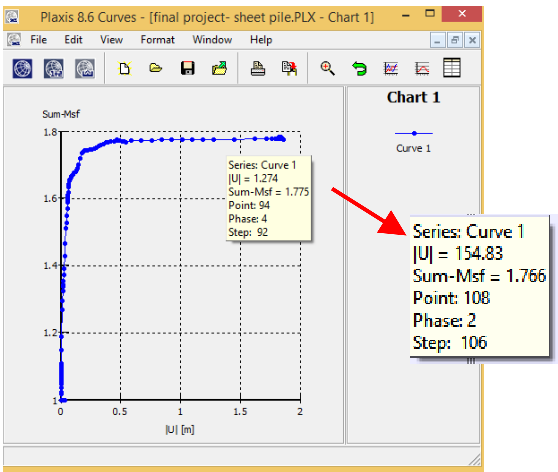

Figure 4. the safety factor due *Gravity Loading* and *Vertical Loading*

3.3 Slope analysis comparing before and after the treatment

Table 4. Summary of safety factor values before treatment and after treatment with gravity wall

Type Calculation	Before treatment	After treatment
Manual	0.95085	1.765062
Plaids	0.9522	1.76601

The safety factor manually before treatment is equal to 0.95085, after treatment increased to 1,765062, as well as by Plaxis, the safety factor was 0.9522, then it increased to 1.7601 after the gravity wall treatment. It can be noted that the gravity wall is made an noted increasing of the safety factor of the piyungan slope.

4 CONCLUSIONS AND RECOMMENDATIONS

Based on slope stability analysis that applying on Piyungan, Yogyakarta with Fellenius and *Plaxis*program v-8.6, the conclusions can be summed up as follows:

1. The slope stability can be stable by providing the Gravity wall as shown in previous chapter when the safety factor of the slope is equal to 1.76601 using Plaxis program.
2. When the slope has been analyzed manually by Fellenius method, the safety factor was equal to 0.95085, while using Plaxis program the safety factor (SF) is 0.9522. So is these two calculation methods demonstrate the value that <1.5 so that's the slope is unstable and need an alternative treatment. After the treatment with Gravity wall and calculated using manual method and *Plaxis* program, the safety factor increased to get those values, manually equal to 1.765062 and *Plaxis* program equal to 1.7660. Thus the

addition of a Gravity wall is enough to increase the safety factor against the sliding of slope.

4.1 **Suggestions**

1. Conducting of soil *sampling* is needed to get an overview of the characteristics of the soil layers to help the plaxis program calculation and modeling accuracy.
2. Additional soil data is needed such as UCT(unconfined compression test) lab test to determine the parameter of land in fill, so that the input parameter of plaxis can be more accurate.
3. The safety factor of external load need to be calculated to be increased, as well as to be accordance with the site's ground conditions.
4. Analysis usingprogram *V.8.6Plaxis* still has a weakness, to obtain more accurate results required a comparison with a method or another program, such as *GEOSLOPE*, *ROC SCIENCE, Z SOIL, SAGE*CRISP,etc.

REFERENCES

Final Project of Ramadhani Fajar R (2016), entitled "Analysis of Slope Stability with Cantilever Retaining Walls Using Program", *Plaxis* conclude that the results of the calculation of slope stability, prior to the treatment alternatives available security numbers Fellenius methods 0.95085 <1.5 (not safe), while the program Plaids 0.9522 <1.5 (not safe). After alternative treatment methods Fellenius security figures obtained 1.744> 1.5 (safe), while the program Plaids 1.7413> 1.5 (safe). By using a retaining wall, slope safety factor to be increased.

Lane and Hanif (2015) entitled "The simulation of cohesion soil stability due to the use of soldier Pile With Modeling of Plaixs And GeoStudio" get

the conclusions of the study that use methods of stability global walls, basement walls declared safe and can be used as a retaining wall because it has value required-Fellenius global stability. :

a. The length of the radius (R) point slip of 10,612 meters.

b. In order to get the value of global stability that occurs in basement wall o3.5 basedon Fellenius method safety factor more than 1,0. Analysis of deflection calculationusing the manual, to get 30% higher of the calculation using the software plaxis.analysis the Safety Factor calculations using the manual to get 46% higher of the calculation using the software *Geoslope - Geostudio 2012.*

Simarmata (2014) entitled "Slope Stability Analysis Using double Sheetstrengthening of Pile and Geogrid Using Element Method Finite(Case Study Jalansiantar - Parapat Km.152) ", concludes the calculation of the safety factor calculation of the safety factor values obtained in the initial condition is 0,78. value of the safety factor in strengthening using double sheet pile and geogrid is 1,09. Value of the safety factor by using a single sheet pile, geogrid and counterweight is 1,23 Value of safety factor by using a double sheet pile, geogrid and counterweight is 1,43 the calculation of the safety factor is the addition of a load safest counterweight behind the sheet pile to obtain a small landslide.

The difference between previous studies with research being undertaken author is building the object to be analyzed is to build a concrete anchorage sheet pile with the method of calculation using Limit state method as well as using *PLAXIS.Siantar - Parapat Km.152).* University of Northern Sumatra. North Sumatra