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SLOPE STABILITY ANALYSIS WITH REINFORCED WALL HOLDER OF CANTILEVER AND MINIPILE TYPE

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ABSTRACT -- *Central Aceh / Gayo Lues-Blangkejeren Border Road Section Km 438 + 800 located in the Gayo Lues Regency is one of the national cross-border roads that connect Takengon City with Gayo Lues Regency and Southeast Aceh towards North Sumatra. Landslides often occur due to landslides in mountainous areas. Landslide events that occur are caused by high rainfall intensity and water flow in the drainage of the road body and the absence of water flow direction building at the end of the drainage, so that water is wasted on the shoulder of the road and water seeps into the road body which can cause heavy soil volume to increase. This can increase the driving force to be large due to increasing soil mass on the slope's body. Thus, it is necessary to analyze the landslide and handling using retaining walls and mini piles. This analysis aims to determine the slip area on the slope and the safety factor figures. The analysis will be conducted to determine the slip area on the slope and the number of safety factors that is using the Plaxis Version 8.6 program. The results of the analysis of the slope stability in the existing conditions showed a safety factor of 1.087 with unsafe slope conditions. Thus, it is necessary to strengthen the slope using cantilever and minipile type retaining walls. The results of the stability analysis after being given reinforcement obtained a safety factor that is 1.205 with unsafe slope conditions. So that additional reinforcement is needed by adding the installation of retaining walls and minipile on both sides of the road body and anchor between retaining walls. The results of the stability analysis after additional reinforcement is obtained the safety factor figure is 1.748 with safe slope conditions.*

Keywords -- *Landslide, Plaxis Program, Retaining Wall, Minipile*

I. INTRODUCTION

Central Aceh / Gayo Lues-Blangkejeren Border Road Section Km 438 + 800 located in the Gayo Lues Regency is one of the national cross-border roads that connect Takengon City with Gayo Lues Regency and Southeast Aceh towards North Sumatra. In addition, this road section is also one of the access points from Takengon to Gayo Lues Regency and Southeast Aceh and vice versa. Along with the increase in population in these districts and tourist sites, it is necessary to have a comfortable and safe road. The increase in traffic volume will have an impact on increasing the burden of vehicle traffic whether it is the burden of private or passenger vehicles and goods vehicles

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that transport logistics and construction materials and heavy equipment. Adding traffic load on the construction of the road body will affect the stability of the road body construction.

Landslides that occur at these locations apart from the high rainfall intensity are also caused by the flow of water in the drainage of the road body and no directional water flow building is made at the end of the channel, so water is discharged on the shoulder of the road and water absorbed into the road can cause severe soil volume increases. This can increase the driving force to be large due to increasing soil mass on the slope. Therefore, the driving force is greater than the holding force and will cause slope instability.

The purpose of the slope stability analysis is to find out the number of safety factors in existing conditions and after the cantilever and minipile type retaining walls are strengthened and to know the slip plane on the slope.

II. LITERATURE REVIEW

2.1 Soil Landslide

Soil landslide Double and Roesyanto (2012) suggested that soil slides are one of the most common in the geotechnical field due to increased shear stress of a soil mass or decreased shear strength of a soil mass. In other words, the shear strength of a soil mass is not able to shoulder the workload that occurs. Disturbances to slope stability can be caused by various human activities and natural conditions. Unstable slopes are very dangerous to the surrounding environment. therefore, slope stability analysis is needed.

2.2 Earth Shear Strength

Hardiyatmo (2006: 302) argues that the shear strength of the soil is the force of resistance carried out by the grains of the soil against pressure or pull. If the land is overloaded it will be retained by the following.

a. Soil cohesion depends on the type of soil and its density

b. Friction between the grains of soil whose magnitude is directly proportional to the normal stress in the shear plane.

The soil shear strength value proposed by Coulomb quoted from Hardiyatmo (2010: 317) can be determined by the following equation:

$$\tau = c + \sigma \tan \phi \qquad (1)$$

Where as:

τ = Shear strength (kg/cm^2);

c = Soil cohesion (kg/cm^2);

σ = Normal voltage in the collapsed field (kg/cm^2); dan

ø = Shear angle in the ground (^{o}).

2.3 Slope collapse

Slope collapse is a problem faced since ancient times, where human and natural activities result in reduced shear strength of the material forming the slope, increased shear stress on the slope, or a combination of both. Factors causing landslides include soil texture, geomorphology and slope or land cover conditions. These factors can be used to estimate slope stability, and determine landslide prone areas.

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2.4 Concept of Safety Factors

The parameters produced in the slope stability analysis are the shape of the collapse plane and the safety factor (FK), while to increase the strength of the soil the slope is strengthened with a pole so that the slope will become more stable. The safety factor is used to identify slope stability which is defined as the ratio between the shear strength of the soil and the shear stress acting on the mass of the soil

$$\text{FK} = \frac{Shear\ strenght}{Shear\ stress} \qquad (2)$$

Where :

FK > 1 stable slope;

FK < 1 unstable slope; and

FK = 1 slope in a critical boundary balance condition

III. RESEARCH METHOD

3.1. Data Collection

The data collection stage is the primary means of determining the scientific solution to a problem. The data collected includes primary data and secondary data. Soil samples are taken at the point of view with steep slope geometry and possible landslides.

3.1.1 Primary Data

Primary data is data obtained from direct observation of researchers at the study site. Data related to primary data such as:

1. Site review with the aim of observing the situation of the research location.
2. Topographic measurements to get the cliff geometry.
3. Data to be tested at the Soil Mechanics Laboratory, Faculty of Engineering, Syiah Kuala University, includes:

- Soil Data

Obtained from soil sampling at the site will then be tested at the Soil Mechanics Laboratory to obtain physical properties of the soil. Soil data needed for soil investigation activities for slope stability analysis on the Takengon-Blangkejeren Km 438 + 800 section using Plaxis Program Version 8.6 includes:

- Physical properties, including: lsi weight (γ) soil, liquid limit, plastic limit, water content, filter analysis and hydrometer analysis.
- Mechanical Properties, including: Direct shear test.

3.1 *Soil Parameters*

These soil parameters are the data used to obtain the results of slope stability analysis calculations. Data used for slope stability analysis using Plaxis software are soil volume weight (γ), cohesion (c), and soil shear angle (ϕ), dilation angle (Ψ), poison ratio (υ) and soil permeability coefficient (kx, ky).

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3.2 Data Processing

Analysis of the slope stability using Plaxis software requires modeling the slope in accordance with existing data so that accurate results are obtained. The parameter values used as input to the plaque software are:

Base soil and embankment parameter data

• Wet volume weight (γb), dry volume weight (γd), permeability (k), cohesion (c), shear angle (ϕ), dilation angle (Ψ), young modulus (E) and poison ratio (υ).

Table 1: Input Parameters in the Plaxis Program

Soil Parameters	Km 438+775			Unit
	Layer 1	Layer 2	Layer 3	
Material model	MC	MC	MC	-
Type of behaviour	*Drained*	*Undrained*	*Undrained*	-
Dry soil weight (γ_{dry})	10,693	12,001	14,486	kN/m^3
Wet soil weight (γ_{wet})	15,206	16,514	20,928	kN/m^3
Horizontal permeability (k_x)	0,01	0,001	0,001	m/day
Vertical permeability (k_y)	0,01	0,001	0,001	m/day
Young's modulus (E_{ref})	78480	29430	19620	kN/m^2
Poisson's ratio (v)	0,3	0,3	0,35	-
Cohession (c)	45,093	35,774	33,648	kN/m^2
Friction angle (ϕ)	20,415	26,967	25,700	°
Dilatancy angle (Ψ)	0	0	0	°

IV. RESULTS AND DISCUSSION

4.1 Slope Stability Analysis Results in Existing Conditions

The results of the analysis of slope stability with existing conditions using the Plaxis program, in accordance with the parameters of the land input and using a vehicle load that is equal to 15 kN / m2, as shown in Figure 3.

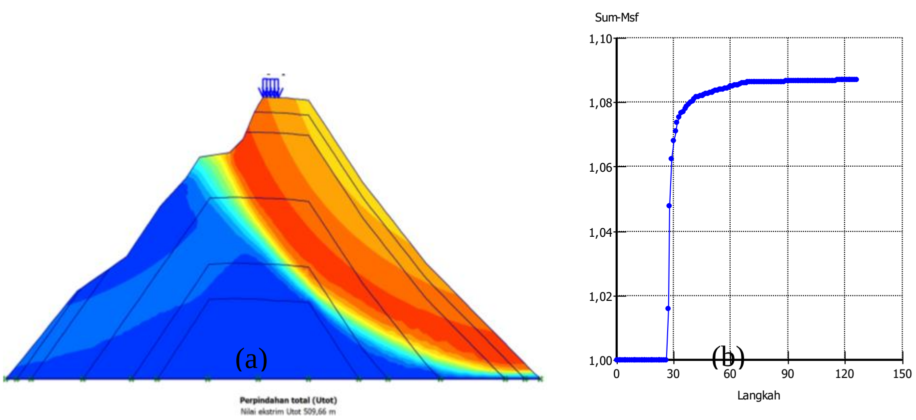

Figure 3: (a) Total Displacement and (b) Safety Factors in the 2D Plaxis Program

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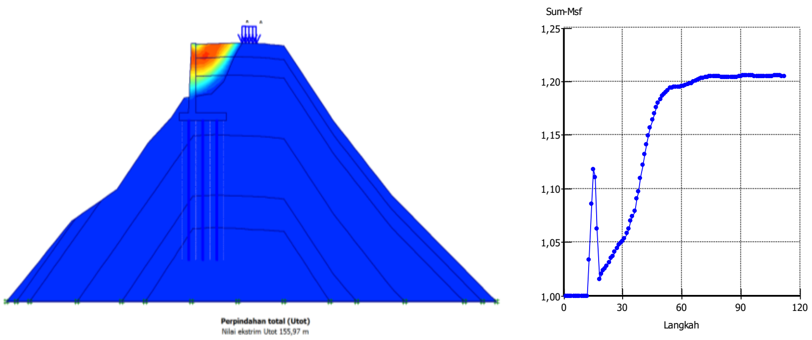
Figure 3.a shows that the analysis of slope stability in exiting conditions using the plaque program shows a circle pattern of right-hand slope collapse with a total displacement rate of 509.66 m.

Figure 3.b shows that the safety factor obtained is 1.087 with unsafe slope conditions (SF> 1.25).

4.2 Slope Stability Analysis Results After Strengthening Cantilever and Minipile Type retaining walls

The results of slope stability analysis after being strengthened by cantilever and minipile type retaining walls using the Plaxis program and vehicle loads are 15 kN / m2, as shown in Figure 4.

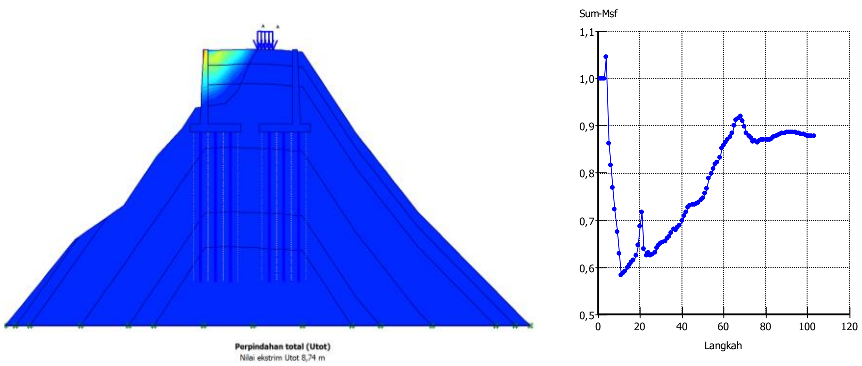


(a) (b)

Figure 4: (a) Total Displacement and (b) Safety Factors in the 2D Plaxis Program

Figure 4.a shows the calculation of slope stability after reinforced cantilever and minipile type retaining walls with a depth of 15 meters on the left side of the road from takengon to Blangkejeren using Plaxis program, the total displacement rate is 155.97 m

Figure 4.b shows that the safety factor obtained is 1,205 with unsafe slope conditions (SF> 1.50).



(a) (b)

Figure 5: (a) Total Displacement and (b) Safety Factors in the 2D Plaxis Program

Figure 5.a shows the calculation of slope stability after being strengthened by cantilever and minipile type retaining walls with a depth of 15 meters on 2 (two) sides of the road using the Plaxis program, the total displacement rate is 8.74 m.

Figure 5.b shows that the safety factor obtained is 0.879 with unsafe slope conditions (SF> 1.50).

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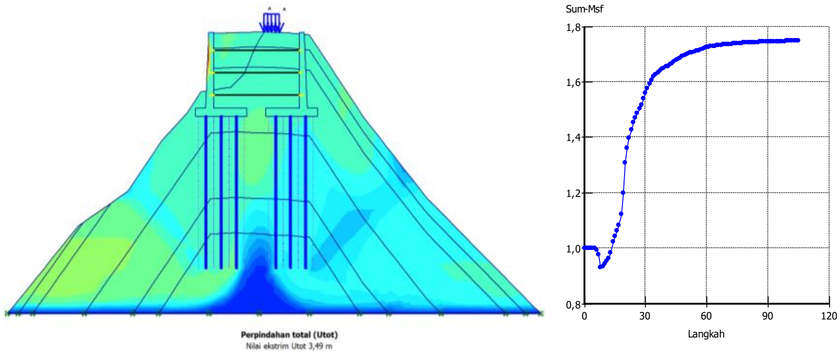

(a) (b)

Figure 5: (a) Total Displacement and (b) Safety Factors in the 2D Plaxis Program

Figure 6.a shows the calculation of slope stability after reinforced cantilever type retaining walls, minipiles with a depth of 15 meters on 2 (two) sides of the road body and anchor using the Plaxis program obtained a total displacement rate of 3.49 m.

Figure 6.b shows that the safety factor obtained is 1.748 with safe slope conditions (SF> 1.50).

4.3 Discussion

Based on the results of slope stability analysis on the Central Aceh / Gayo Lues-Blangkejeren Km 438 + 800 Road Section using the soil input parameters as in Table 1 and the vehicle load of 15 kN / m2 with the Plaxis program in exiting conditions, obtained a circle-shaped slope collapse pattern in the direction avalanche to the right from Takengon direction to Blangkejeren. The safety factor obtained is 1.087 with unsafe slope conditions (SF> 1.25). Thus, slope reinforcement is required by using cantilever and minipile type retaining walls. Installation of slope strengthening is done on the left. This is due to the existing conditions have experienced landslides.

The results of the analysis of the calculation of slope stability with reinforced cantilever and minipile type retaining walls with a depth of 15 meters obtained a safety factor that is equal to 1.205 with unsafe slope conditions (SF> 1.50). Thus, after strengthening the slope, the safety factor number is increased. Therefore, it is necessary to strengthen the slope with cantilever and minipile type retaining walls on 2 (two) sides of the road body. The results of the calculation of the stability of the slope after reinforced cantilever and minipile type retaining walls with a depth of 15 meters on 2 (two) sides of the road obtained safety factor figures that is equal to 0.879 with unsafe slope conditions (SF> 1.50). Therefore, additional reinforcement is needed by using anchor between cantilever type retaining walls to increase the slope safety factor.

The results of the analysis of the calculation of slope stability with reinforced cantilever type retaining walls, minipiles with a depth of 15 meters on 2 (two) sides of the road body and installation of anchors between retaining walls with a slope angle of 0 ° obtained security factor figures of 1.748 with safe slope conditions (SF> 1.50).

V. CONCLUSION

1. Safety Factors in existing conditions and after slope reinforcement with cantilever and minipile type retaining walls using the Plaxis program due to the influence of a traffic load of 15 kN / m2 is unsafe.

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2. Security Factors after additional reinforcement is carried out by cantilever and minipile type retaining walls on 2 (two) sides of the road body and installation of anchors between retaining walls with a slope angle of 0 ° due to the influence of the traffic load of 15 kN / m2 namely 1.748 (SF> 1.50) safe slope conditions.

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