SIMULATION OF OPD WASTE DUMP SLOPE USING THE MORGENSTERN-PRICE METHOD IN WORK AREA OF PT. PETROSEA TBK. PASER DISTRICT, EAST KALIMANTAN PROVINCE

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ABSTRACT

The research was conducted at a company working in the coal mining contract sector, namely PT. Petrosea Tbk. OPD is located in Paser Regency, East Kalimantan. The research aims to create a slope simulation for analysis. This analysis is used to determine the safety value factor with the influence of the parameters used, with reference to the safety value factor based on safe slope criteria according to KEPMEN ESDM Number 1827 K /30/MEM/2018. Parameters in the simulation are material properties in the form of unit weight, cohesion and internal friction angle. The material used is bedrock material in the form of sandstone, and overburden material in the form of a mixture of sandstone and claystone. Engineering is carried out by considering the condition of the groundwater table, namely full saturation and the earthquake vibration coefficient, to be analyzed using the Morgenstern-Price method. The safety factor value that has been obtained in the slope simulation is 1,216, the safety factor value includes unsafe slopes which are affected by groundwater conditions and earthquake vibrations.

Keywords: Waste Dump, Slope Stability Analysis, Morgenstern-Price Method,

INTRODUCTION

The mining system method carried out by PT. Petrosea Tbk. is an open pit mining system that is carried out directly on the surface of the mining area. Generally, this system strips the overburden which has no economic value. The layer is moved to the open pit mine area which is used as a place to store stripped materials, known as the waste dump area.

The out-pit dump (OPD), which is where overburden material is stored outside of the pit area, was the subject of the investigation. It is necessary to do geological engineering investigations, particularly on the slopes of the OPD waste dumps (Marit et al., 2022). These studies are conducted in an effort to stop landslides and to evaluate the importance of the safety factor on a slope. One of the soil mass movements brought on by a disruption in slope stability is a landslip. The existence of slope conditions, constituent materials, and hydrogeological circumstances affect slope stability.

RESEARCH METHOD

In determining the value of the safety factor for a slope, it is expressed as the driving force and resisting force. If the restraining force is greater than the driving force, then the slope is declared safe, and vice versa. If the restraining force is greater, there will be stability disturbances on the slope resulting in an avalanche. The calculation of the factor of safety (FK) for an avalanche can be stated as follows:

$$FK = \frac{Resisting\ Force}{Driving\ force} \quad \text{.............................} \ (2.1)$$

$$F = \frac{T}{S} \quad \text{...} \ (2.2)$$

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F = $\frac{c\ .\ L + \tan\varphi + \sum (W \cos\alpha)}{W \sin\alpha}$ .... (2.3)

The research method in this analysis simulation uses the Limit Equilibrium Method, namely the Morgenstern-Price, which considers all vertical and horizontal forces, and considers the moment of equilibrium. The following sellers used:

$$P \ = \frac{[W_{n-}(X_R - X_L) - \frac{1}{F}(C'(\sin\alpha - \text{ul} \tan\phi' \sin\alpha))]}{\cos\alpha\ (1 + \tan\alpha \frac{\tan\phi'}{E})}$$

.... (2.4)

Information:

W	=	Total weight of slices
XL, XR	=	Working inter-slice force
P	=	The total normal force of the wedge
C	=	Cohesion
Φ	=	Angle of internal friction
l	=	Length of slice
u	=	Pore-water pressure
α	=	Slope angle

Factors that can affect the safety value of slopes include the condition of the groundwater table and the earthquake vibration coefficient. The condition of the groundwater table, according to Hoek and Bray (1981), is one of the causes of the increase in the weight of material on a slope, which can lead to a decrease in the stability of a slope.

The analysis in this simulation is done to determine the value of the factor of safety on a slope by taking into account factors that could make that value decrease, such as the groundwater table factor and the earthquake vibration coefficient value to determine how strong the slope is to withstand the vibrations that are likely to occur, as well as the materials used on the slope. Because the type of material used or where it is placed on a slope will have an impact on how safe it is.

In determining the stability value of a slope by comparing the resultant resisting force with the driving force acting on the body of the slope. The following is the equation for the factor of safety (FK) based on Day (2001) in Irvan et al., (2015):

$$Fs = \frac{\sum(C'l) + \tan\phi'\ (W\cos\alpha - \text{Fh}\sin\alpha - \text{u}l))}{\sum \text{W}\sin\alpha + Fh\cos\alpha}$$

.... (2.4)

Information:

C'	=	Effective cohesion
ϕ'	=	Effective angle of internal friction
u'	=	Pore-water pressure
α	=	Inclination of slice parameter
l	=	Geometric parameter
W	=	Slice bace normal force
Fh	=	Horizontal pseudo static force acting

RESULTS AND DISCUSSION

The study was carried out at PT. Petrosea Tbk. OPD waste dump facility, according to the Balikpapan geological sheet, at Batu Kajang Village, Batu Sopang District, Paser Regency, East Kalimantan, which is a part of the Warukin Formation.

Materials in the Waste Dump Area

The dominant material in the research area or waste dump area based on the results of the SMD block core pit data is sandstone and claystone. Sandstone material is light gray to dark gray, while claystone has a dark gray color.

Figure 1 Core from in situ material drilling from the SMD block pit area

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Material properties Laboratory Test Results

The characteristics used in the research took the form of material properties data (Table 1) that were acquired based on the outcomes of laboratory experiments, including testing of physical properties and tests of the strength of rock friction. The bulk density value will be determined by the physical property test, whilst the cohesion and internal friction angle values will be determined by the internal friction angle test.

Table 1 Residu material properties in waste dump slope geometry engineering simulation (PT. Petrosea Tbk.)

Material	Unit Weight (Kn/ m³)	Cohesion (kPa)	Angle of Internal Friction (°)
Overburden	21.23	78.76	10.22
Bedrock	20.5	142	29.99

Bedrock material is a material that forms the base of the waste dump area that is formed in the pit itself or in the waste dump area. This material is dominant in the form of sandstone.

Overburden material is an ex-situ material because it is not formed naturally without geological processes in the waste dump area, but was formed artificially by humans to form the geometry of the slope and as the current condition of the slope. The overburden material is composed of a mixture of material originating from the SMD pit in the form of sandstone and claystone, so it is referred to as overburden material.

Condition of Research Area

According to observations made in the field, particularly in the out-pit dump region, there are fissures or cracks that are rather lengthy (Figure 2) because the bottom or toe of the waste dump area is not strong enough to bear the extra load. Overburden is the additional load that has been added.

Another factor that can cause reduced resistance is the movement that occurs throughout the area, such as the movement of units in the form of trucks working through the area, and there is mud or mud.

The additional load will affect how strong the foot of the area is, because if the bottom or leg is not strong, then there will be movement that pushes other areas so that it will cause cracks, which are generally referred to as cracks.

Figure 2 Cracks around the SMD block OPD waste dump area

Slope Simulation Analysis

To determine the factor of safety, a slope stability study was carried out using the Rocscience Slide2 software. Taking into account the impact of the state of the groundwater table and the magnitude of the seismic vibration coefficient, the simulation is completed.

The groundwater table condition used is full saturated because the slope is assumed to be pessimistic, because there are several indications that can ensure that the ground water table is close to the surface, such as seepage on the face of the slope.

Meanwhile, the earthquake vibration value used is a horizontal vibration of 0.05 according to the reference from PT. Petrosea Tbk. Horizontal vibration is used because it is a vibration that has a larger or

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more influence on the occurrence of landslides on slopes, especially waste dump slopes.

The safety factor value obtained must be in accordance with the safe slope criteria used, namely based on KEPMEN ESDM Number 1827 K/30/MEM/2018. The analysis used is the overall slope with moderate landslide severity and a static safety factor value of 1.3.

The safety factor has a value of 1.218 according to the simulation findings based on the real parameters used (Figure 3). Due to the influence of the groundwater table, the slope at (Figure 3) has an unsafe factor of safety. According to Arif (2016) and Hoek and Bray (1981), the groundwater table condition is an addition to the weight of the material used on the slopes of the garbage disposal. Therefore, the value of the factor of safety on a slope can change and become unsafe depending on the status of the groundwater level which is considered to be completely saturated.

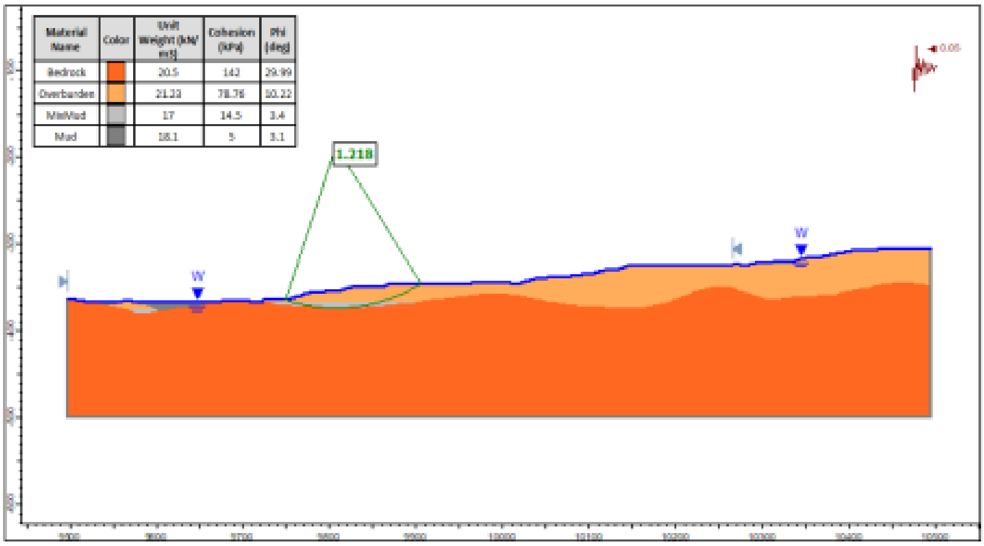

Figure 3 Waste dump slope simulation using the Morgenstern-Price method

The strength of the resisting force on the slope can vary depending on the earthquake vibration coefficient value that was utilised in the simulation (Figure 3). As a result, changing the slope's value becomes dangerous because, if the driving force is stronger, the slope's resisting force will suffer a reduction in resistance, making the slope safety factor value dangerous. If the earthquake vibration grows significantly in dry or wet conditions, the safety factor for slope stability will indicate a declining state.

In addition, the safety factor value obtained can also be influenced by the presence of material in the form of mud as a slip surface, which makes the foot of the slope not strong enough to withstand movements around the waste dump slope area.

CONCLUSION

According to the core data, the material conditions in the waste dump area are sandstone and claystone. This material is insitu material that has formed naturally in the pit area.

According to the outcomes of laboratory testing, bedrock, which serves as the foundation of the trash dump, has a unit weight value of 20.5 kN/m3, a cohesion value of 142 kPa, and an internal friction angle of 29.99°. The mixed-material overburden used to create the slope

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geometry has a unit weight of 21.23 kN/m3, a cohesion of 78.76 kPa, and an internal friction angle of 10.22°.

Based on the requirements of KEPMEN ESDM Number 1827 K/30/MEM/2018, the safety factor value acquired, 1,218 is an unsafe slope value. According to the simulation analysis, the value of the safety factor on the slope is influenced by several factors, including the value of the used earthquake vibration coefficient, the amount of mud that is present on the slope as a slip plane, and the state of the fully saturated groundwater table, which adds weight to each material.

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REFERENCES

Amri, N., Dharmawansyah, D., Hermansyah. (2021). Perbandingan Metode Bishop dan Janbu dalam Analisis Stabilitas Lereng pada OPRIT Jembatan Labu Sawo Sumbawa. Journal of Civil Engineering and Planning, Vol.2, No.1.

Anonim. (2018). Keputusan Menteri Energi Sumber Daya dan Mineral Indonesia Nomor 1827 K/30/MEM/2018. Kementerian Energi dan Sumber Daya Mineral Republik Indonesia.

Arif, I. (2016). Geoteknik Tambang. Mewujudkan Produksi Tambang yang Berkelanjutan dengan Menjaga Kestabilan Lereng. Jakarta: PT Gramedia Pustaka.

Haris, V. T., Lubis, F., Winayati. (2018). Nilai Kohesi dan Sudut Gesek Tanah pada Akses Gerbang Selatan Universitas Lancang Kuning. Jurnal Teknik Sipil, Vol. 4, No.2.

Hidayat, S., Umar, I. (1994). Peta Geologi Lembar Balikpapan, Kalimantan. Bandung: Pusat Penelitian dan Pengembangan Geologi.

Hoek, E., Bray, J.W. (2005). *Rock Slope Engineering Civil and Mining (4th Edition). London and New York: Spon Press. Taylor & Francis Group.*

Irvan, S., Hirnawan, F., Zakaria, Z., Mohammad, F. (2015). *The Effect of Vibration Generated by 2D-Seismic Survey Operation on Natural Slope Instability. Springer International Publishing Switzerland*

Marit, F. A. Y., Nurhakim., Saismana, U. (2022). Perencanaan dan desain *disposal* untuk *Pit Central* dan *Pit North* Tutupan di PT Adaro Indonesia. Jurnal Himasapta, Vol. 7, No.1: 51 - 54.

Takwin, G. A., Turangan, A. E., Rondonuwu, S. G. (2017). Analisis Kestabilan Lereng Metode *Morgenstern-Price* (Studi Kasus: *Diamond Hill Citraland*). TEKNO, Vol. 15/ No. 67.

Zakaria, Z. (2010). Praktikum Geologi Teknik. Jatinangor: Fakultas Teknik Geologi. Universitas Padjadjaran.

Zakaria, Z. (2011). Analisis Kestabilan Lereng. Laboratorium Geologi Teknik, Program Studi Teknik Geologi.

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