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Analysis of slope stability using Spancer and Morgenstren - price methods at Lowwall Pit 81 W Pt Antareja Mahada Makmur Jobsite Perkasa Inakakerta

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Abstract

Background : Stability slope is aspect critical in operation mining coal, specifically method mine open. Research This analyze stability slope in the mine rock coal Bengalon, East Kalimantan, with evaluate geometry slope, properties Mechanic rocks, and apply analysis probability for take into account uncertainty of input parameters. Referring to the Decree of the Minister of Energy and Mineral Resources No. 1827 K/30/MEM/2018 concerning Guidelines Implementation Good Mining Engineering Principles, research This covers measurement geometry slope, testing laboratory characteristic Mechanic rocks, analysis deterministic using method Spancer and Morgenstren - Price. Research results show that combination corner steep slopes, and variability strong shift land as well as material saturation significant lower factor security and improve probability failure slope. In the use of the Method Spencer Dan Morgenstren - Price appropriate used in Stability Analysis slope if back analysis was conducted on the properties mechanic's rock.

Method: Research method done with surveys and mapping, and conducting testing againsttheproperty physical and mechanical rocks. Secondary data related lithology in the research area and profile data company. Data collection techniques are carried out with geometry and result data testing characteristic physical and mechanical rocks. Data then processed use rocscience slide software with method spanker.

Results : Results Stability level slope reviewed from mark factor security show slope the including slope No stable with mark factor security slope with burden Volvo FMX 400 Dump Truck is 48000 by 1.03 Approach analysis with the Spancer and Morgenstren Method - Price is right used in Stability Analysis slope if back analysis was conducted on the properties mechanics rocks . There are 2 settling ponds at PT Antareja Mahada Makmur Perkasa Inakakerta site, namely settling pond 81W and settling pond 71N. This study only discusses settling pond 81W. Settling Pond 81W has 6 compartments with different lengths, widths and depths.

Conclusion : Stability level slope reviewed from mark factor security show slope the including slope No stable with mark factor security slope with burden Volvo FMX 400 Dump Truck is 48000 by 1.03 Approach analysis with the Spancer and Morgenstren Method - Price is right used in Stability Analysis slope if back analysis was conducted on the properties mechanics rocks . There are 2 settling ponds at PT Antareja Mahada Makmur Perkasa Inakakerta site, namely settling pond 81W and settling pond 71N. This study only discusses settling pond 81W. Settling Pond 81W has 6 compartments with different lengths, widths and depths.

Keywords: Slope Stability; Coal Mine; Slope Geometry; Limit Equilibrium Rock Mechanical Properties; Probability Analysis

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1. Introduction

Optimization of environmental and occupational safety and health management in coal mining is very important (Amirudin et al, 2024). The implementation of the improvement plan strategy be seen from the positive changes for all elements targeted for improvement (man/workers, machines and methods) which generally have an impact on reducing environmental pollution and improvement of occupational health and safety (Amirudin et al, 2024). It requires optimization of each element consisting of Policy, Planning, Organization and Personnel, Implementation, Monitoring, Evaluation and Follow-up, Documentation, as well as management review and performance improvement. Data collection methods were carried out using interviews, observation and document review (Amirudin et al., 2024). Implementation of occupational health and safety must involve all elements in the organization from the lowest level to top management (Amirudin, 2024).Mining is sector industry that has impact big for environment. Management environment living in the environment mining as well as implementation his protection need effort systematic and integrated so that the function environment still can sustainable especially in environments that have damaged consequence implementation activity Mining (Sitorus and Wulandari, 2022). Management as well as protection that can implemented, namely design, utilization, control, maintenance, and finally supervision (Siregar, et al. 2019; Maha et al., 2023; Rumpaidus et al., 2018; Qur'ani et al., 2022).

The slope is not stable cause fatality for workers in mining areas The landslide that occurred during the activity process mining capable harm company Good in a way sufficient material big, case landslide slope mine can bother operational mining which has fatal consequences for security worker.

Activity mining open will to form potential slope landslide because of condition slope that is not stable. Stability slope influenced by geometry slope, rainfall rain, nature physical and mechanical rocks. Stability level slope is factor main in determinant geometry slope is structure geology, nature physical and mechanical rocks, as well as groundwater conditions. Ability material excavation is influenced by characteristic physical and mechanical properties of the material include strength press uniaxial, *point load index, sonic velocity* (Syam et al., 2018).

Stability a slope controlled by conditions geology area local, form overall slope, groundwater conditions and also techniques excavation in the process of making slope. Purpose of analysis stability slope for get mark factor security related with condition slope the.

2. Material and methods

Research methods done with surveys and mapping, and conducting testing to characteristic physical and mechanical rocks. Secondary data related lithology in the research area and profile data company. Data collection techniques are carried out with geometry and result data testing characteristic physical and mechanical rocks. Data then processed use *rocscience slide software* with method *spancer.* Safety factor against danger landslide defined as comparison between strong slide on the constituent material slope with strong retainer shift in guard stability.

Table 1 Safety Factor and Probability Values Landslide

Slope Type	**Consequences of failure**	**Acceptance Criteria**		
		Static Safety Factor (min)	**Dynamic Safety Factor (min)**	**Probability of failure (max) PoF (FK≤1)**
Single Slope	Low to high	1,1	None	25-50%
Inter -ramp	Low	1,15 – 1,2	1,0	25%
	Medium	1,2 – 1,3	1,0	20%
	High	1,2 -1,3	1,1	10%
Overall Slope	Low	1,2 -1,3	1,0	15-20%
	Medium	1,3	1,05	10%
	High	1,3 – 1,5	1,1	5%

3. Results and discussion

3.1. Slope Stability Analysis Without Back Analysis

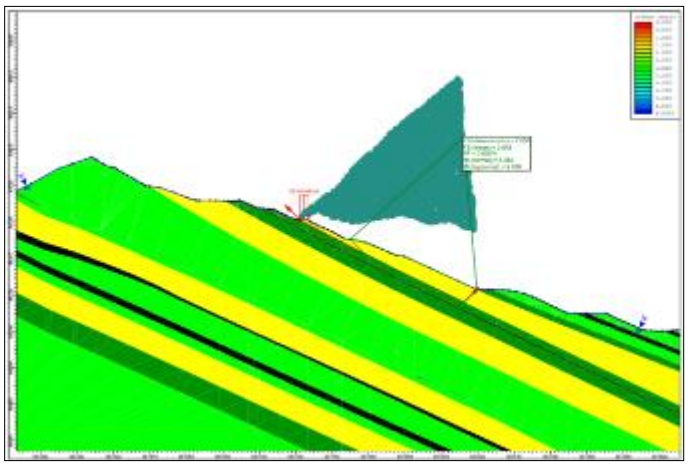

Figure 1 Results of Slope Stability Analysis with Loads Before Back Analysis

Picture 1 is illustration geometry low wall pit slope 81w. Condition existing in the field, Condition slope study own height 32 m divided into 5 levels. Angle slope total 45 ^{0}, with soft material condition and has characteristic fed up Because influence from rainfall rain. Modeling slope done RocScience Slide 6.0. Properties data physical and mechanical the slope used based on trait test results mechanics rock corner shift in influence factor its security. Before done *back analysis* mark factor security slope low wall by 2.5 with *ground pressure* 39.4, adding burden The DT Volvo 400's payload is 48,000 kg. According to the results of rock mechanics testing before Back Analysis was carried out by considering the saturation properties, the following results were obtained:

Table 2 The results of rock mechanics testing

Material Name	Parameter	Distribution	Mean	Std. Dev	Rel. Min	Rel. Max
Sandstone_S76	Cohesion (kPa)	Uniform	24,025	-	5	5
	Internal Friction Angle (°)	Uniform	14,33	-	5	5
	Unit Weigh (dry) (kN/m^3)	Normal	14,478	1,481354	2,710436	3,2716
	Unit Weigh (wet) (kN/m^3)	Gamma	18,4	0,97869	1,827585	1,997

Based on results said, obtained FK value of 2.5 according to ESDM Ministerial Decree No. 1827 K/30/2018 is classified as in slope with Stable Level. Analysis results stability slope based on mark factor security served in the following table:

Table 3 Results of FK Analysis before Back Analysis was carried out

Slope Name	Slope Height	Slope Angle	FK Analysis Results	FK Value Standard	Information
			DT Load Full Load	ESDM Ministerial Decree No. 1827 of 2018	
Lowwall Pit 81W	32 m	45	2.5	1.15-1.2	Stable

3.2. Slope Stability Level Analysis with Back Analysis

Figure 2 is illustration geometry slope lowwall pit 81w. Condition existing in the field, Condition slope study own height 32 m divided into 5 levels. Angle slope total 45 ^{0}, with soft material condition and has characteristic fed up Because influence from rainfall rain. Modeling slope done RocScience Slide 6.0. Properties data physical and mechanical the slope used based on trait test results mechanics rock corner shift in influence factor its security. Before done *back analysis* mark factor security slope lowwall by 2.5 with *ground pressure* 39.4, adding burden The DT Volvo 400's payload is

48,000 kg. In accordance with actual field conditions, the material has a high saturation nature, so it is necessary to carry out back analysis by conducting rock mechanics tests, including:

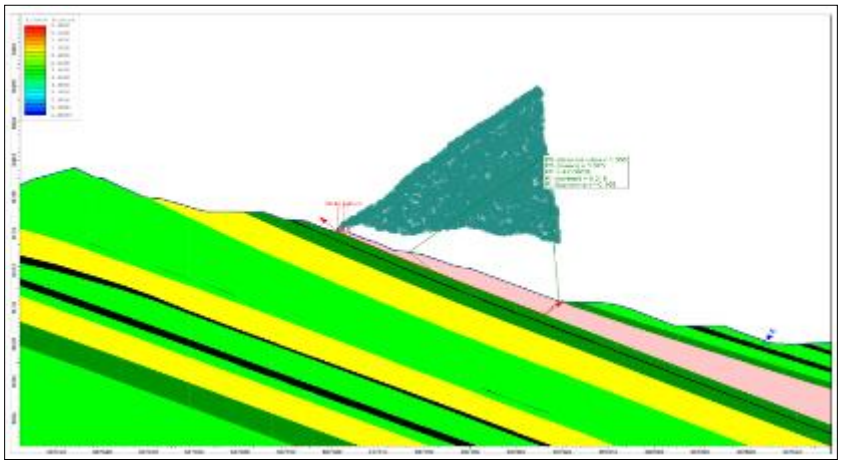

Figure 2 Results of Slope Stability Analysis with Loads

Table 4 Rock mechanics tests

Parameter	Results
Cohesion	24.025
Internal Friction Angle	14.33
Dry Specific Gravity	14,478
Specific GravityWet	18.4

Based on results said, obtained FK value of 1.03 according to ESDM Ministerial Decree No. 1827 K/30/2018 classified as in class critical (FK = 1.07 – 1.25). Stability level slope obtained Of course just related with characteristic physical and nature mechanics on slopes. Approach *Spencer* do calculation *back analysis.* Analysis results stability slope based on mark factor security served in the following table:

Table 5 Results of FK Analysis After Back Analysis

Slope Name	Slope Height	Slope Angle	FK Analysis Results	FK Value Standard	Information
			DT Load Full Load	ESDM Ministerial Decree No. 1827 of 2018	
Lowwall Pit 81W	32m	45	1.03	1.15-1.2	Unstable

4. Conclusion

Based on results research is obtained conclusion as following:

- The level of slope stability reviewed from the safety factor value shows that the slope is an unstable slope with a slope safety factor value with a Volvo FMX 400 Dump Truck load of 48.000 is 1,03.
- Approach analysis with the *Spancer* and *Morgenstren Method - Price* is right used in Stability Analysis slope if back analysis was conducted on the properties mechanic's rock

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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