Slope Stabilization for Coal mining In Prabumulih District, South Sumatera Province, Indonesia

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Abstract

The succed of open pit mining is supported by mine slope stability because it is linked with safety issue and mining productivity. To obtain safe and economic slope design, geotechnical study needed such as geomechanics analysis and slope stability analysis. Geomechanics analysis conducted from few samples to obtain laboratory result of physical and mechanical soil and rock properties. The rock characteristic of slope, rock mechanics are needed to calculate safety factor digitally.

This research is conducted to calculate safety factor of mine slope using seismic load as external factor of slope stability. The location of this research lies at area that will be coal mining area. The exploration drilling shows that research area consisted of claystone, carbonaceous claystone, sandstone and coal as Muaraenim Formation.

The result of slope stability analysis shown that mine slope is safe and economic at 50 meters depth with slope angle no more than 45 degrees considering of seismic condition with $\alpha = 0.1$ g.

Keywords: Coal Mining, Slope Stability Analysis

1. Introduction

The landslide or often called the avalance is a geological phenomena that happened because the movement of the rock or soil with various types. In general, the landslide caused by two factors which is driving factor and the triggering factor. Driving factor are factors that influence the condition of own material, while the triggering factor is a factor that causing the materials moves.

The succed of open pit mining is supported by mine slope stability because it is linked with safety issue and mining productivity. To obtain safe and economic slope design, geotechnical study needed such as geomechanics analysis and slope stability analysis. Geomechanics analysis conducted from few samples to obtain laboratory result of physical and mechanical soil and rock properties. The rock characteristic of slope, rock mechanics are needed to calculate safety factor digitally.

Geology of research area consisting by Late Miocene – Early Pliocene Muaraenim Formation (Tmpm) and Late Pliocene – Pleistocene Kasai Formation (Qtk). The geological structure are northwest – southeast trends antiklinorium (Gafoer, *et.al,* 1986). Muaraenim Formation consisting lithologies namely sandstones, siltstones, fossiled claystones with light yellow colored and coal lenses containe iron oxide as concretion and thin strata. Coals in this Formation are almost low grade lignit. Only on several spots it change becomes high grade coal.

The accelerations in those zones vary between 0.03g to 0.30g (Masyhur Irsyam, et al., 2010). From the attached map, the site is located in the second seismic zone giving a seismic coefficient of 0.10g.

2. Method

Geotechnical drilling is carried out to obtain soil and subsurface rock geomechanics. Rocks and soils sample are taken from geotechnical drilling data and mechanical properties tested at laboratory. The result of laboratory tests are used to calculating slope stability analysis.

Slope stability analysis using slope stability analysis software and simulating safe mine slope with

30, 40, 50, 60 and 70 meters height variation; 20^o, 25^o, 30^o, 35^o, 40^o, 45^o and 50^o degree slope variation; using natural ground water level; static and considering seismic load 0.1 g as horizontal seismic and 0.05 g as horizontal seismic.

Analysis method using circular failure because rocks in the research area generally can be classified as soil based on strength index classification (Hoek & Bray, 1977), thus the calculation did by using Bishop calculation. Safe mine slope is has more than 1.25 value of safety factor in static condition (Bowles. J. E, 1986) and more than 1.05 value in seismic condition.

3. Result

The lithologies found in research area are claystones, sandy claystones, clayey sandstones, sandstones and coal from Muaraenim Formation. Subsurface profile made from several geotechnical drilling data to determine and reconstructed subsurface rock strata that will be used for slope stability analysis profile. Rock strata in research area has 5^o dipping to south east (Figure 2).

Physical and mechanical properties of soil and sub-surface rocks has various value based on the laboratory test results. The table 1 show the physical and mechanical properties used for mine slope stability analysis calculation. Soil and rock properties method are obtained by physical test (unit weight test) and mechanical test (direct shear) in laboratory.

Table 1. The physical and mechanical properties of soil and rocks used for slope stability analysis.

No	Materials	γ (kN/m3)	C (kPa)	φ (°)
1	Soil	16,34	12,00	10,25
2	Claystone 1	18,26	85,26	11,92
3	Claystone 2	18,23	105,84	13,52
4	Claystone 3	15,18	150,92	29,27
5	Claystone 4	17,17	199,92	23,83
6	Sandstone	15,68	350,84	32,15
7	Coal	13,00	182,00	21,00
8	Sandy Claystone 1	14,21	85,26	19,01
9	Sandy Claystone 2	16,82	70,56	22,30

Note : γ = Unit weight
C = Cohession
Φ = Angle of internal friction

Single slope stability analysis with ground water level 6.5 meters below surface shown the slope is safe at 30, 40 and 50 meters with overall slope, also at 60 meters depth with 40^o slope and 70 meters depth with 20^o slope in static condition. While slope stability analysis using seismic load shown the slope is safe at 30 and 40, also 50 meters with 20^o, 25^o, 30^o, 35^o, 40^o and 45^o of slope angle (figure 3).

The figure 4 show relationship between safety factor and slope angle with various depth in static condition and seismic condition. Safety factor value of slope are inversely proportional with depth/slope height and slope, safety factor value will be little worth where the depth or slope height and slope angle are getting greater.

4. Conclusion

Slope stability analysis results show that mine slope safe (stable condition) at 60 metres depth with 40^o slope angle maximum in static condition, while in seismic condition mine slope safe at 50 metres depth with 45^o slope angle and 60 metres with 20^o slope angle maximal. The mine slope with depth and slope angle less than 50 metres with 45^o slope angle is highly recommended result based on slope stability analysis using seismic coefficient, but it is suggested if mine slope opened less than these slope stability result because not all of the other factors both of internal and external factor have considered in these slope stability calculation.

5. Acknowledgment

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6. References

Gafoer, S. Cobrie, T and Purnomo, J. 1986. *Geology of Lahat Quadrangles, Sumatera*. Bandung : Center of Research and Development Geology.

Hoek, E ., dan Bray, J, W . 1977. *Rock Slope Engineering*. London : The Institution of Mining

and Mettalurgy.
Irsyam, Masyhur, et al. 2010. *Peta Hazard Gempa Indonesia 2010*. Jakarta : Kementrian Pekerjaan Umum
Bowles, J.E., 1986. *Physical and Geotechnical Properties of Soil (Soil Mechanics).* Jakarta : Erlangga Publisher.

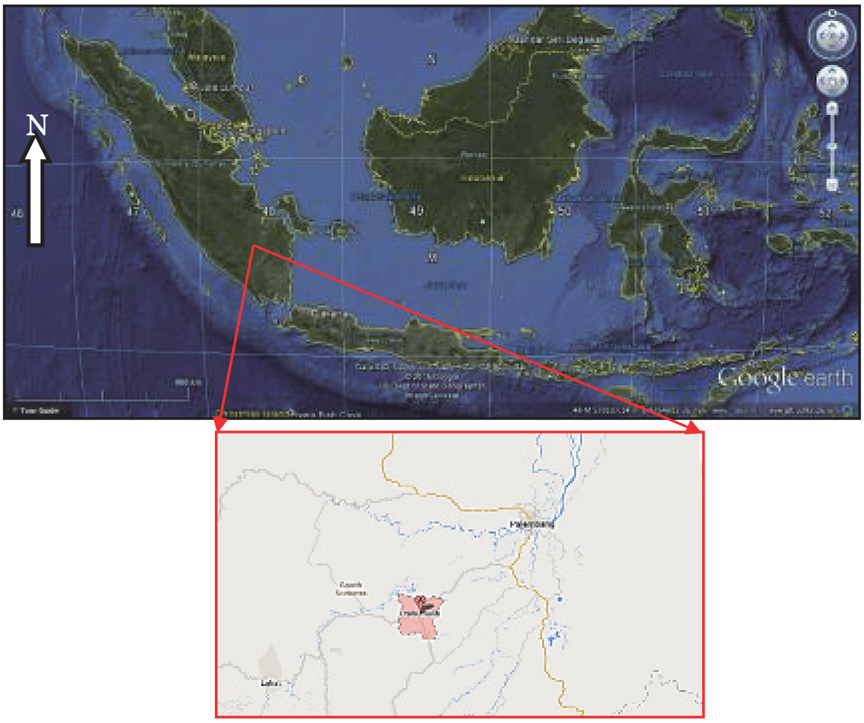

Figure 1. Location of research area (taken from Google Earth, not to scale)

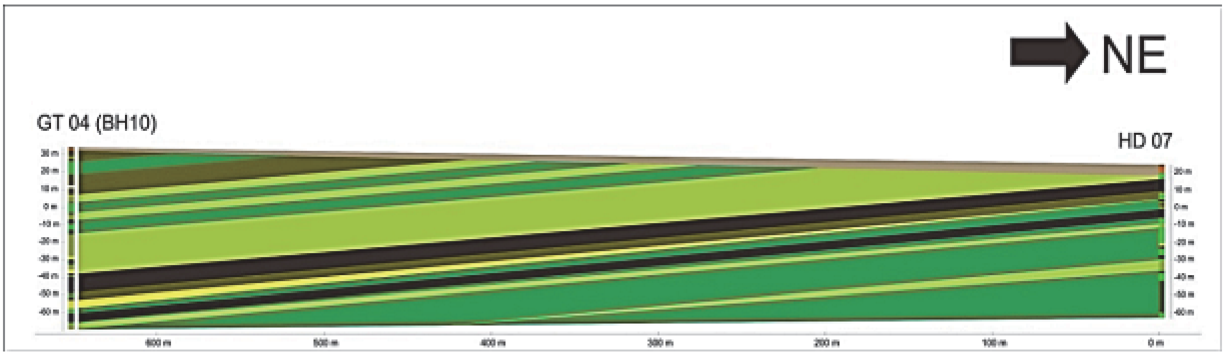

Figure 2. Sub-surface correlation bassed on two geotechnical drilling boreholes (not to scale).

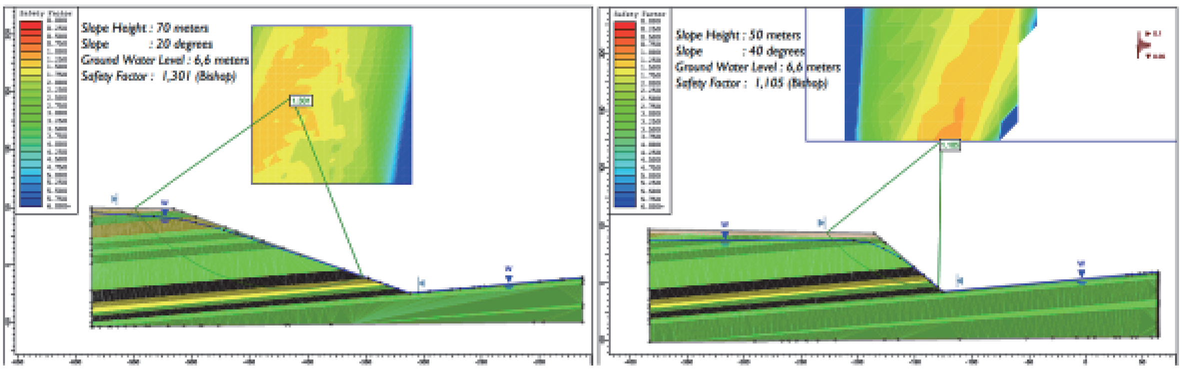

Figure 3. Mine slope stability analysis result in static condition (left) and seismic condition (right).

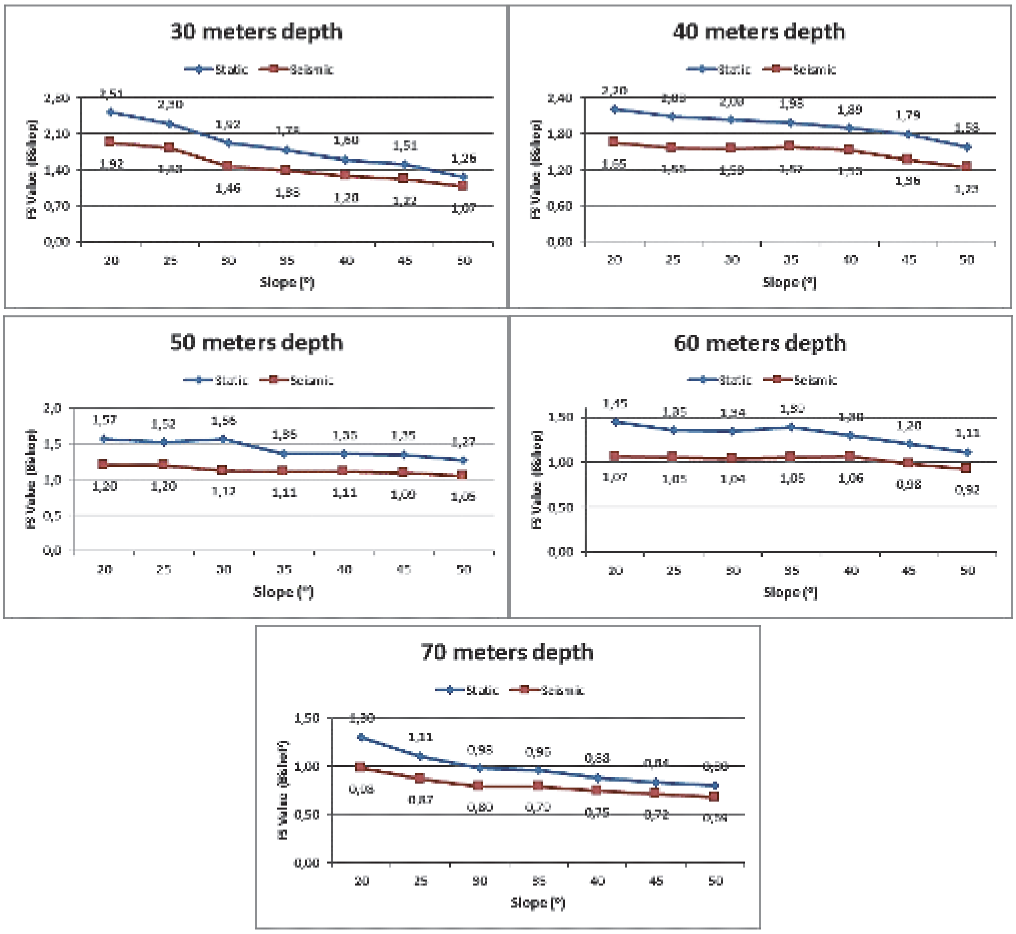

Figure 4. Comparison between safety factor and slope angle at static condition and seismic condition.