SLOPE STABILITY ANALYSIS USING SPENCER METHOD IN PIT 1 AREA OF LIMESTONE MINING PT SUMBAR CALSIUM PRATAMA, NAGARI HALABAN, LAREH SAGO HALABAN, LIMA PULUH KOTA, WEST SUMATRA

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Abstract. *PT Sumbar Calcium Pratama as one of the mining companies that produces calcium material for core and shell separators for the palm oil mill industry, participates by increasing production to meet consumer needs. PT Sumbar Calcium Pratama is one of the mining companies engaged in the mining of class C excavation material (limestone) whose mining operations are carried out by means of Quarry. The results of taking slope geometry data at PT Sumbar Calsium Pratama obtained a slope height of 30 m with a slope angle of 83 °. The Spencer Slice Method was developed by Spencer in 1967. It is one of the most theoretically rigorous wedge methods because it fulfills the balance of forces and moments of the collapsing mass. Thus, it allows for a more precise calculation of the Factor of Safety (FS). The results of the Rock Mass Rating (RMR) analysis of the rock show that the Rock Quality Designation (RQD) of the rock mass of the slope in the pit 1 mining area of PT Sumbar Calsium Pratama has a slope of 2.58%, and the weight of the Rock Mass Rating (RMR) of the slope belongs to class III (medium). Kinematic analysis then obtained the potential for landslides that will occur in the research area in the form of plane avalanches (Planar Failure) of 10%, wedge avalanches (Wedge Failure) of 9.47%, avalanches (Flexural toppling) of 45%. Recommendations in an effort to increase the stability of the research slope of PT Sumbar Calsium Pratama which is in a saturated state is not stable / safe, first by changing the slope geometry in the form of slope height which was originally 30 meters to 24 m or 23 m then obtained FK values of 1.33 and 1.37 (safe / stable). Second, by reducing the slope from 83 ° to 65 ° and 64 °, FK values of 1.3 and 1.38 (safe/stable) were obtained.*

Keywords: *Stability Analysis, Avalanche Type, Spencer Method, RMR.*

1 Introduction

PT Sumbar Calsium Pratama is one of the companies engaged in the limestone mining industry in Lima Puluh Kota Regency. The mining activity applied is an open mining system with a quarry mining system. In the future, land clearing will be carried out for the Pit 2 area at the top of the slope, which makes it necessary to analyze the stability of the slope as a safety evaluation for the company in the future.

2 Literature Review

2.1 Company profile of PT Sumbar Calsium Pratama

The location of PT Sumbar Calcium Pratama Limestone Production Operation IUP is administratively located in Jorong Ateh Loban, Lareh Sago Halaban, Lima Puluh Kota, West Sumatra. Geographically, the mine site of PT Sumbar Calcium Pratama is located at coordinates 0º20'50.2" N-S and 100 45'25.3" E, which covers an area of 25 Ha.

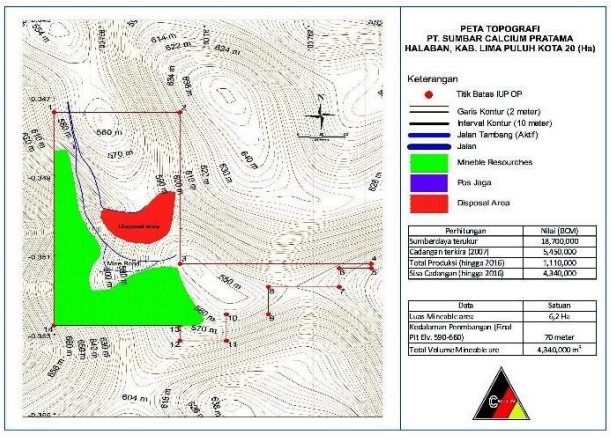

Fig 1. Topography Map of PT Sumbar Calsium Pratama.

2.2 Geology and Stratigraphy

2.2.1 Regional Geology

The geology of PT Sumbar Calsium Pratama is dominated by limestone, a rock composed of the mineral calcium carbonate ($CaCO_3$), which occurs organically and chemically. Organic breakdown of this type comes from a collection of sediments, the remains of hard-shelled marine life, and algae. Chemical reworking is the deposition of the results of organic reworking that takes place not far from the original place. Another type that exists is the deposition of calcium carbonate, climatic conditions and a certain environmental atmosphere, both in sea water, fresh water and lime sinter deposits [1].

2.2.2 Regional Statigraphy

The regional statigraphy of Lima Puluh Kota is the Late Oligocene-Early Miocene limestone rock unit (Ombilin Formation) in a shallow marine depositional environment [2].

2.3 Spencer Method

The Spencer Slice Method was developed by Spencer in 1967. It is one of the most theoretically rigorous Slice Methods because it satisfies the balance of forces and moments of the collapse mass [3]. Thus, it allows for a more precise calculation of the Factor of Safety (FS). The Spencer Method can also be applied to circular and non-circular collapse surfaces [4].

3 Research Methods

3.1 Object Of Research

Fig 2. Slope Area Pit 1 PT Sumbar Calsium Pratama.

3.2 Data Processing Stage

1. Testing the physical and mechanical properties of rocks
2. RMR value calculation
3. Analyzing the type of avalanche
4. Analyzing FK of slope

4 Results And Discussion

4.1. Slope Geometry

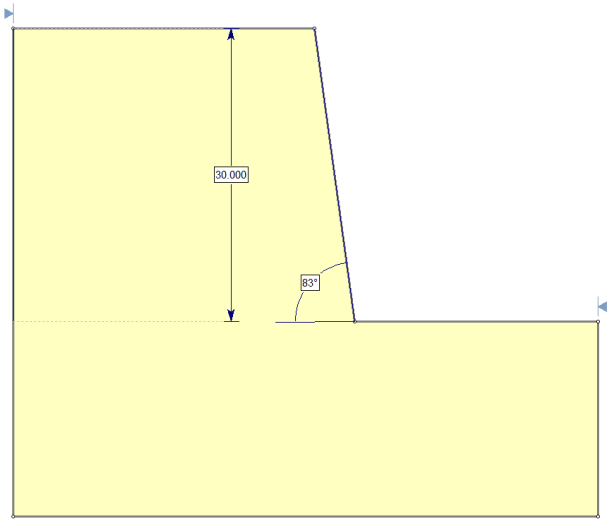

Fig 3. Slope geometry of Pit 1 area PT Sumbar Calsium Pratama.

4.2 Rock Physical Properties Test

Table 1. Test Results of Physical Properties of Rocks

Wn (g)	Ww (g)	Ws (g)	Wo (g)
94,97	95,31	57,51	94,93
123,86	124,39	80,83	123,84
131,81	132,35	82,41	131,72

4.3 Rock Mechanical Properties Test

Table 2. Point Load Index test result data.

Sampel	F	Is	UCS (Bienawski)(Mpa)
1	1,0352	3,6991	85,0802
2	1,0326	2,9780	68,4949
3	1,0343	3,1829	73,2085
average			**75,5946**

Table 3. UCS Result.

Sample	diameter (mm)	panjang (cm)	conus distance	P	
				kN	N
1	54	7,6	52	9,662	9662
2	53,7	7,6	51	7,501	7501
3	53,9	7,6	50	7,693	7693

4.4 Results of Rock Mass Classification (RMR) Analysis

Classification Parameters RMR of the system			
Parameter		Value	Weight
Point Load Index		3,2 Mpa	7
RQD		2,58%	3
Space		6-20 cm	8
Discontinuity condition	Length	9,48	2
	wide	5,7	0
	Roughness	slightly rough	3
	Filling	Soft Filling	3
	Pelapukan	slightly weathered	5
Water Condition		Dry	15
RMR			46
RMR class			**III**
Rock Mass Quality			**Moderate**

4.5 Avalanche Type Analysis

The discontinuous planes are grouped into a set of discontinuous planes. Then plot the position of the discontinuity set, the slope orientation in the form of dip and dip direction and the inner shear angle on the stereonet. Then the potential for landslides on each Scanline will be known by means of a point station [5].

4.5.1. Kinematic Analysis for Plane Landslides.

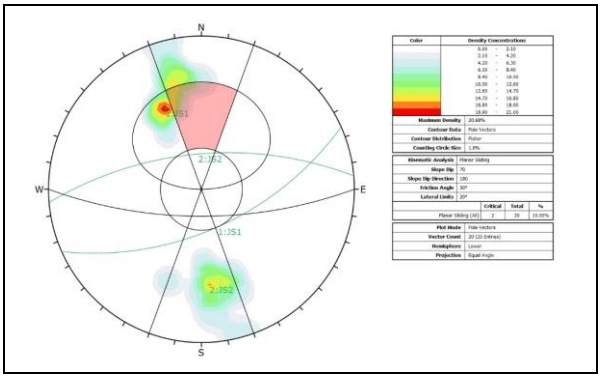

Fig 4. Plane Landslides.

4.5.2. Kinematic Analysis for Wedge Landslides.

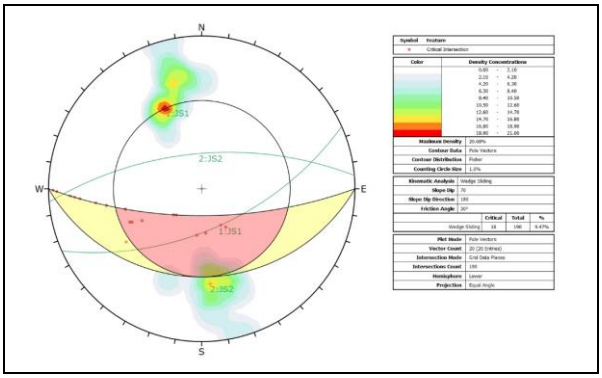

Fig 5. Wedge Landslides.

4.5.3. Kinematic Analysis for Rolling Landslide

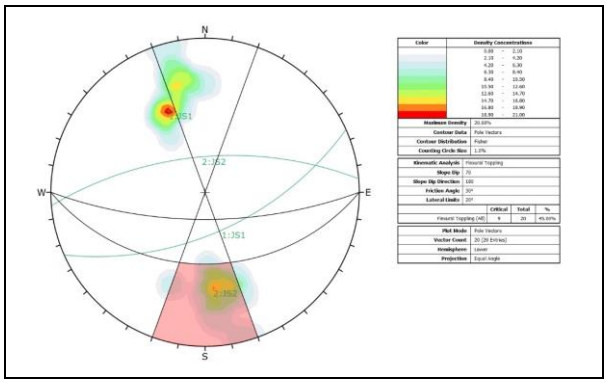

Fig 6. Rolling Landslide.

4.6 Slope Stability Analysis

Modeling of mine slopes to be analyzed by including factors of geometry, rock type, physical and mechanical properties of rocks, insitu stress, loading and boundary conditions, so as to describe and represent the state of mine slopes close to the actual situation in the field. Modeling is done using software. Analysis of slope stability using the boundary equilibrium method with the help of software. [6].

4.6.1. Recommended Slope Geometry Design Using Slide 6.0 Software

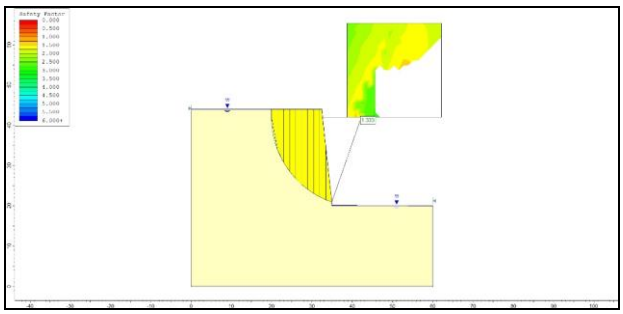

Fig 7. Recommended Slope Height 24 m.

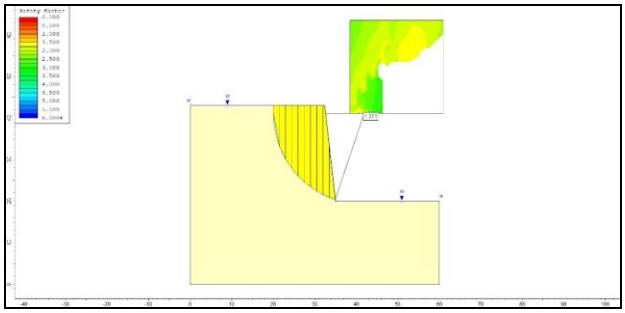

Fig 8. Recommended Slope Height 23 m.

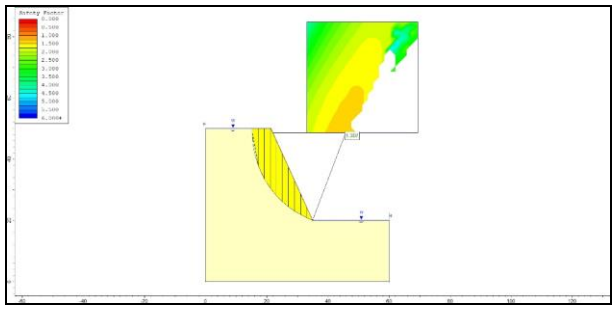

Fig 9. Recommended Slope Angle 65°.

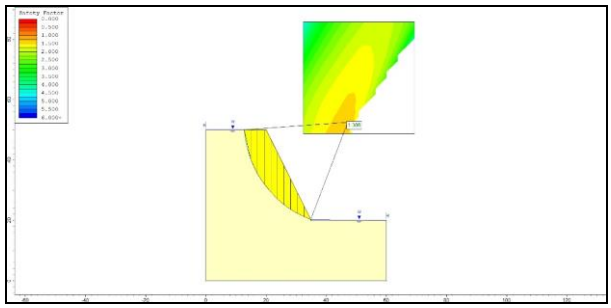

Fig 10. Recommended Slope Angle 64°.

5 Conclusion And Suggestion

5.1 Conclusion

a. The results of the analysis of physical and mechanical properties of rocks in the laboratory are as follows:
Original Fill Weight Value: 26.11 KN/m3
Original Fill Weight Value: 26.10 KN/m3
Original Fill Weight Value: 26.22 KN/m3
The results of the point load index compressive strength test amounted to: 3.28 MPa.

b. The results of the Rock Mass Rating (RMR) analysis of rocks show that the Rock Quality Designation (RQD) of the rock mass of the slope in the pit 1 mining area of PT Sumbar Calsium Pratama has a slope of 2.58%, and the weight of the Rock Mass Rating (RMR) of the slope belongs to class III (medium).

c. Based on the results of the plot of the discontinuity field in the dips software with kinematic analysis, it is obtained that the potential for landslides that will occur in the research area is in the form of a plane avalanche (Planar Failure) of 10%, wedge avalanche (Wedge Failure) of 9.47%, avalanche toppling (Flexural toppling) of 45%.

d. Recommendations in an effort to increase the stability of the research slope of PT Sumbar Calsium Pratama which is in a saturated state is not stable / safe, First, by changing the slope geometry in the form of slope height from 30 meters to 24 m or 23 m, the FK value of 1.33 and 1.37 (safe/stable) is obtained. Second, by reducing the slope from 83° to 65° and 64°, the FK values of 1.3 and 1.38 (safe/stable) are obtained.

5.2 Suggestion

a. To prevent avalanches on saturated slopes, PT Sumbar Clasium Pratama is expected to change the slope geometry.

b. One way to increase the value of the safety factor (FK) of the slope is to reduce the height of the slope and reduce the slope.

c. The need for accuracy when testing samples in the laboratory so that the results obtained are more accurate.

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