World Academy of Science, Engineering and Technology
International Journal of Geotechnical and Geological Engineering
Vol:17, No:07, 2023

Slope Stability Assessment in Metasedimentary Deposit of an Opencast Mine: The Case of the Dikuluwe-Mashamba (DIMA) Mine in the DR Congo

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Abstract : Slope stability assessment is still the biggest challenge in mining activities and civil engineering structures. The slope in an opencast mine frequently reaches multiple weak layers that lead to the instability of the pit. Faults and soft layers throughout the rock would increase weathering and erosion rates. Therefore, it is essential to investigate the stability of the complex strata to figure out how stable they are. In the Dikuluwe-Mashamba (DIMA) area, the lithology of the stratum is a set of metamorphic rocks whose parent rocks are sedimentary rocks with a low degree of metamorphism. Thus, due to the composition and metamorphism of the parent rock, the rock formation is different in hardness and softness, which means that when the content of dolomitic and siliceous is high, the rock is hard. It is softer when the content of argillaceous and sandy is high. Therefore, from the vertical direction, it appears as a weak and hard layer, and from the horizontal direction, it seems like a smooth and hard layer in the same rock layer. From the structural point of view, the main structures in the mining area are the Dikuluwe dipping syncline and the Mashamba dipping anticline, and the occurrence of rock formations varies greatly. During the folding process of the rock formation, the stress will concentrate on the soft layer, causing the weak layer to be broken. At the same time, the phenomenon of interlayer dislocation occurs. This article aimed to evaluate the stability of metasedimentary rocks of the Dikuluwe-Mashamba (DIMA) open-pit mine using limit equilibrium and stereographic methods Based on the presence of statistical structural planes, the stereographic projection was used to study the slope's stability and examine the discontinuity orientation data to identify failure zones along the mine. The results revealed that the slope angle is too steep, and it is easy to induce landslides. The numerical method's sensitivity analysis showed that the slope angle and groundwater significantly impact the slope safety factor. The increase in the groundwater level substantially reduces the stability of the slope. Among the factors affecting the variation in the rate of the safety factor, the bulk density of soil is greater than that of rock mass, the cohesion of soil mass is smaller than that of rock mass, and the friction angle in the rock mass is much larger than that in the soil mass. The analysis showed that the rock mass structure types are mostly scattered and fragmented; the stratum changes considerably, and the variation of rock and soil mechanics parameters is significant.

Keywords : slope stability, weak layer, safety factor, limit equilibrium method, stereography method
Conference Title : ICLSS 2023 : International Conference on Landslides and Slope Stability
Conference Location : Ottawa, Canada
Conference Dates : July 03-04, 2023