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Slope optimisation of an operating open pit mine

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Open pit mines are amongst the world's largest geotechnical structures. Rock slope instability in such environments thus represents a significant hazard. It is the cause of serious injuries or fatalities as well as major financial losses. The main objectives of the current rock slope stability analyses are to determine the rock slope stability conditions, to investigate the potential failure mechanisms and to make recommendations towards the safe and economic operation of the mine.

Valuable input data for these analyses are significant and typically involve rock mass classification, geological and discontinuity mapping as well as laboratory testing. The slope design however, is highly dependent on the orientation of the pit slopes relative to major structural feature orientations. Consultant A identified five major joint sets based on scanline mapping within the pit. Sirovision 3-D photography software was used by Consultant A to collect additional joint orientation data from higher risk and inaccessible areas. Discontinuity data with a persistence exceeding 3 m as well as major structures such as faults, shear zones, dykes and veins were measured by Consultant B. In this study, it was decided to perform the kinematic and slope stability analysis based on measurements for individual cut walls instead of a combination of all discontinuity data for the whole pit, with the intention of avoiding masking of critical sets. Three profiles were suggested to be analysed (AA', BB', CC') in certain cut walls that experienced instabilities and rockfalls, according to Consultant A. The results of the kinematic analysis conducted in the current study for the particular cut walls show that plane and wedge failures are possible in both profiles A-A' and B-B' under the current design slope angle. The Limit Equilibrium (LE) method was employed in analysing the stability of the three selected profiles. The failure mechanisms examined were plane, wedge and toppling. Safety factor calculations were based on the Mohr-Coulomb failure criterion. The results show that both profiles A-A' and B-B' fail under planar failure and fail marginally under wedge failure. There is a possibility of toppling for the three profiles. A change of slope angle and optimization is suggested for the slopes where cutting occurs parallel to the strike of major joint sets.