Evaluation of open pit slope stability using various slope angles and element types

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Abstract:

The success of mining operation primarily is measured by safety and productivity. Rock slope stability is the major concern in open pit mines. Slope instability results in damage to equipment, injuries to personnel, disruption to mining operation and loss overall mine profitability. The objective of this study is to demonstrate a method to select the optimal slope angle related to three principal factors: safety, productivity and mining costs. Also, it aims to investigate the accuracy of numerical analysis using different element types and order. Therefore, series of two-dimensional elasto-plastic finite-element models has been constructed at various slope angles (e.g. 400, 450, 500, 550, 600, 650, and 700) and different element types (e.g. 3-noded triangle (T_3), 6-noded triangle (T_6), 4-noded quadrilateral (Q_4) and 8-noded quadrilateral (Q_8)). The results are presented, discussed and compared at various slope angles and element types in terms of critical strength reduction factor (CSRF) or its equivalent factor of safety (FOS), total rock slope displacement, mine production and mining costs. The results reveal that, the mine productivity increases as slope angle increases, however, slope stability deteriorates. Alternatively, the factor of safety (FOS) decreases as slope angle becomes steeper (e.g. minimum factor of safety is obtained at highest steep angle of 700). Despite of the increasing in computation time, the analysis shows that, the accuracy of the modelling increases when adopting high-order element types (e.g. 8-noded quadrilateral and 6-noded triangle elements).

Keywords:

Slope stability, open pit mine, critical strength reduction factor (CSRF), open pit excavation sequence, FEM element type/order

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