

ABSTRACT

The planning of open pit mines, and road and rail cuttings constitutes one of the activities usually undertaken by geotechnical engineers. However, this endeavour faces major challenges such as the correct design of rock slopes, the evaluation of their stability and the risk associated with them. Two main analytical methods are used in this process: the Limit Equilibrium (LE) analysis and the Numerical Modelling (NM) method; Slide and Phase2 programmes will be used respectively in this regard. Previous studies have shown some discrepancies between their results in assessing the probabilities of slope failure and the consequent economic risks. This research project aims to understand the reasons behind these divergences and possibly to find some ways of reducing them.

To attain these objectives, a homogeneous slope model was adopted. It required a detailed validation study depending on the analytical method, such that the settings would carefully be calibrated to avoid any further misinterpretation of the results. For Phase2, attention was given with regard to the number of mesh elements and their type, and for Slide, the number of slices. In addition, for both methods, attention was given to the adequate distribution of rock mass variables, the adequate failure criterion, etc. Deterministic and probabilistic assessments were performed to better interpret the differences to be found from these methods and results. The response surface methodology (RSM) facilitated the probabilistic studies, to avoid the constraints of long computer run times and to ease the study of the influence of the rock mass parameters on the slope stability.

For the considered model, 25 slices and 1500 mesh elements were found adequate to better assess the probability of failure (POF), while 1000 slices and 50 000 mesh elements provided results of estimated failure volumes. Well defined distributions of rock mass variables have proven indispensable to better assess the POF as well as the risk associated with the slope failure. Application of the Hoek Brown criterion resulted in the LE analysis predicting higher failure volumes than when Mohr Coulomb criterion was used. With the NM method, care was taken not to under or overestimate the resultant failure volume when extracting the path of the failure surface. Deterministic assessments showed that the risk determined from NM analyses is not always greater than that from LE analyses. The addition of rock mass parameters not taken into account in LE analyses results does not sensibly influence the POF and the failure volume outcomes, but can in some conditions influence the behaviour of the outcome risk of slope failure. In essence, LE and NM methods can be relied on for probabilistic studies, or even for risk assessments conditioned by carefully setting the models, and in case of LE being adopted to assess the risk, it is recommended to introduce a multiplying factor for cases similar to those that have already been analysed.