

ABSTRACT

The dump slope failures often lead to loss of life, environmental damage, production loss, and sometimes mine closure. Numerical modelling is one of the most suitable methods to analyze dump slope stability. However, it is time-consuming, expensive, and requires excellent skills. Further, the stability analysis incorporating various uncertainties concerning the geotechnical properties of the dump material is a major challenge, even today.

The stability rating and hazard classification are suitable alternatives to the numerical modelling for preliminary design and stability analysis of dump slope structures. However, the existing knowledge base mostly classifies the hazard qualitatively. Some of the quantitative hazard classifications are site-specific and suitable for single-bench or small-sized dump structures. The hazards associated with the crucial stability governing parameters also have not been defined so far. Therefore, this study addresses these gaps in the design of optimally stable dump slope structures to avoid the chances of their failure.

The total dump height, bench height, bench slope angle, bench width, density, cohesion, and friction angle of OB dump material were the prime parameters in the design of the dump slope structure. The study revealed that the bench slope angle and the friction angle possessed the most significant impact while the density and total dump height showed the least impact on the stability of the dump slope structure. Safety factor (FoS) with maximum horizontal displacement (XDIS) and shear strain increment (SSI) can be used to determine vulnerable zones of failure in dump slopes for their remediation and avoidance of large-scale failure. The stability of dump slopes was classified into three categories: 'Stable', 'Critically Stable', and 'Unstable'. The critically stable slope structures were more susceptible to failure. During the hazard quantification, the Latin

Hypercube sampling method with a lognormal probability distribution function provided accurate results for the considered database. The design limit of FoS greater than 1.30, XDIS less than 10 mm, and SSI less than 0.25% with stability rating greater than 75.4 can be used to design optimally safe and long-term stable dump slope structures.