Risk Analysis of Rock Slope Stability and Stochastic Properties of Discontinuity Parameters

Hyuck-Jin Park

Korea Institute of Construction Technology
Geotechnical Engineering Division
hjpark@kict.re.kr

One of the most difficult and important jobs in rock slope engineering is the selection of the representative values from widely scattered discontinuity data. This is because uncertainty and variability are involved in data and measurements obtained in field or tested in laboratory. Therefore, there are many efforts to limit and quantify the uncertainty and variability in data and the results of analysis. Probabilistic or risk analysis is proposed as one of the most effective analysis methods to deal with the uncertainty and variability. In the risk analysis, the discontinuity parameters are considered as a random variables because many discontinuity parameters such as orientation, length and spacing are widely scattered in field data and measurements and therefore, the true values for the parameters cannot be evaluated. Therefore, in the risk analysis, the probability of failure replaces the factor of safety because the factor of safety itself should be considered as a random variable.

Objectives of this research are to characterize stochastic properties of discontinuity parameters, conduct probabilistic analysis of rock slope stability and to compare deterministic and probabilistic results. Therefore, the random properties of discontinuity parameters is evaluated from field data and test results, and then the stability of rock slope is analyzed based on the evaluated random properties of discontinuity parameters and risk analysis procedure. As an analysis model for slope stability in this study, the Monte Carlo simulation technique is adopted to analyze the possibility of failure of slopes in the study site.

To evaluate the stability of rock slopes, two conditions, that is, kinematic and kinetic conditions of rock blocks defined by discontinuities should be considered. Especially in this study, the two conditions were expressed as the probability that a rock block is kinematically unstable and the probability that the block is kinematically unstable. Then the probability of failure is accomplished by multiplying the probability of kinematic instability by the probability of kinetic instability.

After the evaluation of the probability of failure, in order to compare the results of

the probabilistic analysis, the deterministic analysis is carried out using the same input values and procedure. Then the results between the deterministic and the probabilistic analyses are compared and the differences between two analysis results are discussed. The results of comparison between the deterministic analysis and probabilistic analysis indicate that the results of probabilistic analysis are quite different from those of the deterministic analysis. Consequently, the deterministic analysis is unable to represent the actual condition of rock slope because this analysis does not consider random properties of parameters. By contrast, the probabilistic analysis is more representative of the actual behavior of parameters and provides analysis results which are closer to actual condition of the rock slope.