Секция «Инженерная геология»

Probabilistic analysis of the stability of a slope in Sochi

Научный руководитель – Зеркаль Олег Владимирович

Kang Kai
Graduate (master)
Московский государственный университет имени М.В.Ломоносова, Геологический факультет, Кафедра инженерной и экологической геологии, Москва, Россия
E-mail: kevinkang8@hotmail.com

Various uncertainties exist in slope engineering, such as inherent spatial variability of soil properties, changing environmental conditions. Effects of these uncertainties on probability of slope failure are often significant[1]. Several probabilistic methodologies have been developed to incorporate these uncertainties in slope stability analysis, such as Monte Carlo Simulation method[4]. This study was based on Monte Carlo simulation with limit equilibrium method (Morgenstern-Price method).

A landslide was identified near a tourist ropeway station which is located in the middle part of Aibga ridge northern slope near Krasnaya Polyana in Great Sochi. The slope of landslide consists of two layers: upper layer is Quaternary deposit(Q) with gravely, clay-filled soil; lower layer is Jurassic porphyrite bedrock(J_2). Based on experimental result, the variability of the soil properties is known: the unit weight is 20.7-24.8 kN/m^3, cohesion is 7.3-12 kPa and friction angle is 26-30°. Assumed that variability distribution of the soil properties is a normal distribution with a specified mean value and standard deviation of a parameter. In addition, the study area is located in the zone where the probability of 8-point shakings during the next 50 years is 10%[3]. A normal distribution was also applied to seismic coefficient. The probabilistic analysis was performed with SLOPE/W[2]. After the 2000 Monte Carlo simulation, the results of probabilistic analysis were achieved, including mean factor of safety, probability of failure.

In probabilistic analysis, mean factor of safety is 0.97 and the probability of failure is computed to be 89% in dynamic state. Compared with results from conventional limit equilibrium analysis, the results from probabilistic analysis show that the slope is unstable in dynamic state, however, with more information indicating failure probability.

In Russia, probabilistic analysis was conducted by some scholars[5], however, is yet not routine in practice of real construction. This study shows that probabilistic analysis can provide a robust and simple way to assess failure probability, and can be applied in practice with more reasonable results.

References

1) El-Ramly, H., Morgenstern, N.R. and Cruden, D.M., 2002. Probabilistic slope stability analysis for practice. Canadian Geotechnical Journal, 39(3), pp.665-683.
2) Krahn, J., 2007. Stability Modeling with SLOPE/W, An Engineering Methodology, Third Edition, Prepared and printed in-house by GEO-SLOPE International Ltd, Calgary, Alberta, Canada, p.355.
3) SP 14.13330.2014 “Construction in Seismic Regions. SNiP II-7-81*” (actual drafting). M.: FAU "FTsS", 2014, p. 126. (in Russian)
4) Wang, Y., Cao, Z. and Au, S.K., 2010. Efficient Monte Carlo simulation of parameter sensitivity in probabilistic slope stability analysis. Computers and Geotechnics, 37(7), pp.1015-1022.

5) Zerkal O.V., Fomenko I.K. Influense of various factors on the results of probabilistic analysis of landslide activization// Engineering Geology. 2016. № 1, pp.16-21.(in Russian)