INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

Name of the Student	:	Rubi Chakraborty
Roll Number	:	166104040
Programme of Study	:	Ph.D.

Thesis Title: Probabilistic Assessment of Toe-Excavation Induced Hillslope Instability Involving Random Field Modeling of Spatial Variability

Name of Thesis Supervisor(s)	:	Dr. Arindam Dey
Thesis Submitted to the Department/ Center	:	Civil Engineering
Date of completion of Thesis Viva-Voce Exam	:	25.01.2022
Key words for description of Thesis Work	:	Hillslope instability; Deterministic and Probabilistic assessment; Toe-excavated hillslopes; Limit Equilibrium Method; Factor of safety; Random variable; Probability of failure; Spatial variability; Random field; Random Finite Element Method; Sheet pile anchor retention (SPAR); Seismic response.

SHORT ABSTRACT

In mountainous territory of India, roadways are the pre-eminent means of conveyance and communication. For last few years, rapid growth in the population has increased the requirement of urbanization, leading to an enhanced necessity of more highways along the hill slopes. Slope excavation in hilly regions is a traditional practice for construction of new roads or widening of the existing roads. Hill slope failures due to toe cutting and excavation need notable attention as it may cause high level of casualties in terms of loss of lives, property and economy. As immense accountability is associated with cut slope failures, geotechnical engineers and highway planners must perform rigorous investigation to predict the influence of toe cutting on hill slopes. Typically, the consequences of toe cut on the stability of hill slopes is reviewed based on the deterministic Limit Equilibrium Method (LEM) that predicts the failure of a cut slope by a single measure of factor of safety (FoS). Owing to the inevitable uncertainty in geotechnical properties, especially those related to soil strength and lack of representative in-situ data in hilly regions, deterministic LEM is incapable of appropriate assessment of slope failure. Hence, the analysis of influence of toe excavation on slope stability is highly persuadable to probabilistic treatments. To encounter the uncertainty related to geotechnical engineering practise, this dissertation presents the assessment of toe excavation induced slope instability in a probabilistic framework. To deal with uncertainty in soil shear strength, the shear strength parameters are considered as random variables and the cross-correlation between them, as well as their spatial variation in slope domain, is taken into account. Firstly, a stochastic model of spatially varying Standard Penetration Test (SPT)-*N* data is developed utilising the random field theory. Thereafter, a report

is provided stating the influence of various parameters on probabilistic slope stability study using a simplistic LEM-based probabilistic approach. A schematic approach to incorporate the LEM based probabilistic method for toe excavation induced slope stability study is presented. The study is further extended to investigate the performance of a sheet pile (SP) wall and a sheet pile anchor retention (SPAR) system as a retention measure against the cut slope failure through probabilistic analysis. Further, the study incorporated Random Finite Element Method (RFEM) for probabilistic cut slope analysis to assess the efficacy of the advanced RFEM over the traditional LEM based probabilistic approach for cut slope stability analysis. Finally, the response of the cut slope is also presented within a probabilistic framework under seismic condition. The outcomes of the study have been successful in illustrating the importance of a probabilistic approach over the conventional deterministic slope stability analysis, where the former clearly elucidates that slopes adjudged safe from deterministic yet might have high probabilities of failure, and that the same should be accounted for design of the slope stabilization measures. The study also reveals that identifying the variability in the in-situ soil properties is immensely important in arriving at a suitable probabilistic analysis and design, and this calls for a detailed site investigation for developing any successful understanding of the hillslope stability and slope stabilization practices.