ASSESSMENT OF SLOPE STABILITY AND STABILIZATION TECHNIQUES THROUGH PROBABILISTIC APPROACH

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ABSTRACT

Uncertainty and randomness of data is a major issue associated in geotechnical engineering. It is therefore desirable to use methods and concepts in engineering planning and design that can facilitate the evaluation and analysis of uncertainty. Formal probabilistic approach provides a useful framework to incorporate these uncertainties in slope instability problems. Under the research described in this thesis, number of probabilistic models have been developed to evaluate the stability of slopes and their use in the evaluation of stability of slopes and the evaluation of effectiveness of various stabilization techniques have been discussed.

Two probabilistic analytical models that can be used to evaluate the stability of slopes that can fail either along circular failure surfaces or non-circular failure surfaces have been developed. These models formally recognize the uncertainties associated with various geotechnical parameters and provide means to quantify their effects on the stability. The result is given in the form of probability of unsatisfactory performance of the slope. Each model developed was facilitated to perform computations in five different ways ranging from theoretically sound methods to some approximate methods, and the results obtained were compared with each other. In addition, the results were compared with the results obtained by a commercial software, wherever applicable. In addition, two other probabilistic analytical models were developed to analyze the slopes stabilized by soil nailing.

It is seen that the behavior of the probabilistic models developed under this research perform satisfactorily, and it can be recommended to use these models in routine problems of slope instability to provide more realistic results incorporating the uncertainties associated with

various geotechnical parameters. Analyses of a number of examples and case histories discuss the uses of the probability of failure in decision making to evaluate the stability of slopes as well as the effectiveness of various stabilization techniques. It also emphasizes the importance of the appropriate failure mechanism and the appropriate deterministic model in the probabilistic analysis. Analysis of case histories provides an important discussion showing the inadequacy of the conventional factor of safety alone in evaluating the stability of slopes.

DECLARATION

The work included in this thesis in part or whole, has not been submitted for any other academic qualification at any institution.

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UOM Verified Signature

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LIST OF SYMBOLS

$\overline{F}$	- Mean Factor of Safety
$\bar{x}_i$	- Mean Value of "i"th Random Variable
α	- Angle of the Nail to the Horizontal
ϕ	- Angle of Internal Friction
γ	- Bulk Density
σ	- Standard Deviation
β	- Reliability Index
ϕ'	- Effective Angle of Internal Friction
$\sigma_{\phi'}$	- Standard Deviation of Effective Angle of Internal Friction
$\sigma_{c'}$	- Standard Deviation of Effective Cohesion
σ_F	- Standard Deviation of Factor of Safety
σ_{F0}	- Standard Deviation of Uncorrected Factor of Safety
θ_i	- Slice Angle of "i"th Slice
β_{LN}	- Lognormal Reliability Index
ϕ_u	- Undrained Angle of Internal Friction
σ_u	- Standard Deviation of Pore Pressure
δ_{xi}	- Small Increment applicable ti "i"th Random Variable
σ_{xi}	- Standard Deviation of "i"th Random Variable
Δx_i	- Width of "i"th Slice
c	- Cohesion
c'	- Effective Cohesion
COV	- Coefficient of Variation
COV (F)	- Coefficient of Variation of Factor of Safety
COV(ϕ)	- Coefficient of Variation of Angle of Internal Friction
COV(c)	- Coefficient of Variation of Cohesion
COV(u)	- Coefficient of Variation of Pore Pressure
c_u	- Undrained Cohesion
d	- Diameter of a Nail
$E_{L,i}$	- Side Normal Force acting on "i"th Slice (Left Boundary)
$E_{R,i}$	- Side Normal Force acting on "i"th Slice (Right Boundary)
F	- Factor of Safety
F_0	- Uncorrected Factor of Safety for Janbu's Simplified Method
f_0	- Janbu's Correction Factor for Factor of Safety
f_b	- Bond Coefficient
f_y	- Yield Strength of Nail Material

HCV	- Highest Conceivable Value
h_i	- Average Height of the "i"th Slice
l	- Effective Length of a Nail
LCV	- Lowest Conceivable Value
n	- Total number of Nails passing through a particular Slice
N	- Total number of samples
N_i'	- Effective Normal Force on "i"th Slice
P_f	- Probability of Failure
$P_f(LN)$	- Probability of Failure assuming Lognormal Distribution for FOS
$P_f(N)$	- Probability of Failure assuming Normal Distribution for FOS
Q_i	- Surcharge acting on "i"th Slice
SM	- Safety Margin
$T_{m,i}$	- Shear Force acting along the Failure Surface on the "i"th Slicce
T_N	- Force Mobilized in Nails
$T_{N,i}$	- Nail Force acting on the "i"th Slice
U_i	- Pore Pressure Force on "i"th Slice
u_i	- Pore Pressure acting on "i"th Slice
V_F	- Variance of Factor of Safety
W_i	- Weight of "i"th Slice
x_i	- "i" th random variable

Note:

Symbols used in the flowcharts are described in the same flowcharts