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ESTIMATION OF LIQUEFACTION FROM CASE HISTORIES

A critical parameter in the evaluation of the liquefaction of soils is the residual or liquefied shear strength. Liquefaction of granular soils can have extremely detrimental effects on the stability of soil slopes and deposits, and on structures founded on them. This liquefied shear strength determines the magnitude of the deformation that the soil will undergo once it has liquefied. Current procedures for estimating the liquefied shear strength are based on laboratory testing programs or from the back-analysis of case histories of liquefaction failures where in-situ test data were available. The case-histories approach is the procedure that is preferred in practice. However, it has several limitations including the very limited amount of data available, the significant uncertainties involved in the back-calculation of the liquefied shear strengths, and the lack of consistent and rational methods in the use of the available data. To address these current limitations, this paper proposes new probabilistic liquefied shear strength criteria for liquefiable soils from case histories.

The paper presents probabilistic undrained residual or liquefied shear strength values of liquefiable soils as function of SPT blow count. The liquefied shear strengths were back-calculated using slope stability analysis of previous case histories of flow liquefaction failures. Probabilistic procedures, including the First-Order Reliability Method (FORM) and Monte Carlo Simulations (MCS) were used in combination with limit equilibrium methods to analyze case histories of flow failure presented in the deterministic companion paper. Depending on the post-failure geometry of the case history, either the simplified infinite slope stability analysis or the more general Spencer method of slices analysis was used in the back analysis. The Beta Probability Density Function was used to model the statistical distributions and uncertainties in the geotechnical parameters involved in the probabilistic analyses. For FORM, a Bayesian Mapping procedure is used where values of PF are computed from the probability density function of the reliability indices of flow failure. The logistic mapping function is obtained by relating the deterministic factor of safety *FS* to P_F for the liquefied shear strength relationships. A parameter C_1 was introduced to account for model uncertainty in the reliability calculations.

Probabilistic *Su-LIQ* versus minimum $(N_1)60$ criteria were presented for P_F contours corresponding to 2 %, 16 %, and 50 %. It was shown that the P_F = 50 % relationship is very close to the best fit relations obtained from the deterministic analysis of the case histories. The probabilistic *Su-LIQ* versus minimum $(N_1)60$ criteria provide a more rational procedure for estimating the post-liquefaction stability of cohesionless soils deposits by providing estimates of the probability of failure in addition to traditional values of factor of safety. The probability of failure can account for the different uncertainties in the back calculation of the liquefied shear strength values from case histories, and the natural variability and uncertainties and properties of soil deposits.

Key words: liquefaction of soils, residual shear strength, back analysis, $(N_1)60$ parameter, SPT, Monte Carlo simulation.

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