

C-17: Probabilistic analysis in soil and foundation engineering

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Soil engineering problems are characterized by numerous uncertainties. Due to these uncertainties, soil variables can be treated as random variables and they are subjected to analysis by probabilistic methods. In simple terms probabilistic techniques are the rules of uncertainty and these have to be used consciously to analyse uncertain soil engineering systems. If an uncertain system, like a model for a soil engineering problem is analysed by 'certain rules', in principle engineers are not precise and their final deterministic solutions will not be reliable. Probabilistic concepts are very useful as they can handle decision problems giving numerical answers to uncertainties, thus reducing the subjective personal element of design. Further they are based on mean [average], variance and distribution of uncertain

variables, whereas deterministic methods incorporate only average values. By using only averages, data which are collected by expensive soil testing methods, are not fully utilized in the analysis.

After deciding that probabilistic methods are required to analyse an uncertain soil engineering problem, next step would be the formulation of probabilistic model. In this type of model, variables can be deterministic or probabilistic according to the extent of uncertainty associated with them. An important part of this exercise is the identification of the probabilistic variables in the model.

Next, this formulated model will operate on standard probabilistic concepts and laws and knowledge of these are essential to the engineer to analyse the model. In addition to these rules, he will have various sets of assumptions which simplify the mathematical computations involved in the analysis. These assumptions will reduce the complexity of the model. During the process of analysis these assumptions have to be tested for their accuracy using probabilistic methods.

In this research, design of earth retaining structures were carried out using probabilistic approach. This study is related to 'Rural Roads Component' in Integrated Rural Development Project (IRDP), Kegalle District. Under this project 125 km of rural roads were constructed in 9 electorates of Kegalle District, with total approximate cost of US\$ 1.15 M. Earth retaining structures are essential structural elements on roads and they constitute high unit cost items in road construction. Therefore, more careful designing process is required for them. In the probabilistic model, Safety Margin concept is used and the factor of safety in conventional deterministic approach is replaced by reliability. Also a method of computing the critical reliability, that an earth retaining structure should have for a particular design is suggested.

Further, the probabilistic analysis of bearing capacity of soils for foundations is analysed. This study is related to the buildings constructed for 'project management' component of IRDP. In the analysis, the variable Bearing Capacity is treated as a random variable having a distribution. By using the Safety Margin concept, reliability of foundation in respect of bearing can be computed. It is assumed that Safety Margin is normally distributed, and this assumption is tested using Chi-Square Goodness of fit test and found to be correct.