ELASTO-PLASTIC FINITE ELEMENT ANALYSIS OF GEOMATERIALS WITH RANDOMLY DISTRIBUTED SHEAR STRENGTH

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ABSTRACT

The majority of geotechnical analyses are deterministic, in that the inherent variability of the soil is not modeled directly, rather some "factor of safety" is applied to results computed using "average" soil properties. In the present study, the influence of randomly distributed shear strength is rigorously assessed via numerical experiments involving compressive strength and slope stability. The model involves combining random field theory with an elasto-plastic finite element algorithm in a Monte-Carlo framework. Since the problem is nonlinear, each realization of the Monte-Carlo process now involves an iterative approach which highlights the need for efficiency in the solution algorithms. The influence on failure loads of the soil's shear strength variance and spatial correlation length is then assessed parametrically. It is found that the "average" shear strength of the soil is not necessarily the best indicator of the overall strength of the random material. The results of this study enable traditional approaches involving "factors of safety" to be re-interpreted in the context of reliability based design.

The work presented in this paper forms part of a broader study in which classical soil mechanics problems are revisited using random field models. Earlier work on steady seepage and foundation settlements has already given useful insight into the impact of statistically controlled heterogeneity on geotechnical design. The extension of the work to include stability problems will encourage the use of the "Probability of Failure" (or Reliability Index) as a more useful measure of the level of safety in a design.

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