# ABSTRACT

This dissertation explores the spatial variability of soil properties by comparing the results of foundation settlement analysis using both the hardening soil model (HSM) and the Mohr-Coulomb (MC) material models. There are no earlier attempts known to the author of using the hardening soil model to analyze foundation settlement under soil spatial variability; therefore, this dissertation is of particular interest for all engineers and researchers interested in using the hardening soil model. The aim of this dissertation is to examine the effect of spatial variation in soil properties on the assessment of shallow foundation settlement for a strip footing placed on one- and two-layered soil profiles. To account for soil spatial variability, the influence of stiffness and shear strength parameters is modeled separately and jointly using isotropic and anisotropic random fields with specified vertical and horizontal scales of fluctuation (SoF). In the case of an anisotropic correlation structure, greater horizontal fluctuation scales are assumed compared to the vertical ones. To ensure greater precision, the random finite element method (RFEM) technique incorporates HSM in probabilistic applications. The proposed approach connects commercial software (ZSoil) with the author's own procedures implemented in MATLAB in the framework of the Monte Carlo method. The importance of the model parameters was investigated to propose parameters whose spatial variability has a decisive influence on the settlement distributions obtained. Insights obtained from one- and two-layer soil profile probabilistic analyzes of the hardening soil model and the Mohr-Coulomb model indicate that the joint analysis of spatially variable stiffness and strength parameters had a more significant impact on foundation settlement than when the parameters were analyzed separately. In addition to this, the mean settlement results obtained on different scenarios in one- and two-layer soil profiles clearly demonstrate higher settlements obtained by the hardening soil model. Furthermore, to further explore the impact of uncertainty in estimating the scale of fluctuation on settlement analysis, 1000 different maximum likelihood estimations of vertical and horizontal SoF values were adopted from Kawa (2023). Through this analysis, the mean settlement result obtained does not show significant changes compared to the mean settlement results analyzed previously using assumed fluctuation scales. However, the mean settlement obtained from averaging the 1000 vertical and horizontal SoF values ($SoF_{Avg}$), observed in both soil profiles and material models, is slightly higher than that obtained using 1000 different maximum likelihood vertical and horizontal SoF values. Nevertheless, the results of the coefficients of variation of settlement mostly show a contrary trend. Finally, the Kolmogorov-Smirnov statistical test was performed to assess the goodness-of-fit of the lognormal distribution, revealing fundamental differences in the distribution patterns of output data despite the best-fit relationship between the Mohr-Coulomb and hardening soil model parameters.



Keywords: HSM; MC; spatial variability; SoF; RFEM; Monte Carlo; foundation settlement.



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