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Probabilistic Analysis of Bearing Capacity of Isolated Footing using Monte Carlo Simulation

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Abstract : The allowable bearing capacity of foundation systems is determined by applying a factor of safety to the ultimate bearing capacity. Conventional ultimate bearing capacity calculations routines are based on deterministic input parameters where the nonuniformity and inhomogeneity of soil and site properties are not accounted for. Hence, the laws of mathematics like probability calculus and statistical analysis cannot be directly applied to foundation engineering. It's assumed that the Factor of Safety, typically as high as 3.0, incorporates the uncertainty of the input parameters. This factor of safety is estimated based on subjective judgement rather than objective facts. It is an ambiguous term. Hence, a probabilistic analysis of the bearing capacity of an isolated footing on a clayey soil is carried out by using the Monte Carlo Simulation method. This simulated model was compared with the traditional discrete model. It was found out that the bearing capacity of soil was found higher for the simulated model compared with the discrete model. This was verified by doing the sensitivity analysis. As the number of simulations was increased, there was a significant % increase of the bearing capacity compared with discrete bearing capacity. The bearing capacity values obtained by simulation was found to follow a normal distribution. While using the traditional value of Factor of safety 3, the allowable bearing capacity had lower probability (0.03717) of occurring in the field compared to a higher probability (0.15866), while using the simulation derived factor of safety of 1.5. This means the traditional factor of safety is giving us bearing capacity that is less likely occurring/available in the field. This shows the subjective nature of factor of safety, and hence probability method is suggested to address the variability of the input parameters in bearing capacity equations.

Keywords : bearing capacity, factor of safety, isolated footing, montecarlo simulation
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