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Reliability analysis of shallow foundations by means of limit analysis with random slip lines

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In order to evaluate credible reliability measures when bearing capacity of a shallow foundation is considered it is reasonable to describe soil strength properties in terms of random field's theory. As a next step the selected random field can be spatially averaged by means of a procedure introduced by Vanmarcke (1977). Earlier experiences have proved that, without applying spatial averaging procedure, reliability computations carried out in the context of foundation's bearing capacity had given significantly small values of reliability indices (large values of failure's probability) even for foundations which were considered as relatively safe. On the other hand the volume of the area under averaging strongly affects results of reliability computations. Hence the selection of the averaged area constitutes a vital problem and has to be dependent on the failure mechanism under consideration. In the present study local averages associated with kinematically admissible mechanism of failure proposed by Prandtl (1920) are considered. Soil strength parameters are assumed to constitute anisotropic random fields with different values of vertical and horizontal fluctuation scales. These fields are subjected to averaging along potential slip lines within the mechanism under consideration.
Due to random fluctuations of the angle of internal friction the location of a slip line is changeable. Therefore it was necessary to solve the problem of spatial averaging of the random field along the varying slip lines. In order to incorporate an anisotropy of soil properties random fields the vertical correlation length was assumed to significantly shorter than the horizontal one. Finally, reliability indices were evaluated for foundations of various width by means of the Monte Carlo simulation. By numerical examples it is demonstrated that for reasonable proportions (from practical viewpoint) between horizontal and vertical fluctuation scales the reliability indices resulting in two-dimensional case only slightly differs from resulting that obtained in one-dimensional. This means that the simpler one-dimensional approach can be usually utilised when reliability measures of shallow strip foundation are carried out.

References:

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