Behaviour of Anchors in Sand: Deterministic and Probabilistic Analysis

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SUMMARY

During the last century anchors have found many applications in geotechnical engineering. The progress achieved in anchoring technology has widely contributed to the development of challenging structures such as bridges and dams. The research work gathered and presented in this thesis, dealing with circular anchors horizontally buried in sand, consists of two main parts.

The first part of this thesis is concerned with a deterministic study of the behaviour of circular plate anchors embedded in sand. First, laboratory tests were performed on small scale circular plate anchors. Quantitative tests dealt with measurement of anchor capacity at different depths of embedment and different states of density while qualitative tests showed the shape of failure surface at shallow and deep mode. Thereafter an axisymmetric finite element analysis using a Mohr-Coulomb yield criterion was carried out.

The observations from laboratory tests and the finite element analysis showed that different modes of failure occurred for plate anchors at shallow and deep embedment depths. Therefore models with hyperbolic and truncated cone failure surface were proposed for the prediction of anchor capacity of circular plate anchors buried shallowly or deeply in sand. The truncated conical model has a varying apex angle and the hyperbolic model has different loci distance values for the different relative densities of the sand. The predictions of the proposed models were compared to other authors' field and laboratory pullout test results. In general, a good agreement was obtained.

In the last decades, research showed the necessity to perform statistics-based design that gives more information about the safety situation of the works than the classical total safety factor design. Therefore, the second part of this thesis was concerned with a probabilistic approach to the analysis of anchors. The calibration of four models was carried out: the two models proposed in this thesis and two other models from other authors namely; Meyerhof & Adams 1968, and Ghaly & Hanna 1994. The analysis of the capacity factors of the three models

(Meyerhof-Adams model, truncated cone model and hyperbolic model) showed that the mean was approximately 1 and the standard deviation 0.20. Based on results from screw anchors, Ghaly-Hanna model appeared to be inappropriate for the design of plate anchors.

The reliability-based analysis of five models using Hasofer-Lind method showed that in general the reliability index β decreases with increasing uncertainties. Due to variations of the sensitivity factors and the coefficients of variation, major changes occur in the partial coefficients for different characteristic values. These changes take place for common values of the coefficients of variation.

The analysis of the reliability of single and groups of anchors as parallel geomechanical systems showed the importance of soils properties' fluctuations about the trend. The study of measurements in a compacted road embankment showed that the soil variability was different in the three directions. The scale of fluctuation is a parameter that can be controlled during the installation of ground anchors.