Abstract

Geotechnical design is the raison d'être of the geotechnical engineering profession. To design geo-structures, a solid understanding of the mechanisms of failure is essential. What is often overlooked in the shift towards probabilistic methods of analysis and the development of codes of practice (e.g. Eurocode 7) is the correct identification of serviceability failure as the most common limiting state. Selection of soil parameters is the key decision in a geotechnical design calculation and yet most codified design approaches give little if any guidance on this.

Examination of the literature reveals that codes of practice and design methods based on statistical reliability methods are almost totally focussed on the prediction of geotechnical collapse (a very rare event) and that the partial factors that are used in most limit state design approaches are merely calibrated to reflect traditional values of the global factor of safety (FOS) that geotechnical practitioners are familiar with. There is an alternative. The mobilised strength design (MSD) method can estimate ground deformations provided the mechanism can be identified and the soil stress strain behaviour appropriately understood. This is where geotechnical design research should be focussed.

To contrast varying traditional design methods, a benchmarking study of bored pile design in London Clay (via codified methods) is presented to show how different codes of practice deal with uncertainty during the design process. The results reveal that most codes' implicit global factors of safety are rather similar and very high.

To use MSD, an estimate of the stress-strain response of the soil is needed. Two geotechnical databases of stress-strain behaviour of clays and silts were compiled and analysed. General stress-strain curves for the low-strain and moderate strain regions are developed and the uncertainty in the prediction of soil stiffness degradation and/or strength mobilisation is evaluated statistically. The normalised curves can be considered simple hardening laws for clays that can also be incorporated in numerical analysis.

After applying the MSD-solution for shallow foundation settlement along with the normalised stress-strain curves, the idea of using a single value of FOS to prevent excessive settlement is shown to be futile. Using the stress-strain databases and the pile design case study a simplified MSD-style model was developed that reasonably predicts the settlement of bored piles in London clay, verified by a published database of load-test information. With the new prediction model for pile settlement and the new understanding of soil stress-strain, a new set of partial factors is proposed for pile design in stiff clays. Variation of geotechnical properties in both total stress and effective stress methods of analysis are also studied, as well as improved methods to assign parameters for design.

For sustainable geotechnical design the tools developed in this thesis will provide a basis for the necessary changes in the philosophy of geotechnical design in the 21st century.

Keywords: *geotechnical design, databases, correlations, soil stiffness, strength, soil stress-strain, foundations, limit state design, codes of practice*