Critical State Soil Mechanics

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Preface

This book is about the mechanical properties of saturated remoulded soil. It is written at the level of understanding of a final-year undergraduate student of civil engineering; it should also be of direct interest to post-graduate students and to practising civil engineers who are concerned with testing soil specimens or designing works that involve soil.

Our purpose is to focus attention on the critical state concept and demonstrate what we believe to be its importance in a proper understanding of the mechanical behaviour of soils. We have tried to achieve this by means of various simple mechanical models that represent (with varying degrees of accuracy) the laboratory behaviour of remoulded soils. We have not written a standard text on soil mechanics, and, as a consequence, we have purposely not considered partly saturated, structured, anisotropic, sensitive, or stabilized soil. We have not discussed dynamic, seismic, or damping properties of soils; we have deliberately omitted such topics as the prediction of settlement based on Boussinesq's functions for elastic stress distributions as they are not directly relevant to our purpose.

The material presented in this book is largely drawn from the courses of lectures and associated laboratory classes that we offered to our final year civil engineering undergraduates and advanced students in *1965/6* and 1966/7. Their courses also included material covered by standard textbooks such as *Soil Mechanics in Engineering Practice* by K. Terzaghi and R. B. Peck (Wiley 1948), *Fundamentals of Soil Mechanics* by D. W. Taylor (Wiley 1948) or *Principles of Soil Mechanics* by R. F. Scott (Addison-Wesley 1963).

In order to create a proper background for the critical state concept we have felt it necessary to emphasize certain aspects of continuum mechanics related to stress and strain in chapter 2 and to develop the well-established theories of seepage and one-dimensional consolidation in chapters 3 and 4. We have discussed the theoretical treatment of these two topics only in relation to the routine experiments conducted in the laboratory by our students, where they obtained close experimental confirmation of the relevance of these theories to saturated remoulded soil samples. Modifications of these theories, application to field problems, three-dimensional consolidation, and consideration of secondary effects, etc., are beyond the scope of this book.

In chapters *5* and 6, we develop two models for the yielding of soil as isotropic plastic materials. These models were given the names Granta-gravel and Cam-clay from that river that runs past our laboratory, which is called the Granta in its upper reaches and the Cam in its lower reaches. These names have the advantage that each relates to one specific artificial material with a certain distinct stress – strain character. Granta-gravel is an ideal rigid/plastic material leading directly to Cam-clay which is an ideal elastic/plastic material. It was not intended that Granta-gravel should be a model for the yielding of dense sand at some early stage of stressing before failure: at that stage, where Rowe's concept of stress dilatancy offers a better interpretation of actual test data, the simple Granta-gravel model remains quite rigid. However, at peak stress, when Granta-gravel does yield, the model fits our purpose and it serves to introduce Taylor's dilatancy calculation towards the end of chapter *5*.

Chapter 6 ends with a radical interpretation of the index tests that are widely used for soil classification, and chapter 7 includes a suggested computation of 'triaxial' test data that allows students to interpret much significant data which are neglected in normal methods of analysis. The remainder of chapter 7 and chapter 8 are devoted to testing the relevance of the two models, and to suggesting criteria based on the critical state concept for choice of strength parameters in design problems.

Chapter 9 begins by drawing attention to the actual work of Coulomb – which is often inaccurately reported – and its development at Gothenberg; and then introduces Sokolovski's calculations of two-dimensional fields of limiting stress into which we consider it appropriate to introduce critical state strength parameters. We conclude in chapter 10 by demonstrating the place that the critical state concept has in our understanding of the mechanical behaviour of soils.

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To K. H. Roscoe