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BEHAVIOUR OF GRANULAR MATERIALS

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PREFACE

Granular materials are of great importance in civil engineering or in manufacturing processes whether they be granular soils, powder for compaction, powder for sintering, powder for ceramics, agricultural products (grains) or raw materials for industries.

Due to their discontinuous nature, the behaviour of such materials is complex and their modelling is quite difficult. Many models have been proposed in the literature but some typical phenomena are not yet really taken into account (the role of fabric, strain localization in shear band, etc,...). On the other hand, new methods such as the micromechanical approach (homogenization techniques, Distinct Element Method) have been developed in the last few years providing new powerful tools for the modelling of granular media. Furthermore, modern technology stimulates these developments by requiring a more precise description of the behaviour of granular materials to be considered in numerical tools such as the Finite Element Method.

The goal of this book is to propose the state of the art on the behaviour of granular materials considered in a dense state and submitted to static or dynamic loadings (rapid flow is not considered). Our purpose is to present the three complementary approaches which are:

- experimental analyses which demonstrate the main features of the behaviour of granular materials;*
- micromechanical analysis using homogenization techniques or numerical modelling (D.E.M.) which allow the understanding and the modelling of the behaviour of granular materials from the knowledge of local phenomena;*
- phenomenological modelling which remains necessary to use numerical tools such as the F.E.M., allowing many kinds of boundary problems to be solved. Different kinds of constitutive laws will be presented as well as the modelling of coupling phenomena for undrained conditions. A particular*

attention will be devoted to the analysis and modelling of shear banding in granular materials.

These three approaches are often presented in different papers or books. One of the purposes of this book is to show that these approaches are complementary and to contribute to a better understanding of the links between them.

This book has been written from the lecture notes proposed for the advanced school entitled: "Behaviour of granular materials", organised by the CISM (Udine) to which I would like to express my thanks for its invitation to coordinate this course. I also wish to express my appreciation to all the lecturers of this school for their kind cooperation and excellent work.

We hope that this book may serve as a good reference for scientists and engineers not only in geomechanics, but also in wide disciplines in engineering dealing with granular materials.

Bernard Cambou

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