Administrative report of TC34 – Deformation of earth materials

Compte rendu technique de la No. CT 34 – Deformation de matériaux en terre

I.Vardoulakis – *National Technical University of Athens, Greece*

ABSTRACT: This note contains the information concerning the activities of TC34 on Deformation of Earth Materials in form of an Administrative Report to the Secretary General of the ISSMGE.

1 TERMS OF REFERENCE

The terms of Reference of TC34 on "Deformation of Earth Materials" are:

1. Constitutive relations of earth materials. Numerical implementations. Robust analysis. Regularisation of softening models.
2. Constitutive parameter determination using lab and field test results. Inverse analysis and upscaling.
3. Mechanical instabilities: progressive failure, localisation, liquefaction and rapid flows.
4. Thermo-hydro-mechanically coupled deformations of earth materials.

Points (3) and (4) belong to the interface between Fluid and Soil Mechanics, an important domain for scientific research and engineering practice. As dramatic witness of this fact we attach here the view of the Santa Tecla neighbourhood of San Salvador after the recent earthquake, measuring 7.6 on the Richter scale.

Photo 1: Las Colinas landslide of January 13, 2001, near San Salvador city (El Diario de Hoy REUTERS).

2 ACTIVITIES INITIATED

1. Meetings of the Japanese Supporting Committee of TC34 (JSC) (March 30, 2000, June 5, 2000 Gifu, December 15, 2000, Tokyo, Japan).
2. Japanese Workshop on "Deformation of Earth Materials", organised by the JSC (June 12, 2000, Gifu, Japan).
3. Annual Meeting of TC34 (October 5, 2000, Aussois, France)
4. International Workshop on Deformation of Earth Materials, Sendai, Japan (May 23, 2001).
5. Joint Satellite Workshop with TC35 during the 15thICSMGE at Istanbul, Turkey (August 25, 2001).
6. Meeting of TC34 during the 15thICSMGE.
7. International Symposium or Workshop at Osaka, 2005 during or before the 16thICSMGE.

3 ACTIVITIES COMPLETED

1. Meetings of the JSC (March 30, 2000, June, 5,2000 Gifu, December 15, 2000 Tokyo).
2. Japanese Workshop on Deformation of Earth Materials, organised by the JSC (June 12, 2000, Gifu Japan, 80 participants). Topics: Time Dependent Behaviour (Prof. Tatsuoka) Constitutive Modelling (Prof. Kishino) Localisation (Prof. Oka and Dr. Ohtani) Liquefaction (Dr.Uzuoka) Reclamation (Dr. Miyake).
3. Annual meeting of TC34, organised in Aussois France on Thursday October 5, 2000 jointly by Professors Felix Darve and Ioannis Vardoulakis in parallel to the activities of the ALERT annual School and Workshop. The following members of the committee participated at that meeting:

1. Prof. Ioannis Vardoulakis, N.T.U. Athens, Greece (chair).
2. Prof. Felix Darve, I.N.P. de Grenoble, France.
3. Prof. Dimitrios Kolymbas, I.G.T. University of Innsbruck, Austria.
4. Prof. Roberto Nova, Politecnico di Milano, Italy.
5. Prof. Fusao Oka, Kyoto University, Japan.
6. Prof. Emanuel Pastor, CEDEX Madrid, Spain.
7. Prof. David Muir Wood, University of Bristol, U.K.

The committee discussed a proposal by Professor Malcolm Bolton (U.K.) for the joint organisation of a Satellite Workshop on Fundamentals of soil behaviour, preceding the 15th ICSMGE, at Istanbul on Friday and Saturday 24-25, August 2001 at the auspices of the Technical Committees 34 and 35 of the ISSMGE. Following email exchanges between members of TC34 (Profs. F. Oka and I. Vardoulakis) and Prof. M. Bolton, the issue was decided favourably, and members of TC34 and the JSC have been encouraged to participate in that Workshop.

It was also decided to invite Professor and associate Head Kam Tim Chau, of the Department of Civil & Structural Engineering of the Hong Kong Polytechnic University to join the core of TC34.

The key question raised in the Aussois meeting of TC34 was as of how to close the gap between advanced Soil Mechanics research, in the domains addressed in the terms of reference of TC34, on one hand and engineering practice on the other hand. The idea is to try to introduce the new and advanced concepts

and methodologies as soon as possible in the education and continued education system of geotechnical engineers.

Along this line of thought Professor F. Darve discussed about innovations in Soil Mechanics curricula. He has pledged about a unified view of Soil Mechanics by introducing all different aspects of soil behaviour through a "unique" constitutive setting. He pointed out that within a unified view of Soil Mechanics, large and small strains are different aspects of the same behaviour and that it is not possible to have drained and undrained properties, static vs. dynamic etc.

Professor E. Pastor underlined the aspect of Engineering as the art of prediction and optimisation. For that we need to confront ourselves with issues of:

- Mathematical modelling.
- Constitutive modelling.
- Numerical and analytical modelling.

For that one needs basic knowledge in Mechanics and Strength of Materials, in addition must come concepts from Critical State Soil Mechanics and basic physical properties that characterise cohesive and granular soils. Another important issue is the coupling between fluid flow and deformation, and in order to perform analysis one needs a precise mathematical-mechanical framework. Failure is classified as diffuse and localised, static or dynamic. Modelling on the other hand presumes reliable parameter determination. In this context Prof. Pastor pointed to the fact that Laboratory tests are very important, however their interpretation is always theory bound. Modelling will, in his opinion, help to solve practical problems, and case studies like foundations, slopes, embankments and dams using relatively simple FE codes. In all these activities there is need for data and use of correlations for parameter determination. This will allow the engineer to make the connection between reality and model.

Professor D. M. Wood pointed to the usefulness of one dimensional modelling to Soil Mechanics and that non-linearity is a key issue for practical applications. He stressed also the need of a "unified" constitutive model that will help to draw the parallels with other materials. In particular he raised the following points that could be introduced effectively through 1D Soil Mechanics:

- Effective stress
- Stiffness in oedometric conditions (particles and voids lead to asymptotic compaction stiffening effect).
- Shear strength is frictional and density dependent. Within Critical state Soil Mechanics one has to use at least three "state" parameters (p, q, e).
- Drained vs. undrained strength theory.
- 1D flow problems steady as well as transient ones.

He pointed out however that:

a) Some 2D extensions like flow nets and 2D strength models are very important.

b) Elastic analysis is used for soil structure interaction analysis.

c) Non-linearity is a key issue for practical applications.

Professor R. Nova pointed to the "straight jacket" of elasticity and to a variety of so called "simple" particular models, which might have lead to misconceptions about the deformation of Earth Materials and moreover to the fact that parameters depend on the problem we want to solve.

He pointed out to the importance of putting effort on understanding basics and developing skills on modelling, e.g. tackling foundations, slopes, retaining walls by using FE and/or more classical tools. One has to point out the basic differences between sands and clays and introduce the role of fluid and illustrate Terzaghi's effective stress principle. A solid background in Mechanics is necessary, where one should get acquainted with concepts like equilibrium, continuity, Darcy's law, seepage and transient pore pressure evolutions in soil consolidation etc. One should also discuss constitutive theory for soils based however on simple drained and undrained triaxial testing, summarise the findings of Cam-clay theory and provide a short of "unified" constitutive framework. Finally Prof. Nova pointed to the need of the use of a computer program to solve practical problems.

Professor F. Oka reported on his experiences with the Japanese Supporting Committee of TC34. As far as the key question of the meeting he pointed that on top of a basic "Terzaghi-type" course in Soil Mechanics new courses on liquefaction and dynamic properties of soils are introduced in Japan successfully. Laboratory tests include P and S-wave monitoring in unconfined conditions. On graduate level the basic typical behaviours of sands and clays and critical state concepts are introduced, basic continuum balance laws, concepts from elasticity, plasticity, the cam-clay model, visco-plastic models as well as 2D Biot type consolidation theory, theory and analysis of liquefaction phenomena. Professor Oka pointed to the need for limit analysis courses, covering the upper and lower bound theorems in particular and to the need of strengthening the basic concepts, in general. As a prerequisite of all this there is an undergraduate Continuum Mechanics course, with emphasis on tensor analysis, balance laws, elasticity and visco-elasticity, 1D wave propagation and fluid mechanics problems. In order to apply successfully this knowledge a graduate level course on FE analysis gives the opportunity to write code covering simple visco-plasticity problems for 1D settlement in clays. Finally Professor Oka points to the lack of appropriate textbooks that cover these more advanced topics (like Biot-type ideas, constitutive laws etc.)

Professor D. Kolymbas pointed to the need that new and successful achievements should enter our curricula. This reform is asked to be implement by the professors. However the increasing number of partial disciplines and experts induces naturally a difficulty to steer such a reform, since there is a tight entanglement among students, teachers, administrators and state mostly through funding policies. In other words, Prof. Kolymbas said that "we should teach whatever industry needs and industry needs little, since for construction companies the profit is marginal. So the industry has no interest in improvements as far as the knowledge basis is concerned of the engineers we produce. This results in a net cut down on basic curricula. In conclusion Professor Kolymbas means that our Society and not Industry should be interested in the issue at hand. In this context he pointed that:

- Attracting good students is a real problem; a problem however general for Engineering and Science.
- In the quest for globalisation, standards are becoming very important.

Professor G. Gudehus communicated in a letter to the chairman of TC34 the results from his recent Reports to the German Geotechnik, concerning the German code of practice DIN 1054100 for Geotechnical safety assessments.

Following the reports by the individual committee members in Aussois it was decided that it is worthwhile to organise a Workshop on "Deformation of Earth Materials", to be held in parallel with the 4th International Conference on "Micromechanics of Granular Media", May 21-25, 2001 in Sendai, Japan.

4 ACTIVITIES TO BE COMPLETED

At the meeting on December 15 the Japanese Supporting Committee of TC34 decided to support officially the International Workshop on Deformation of Earth Materials of TC34 to be held in Sendai, Japan.

The Sendai International Workshop of TC34 will be held at Aoba Memorial Hall, Tohoku University, Sendai, May 23, 2001 during the International Conference Powders & Grains . Professor Y. Kishino of Tohoku University will be the host. The International Workshop of TC34 will be held at Sendai jointly with the JSC. It is expected to accommodate about 18 invited speakers; i.e. (12) from abroad and (6) from Japan.

The contributed papers at the International Workshop of TC34 are sent in camera-ready form to Professor F. Oka by March 31, 2001, and the Japanese Supporting Committee of TC34 will publish the proceedings prior to the conference.