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Administrative report: TC34 – Prediction methods in large strain geomechanics

Compte rendu sur la CT-34

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ABSTRACT

This note contains the information concerning the activities of TC34 on the Prediction Methods in Large Strain Geomechanics during the period of 2001-2005 in form of an administrative report to the secretary general of the ISSMGE

1 INTRODUCTION

In the last two decades, prediction methods for the behavior of geomaterials has been greatly developed based on the ongoing research on constitutive modeling and numerical analysis methods. Nowadays, computational methods play a very important role in geotechnical engineering. There are several issues which are related to large deformation and failure in geomechanics, such as constitutive modeling and calibration, mechanical instabilities, strain localization and progressive failure, modeling of chemo-thermo-hydro-mechanical coupled behavior, verification and validation of modeling. Photo 1 shows shear bands observed after the CIU test.

The importance of these developments were recognized by the Technical Committee 34 of ISSMGE on 'Prediction methods in large strain geomechanics' which was established 2001 after the Istanbul Conference as a continuation of the previous one on the 'Deformation of Earth Materials.'

This is an administrative report on TC-34 of ISSMGE activities for the period of 2001-2005. First of all, the objective and terms of reference, and the members of TC-34 including those of Japanese supporting committee are introduced. Then, the activities by TC-34 during this period are summarized. Finally, the future prospects for TC-34 including their topics and activities are presented.

2 TERMS OF REFERENCE

Terms of reference for the TC-34 are shown as follows:

- 1) Prediction of mechanical and thermo-hydrmechanical stabilities: Large deformation, strain localization, progressive failure, liquefaction, ground water flow analysis with contamination from toxic materials, temperature dependent behavior of saturated-geomaterials and rapid flows of complex geo-fluids such as mud flow;
- 2) Development of advanced prediction methods based on new numerical and analytical techniques such as mesh free FEM, large deformation analysis and performance based design method aided by sophisticated numerical modeling;
- 3) Advanced constitutive modelling of geomaterials including cyclic plasticity, viscoplasticity and unconventional plasticity etc. for natural and treated geo material. Numerical implementations and constitutive parameter determination using laboratory and field test results. Inverse analysis and upscaling;

- 4) Evaluation of existing prediction methods such as elastic and simplified elasto-plastic numerical analysis, and limit analysis etc.

The main topic of TC34 is 'Mechanical instabilities and large deformation in geomechanics.' This topic covers Prediction methods in large deformation problem, progressive failure, localization, liquefaction and rapid flows. The secondly important topic is 'Thermo-hydro-mechanically coupled deformations of geomaterials.'

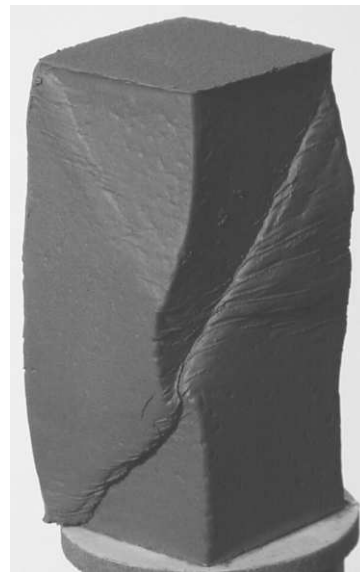


Photo 1. Picture of shear bands after CIU test

3 MEMBERS AND SUPPORTING COMMITTEE

A well-selected international group of experts were appointed as responsible members of this committee based on the candidates recommended by ISSMGE member's societies, presided from 2001 to 2005 by Prof. F. Oka of Kyoto University as the Chairman and Prof. A. Murakami of Okayama University as the Secretary, who were finalized by the ISSMGE President. List of members are shown in the APPENDIX. TC-34 has also set up the supporting committee in the framework of the Japanese Geotechnical Society (JGS) in order to enhance the activities of

TC-34. The members of Japanese Supporting Committee are also listed in the APPENDIX.

4 REVIEW OF ACTIVITIES

4.1 TC-34 Website and Newsletters

TC-34 homepage has been constructed at the site below and all the formal information and the activities have been updated in this website.

<http://nakisuna2.kuciv.kyoto-u.ac.jp/tc34/index.htm>

Newsletters have been issued via e-mail. During the period of 2001-2005, a total of 17 newsletters were published.

4.2 IWS-Athens 2003

The International Workshop on Prediction and Simulation Methods in Geomechanics was held in Athens on 14-15 Oct., 2003 by the second term activity of TC-34 under the sponsorship of the ISSMGE, the JGS, the Hellenic Society of SMFE, DIGA, Kyoto University and the National Technical University of Athens. The proceeding edited by F. Oka, I. Vardoulakis, A. Murakami and T. Kodaka was published including 50 papers. The organization of the Workshop is done by the members of the organizing committee with the aid of the international advisory committee as listed below.

- Organizing Committee

Chairmen:

F. Oka (Japan)

I. Vardoulakis (Greece)

Secretary General:

A. Murakami (Japan)

Organizing Members:

K.T. Chau (Hong Kong)

Y. Dafalias (Greece)

F. Darve (France)

G. Gazetas (Greece)

R. Nova (Italy)

M. Stavropoulou (Greece)

M. Pastor (Spain)

T. Kodaka (Japan)

International Advisory Committee:

P. van den Berg (The Netherlands)

A. Cividini (Italy)

A. Gens (Spain)

S.-R. Kim (Korea)

D. Kolymbas (Austria)

J. F. Labuz (USA)

P. V. Lade (USA)

G. Lámer (Hungary)

T. Lämsivaara (Finland)

R. L. Michalowski (USA)

H. B. Mühlhaus (Australia)

J.P.B. Serra (Portugal)

J. Sulem (France)

C. Tamagnini (Italy)

R. Wan (Canada)

D. Muir Wood (UK)

Main themes of the Workshop are:

1. Prediction of mechanical and thermo-hydromechanical stabilities: Large deformation, strain localization, progressive failure, liquefaction.
2. Development of advanced prediction methods, based on new numerical and analytical techniques.

3. Numerical implementation and constitutive parameter determination. Evaluation of existing prediction methods such as elastic, simplified elasto-plastic analysis and limit analysis.

4.3 Special Issue on Prediction and Simulation Methods in Geomechanics of Soils and Foundations

Due the high quality of the presentations during this IWS-Athens, it was decided, with the approval of the JGS, to dedicate a special issue of *Soils and Foundations*, where full length papers of the communications could be published. The rapid review of the editorial committee of *Soils and Foundations* made it possible to publish this special issue on the 'Prediction and Simulation Methods in Geomechanics,' which is comprised of 15 papers in Vol.45, No.2, i.e., April issue of 2005. It is expected that a number of related papers will also be published in the coming issue.

The main aim in publishing this special issue of *Soils and Foundations* was to provide to researchers and engineers a forum of international exposure to present the recent advances on the subjects of 'Prediction Methods in Large Strain Geomechanics as well as on Degradation and Instabilities in Geomaterials.'

4.4 Organizing Sessions in the Regional Conferences and Related Conferences

(1) Discussion Sessions at the Annual Conference of the JGS: July 2002 through 2005.

THEME: Deformation and Failure of Geomaterials

DATE: July 16, 2002

PLACE: Osaka, Japan

CONTENTS:

- 1) Opening address by F. Oka (Japan)
- 2) General report on the accepted papers (21 papers)
- 3) Discussion

Chairpersons: M. Hori (Japan) and A. Murakami (Japan)

THEME: Computational Geotechnics

DATE: July 2, 2003

PLACE: Akita, Japan

CONTENTS:

- 1) Opening address by F. Oka (Japan)
- 2) General report on the accepted papers (17 papers)
- 3) Discussion

Chairpersons: Y. Kishino (Japan), K. Komiya (Japan) and H. Sakaguchi (Japan)

THEME: Computational Geotechnics

DATE: July 7, 2004

PLACE: Niigata, Japan

CONTENTS:

- 1) Opening address by F. Oka (Japan)
- 2) General report on the accepted papers (13 papers)
- 3) Discussion

Chairpersons: F. Zhang (Japan) and T. Matsushima (Japan)

THEME: Mechanics of Multi-phase Ground (Analysis for Saturated/Unsaturated ground)

DATE: July 5, 2005

PLACE: Hakodate, Japan

CONTENTS:

- 1) Opening address by F. Oka (Japan)
- 2) Panel discussion

- a) Panelists
- / Significance of saturated-unsaturated seepage analysis
M. Nishigaki (Japan)
 - / Elasto-plastic constitutive model for analysis of multi-phase ground Y. Kohgo (Japan)
 - / Analysis method and stress invariant for multi-phase geomaterials F. Oka (Japan)
 - / Construction of artificial tide land from geo-engineering point of view M. Miyake (Japan)
- b) Discussion
Chairperson: S. Sunami (Japan)
- 3) General report on the accepted papers (8 papers)
- 4) Discussion
Chairperson: Y. Kohgo (Japan)

(2) Meetings and Workshops

Meeting during the 6th IWBIDG

THEME: SOA report of TC34, Future activities

DATE: June 4, 2002

PLACE: St. John University, Minnesota, USA

ATTENDANCE: F. Oka, R. Nova, F. Darve, H.-B. Mühlhaus, R. Michalowski, J. Labus, P. Lade, I. Vardoulakis, R. Wan

Workshop during 13th ECSMGE in 2003.

THEME: Prediction Methods in Large Strain Geomechanics

DATE: August 24, 2003

PLACE: Prague, Czech Republic

CONTENTS:

Followings are the list of submitted papers from TC-34:

- 1) Technical Papers:
 - / Investigation of progressive failure in composite soils using X-ray CT scanner J.Otani (Japan)
 - / Mitigation of the effects induced by the rise of the water table around underground structures A. Cividini (Italy)
 - / Progressive failure of slope due to heavy rain and its 3D-numerical simulation F.Zhang (Japan)
- 2) Discussion: Chairman F.Oka (Japan)
- 3) Suggestions for future activities of TC 34

Meeting during the IWS-Athens 2003

THEME: SOA report of TC34, Future activities

DATE: October 14, 2003

PLACE: The NTU of Athens, Greece

ATTENDANCE: F. Oka, R. Nova, F. Darve, M. Pastor, R. Michalowski, J. Labus, K.T. Chau, I. Vardoulakis, R. Wan, M.M. Farias

Meeting during the 7th IWBIDG

THEME: SOA report of TC34, Osaka Conference and Future activities

DATE: June 14, 2005

PLACE: Chania, Greece

ATTENDANCE: F. Oka, R. Nova, F. Darve, H.-B. Mühlhaus, R. Charlier, J.Sulem, I. Vardoulakis, R. Wan

(3) Organization of the Minisymposium at 6th WCCM and APCOM'04 in 2004

THEME: Computational Geotechnics

DATE: Sept. 7, 2004

PLACE: Beijing, China

CONTENTS:

- 1) Keynote Lecture:
 - Thermo-hydro-mechanically coupled finite element analysis of cohesive soil using an elasto-viscoplastic model – F. Oka (Japan)
 - Element-free analysis for saturated soil within finite strain – A. Murakami (Japan)

2) Presentations:

/ Virtual element test of sand

T. Matsushima (Japan) :

/ Intelligent finite element method: development of the algorithm

A. A. Javadi (UK)

/ Intelligent finite element method: development of the algorithm

A. A. Javadi (UK)

/ Movement and impact force of earth and rock mass from landslide

G. Chen (China)

/ Prediction of earth pressures on a pile group due to liquefaction induced ground flow

R. Uzuoka (Japan)

/ Implementation of a micro-polar hypoplastic model for granular materials with localized deformation

W. Huang

/ Three-dimensional numerical simulation of pile-soil seismic interaction in saturated deposits with liquefiable sand and soft clay

Y. Huang

/ Description of anisotropic behavior of sand through modified stress method

Y. Tobita (Japan)

/ Finite element modeling of the behavior of unsaturated soils

A. A. Javadi (UK)

(4) Co-sponsored Conferences and Workshops

1. International Conference on Reconstruction of Historical Cities and Geotechnical Engineering in September 17 – 18, 2003.
2. International Workshop on Geotechnical X-Ray CT in November 6 - 7, 2003.
3. 5th International Conference on Case Histories in Geotechnical Engineering in April 13 - 17, 2004.
4. 7th International Workshop on Bifurcation, Instabilities and Degradation in Geomechanics in June 13-15, 2005.
5. Powders & Grains 2005 in July 18-22, 2005

4.5 Publications

Following is the list of our publications:

- (1) Prediction and Simulation Methods in Geomechanics (Proc. of IWS on Prediction and Simulation Methods in Geomechanics (IWS-Athens 2003), Athens, Greece, 2003)

4.6 Meetings of Japanese Supporting Committee

The meetings were held by Japanese Supporting Committee for three or four times in each year and the discussion by this supporting committee was a guideline for the whole activities by TC-34. Meetings were held as following schedule:

/ 1st meeting: November 29, 2002, Kyoto

/ 2nd meeting: March 28, 2003, Tokyo

/ 3rd meeting: July 2, 2003, Akita

/ 4th meeting: September 9, 2003, Tokyo

/ 5th meeting: July 7, 2004, Niigata

/ 6th meeting: October 15, 2004, Tokyo

/ 7th meeting: March 28, 2005, Tokyo

/ 8th meeting: July 5, 2005, Hakodate

5 CONCLUDING REMARKS

5.1 *Summary of Activities*

TC-34 activities in the period of 2001 to 2005 are summarized:
(1) four organized sessions in the annual conferences of the JGS,
(2) six meetings, workshops and related conferences,
(3) eight meetings for the Japanese Supporting Committee, and
(4) one publication

5.2 *Planned Activity for 16 ICSMGE at Osaka*

1. *Strong support for the 16th ICSMGE in 2005 by Oka as the Vice-Head of the Academic Assembly of the Organizing Committee of 16 ICSMGE and by Murakami as the Secretary of the Academic Assembly of the Organizing Committee of 16 ICSMGE;*
2. *Plenary Lecture entitled 'Computational modeling of large deformation and failure of geomaterials' given by Oka;*
3. *General Reporter in the Technical Session 1e entitled 'Analysis' by Murakami;*
4. *Panelists in the Technical Sessions by core members.*
5. *State-of-the-art Report of TC34 at 16 ICSMGE.*
6. *TC meeting, Sept.11 and 14 during the Osaka Conference*
7. *Support for GeoX2006, Aussois, France October 5-7, 2006.*

5.3 *Next Host Member Society*

The TC-34 has obtained good results in this period of 2001-2005, providing successful contributions towards the development of prediction methods in large strain geomechanics. It is believed that the fruitful outcomes of TC-34 activities are attribute to the great efforts of the Japanese Supporting Committee established in the framework of the JGS. Thus, a large number of TC-34 members wish that the JGS would be strongly expected to be a Host Member Society of TC-34 for the forthcoming term of 2005-2009.

APPENDIX : LIST OF MEMBERS

- TECHNICAL COMMITTEE #34

CHAIRMAN:

Oka, F., Japan

SECRETARY:

Murakami, A., Japan

CORE MEMBERS:

Vardoulakis, I. Greece

Chau, K.T., China

Darve, F., France

Nova, R., Italy

MEMBERS:

van den Berg, P., The Netherlands

Cividini, A., Italy

Charlier, R., Belgium

de Farias, M.M., Brazil

Gens, A., Spain

Gudehus, G., Germany

Kim, S.R., Korea

Kolymbas, D., Austria

Labuz, J.F., U.S.A.

Lade, P.V., U.S.A.

Lámer, G., Hungary

Länsivaara, T., Finland

Michalowski, R.L., U.S.A.

Mühlhaus, H.B., Australia

Pastor, M., Spain

Serra, J.P.B., Portugal

Sulem, J., France

Tamagnini, C., Italy

Wan, R., Canada

Muir Wood, D., U.K.

- JAPANESE SUPPORTING COMMITTEE

CHAIRMAN:

Oka, F., Kyoto University

SECRETARY GENERAL

Murakami, A., Okayama University

SECRETARY

Kodaka, T., Kyoto University

MEMBERS:

Asaoka, A., Nagoya University

Iizuka, A., Kobe University

Iwakuma, T., Tohoku University

Uzuoka, R., Tohoku University

Otani, J., Kumamoto University

Oda, M., Saitama University

Kishino, Y., Tohoku University

Kohgo, Y., National Research Institute of Agr. Engng.

Komiya, K., Chiba Institute of Technology

Sakaguchi, H., Japan Marine Science & Technology Center

Sunami, S., Nikken Sekkei Ltd.

Sekiguchi, K., JFK R&D Corporation

Takahashi, A., Public Works Research Institute

Tatsuoka, F., Tokyo University of Science

Tamura, T., Kyoto University

Zhang, F., Nagoya Institute of Technology

Tobita, Y., Tohoku Gakuin Univeristy

Nakai, T., Nagoya Institute of Technology

Nakano, M., Nagoya University

Noda, T., Nagoya University

Hori, M., The University of Tokyo

Maeda, K., Nagoya Institute of Technology

Matsushima, T., Tsukuba University

Miyake, M., Toyo Construction Corporation

Yashima, A., Gifu University

Yoshida, N., Kobe University