

# INTERNATIONAL SOCIETY FOR SOIL MECHANICS AND GEOTECHNICAL ENGINEERING



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## Administrative report: TC 9 – Earth reinforcement Compte rendu sur la CT-9

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### ABSTRACT

The general objective of TC-9 in the period 2001-2005 was to focus on the use of full range of developed and new/novel techniques including geosynthetics, nailing, and other methods for ground reinforcement using artificial material placed in the soil. And co-operation with TC-17 was required. Under these guidelines, not only TC-9 meetings but also the organizing sessions have been done whenever the related international symposia/conferences were held. The joint activities with TC-17 were also examined. A starting activity was the International Symposium on Earth Reinforcement (IS Kyushu 2001), which was held on November 14-16, 2001 in Fukuoka, Japan under the joint-auspices of the Japanese Geotechnical Society and the TC-9. Here in this report, the activities by TC-9 during this period are summarized. On the basis of these activities, the future prospects of TC-9 including theme and activities are also presented.

### 1 INTRODUCTION

TC-9 covers the professional area of the subjects on any kinds of earth reinforcement technique. The title of TC-9 had been called “Geotextiles and Geosynthetics” during the period 1994-1997. But the name of TC-9 was changed to “Geosynthetics and Earth Reinforcement” in order to match their activities in the next period 1997-2001. This was based on the great success of IS Kyushu (International Symposium on Earth Reinforcement) which were held in Fukuoka, Japan in 1988, 1992 and 1996. For this reason, the Japanese Geotechnical Society (JGS) had supported the activities of TC-9 as a Host Member Society, and a supporting committee had been established in the framework of JGS. The President of ISSMGE for the period 2001-2005 presented the new general objective for TC-9 and decided that JGS continues to support TC-9 as a Host Member Society.

This is an administrative report on TC-9/ISSMGE activities for the period 2001-2005. First of all, the objective and terms of reference, and the members of TC-9 including those of Japanese supporting committee are introduced. Then, the activities by TC-9 during this period are summarized. Finally, the future prospects for TC-9 including their topics and activities are presented.

### 2 OBJECTIVE AND TERMS OF REFERENCE

The general objective of TC-9 is to focus on the use of full range of developed and new/novel techniques including geosynthetics, nailing, and other methods for ground reinforcement using artificial material placed in the soil. And co-operation with TC-17 is required.

Terms of reference for the TC-9 are shown as follows:

- 1) To continue enhancement in developing and spreading the experiences and knowledge on earth reinforcement practice, along the lines of the objectives stipulated for this TC;
- 2) To promote research and development, along the lines of objectives stipulated for this TC;
- 3) To promote publication of education materials on earth reinforcement practice for engineers and students;

- 4) To contribute international symposia/conferences related to earth reinforcement; and
- 5) To collaborate with TC-17.

### 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. H.Ochiai as Chairman and Prof. J.Otani as Secretary, who were finalized by the ISSMGE President. List of members are shown in the APPENDIX. TC-9 has also set up the supporting committee in the framework of the Japanese Geotechnical Society (JGS) in order to enhance the activities of TC-9. The members of Japanese Supporting Committee are also listed in the APPENDIX.

### 4 REVIEW OF ACTIVITIES

#### 4.1 TC-9 Website

TC-9 home page has been successfully used and all the formal information and the activities have been updated in this website. (TC-9 home page: <http://www.nda.ac.jp/cc/users/miyamiya/tc9/>)

#### 4.2 IS Kyushu 2001

The International Symposium on Earth Reinforcement, IS Kyushu 2001, was held at Garden Palace Hotel in Fukuoka, Japan on November 14-16, 2001 under the joint-auspices of the Japanese Geotechnical Society (JGS) and the TC-9. This symposium was a continuation of the three previous international symposia, IS Kyushu '88, '92, and '96 which have provided successful contributions to the development of earth reinforcement practice in geotechnical engineering. The aim of those symposia was to discuss various problems and topics on earth reinforcement for the benefit of collecting and exchanging knowledge concerning recent developed techniques and to spread the knowledge to all the countries of the world for further development. Recently, a

global standardization became a key issue for testing and design around the world and new design concepts such as limit state design and performance based design have been discussed. This symposium offered an excellent opportunity to discuss such issues. The outcomes of TC-9 activities were published in the symposium proceedings, which were published by BALKEMA.

#### 4.3 Organizing Sessions in the Regional Conferences and Related Conferences

- (1) TC-9 session during 12<sup>th</sup> Asian Regional Conference  
 THEME: Combined technology in earth reinforcement  
 DATE: August 7, 2003  
 PLACE: Singapore  
 CONTENTS:  
 1) Opening address by H. Ochiai (Japan)  
 2) General report on the accepted papers (16 papers) by S.A.Tan (Singapore)  
 3) Discussion on future development of earth reinforcement  
 a) Panelists  
 / Recent case histories on combined technology with earth reinforcement in Japan Y.Miyata (Japan)  
 / Performance of an embankment on soft clay supported by geogrid and concrete piles E.C. Shin (Korea)  
 / Southeast Asian practice of soil reinforcement in combination with other soil improvement methods  
 Mr.Lawson(Malaysia)  
 / Behavior of Hexagonal Wire Reinforced Embankment on Jet Grouted Cement piles D.T. Bergado(Thailand)  
 b) Discussion  
 Chairpersons:Prof.Otani (Japan) and Dr.Yeo(Hong Kong)
- (2) TC-9 and TC-17 Jointed Special Session during 13<sup>th</sup> African Regional Conference  
 THEME: Reinforcement and Improvement of Soil  
 DATE: December 8-11,2003  
 PLACE: Marrakech, Morocco  
 CONTENTS:  
 Followings are the list of submitted papers from TC-9:  
 1) Keynote lecture: Current case histories of reinforced soil retaining wall technique in Japan  
 J.Otani, H.Ochiai, Y.Miyata and T.Hirai (Japan)  
 2) Technical Papers:  
 / Response of sheet reinforcement to transverse downward force/ displacement  
 M.R.M. Madhav and T.P. Manoj (India)  
 / Constitutive parameters of compacted sandy soils  
 A.Iizuka, M. Hirata and H.Ohta (Japan)  
 / Soft soil improvement due to vivrocompacted columns installation  
 J.M. Debats, Z. Guetif and M. Bouassida (Tunisie)  
 / Landfill cap cover issue –Improvement of the capability to sustain differential settlement”  
 J.P. Gourc, O. Ple and P. Villard (France)  
 / Geosynthetics and Erosion control  
 R. Philippe (France)

It is noted that the contents of TC-9 session during Asian Regional Conference in Singapore was also reported during this session.

- (3) Special Session at 3<sup>rd</sup> Asian Regional Conference on Geosynthetics  
 THEME: Role of numerical analysis on earth reinforcement  
 DATE: June 21-22, 2004  
 PLACE: Seoul, Korea  
 CONTENTS:

- 1) Keynote Lecture: The role of numerical simulation for geosynthetic reinforced soil structures  
 - from laboratory tests to full scale structures –  
 A. Iizuka (Japan)

#### 2) Panelist Presentations:

- / Design of a Geosynthetics Reinforced Segmental Retaining Wall in a Tiered Arrangement -Use of Numerical Modelling as Design Aid  
 C. Yoo (Korea) :  
 / Finite Element Analysis of a Soil Nailed Slope -Some Recent Experience  
 S. A. Tan (Singapore)  
 / Application of Numerical Modelling to the Design of Reinforced Soil Walls for Infrastructure Projects -Some Australian Experiences  
 R. Lo (Australia)

- (4) TC-9 and TC-17 Jointed Seminar in Hong Kong  
 THEME: One-Day Seminar on Ground Treatment  
 DATE: April 17, 2004  
 PLACE: Hong Kong  
 CONTENTS:  
 Following is the list of presentations from TC-9.  
 / Introduction of technical committee TC-9 and TC-17  
 J.Otani (Japan)  
 / Soil sedimentation and vertical drain method  
 M. Katagiri (Japan)  
 / Development of Pneumatic Flow Mixing Method and its Application  
 M. Kitazume (Japan)  
 / Sand Compaction Pile Method  
 M. Nozu (Japan)
- (5) Co-sponsored session between TC-9 and ASCE during Geo-Frontiers  
 THEME: International Perspectives on Soil Reinforcement Applications  
 DATE: January 24, 2005  
 PLACE: Austin, U.S.A.  
 CONTENTS:  
 Following is the list of presentations from TC-9.  
 / Geosynthetic Reinforcement for Soft Foundations: Brazilian Perspectives E. Palmeira (Brazil)  
 / Geosynthetic Reinforcement in Landfill Design: European Perspectives J.P. Gourc (France)  
 / Geosynthetic Reinforcement in Landfill Design: US Perspectives J.G. Zornberg (U.S.A.)  
 / Geosynthetic-Reinforced Soil Walls and Slopes: Japanese Perspectives J. Otani (Japan)  
 / Geosynthetic-Reinforced Soil Walls and Slopes: European Perspectives C.J.F.P. Jones (U.K)

#### 4.4 Publications

Following is the list of our publications:

- (1) Proceedings of International Symposium on Earth Reinforcement (IS Kyushu), Vol.1 and 2, BALKEMA, November, 14-16,2001.  
 (2) Proceedings of 12<sup>th</sup> Asian Regional Conference Vol.2, pp.1303-1335, 2003.  
 (3) Proceedings of 13<sup>th</sup> African Regional Conference, pp.673-768, 2003.  
 (4) Proceedings of 3<sup>rd</sup> Asian Regional Conference on Geosynthetics, pp. 153-203, 2004.  
 (5) Proceedings of Seminar on Ground Treatment, total number of pages:167, 2004.  
 (6) Proceedings of Geo-Frontiers, CD-ROM, 2005.

- (7) Special Publications "Combined Technology in Earth Reinforcement, editors by H.Ochiai, J.Otani, and Y.Miyata, Total number of pages:30, 2004.

## 5 TC-9 MEETINGS

TC-9 have set up mailing list which is [issmge\\_tc9@cc.nda.ac.jp](mailto:issmge_tc9@cc.nda.ac.jp) in order to discuss on e-mail. And meantime, the meetings during the conferences on the related topics with earth reinforcement were organized as much as possible. Followings are the contents of the meeting, in which we have done in the period 2001-2005

### 5.1 1st meeting

DATE: September 23, 2002 from 16:30 to 18:00  
PLACE: Nice, France during 7th International Geosynthetic Conference  
AGENDA:

- / Opening address by Chairman (Prof. Ochiai)
  - / Introduction of new TC-9 (including the topics which are concerned by TC-9)
  - / Introduction of members
  - / Terms of reference and action plan
  - / Possible our activities
  - / Short presentations
- Dr.Miyata(Japan) of Japanese Supporting Members introduced the case histories of the "Earth Reinforcement Technique Combined with Other Methods" such as pile foundation, soil improvement, some pre-stress and others.

PARTICIPANTS: 35

### 5.2 2nd Meeting

DATE: June 25, 2003 from 12:30 to 13:30  
PLACE: MIT, Boston, U.S.A. during Pan American Conference  
AGENDA:

- / Presentation 1: Comparison of International Design Criteria for Geosynthetic-Reinforced Soil Structures (by J.Zornberg)
- / Presentation 2: Summary of procedures/criteria/practice in Japan (by J.Otani)
- / Discussion - Future activities in this area to be organized by TC-9

PARTICIPANTS: 5

### 5.3 3rd Meeting

DATE: August 24, 2003 from 15:00-17:00  
PLACE: Prague, Czech during European Regional Conference  
AGENDA:

- / Presentations for some of the activities in Europe
- / Report on the TC-9 session during Asian Regional Conference held in Singapore in August, 2003
- / Report on the TC-9 meeting in Boston during Pan American Regional Conference
- / Informal discussion on the way of TC-9 activities

PARTICIPANTS: 10

### 5.4 4th Meeting

DATE: June 23, 2003 from 13:00-14:00  
PLACE: Seoul, Korea during GeoAsia 2004  
AGENDA:  
/ Opening Address by Chairman of TC-9, Prof.Ochiai of Kyushu University, Japan

- / Brief summaries on our activities so far
- / Contents of final report by TC-9
- / Discussion on Chairmanship of next period of TC-9 (from 2005 to 2009)

PARTICIPANTS: 23

### 5.5 5th Meeting

DATE: January 25 from 17:00 to 19:00, 2005  
PLACE: Austin, U.S.A. during Geo-Frontiers  
AGENDA:

- / Summary of our activities
- / About final reports
- / About session at Osaka conference
- / About next TC-9 host
- / About next IS Kyushu
- / Schedule of next (final) meeting

PARTICIPANTS: 15

### 5.6 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-9. Meetings were held as following schedule:

- / 1<sup>st</sup> meeting: June 5, 2002, Tokyo
- / 2<sup>nd</sup> meeting: September 2, 2002, Tokyo
- / 3<sup>rd</sup> meeting: December 4, 2002, Tokyo
- / 4<sup>th</sup> meeting: March 13, 2003, Tokyo
- / 5<sup>th</sup> meeting: July 3, 2003, Akita
- / 6<sup>th</sup> meeting: November 28, 2003, Tokyo
- / 7<sup>th</sup> meeting: March 17, 2004, Tokyo
- / 8<sup>th</sup> meeting: June 17, 2004, Tokyo
- / 9<sup>th</sup> meeting: September 30, 2004, Tokyo
- / 10<sup>th</sup> meeting: December 12, 2004, Tokyo
- / 11<sup>th</sup> meeting: March 17, 2005, Tokyo
- / 12<sup>th</sup> meeting: June 8, 2005, Tokyo

## 6 CONCLUDING REMARKS

### 6.1 Summary of Activities

TC-9 activities in the period 2001 to 2005 are summarized:

- (1) five organized sessions in the regional conferences and other conferences and symposia,
- (2) five TC-9 meetings during the regional and the related conferences,
- (3) more than ten meetings for the Japanese Supporting Committee, and
- (4) seven publications

Those activities have also been done within the framework of following cooperation:

- (1) TC-17/ISSMGE (Ground Improvement), and
- (2) IGS (International Geosynthetic Society)

### 6.2 Expected Activities from Now on

Following activities have already assigned as TC-9 activities:

- (1) To organize a technical session whose topic is earth reinforcement at Osaka Conference (16th ICSMGE) on September 15, 2005;
- (2) To publish an educational textbook entitled "Earth Reinforcement Technique -New Horizon-" (in Japanese) by Japanese Supporting Committee of TC-9 in 2005;

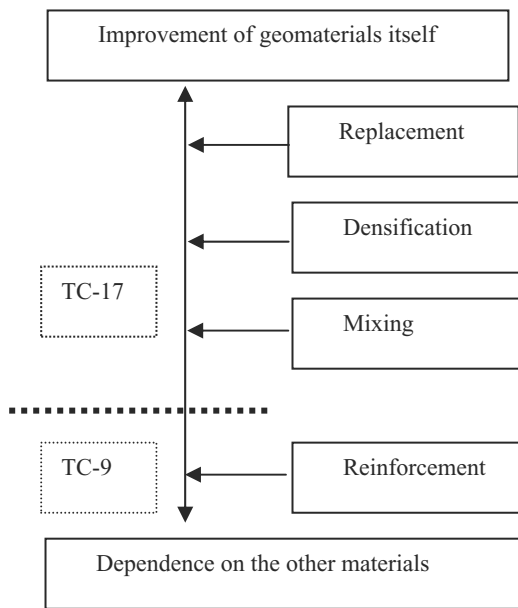


Figure 1 Classification of the topics by TC-9 and TC-17.

- (3) To organize a technical session at 8th ICG (International Conference on Geosynthetics) in Yokohama on September 18-22, 2006. This has been decided between ISSMGE and IGS presidents;
- (4) To support 5th IS Kyushu (International Symposium on Earth Reinforcement) in Fukuoka, Japan in 2007. The IS Kyushu will be held as one of the activities by TC-9 according to the agreement of TC-9 members.

### 6.3 Topic under TC-9

The title of TC-9 has been changed as follows:

- (1) 1993-1997: Geotextiles and Geosynthetics,
- (2) 1997-2001: Geosynthetics and Earth Reinforcement, and
- (3) 2001-2005: Earth Reinforcement

For the period 2001-2005, the ISSMGE President presented the new general objective for TC-9, by which the topics under TC-9 became wide range of "earth reinforcement" including the topic of "ground improvement" which was originally covered by TC-17.

In order to enhance the activities by TC-17, it is advisable to distinguish the topics under TC-9 and TC-17 clearly based on the principle of ground improvement. We have suggested the topics, which have to be covered by TC-9, in the final report of previous term (1997-2001), as shown in Figure 1. We would like to propose this figure again in order to enhance mutual activities between TC-9 and TC-17. Of course, the education of earth reinforcement is very important issue, so that it should be continued both the system and material of education. Topics on the design and testing methods for earth reinforcement will be discussed in TC-9. To co-operate with TC-17 as well as the International Geosynthetics Society (IGS) should also be important activities of TC-9.

### 6.4 Next Host Member Society

The TC-9 has obtained good results in this period 2001-2005, providing successful contributions towards the development of the earth reinforcement practice. It is believed that the fruitful outcomes of TC-9 activities are attribute to the great efforts of

Japanese Supporting Committee established in the framework of Japanese Geotechnical Society. Thus, a large number of TC-9 members wish that the Japanese Geotechnical Society would be strongly expected to be a Host Member Society of TC-9 for the next term (2005-2009) again.

### APPENDIX : LIST OF MEMBERS

#### CHAIRMAN:

Ochiai, H., Japan

#### SECRETARY:

Otani, J., Japan

#### CORE MEMBERS:

Gassler, G., Germany

Gourc, J.P., France

Madhav, M., India

Oden, K., Sweden

Palmeira, E.M., Brazil

Tan, S.A., Singapore

Zornberg, J., U.S.A.

#### MEMBERS:

Abramento, M., Brazil

Bouassida, M., Tunisia

Bekenov, T.N., Kazakhstan

Bathurst, R.J., Canada

Bergado, D., Thailand

Cazzuffi, D.A., Italy

Chang, D.T.T., Taiwan

Ehrlich, M., Brazil

Garcia-Mina, J., Spain

Guler, E.F., Turkey

Herle, V., Czech Rep.

Heerten, G., Germany

Jones, C.J.F.P., UK

Kvasnicka, P., Croatia

Kitazume, M., Japan

Lafleur, J., Canada

Lam, A, Hong Kong

Lawson, C.R., Malaysia

Leshchinsky, D., U.S.A.

Liausu, Ph., France

Lopes, M.D.G.A., Portugal

Lo, R., Australia

Matys, M., Slovak Republic

Moraci, N., Italy

Rajagopal, K., India

Rathmayer, H., Finland

Rowe, R.K., Canada

Scharle, P., Hungary

Timofeeva, L.M., Russia

Uriel, S., Spain

Voskamp, W., Netherlands

Yeo, K.C., Hong Kong

Yoo, C., Korea

### JAPANESE SUPPORTING COMMITTEE

#### CHAIRMAN:

Ochiai, H., Japan

#### SECRETARY GENERAL

Otani, J., Japan

#### SECRETARY

Katagiri, M., Japan

Hirai, T., Japan

Miyata, Y., Japan

MEMBERS:

Aoki, M., Japan  
Fukuda, N., Japan  
Iizuka, A., Japan  
Kitazume, M., Japan  
Kojima, K., Japan  
Konami, T., Japan  
Kotake, N., Japan  
Kumagai, K., Japan  
Kuwano, J., Japan  
Nagao, K., Japan  
Nozu, M., Japan  
Ogata, K., Japan  
Otani, Y., Japan  
Tsukamoto, Y., Japan  
Uchimura, T., Japan  
Yokota, Y., Japan  
Wada, H., Japan