

IGS NEWS



NEWSLETTER OF THE INTERNATIONAL GEOSYNTHETICS SOCIETY

Dedicated to the scientific and engineering development of geotextiles, geomembranes, related products, and associated technologies

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The IGS Officers and Council Members

A total of 17 candidates ran for eight council positions on the IGS Council for the 2004 to 2008 term, and the election was held by postal ballot in May 2004. Congratulations to the new and re-elected Council members! Please see the listings below for the new Council Members (2004 to 2008) and for an updated list of co-opted members and additional changes to Council. Biographies of the new Council members can be found in the March 2004 issue of *IGS News*, or on the IGS website.

Council Members (2004-2008)

Abdelmalek Bouazza (Australia)
John Cowland (Hong Kong-China)
Pierpaolo Fantini (Italy)
Danette Halloran (USA)
Masashi Kamon (Japan)
Bernard Myles (United Kingdom)
Mike Sadlier (Australia)
Jorge G. Zornberg (USA)

Co-opted Council Members (2004-2008)

Eun-chul Shin (Korea)

President Daniele Cazzuffi
Vice-President Fumio Tatsuoka
Immediate Past-President Richard J. Bathurst
Treasurer Wim Voskamp
Secretary Peter Stevenson

Council Members (2002-2006)

Gerhard Bräu (Germany)
Steve Corbet (United Kingdom)
Philippe Delmas (France)
Michele Maugeri (Italy)
Hiroshi Miki (Japan)
Ennio Palmeira (Brazil)
Peter Stevenson (USA)
Wim Voskamp (The Netherlands)

Co-opted Council Members (2002-2006)

Ernesto Alio (Venezuela)
Cheng Gang Bao (China)
Barry Christopher (USA)
G. Venkatappa Rao (India)

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NEW IGS MEMBERSHIP BENEFITS REQUIRE ELECTRONIC COMMUNICATION

Visit the IGS WWW site: www.geosyntheticssociety.org

IGS Officers, Council, and Committee Meetings (Seoul, Korea, 18-20 June 2004)

The IGS Council met in Seoul Korea on 20 June 2004 at the Hotel Seoul Education & Culture Center. The Council meeting was held after the IGS Officers meeting (18 June) and the IGS Committee meetings (19 June) and prior to the opening of the *GeoAsia 2004 Conference and Exhibition* hosted by the Korean Chapter of the IGS from 21 to 23 June 2004.

IGS President, Daniele Cazzuffi, called the IGS Council meeting to order at 9:07 AM and the meeting closed at 6:30 PM. Present were the five officers: President Daniele Cazzuffi, Vice President Fumio Tatsuoka, Past President Richard Bathurst, Treasurer Philippe Delmas, and Secretary Pete Stevenson. Council Members present were Mike Sadlier and Malek Bouazza (Australia), Pierpaolo Fantini and Michele Maugeri (Italy), Jorge Zornberg and Danette Halloran (USA), Hiroshi Miki and Masashi Kamon (Japan), Steve Corbet and Bernard Myles (UK), John Cowland (Hong Kong-China) and Cheng-Gang Bao (China), Ennio Palmeira (Brazil), Gerhard Bräu (Germany), Eun-chul Shin (Korea), G.V. Rao (India), Wim Voskamp (Netherlands), and Rosemary Stevenson (IGS Office Manager). Apologies were presented for Ernesto Alio (Venezuela) and Barry Christopher (USA).

The newly elected Council Members (A. Bouazza, P. Fantini, and J.G. Zornberg) received a warm welcome from President D. Cazzuffi.

Many decisions were taken by the IGS Council. First was the election of Chris Lawson to present the Giroud Lecture in Yokohama, Japan at the International Conference on Geosynthetics (8th ICG) in 2006. It was also unanimously decided to co-opt Eun-chul Shin (Korea) in the IGS Council for the period 2004 to 2008 and to elect Wim Voskamp as IGS Treasurer from



The 2004-2008 IGS Council Officers and Council Members. IGS Council Members (standing left to right): H. Miki, C.G. Bao, G.V. Rao, J. Cowland, E. Palmeira, M. Maugeri, G. Bräu, M. Kamon, M. Sadlier, D. Halloran, J.G. Zornberg, P. Fantini, W. Voskamp, S. Corbet, B. Myles, and M. Bouazza (not pictured in the photo is Eun-Chul Shin). IGS Officers (sitting left to right): P. Delmas, R.J. Bathurst, D. Cazzuffi, F. Tatsuoka, and P. Stevenson.

2004 to 2006, following the resignation of Treasurer Philippe Delmas, due to personal reasons.

After a lively discussion, it was also decided to change the IGS election system to electronic balloting. Currently, ballots are cast by mail or at the Ordinary General Assembly (OGA) and the participation rate is relatively low (particularly the postal ballot) at a high cost both to the IGS and to the Membership. Ironically, this change in balloting will require one last postal ballot to approve the bylaw change to electronic balloting. The goal is to mail this last postal ballot in the last quarter of 2004.

Another important decision involved the venue for the Asian regional conference on geosynthetics in 2008; it was decided unanimously to assign the organisation of *Geosynthetics Asia 2008* to the IGS Chinese Chapter. The *GeoAsia 2008 Conference and Exhibition* will take place in Shanghai at the beginning of June 2008. In the same year, the European regional conference will be organised by the IGS British Chapter; *EuroGeo4* will be in Edinburgh, Scotland, in September 2008.

Meanwhile, *GeoFrontiers 2005* will have a very significant geosynthetics presence including both the North

American Geosynthetics Society (NAGS) and the IGS. There is potential Pan American cooperation between the North American and the South American IGS Activity Committees for the organisation of a conference and exhibition, with the possibility of being held in Cancun, Mexico, in 2007.

The IGS Awards Committee met in Munich immediately after *EuroGeo3* and the awards presentation were planned for *GeoAsia 2004* in Seoul. The 2004 IGS Awards were assigned to J.P. Giroud, Allen L. Li and R. Kerry Rowe (joint), Ennio Palmeira and Maria Gardoni (joint), Jorge Zornberg, and Masahiro Shinoda. The Young IGS Award was assigned to Jan Kupec.

In Seoul, award presentations were made to Rowe, Palmeira, Shinoda, Zornberg, and Kupec (see p. 4). Rowe accepted for his colleague Li, and Palmeira accepted for his colleague Gardoni. J.P. Giroud will receive his IGS Award in Austin, Texas, USA, at *GeoFrontiers* in January 2005.

The IGS Students Awards program was also discussed during the IGS Council Meeting. Student award winners are being asked to complete a questionnaire/survey. The survey responses from the nine student award

winners attending *EuroGeo4* in Munich (i.e., students from Belgium, France, Germany, Italy, Portugal, Romania, UK, Brazil and South Africa, see below) were presented and discussed. More survey results will be available soon from the second group of six student award winners who attended *GeoAsia 2004* in Seoul (i.e., students from China, India, Korea, Japan, South East Asia, and North America).

The Council awarded the IGS Service award to Jim Paul for his outstanding efforts on behalf of the IGS while acting as Chair of the Education Committee (up to 2002) and the European Activity Committee (2002-2004). IGS President, Daniele Cazzuffi, presented the IGS Service Award to Jim Paul during the closing ceremony of *GeoAsia 2004* (see p. 5).

The Education Committee, led by Ennio Palmeira, is preparing geosynthetic applications brochures. The objective is to produce seven or eight brochures by the end of 2004 for adoption by the next IGS Council Meeting in January 2005. The IGS videos have been digitized and will be published on DVD and mailed to the membership.

The Policy Committee was newly renamed the Strategy Committee and is led by John Cowland. This Committee is reviewing future opportunities and directions for the IGS, particularly focusing on geographical representation of the Society, which was proposed by the Vice-President, Fumio Tatsuoaka.

Planning for the 8th ICG to be held in Yokohama, Japan, in September 2006, is in high gear and preparations are going well. The organisers have adopted

an innovative strategy to involve IGS chapters worldwide, by inviting the chapters to organise the submission of case history papers. The goal is to have at least 100 papers directly from the IGS chapters to increase the number of papers usually sent through a direct paper submission process.

The next IGS Meetings will be held in Austin, Texas, USA, in January 2005 before *GeoFrontiers 2005*. More specifically, the IGS Officers Meeting is on 21 January, the IGS Committees Meetings on 22 January, and the IGS Council Meeting on 23 January.

reported by Daniele Cazzuffi, IGS President, and Pete Stevenson, IGS Secretary

IGS Student Award Recipients

A total of 15 IGS Student Awards were assigned for the third award period of 2003 to 2004 – congratulations to all!

The IGS Student Award was established to disseminate knowledge and to improve communication and understanding of geotextiles, geomembranes,

related products, and associated technologies among young geotechnical and geoenvironmental student engineers around the world.

The Awards were presented at the 2004 IGS regional conferences, i.e., *EuroGeo3* (9 Awards) and *GeoAsia 2004* (6 Awards).

At *EuroGeo3* in March 2004, Awards were presented to the following students (see photo): Margarida Pinho Lopes (Portugal), Diane Tenea (Romania), Jan Kupec (United Kingdom), Axel Ruiken (Germany), Sidnei Helder Cardoso Teixeira (Brazil), Enrico Crippa (Italy), Anton Bain



2003-2004 IGS Student Award recipients at *EuroGeo3* in March 2004 (left to right): Margarida Pinho Lopes (Portuguese Chapter), Diane Tenea (Romanian Chapter), Jan Kupec (UK Chapter), Axel Ruiken (German Chapter), Sidnei Helder Cardoso Teixeira (Brazilian Chapter), Enrico Crippa (Italian Chapter), and Anton Bain (South African Chapter). Not pictured are Bruno Chareyre (French Chapter) and Sofie Desot (Belgium Chapter).



2003-2004 IGS Student Award recipients at *GeoAsia 2004* in June 2004 (left to right): Wang Jun-Qi (Chinese Chapter), S. Jayalekshmi (Indian Chapter), Fadzilah Saidin (North American Geosynthetic Society), Phoon Hung Leong (S.E. Asian Chapter), and Kouichi Inoue (Japanese Chapter). Not pictured is Min Ho Jang (Korean Chapter).

(South Africa), Bruno Chareyre (France), and Sofie Desot (Belgium).

At *GeoAsia 2004* in June 2004, Awards were presented to the following students (see photo): Wang Jun-Qi (China), S. Jayalekshmi (India), Fadzilah Saidin (USA), Phoon Hung Leong (Singapore), Kouichi Inoue (Japan),

and Min Ho Jang (Korea).

For more information on the IGS Student Award Program, see the November 2003 issue of *IGS News* (p. 9).

The fourth IGS Student Award period will be 2005-2006 and awards will be assigned in the year 2006. All

successful candidates, selected by each of the IGS Chapters, will attend the *8th International Conference on Geosynthetics* (Yokohama, Japan, 18-22 September 2006).

reported by *Karina McInnis*
IGS News Editor

IGS Awards and IGS Young Member Award

IGS awards are granted biennially in recognition of achievements by individuals or groups of individuals who have made an outstanding contribution to the development and use of geosynthetics, related products or associated technologies, through their scientific and technological work. The Awards for 2004 recognise achievements for the four-year period 2000 through 2003. For more information on the IGS Awards, visit the IGS website.

A total of 15 award packages were submitted for the IGS Award category (a maximum of five are awarded in a competition) and three for the Young IGS Award category for candidates 36 years or younger at 31 December 2003 (a maximum of one can be awarded).

The IGS Award Committee met on 4 March 2004 at *EuroGeo3* in Munich, Germany and comprised the following voting members: Co-chairs Richard Bathurst (Canada) and Joe Fluet (USA); and Michele Maugeri (Italy), J.P. Gourc (France) and Hiroshi Miki (Japan). The deliberations of the committee at a meeting held in Munich, Germany in March 2004 were recorded by Pete Stevenson, IGS Secretary.

A total of five IGS Awards and one Young IGS Member Award were granted (see below for more details).

Each of the award winners, except for J.P. Giroud, was presented with a gold medal and framed certificate at a special ceremony held during *GeoAsia2004* in Seoul, Korea in June 2004. J.P. Giroud was unable to attend the Conference and will receive his award in January 2005 at *GeoFrontiers 2005*. Citations for each award will be available on the IGS website.

The IGS Award Committee



IGS Award recipients at *GeoAsia 2004*. Left photo: R. Kerry Rowe receiving the award from M. Maugeri and P. Stevenson. Right photo: Ennio Palmeira, Jorge Zornberg, Masahiro Shinoda, and Jan Kupec (Young IGS Member Award). Allen Li, Maria Gardoni, and J.P. Giroud were unable to attend the Conference.

reported to the IGS Officers and Council at meetings held in conjunction with *GeoAsia 2004*, that the submissions in both categories were of high quality and, consequently, the Committee worked very hard to select the award winners in this year's competition.

Each award winner(s) has been extended the offer to publish a brief synopsis of their award-winning work in the current and subsequent issues of *IGS News*.

Young IGS Member Award

Load-Strain Behaviour and Testing of Polymeric Geogrids Subjected to Combined Sustained and Shock Loading

Jan Kupec (United Kingdom)

See page 13 of this issue for a synopsis of this work.

IGS Awards

Contribution to the Study of Drainage and Filtration with Geotextiles

Maria das Graças A. Gardoni and Ennio M. Palmeira (Brazil)

Criteria for Geotextile and Granular Filters

Jean Pierre Giroud (USA)

Combined Use of Geosynthetic Reinforcement and Prefabricated Vertical Drains (PVDs)

Allen Lunzhu Li and R. Kerry Rowe (Canada)

See page 15 of this issue for a synopsis of this work.

Seismic Stability of Preloaded and Prestressed Reinforced Soil Structures

Masahiro Shinoda (Japan)

Advances in Geosynthetic Reinforced Soil Design

Jorge G. Zornberg (USA)

reported by *R.J. Bathurst*, IGS Past President

IGS Service Award

The fourth IGS Service Award recipient is Jim Paul. Jim is being recognised for his outstanding contributions to the IGS, while acting as Chair of the Education Committee (up to 2002) and the European Activity Committee (2002–2004). IGS President, Daniele Cazzuffi, presented the IGS Service Award to Jim during the closing ceremony of *GeoAsia 2004* (see photo).

In July 2001, the first IGS Service Award was presented to David Elton, past *IGS News* Editor (1994 to 2001).

In November 2001, the second and

third IGS Service Awards were given to Chris Lawson and Toshi-nobu Akagi for their service on the IGS Council. Both Chris and Toshi-nobu were elected to Council in 1992 and served as such until 2000.

In September 2002, the third IGS Service Award was given to Jean Renard in recognition of his contribution to the geosynthetics industry and the French Chapter of the IGS.

*reported by Karina McInnis, IGS
New Editor*



Jim Paul (centre) receiving the fourth IGS Service Award from IGS President, Daniele Cazzuffi (left) at *GeoAsia 2004* in June 2004.

Third European Geosynthetics Conference, EuroGeo3 “Geotechnical Engineering with Geosynthetics”

1 to 4 March 2004, Munich, Germany

The *Third European Geosynthetics Conference, EuroGeo3*, was held on 1 to 4 March 2004 in Munich, Germany, at the Technische Universität München (TUM) and was a great success!

EuroGeo3 was organised by the German Geotechnical Society (Deutsche Gesellschaft für Geotechnik e.V., DGGT), the German IGS Chapter (Chair: Prof. Dr.-Ing. E.h. Rudolf Floss) and the TUM-Zentrum Geotechnik. The Conference was held under the auspices of the IGS and with the support of Industrieverband Geokunststoffe e.V. (IVG).

There were more than 550 registered conference participants coming from approximately 50 countries; 56 companies from 21 countries took part in the exhibition; and an additional 300, non-registered individuals were either working or visiting the exhibition. This demonstrates a large interest in the many possible applications of geosynthetics.

The combination of an interesting scientific program, a very informative exhibition, and relatively low conference rates for the participants contributed to the ability to attract such large numbers of mainly users, consultants, scientists, and producers of geosynthetics.

The Conference was opened by Prof. Floss (Chair of the German IGS Chap-

ter, and Head of the Scientific Committee of *EuroGeo3*) and Prof. Nussbaumer (Chair of DGGT). Words of welcome were delivered by Prof. Rank (TUM Vice President), Dr.-Ing. D.Cazzuffi (IGS President), Prof. van Impe (ISSMGE President), and Prof. Seco Pinto (ISSMGE European Vice President). Their words demonstrated the strong commitment to form international cooperation and knowledge sharing between soil mechanics and geotechnical engineering and geosynthetic engineering, which has been a continuing priority in Germany for many years.

Introduction and Mercer Lectures

Prof. Rudolf Floss started the Conference’s scientific program with the Introduction Lecture titled “Design Fundamentals for Geosynthetic Soil Technique” as it relates to the European standardisation process. This was followed by the Mercer Lecture given by Prof. Richard J. Bathurst (GeoEngineering Centre at Queen’s-RMC, Royal Military College, Canada) and titled “Reinforcement Loads in Geosynthetic Walls and the Case for a New Working Stress Design Method.”

Scientific Lectures and Sessions

Approximately 120 presentations were given in three parallel sessions over the four days. These presentations were chosen from approximately 250 abstracts received by the International Scientific Committee. The session topics covered all applications and themes relating to geosynthetics research and development.

In addition, 20 well-frequented poster presentations on the three themes were given during the coffee breaks and lunches. All of the poster presentations and written papers document the outstanding quality of the work of the authors and make a valuable reference library resource.

Workshops

Another Conference highlight was the workshops dealing with four of the mainly discussed topics in the field of geosynthetics:

- *Geosynthetics and the CE Mark*
Chair: Prof. J. Müller-Rochholz, FH Münster
- *Geosynthetics - Dynamic Loading*
Chair: Prof. H. Klapperich, TU Bergakademie Freiberg
- *Soil Reinforcement Interaction*
Chair: Prof. A. McGown, UK



Speakers at the EuroGeo3 Opening Ceremony (left to right): Prof. Vogt, Prof. Nussbaumer, Prof. Seco e Pinto, Prof. Tatsuoaka, Prof. van Impe, Prof. Floss, Prof. Bathurst, Dr.-Ing. Cazzuffi, Dr. Heerten, Mr. Bräu, and Mr. Paul.

• *The Service Life of Geomembrane Liners*

Chair: A. Needham, UK

The invited introductory lectures were followed by intensive discussions demonstrating the different opinions and approaches in different countries and institutes. The results will be incorporated in the preparation of national and international regulations. Unfortunately, it was not possible to record the discussions during the workshops; however, for a few of the workshops, summaries will be published in subsequent issues of *IGS News*.

Closing Session

Dr. Heerten (DGGT Vice-President) chaired the closing session, which comprised four invited speakers who were requested to summarise the Conference presentations.

- *Reinforcement*: Prof. McGown (UK) stated that the presentations showed in detail the construction and control methods as well as the monitoring of the work during and after the construction. This is helpful for the acceptance of the application of geosynthetics and leads to more accurate and practical design methods and regulations. He noted that design methods and calculations could be improved if calibrated to practical applications and the material property test-

ing methods, and how they are incorporated into the design calculations should be clearly stated. He also noted that there is still a lack of description of soil-reinforcement interaction.

- *Environmental Applications*:

Prof. Katzenbach (Germany) summarised that geosynthetics are resource protecting and environment friendly. He also stated that geosynthetics are replacing classical building materials such as concrete and steel in many applications due to their chemical and mechanical resistance, as well as the cost-effective construction methods that are possible.

- *Durability of Geosynthetics*: Dr. Greenwood (United Kingdom) presented the main issues surrounding the durability of geosynthetics and the methods of investigation. In the end, he reported that test methods for predicting the lifetime of geosynthetic products is well on its way.
- *Quality Control*: Dr. Delmas (France) stated that the CE marking is still a work in progress and requires further improvement. For on-site testing, technical reports are in preparation at CEN.

Technical Exhibition

The Exhibition was an important meeting point for discussions and presentations of newly developed products and applications. All coffee breaks and lunches were served at the Exhibition location, thus, it was an ideal opportunity for exhibitors to interact with individuals attending the Conference and exhibition.

Social Events and Activities

The Evening Reception was held on Monday, 1 March and was sponsored by Industrieverband Geokunststoffe (IVG). In addition to wine, beer, and bavarian food specialities, a jazz band made for a very friendly atmosphere.

The traditional football/soccer match took place indoors due to undesirable weather conditions. The Anglo-Saxon team took revenge for their defeat at *EuroGeo2* in Bologna and beat the Latin team by several goals.

The final social event of *EuroGeo3* was the Festive Evening on Wednesday, 3 March in the original “Hofbräuhaus am Platzl.” More than 320 participants enjoyed the famous beer, the Bavarian food, and the traditional folk music presented by the “d’Oberlauer.”

In Conclusion and Thanks

EuroGeo3 was a great event with a tremendous amount of very positive feedback from participants, due to the efforts of the authors, the scientific and organising committees, the exhibitors with the main sponsors (Nauw Faser-technik and Tensar International), and, last but not least, the on-site Confer-



Traditional folk musicians, d’Oberlauer, at the “Festive Evening” in the Hofbräuhaus am Platzl.



Audience at the “Festive Evening” in the Hofbräuhaus am Platzl.

ence Staff. Special thanks to all of you! For further information on the exhibitors and more photos of the Conference events please visit the website, www.gb.bv.tum.de/eurogeo3.

If the positive outcome of *EuroGeo3* (in addition to the success of *EuroGeo1* in Maastricht (1996) and *EuroGeo2* in Bologna (2000)) is to be an indication, having European confer-

ences between the international IGS conferences is working very well. See you at *EuroGeo4* in Edinburgh, Scotland, in September 2008!

Conference Proceedings

The proceedings are available in hard-copy (two volumes, approximately 800 pages, 75 EUR) or CD-Rom (20 EUR) and can be ordered from:

TUM - Zentrum Geotechnik
Baumbachstrasse 7
81245 München, Germany
Fax. 49/89 289 27189
E-mail: eurogeo3@bv.tum.de.

reported by Gerhard Bräu, Chair of EuroGeo3 Organising Committee and IGS Council Member

Asian Regional Conference on Geosynthetics – GeoAsia 2004 “Now and Future of Geosynthetics in Civil Engineering”

21 to 23 June 2004, Seoul, Korea

GeoAsia 2004, which was held 21 to 23 June 2004 in Seoul, Korea was a tremendously successful event. The Conference was organised by the Korean Geosynthetics Society (the Korean IGS Chapter), under the auspices of the IGS.

Participation

There were 288 participants from 24 different countries. The largest participation, of course, came from Korea with 126 participants, followed by Japan and China, with 65 and 17 participants, respectively. Considering the contributions from many countries from various continents, *GeoAsia 2004* was truly an international conference.

Exhibition

There were 24 exhibitors from all over the world. The exhibition location, which was just outside the Conference Ball Rooms, was very efficient in draw-



ing a constant stream of participants, thanks to a number of coffee breaks near the exhibition area. The exhibitors expressed considerable satisfaction with the exhibition set-up.

Technical Programs

In addition to eight different general sessions on a variety of geosynthetics topics, the Mercer Lecture and five Keynote Lectures were delivered as listed below. Also organised was the ISSMGE TC-9 Special Session on “The Role of Numerical Modeling in Geosynthetics.”

(1) Mercer Lecture

“A new limit state design method for design of geosynthetic reinforced soil wall” by Prof. R.J. Bathurst, *GeoEngineering Centre at Queen’s-RMC, Canada*

(2) Keynote Lectures

“An old but new issue: viscous properties of polymer geosynthetic reinforcement and geosynthetic-reinforced soil structures” by Prof. F. Tatsuoka, *Tokyo University of Science, Japan*

“Study on the interaction characteristics of geosynthetics and soil” by Prof.

C.G. Bao, Yangtze Water Scientific Research Institute, China

“Design fundamentals for geosynthetic soil technique” by Prof. R. Floss and Mr. G. Bräu, *Technische Universität of München, Germany*

“Resolving some of the outstanding issues in landfill barrier design” by Prof. R.K. Rowe, *Queen’s University, Canada*

“Friction properties of a geosynthetic interface. Application to the stability of liner systems on landfill and canal slopes” by Prof. J.P. Gourc, *Grenoble University, France*

(3) General Sessions

- Reinforced Structures I
- Soft Ground Improvement
- Materials, Testing, and Analysis I
- Roads and Railways
- Landfill and Hydraulic Applications
- Durability and Damage
- Materials, Testing, and Analysis II



GeoAsia 2004 opening address by Conference Chair Prof. J.B. Shim.



Prof. Richard J. Bathurst presenting the 2004 Mercer Lecture at GeoAsia 2004.

- Reinforced Structures II

(4) ISSMGE TC-9 Special Session

The Special Session on “The Role of Numerical Modeling in Geosynthetics” comprised an invited lecture by Prof. A. Iizuka of Kobe University, Japan, and a discussion. There were three discussion panelists:

- Prof. C. Yoo, Sungkyunkwan University, Korea
- Prof. S.A. Tan, National University of Singapore, Singapore
- Prof. S.R. Lo, University of New South Wales, Australia

Special Events

On the second day of the Conference, two concurrent events were held: (1) Technical Site Visit, and (2) Training Course.

1) Technical Site Visit

On Tuesday, 22 June, approximately 50 individuals participated in the half-day technical site visit to the Sudokwon Landfill Site in Seoul, which is

one of the largest single landfill sites in the world and currently handles approximately 20,000 tons of waste per day.

2) Training Course

On Tuesday, 22 June, a half-day training course was organised by the IGS Education Committee (Chaired by Prof. E. Palmeira, Brazil). The course was introduced by IGS President, Dr.-Ing D. Cazzuffi, and Prof. R.J. Bathurst, Prof. E. Palmeira, and B. Myles delivered lectures on a variety of topics related to geosynthetics. Approximately 40 participants joined the training course.

Farewell Banquet

The Farewell Banquet was a memorable event not only for those from outside of Korea but also for Koreans. Apart from the excellent dinner, the traditional Korean Folk performance by young artists fascinated and entertained approximately 100 participants.

A Word of Thanks

The members of Organising Committee of *GeoAsia 2004* (Chaired by Prof. J.B. Shim) express sincere gratitude to all of the Conference participants from all over the world. A special thanks goes to the IGS Officers and Council Members, especially the IGS President (Dr.-Ing. D. Cazzuffi) and Vice President (Prof. F. Tatsuoka); the success of *GeoAsia 2004* would not have been possible without their support.

For Further Information Contact

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Visit www.kgss.or.kr/geoasia2004/ to view Conference photos

*reported by Prof. Chungsik Yoo,
Secretary General, GeoAsia 2004, IGS
Member*

Australasian Chapter Activities and One-Day Courses (October 2003 to April 2004)

Australasian Chapter Elections

Subsequent to a postal ballot held in April 2004, the IGS Australasian Chapter officers for the period 2004-2006 will be as follows:

- Mike Sadlier (President)
- Matthew Eberle (Vice-President)
- Ian Hulse (Secretary)
- Fred Gassner (Treasurer)

One-Day Courses (October 2003)

The new Australasian Chapter organised a series of one-day courses titled “Geosynthetics Advances In Transportation Applications.” The courses were presented by Dr. Barry Christopher in Melbourne, Sydney, and Brisbane, in October 2003, and were supported with ‘seed’ loan funding by the IGS.

The courses were well supported with almost a total of 100 persons attending at the three venues.

A number of new IGS members

were signed up and the course has improved the industry exposure and profile of the Chapter and its future activities.

After the course at the last venue in Brisbane, a meeting of the Australian Standards Committee on Geosynthetics was held. This meeting was also attended by Barry Christopher and several ACIGS members, as can be seen in the photograph above.



Several of the Geosynthetics one-day course participants (from left to right): Malek Bouazza*, Peter Reynolds, David Haviland, Ross Stewart*, Martin Smith*, Manfred Hausmann*, Bob Miller, Karen Hitchener, Barry Christopher*, Simon Restall*, and Mike Sadlier*. (Note: * IGS members).

reported by Mike Sadlier and Malek Bouazza, IGS Council Members

Plastics Pipes XII Conference

19 to 22 April 2004, Baveno-Milano, Italy

The Twelfth International Plastics Pipes Conference was held at Baveno near Milano, a beautiful lakeshore town of Lago Maggiore near the Italian-Swiss Alps.

This Conference takes place every three years and has been running for over three decades. The Conference was first established in the United Kingdom and then became a European event, with the last four conferences being held in different European countries.

Plastics Pipes XII was co-sponsored by three organisations: PE100+ Association, Plastics Pipe Institute, and PVC-4-pipes.

Approximately 550 delegates from different parts of the world attended the Conference. Over 200 abstracts were submitted, and the number of oral pre-

sentations increased from 77 in the previous conference to 115, in addition to 33 poster presentations. A half-day workshop on plastics pipes technologies preceded the main conference. There were also 20 exhibitors.

The Conference program consisted of 11 sessions that were divided into two parallel series. One of the series was focused on installer and end-user group interests, by including case histories, solutions to technical and engineering issues, and market and business opportunities. The second series focused on scientific and technical developments in the field. The applications were primarily on gas and water pressure pipes, but also extended to non-pressure structural pipes and pipes for rehabilitation.

The IGS President, Daniele Cazzuffi (Italy), attended the Opening Session, IGS Member, Grace Hsuan (USA), presented a paper titled "Evaluation of Stress Crack Resistance of HDPE Corrugated Pipes," and IGS Member, Tom Sangster (Switzerland), attended the Conference.

The *Plastics Pipes XIII Conference* will be held in Washington, D.C., USA, on 2 to 5 October 2006, i.e., two weeks after the *8th International Conference on Geosynthetics* (Yokohama, Japan, 18 to 22 September 2006). This will be the first time the Conference will be held outside of Europe.

reported by Dr. Grace Hsuan, North American Geosynthetics Society President-Elect

5th Rencontres Géosynthétiques

November 2003 to March 2004, Colmar-Lille-Avignon, France

The 7th International Conference on Geosynthetics (7th ICG), in Nice, France, provided an ideal opportunity to create and propose an exceptionally innovative format for the 5th *Rencontres Géosynthétiques*. As a result, it was decided that the 5th *Rencontres Géosynthétiques* would be held in three different locations: Colmar (Alsace, 25-26 November 2003), Lille (Nord-Pas-de-Calais, 10-11 February 2004) and Avignon (Provence Alpes côte d'Azur, 30-31 March 2004).

The CFG's Conference mandate was to meet the needs of a large French-speaking public and to disseminate information on state-of-the-art geosynthetics practice particularly for individuals not familiar with the use of geosynthetics. Teams of French-speaking geosynthetics specialists were solicited to synthesize 7th ICG papers in the form of distinctive or original works.

Approximately 424 individuals from 148 different private, public, or university organisations attended the

5th *Rencontres Géosynthétiques*. The Conference is considered a success in meeting its mandate because the audience comprised 46% of those whom are not IGS Members.

A training course preceded each conference. In addition, a technical exhibition was held during each of the three sessions and comprised 19 different exhibitors and enabled the exchange of information between individuals in the private sector and academia. A summary of the sessions (and themes) held at each of the three locations is outlined below.

Summary of Conference Sessions

Colmar (Alsace) 25-26 November 2003

- (a) Four lectures for each of the following themes were given:
- Erosion and ageing of geotextiles
 - Landfills
- (b) Two original, local case histories on each theme were also presented:

- Protection of bank - green reinforcement (in eastern France)
 - Sealing in landfills
- (c) Training Course (50 attendees)

Lille (Nord-Pas-de-Calais) 10-11 February 2004

- (a) Four lectures for each of the following themes were given:
- Transportation and hydraulic works
 - Landfills
- (b) Two original, local case histories on each theme were also presented:
- Bridge embankment on compressible soil (in Lille)
 - Landfill installation in Bailleuil (in northern France)
- (c) Training Course (25 attendees)



**Avignon (Provence Alpes Côte d'Azur)
30-31 March 2004**

- (a) Four lectures for each of the following themes were given:
- Transportation and hydraulic works
 - Erosion and ageing of geotextiles
- (b) Two original, local case histories on each theme were also presented:
- Reinforced soil structures using three-dimensional nonwoven sheets

- Embankment and coastal protection structures made with geosynthetic tubes (on the French coast)
- (c) Training Course (25 attendees)

A very friendly atmosphere was present during each 5th *Rencontres* session. Each session concluded with an evening dinner with outstanding entertainment. In addition, the following extracurricular activities took place: vis-

its to old coal mines at the Miner Historical Center in northern France; and olive oil and French wine tasting, with explanations from professional oenologists at the Palais des Papes of Avignon.

*reported by Elisabeth Haza and
Nathalie Touze-Foltz, Co-Presidents of
the 5th Rencontres Géosynthétiques
Organising Committee*

2005 Rankine Lecture: Dr. R. Kerry Rowe

In March 2004, Tony Bracegirdle, Chair of the British Geotechnical Association (BGA) announced that Dr. R. Kerry Rowe will be the 2005 Rankine Lecturer. Dr. Rowe, IGS President from 1990 to 1994, is currently Professor of Civil Engineering and Vice-Principal (Research) at Queen's University in Kingston, Ontario, Canada.

Dr. Rowe, renowned for his seminal contributions to the creation of safer landfill designs, was chosen by the BGA to deliver their prestigious Rankine Lecture in London, on 23

March 2005.

Rankine lecturers are chosen based on their international standing and reputation, their technical expertise and contribution to geotechnical engineering, their ability to deliver an outstanding lecture, and to produce a published paper that would serve as a landmark to industry. The selection process is carried out in secrecy and begins one year in advance of the announcement.

William Rankine, for whom the lecture is named, was a Scottish-born, 19th-century civil engineer whose scientific findings form the foundation of

modern thermodynamics and soil mechanics. He is also renowned internationally for pioneering engineering education.



Dr. Rowe's paper will also be published in *Geotechnique*.

*reported by Karina McInnis, IGS News
Editor*

First Meeting of 8/ICG International Paper Selection Committee and 8/ICG Bulletin No. 1 - Call for Papers (Yokohama, Japan, 2006)

The first meeting of the International Paper Selection Committee (IPSC) for the 8th *International Conference on Geosynthetics (8ICG)* was held in Seoul, Korea, on 22 June 2004 prior to the *GeoAsia 2004* Conference. The meeting room was provided by courtesy of the Organising Committee of *GeoAsia 2004*.

The attendees were as follows: Prof. R.J. Bathurst, Dr.-Ing. D. Cazzuffi, Prof. J.-P. Gourc, Prof. M. Kamon, Mr. C. Lawson, and Prof. F. Tatsuoka from the IPSC; and Prof. J. Koseki, Dr. N. Kiyokawa, and Ms. Y. Akana from the Organising Committee of the 8ICG. Discussions were held and decisions were made regarding keynote lectures, papers, proceedings, scientific pro-

gram, and schedules.

Call for Papers

The 8ICG will be held at Yokohama, Japan, 18-22 September 2006 and will be accepting papers on the following applications of geosynthetics:

- Transport (roads, railways, tunnels, airports, etc.)
- Hydraulic structures (dams, canals, reservoirs, etc.)
- Erosion control and coastal works
- Soil improvement and reinforcement
- Mining
- Waste landfills
- Remediation of contaminated sites
- Landscaping and environmental mitigation

- Prevention of natural and technological risks
- Agriculture and forests
- Innovative geo-materials and construction methods
- Education and technology transfer
- Others

Papers may cover any of the subjects described above (see the Conference website for more details). The abstracts and final manuscripts will be reviewed by international experts appointed by the organising committee in cooperation with the IPSC. These papers must be original, previously unpublished work and must not be of any commercial nature.



Key Dates for Abstracts

Deadline for receiving abstracts: 31 March 2005

Decision of Organising Committee sent to authors: July 2005

Deadline for receiving completed papers: 31 October 2005

For details on abstract submission, please visit the Conference website.

Contact Information

For more information on the submission of abstracts, full papers, and the Conference in general, contact:

Conference Secretariat
8ICG-Yokohama 2006

Tel.: 81/3 3837 2503
Fax: 81/3 3837 5818
E-mail: info@8icg-yokohama.org
www.8icg-yokohama.org

reported by Junichi Koseki, Vice Chair of Scientific and Program Division, Organising Committee of 8ICG and IGS Member

International Conference on Eco-Engineering The Use of Vegetation to Improve Slope Stability

13 to 17 September 2004, Thessaloniki, Greece

The *International Conference on Eco-Engineering* is being held in Thessaloniki, Greece, on 13 to 17 September 2004 under the auspices of the IGS, the International Union of Forests Research Organization (IUFRO), the European Society for Soil Conservation (ESSC), and the World Association of Soil and Water Conservation.

Eco-engineering is a relatively new discipline and is the result of needs of construction engineers, ecologists, and foresters to produce economically viable, sustaining, and safe constructions in both urban and natural environments. The use of correct management strategies in forested areas and eco-constructions in zones at risk could diminish the occurrence of landslides, avalanches, and erosion.

Objectives

This Conference aims to bring together civil and geotechnical engineers, soil scientists, geomorphologists, foresters, and ecologists from both scientific and professional backgrounds. Not only will the Conference serve as a forum for researchers to discuss the latest advances in all aspects of eco-engineering research, but a special emphasis on new methodology and techniques will be made.

Conference Topics

• Root-soil interaction

Root anchorage, root architecture, root/soil interface, root growth, tree stability, and modelling

• Root reinforcement

Root strength, root distribution and morphology, soil shear strength, and slope failure

• Slope degradation

Debris flow, avalanches, rockfall, barrier forests, forest fires, pathogens, wind throw, silviculture, and human intervention

• Soil erosion and conservation

Soil loss, run-off, sub-surface erosion, soil quality, soil sealing, and desertification

• Riverbank and coastline protection measures

Flow mitigation, torrent control, hydrological structures, hydraulic structures, and sustainable planning

• Slope hydrology

Infiltration, percolation, storage and run off, interception and evapotranspiration, water balance, crop water use and sustainability, and land use change

• Slope stability modelling

Mechanistic and empirical models, static and dynamic slope stability analyses, unsaturated strength, soil moisture relations and vegetation, and post-failure.

• Vegetation and eco-engineering

Ecology, plant establishment, re-vegetation, plant management, bio-remediation, species selection, and non-woody vegetation/grasses

• Plant growth and engineering

Reliability: optimisation of techniques, temporal performance, seasonality, disturbances, and life

• Earth stabilising and retaining techniques

Retaining wall, cuts and embankments, mulches, geosynthetics, soil nails, and chemical stabilisers

• Land Restoration

Integral restoration techniques, postfire revegetation, and eco-restoration

• Risk management and decision support systems

Strategic and disaster management, GIS, modelling, choice of tools, and new systems

• Benefits and liabilities in slope and erosion control

Economic factors, resource sustainability, legislation, and cost analysis.

• Mountain biodiversity and slope stability

Biological richness, structural diversity, grazing, land use changes, extreme events, insurance hypothesis, slope integrity, and landslides.

Official Language

The official language of the Conference is English.

Conference Proceedings

Proceedings will be published in a volume of the series *Developments in Plant and Soil Sciences*, Kluwer Academic Publishers, Dordrecht. A selection of papers will also be published in special editions of the journals *Plant and Soil* and *Geological and Geotechnical Engineering*.

For Further Information Contact:

Alexia Stokes
Laboratoire de Rhéologie du Bois de Bordeaux

4th International Conference on Filters and Drainage in Geotechnical & Environmental Engineering - GeoFilters 2004

19 to 21 October 2004, Stellenbosch, South Africa

The *Fourth International Conference on Filters and Drainage in Geotechnical and Environmental Engineering, GeoFilters 2004*, will be held on 19 to 21 October 2004 just outside the University town of Stellenbosch, South Africa on the Spier Wine Estate. The Conference is being organised by the University of the Witwatersrand (School of Civil & Environmental Engineering), under the auspices of the IGS, the Environmental Engineering Division of the South African Institution of Civil Engineering, and the Geotechnical Engineering Division of the South African Institution of Civil Engineering.

Objectives of the Conference

- Establish the state of the art in developments relating to all aspects of filtration and drainage.
- Present cases of successful implementation of filtration and drainage systems and discuss criteria of success.
- Continue the vigorous debate of the equivalency between natural and synthetic filters.

- Bring together practitioners, researchers, manufacturers and all other users of natural and synthetic filters and drainage systems.

Conference Theme and Topics

The working theme of *GeoFilters 2004* is "Filter Requirements and Proven Performance." The Conference topics are as follows:

- New geofilter developments and products
- Case histories: proven performance
- Instances of geofilter failure
- Durability and long-term behaviour of geofilters
- Erosion control using geofilters
- Laboratory testing of geofilters

Keynote Lecture

The Keynote Lecture will be given by Prof. Kerry Rowe of Queens University, Canada, entitled, "Filtering and Drainage of Contaminated Water" and will deal with subjects including landfill leachate and agricultural drainage water.

Workshop

It is proposed to run a half-day workshop in conjunction with the Conference on the topic of "Capillary Barriers," emphasising the use of these barriers in capping systems. The workshop is anticipated to be held on the day after the Conference.

If you are interested in attending such a workshop, please contact Prof. Andy Fourie, Conference Chair, at the contact information given below. Please also indicate when you would prefer to attend such a workshop.

Address for Correspondence

Prof A.B. Fourie, *Geofilters 2004*
School of Civil & Environmental Eng.
University of the Witwatersrand
Private Bag 3
Wits 2050, SOUTH AFRICA
E-mail: andyf@civil.wits.ac.za
Official Conference website:
www.wits.ac.za/geofilters2004

Geo-Frontiers 2005 Congress

24 to 26 January 2005, Austin, Texas, USA

Geo-Frontiers 2005 is a broad-based Congress that will combine the *Geo-Institute 2005 Congress* and the Geosynthetic Materials Association (GMA) *Geosynthetics 2005 Conference*. The Congress will showcase recent advancements in design, manufacturing, and construction; offer a forum to debate future directions for the industry; and bring together participants and exhibitors

from multiple professional and trade organisations

The Congress is being organised by the Geo-Institute (ASCE) and the GMA (Industrial Fabrics Association International, IFAI) and will be held at the Hilton Austin Convention Center Hotel in downtown Austin, Texas, USA from 24 to 26 January 2005. The Congress is being organised under the auspices of the IGS.

Congress Tracks/Themes

Geo-Frontiers will have a broad and exciting technical program. The following are the nine Congress tracks:

- Earthquake Engineering and Soil Dynamics
- Erosion Control
- Foundations
- Geotechnical Professional Issues
- Pavements
- Site Characterisation and Modeling

- Slopes and Retaining Structures
- Soil Improvement and Grouting
- Waste Containment and Remediation

Technical Paper Sessions

Authors are invited to submit technical papers related to session topics within each track (visit the Congress website given below for a list of the 48 session topics). Papers presenting all facets of a specific project are encouraged and all papers will be published as part of the Congress proceedings. Authors invited to publish a paper are expected to register for the Congress at the appropriate fee(s), attend the Congress, and make their presentation(s) in person.

Panel Discussions

The panel discussions will be 90-minute sessions bringing professionals together for discussion and debate about technical and non-technical subjects and industry issues, such as political influences, social trends, and their impact on engineering, or career choices. A facilitator will be present with several panelists to present differing viewpoints.

Hands-On Workshops

Hands-on workshops will be two- to four-hour long sessions to describe and demonstrate real-world applications of technology. The intent is for providers to focus on practical, "how-to" techniques that include planning, design, construction, and/or testing.

Short Courses

Proposals for short course topics are invited and should include the course title, a description of the course with a summary of its learning objectives, a list of instructors and their qualifications, and a summary of course handouts.

For More Information

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www.asce.org/conferences/geofrontiers05/index.cfm

“Load-Strain Behaviour and Testing of Polymeric Geogrids Subjected to Combined Sustained and Shock Loading”

by Mr. Jan Kupec, 2004 Young IGS Member Award Recipient

Editor's Note: Mr. Jan Kupec received the Young IGS Member Award at GeoAsia 2004 in Seoul, Korea, for his contributions to "Load-Strain Behaviour and Testing of Polymeric Geogrids Subjected to Combined Sustained and Shock Loading." The following article was contributed by Mr. Kupec upon request.

The following is a summary of the research that I have undertaken in the past three years of my Ph.D at the University of Strathclyde in Glasgow, UK under the supervision of Professor Alan McGown. I am now in my final year of my Ph.D. studies.

As well as working on my research, I am now working full-time as a lecturer at the Department of Civil Engineering. My teaching focuses on Geotechnics and the Behaviour of Advanced Engineering Materials, as well as, Engineering Geology and Soil Mechanics. I started my studies in Civil Engineering at the Technische Universität in Darmstadt, Germany. In 1998, I went on the European student exchange program ERASMUS to Scotland where I graduated in 2000 with a MSc in Research.

Initially, I was involved in the development of a test methodology to determine the load-strain behaviour of

polymeric geogrids subject to short-term multi-stage loadings, such as explosions, shocks, or seismic events. This required modification of the Isochronous Strain Energy (ISE) approach to deal with this type of loading regime and the development of a new type of test rig, which can apply a combination of sustained and short-term loadings.

On these bases, I demonstrated that geosynthetics employed in reinforced soil structures exhibit a much higher resistance against short-term loadings than previously considered in design. Additionally, my work has shown that sustained loads do not adversely influence the short-term tensile strength of a polymeric material. Changes to current design methods in the form of a modified material approach were suggested. Several publications on this topic were prepared.

I have been further involved in the characterisation of a newly developed range of geogrids with welded junctions. I have conducted uniaxial index and performance testing under different loading regimes. This required the development of an innovative clamping mechanism as existing clamps proved to be unsatisfactory for this type of geogrid. This new

clamping mechanism is now widely used. A wide range of Constant Rate of Strain (CRS) tests and sustained loading (creep) tests were conducted on geogrids with welded junctions and the ISE approach was used to characterise these products in a manner previously not possible. Several publications on this topic were prepared.

Since 2001, I have undertaken a wide range of small-scale testing and numerical modelling of walls and steep slopes with non-linear lateral soil wall boundaries. The objective of this work is to develop a means of controlling the magnitude and distribution of lateral earth pressures and basal bearing pressures developed by walls and steep slopes. I have shown that this can indeed be achieved and that an optimisation of the reinforcement layout results to such a degree that the reinforcement spacing, length and type may be made constant no matter the height of the reinforced soil structure. Additionally, I have suggested new and innovative design and construction methods for such walls and steep slopes. Several publications on this topic were prepared.

Development of "in-isolation" geo-

grid junction strength test methods have also been part of my research. Previous work undertaken by others has indicated that the behaviour of welded and heat-bonded junctions may be critical to geogrid performance. Established test methods proved unsatisfactory for some types of geogrids and a new test method was, therefore, developed. Higher junction strengths for products with welded junctions were observed than previously determined by other methods. Several publications on this topic were prepared.

A more recent research interest has been the development of biaxial testing methods for biaxial geogrid products with different junction types. Biaxial CRS and sustained loading (creep) test rigs were developed and test results directly compared to product properties determined by uniaxial testing. An advanced form of Digital Photogrammetry was developed to measure the strain distribution on the test samples.

Test results from biaxial CRS testing have confirmed the effect of Poisson's Ratio for all geogrids tested. Additionally, test results from biaxial sustained load (creep) testing has indicated much higher biaxial stiffnesses than anticipated mainly due to stress/strain changes in the behaviour of the junctions. To characterise, compare, and correlate the load-strain behaviour of biaxial geogrids the only viable analytical means was the ISE approach. The reason for this is that energy is a scalar and not a directional

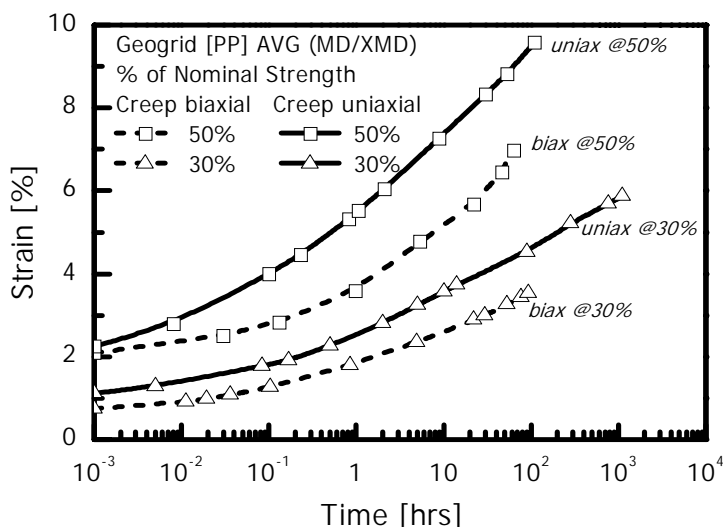


Biaxial sustained loading (creep) test apparatus.

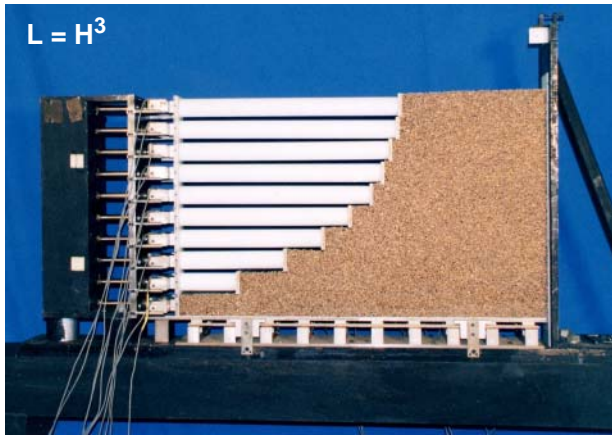
property. On this basis it has been suggested that for particular applications, e.g. roads, railways, loading pads or foundations, the biaxial material properties for the design of such structures

should be adopted. Several publications on this topic were prepared. The above research undertaken on the structural behaviour of reinforced soil structures in void spanning applications or within piled embankments. Several publications on this topic are in preparation.

Furthermore, I have been involved in development and operation of state-of-the-art geotechnical and geosynthetic testing equipment as well as surveying and structural monitoring instruments. I was engaged in the



Typical test results from biaxial sustained load (creep) testing.



Test model of cubic lateral soil-wall boundary.

design, testing, and implementation of monitoring and early-warning systems for nuclear power plants and GPS-based structural monitoring systems. Furthermore, I have assisted in various legal proceedings and back-analysis of many case studies.

Lastly, acknowledgements are due. Professor Alan McGown is my mentor

and supervisor, whom I am very grateful for his guidance and advice. It is his work, as much as it is mine. Furthermore, I wish to thank Dr. Georg Heerten and Mr. Jim Paul for their support of this research. The work mentioned above was conducted in Department of Civil Engineering at the University of Strathclyde in Glasgow, UK.

Lastly, I wish to express my gratitude to the IGS and the IGS Awards Committee for the acknowledgement of my work with the Young IGS Member Award.

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“Combined Use of Geosynthetic Reinforcement and Prefabricated Vertical Drains (PVDs)”

by Drs. Allen Lunzhu Li and R. Kerry Rowe, 2004 IGS Award Recipients

Editor’s Note: Drs. R. Kerry Rowe and Allen Li received a 2004 IGS Award at GeoAsia 2004 in Seoul, Korea, for their contributions to “Combined Use of Geosynthetic Reinforcement and Prefabricated Vertical Drains (PVDs).” The following article was contributed by Drs. Li and Rowe upon request.

The work for which the IGS Award is made to Drs. Allen L. Li and R. Kerry Rowe relates to two aspects of reinforced embankment behaviour as summarised below.

The combined use of geosynthetic reinforcement and prefabricated vertical drains (PVDs). While there has been empirical evidence that the combination of reinforcement and PVDs can allow safe construction in circumstances where it would not otherwise have been possible, the paper by Li and Rowe (2001) provides theoretically based evidence of the significant synergistic effects of combining these two techniques for soil improvement. The paper presents a design method that allows design engineers to take account of these synergistic effects. This approach provides a means calculating consolidation during construction and incorporating the soil strength gain as part of the reinforcement design process. The design technique only requires hand or spreadsheet calcula-

tions to design the PVD system and assess the consolidation. The reinforcement design can then be conducted using existing limit equilibrium programs according to current practice.

The Li and Rowe (2001) approach involves selecting a PVD spacing and then calculating the degree of consolidation at any time of interest. All assumptions of Terzaghi’s consolidation theory are preserved except that the current approach considers both the change in compressibility as a soil moves from the overconsolidated to normally consolidated state and the time-dependent loading.

The average degrees of consolidation when the soil is in an overconsolidated stress range ($\bar{U}_{O/C}$) and when the soil is in a normally consolidated stress range ($\bar{U}_{U/C}$) are calculated using consolidation coefficients $C_{O/C}$ and $C_{N/C}$ for overconsolidated and normally consolidated soils, respectively. The total average degree of consolidation is given by the following equation:

$$\bar{U} = \bar{U}_{O/C} + (1 - \bar{U}_{O/C})\bar{U}_{U/C}$$

Olson’s solution (1977) is used to calculate the average degree of consolidation \bar{U}_v and \bar{U}_h for vertical and radial drainage, respectively. The combined effects of vertical and radial consolida-

tion are considered using the method of Carrillo (1942):

$$\bar{U} = 1 - (1 - \bar{U}_h)(1 - \bar{U}_v)$$

Using this approach, the average degree of consolidation at the end of construction for different construction rates can be calculated. The corresponding increase in undrained shear strength can be estimated using a strength ratio s_u/σ_p' for a given soil. Figure 1 shows the improvement of the consolidation prediction of the proposed approach over the classic consolidation theory. The proposed approach is relatively simple and compares well with finite element results.

The proposed design method for reinforced embankments on foundations with PVDs involves 15 design steps, which can be easily followed. An Excel spreadsheet program has been developed for vertical drain design*. Many limit equilibrium computer programs designed for the analysis of reinforced embankments can be used for the reinforcement design. The photos in Figure 2 show a field case before and after construction.

The behaviour and design of embankments on rate sensitive soils. Post-construction failure of unreinforced embankments on rate sensitive

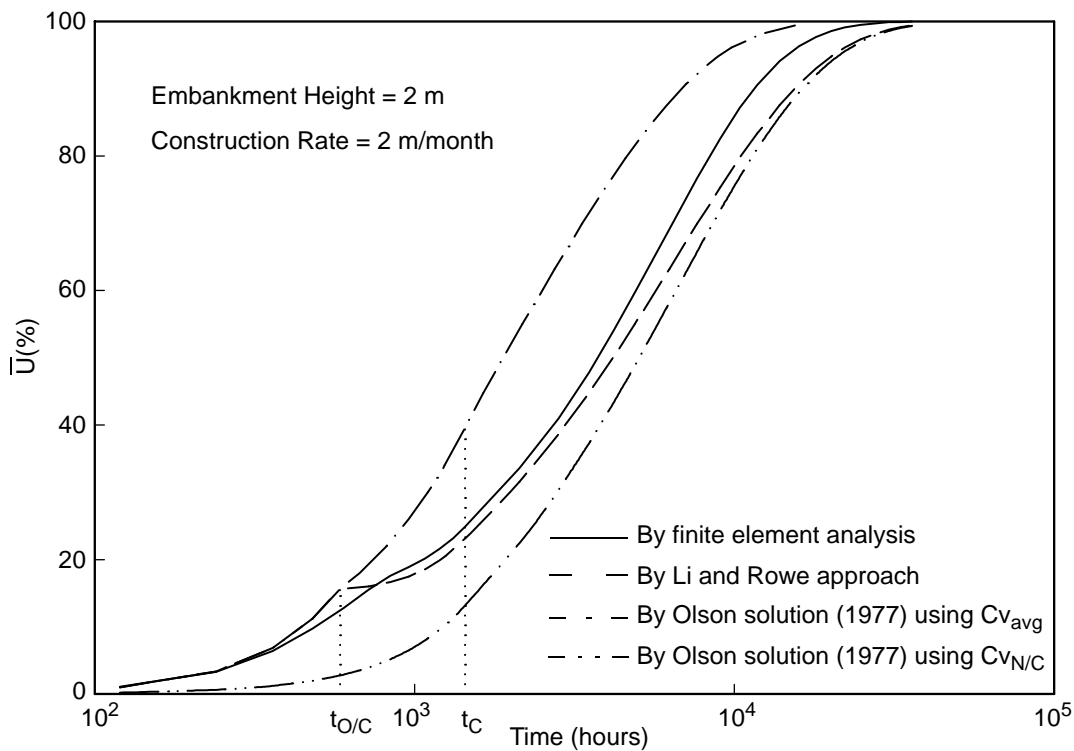


Figure 1. Comparison of calculated average degree of consolidation for a foundation soil installed with PVDs.

soils has been attributed to a loss of shear strength with time and the build up of excess pore pressures that exceed the applied load due to construction. Under working conditions, when reinforcement is used to allow construction of embankments to heights that exceed what could be achieved without reinforcement, the soil is subjected to higher shear stresses than would be the case for an unreinforced embankment. As evident from published field cases,

this creates the potential for unexpectedly large deformations, and even failure, if the embankment is designed using conventional techniques and data (e.g. field vane strength). Li and Rowe (2002a,b) examine the effects of strain rate sensitivity on the performance of reinforced embankments. This allows an understanding of the importance of using an appropriate strain-rate adjusted undrained shear strength in developing the reinforced embankment

design. Most significantly this research results in a practical design methodology that can be used to adjust the soil strength for rate effects using a critical strain rate. It is then shown that embankments designed based on this approach can be expected to perform well under working stress conditions.

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Figure 2. A 9-m high railway embankment extension was constructed on a soil clay deposit within a tight schedule by accelerating consolidation and strength gain using PVDs.

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* A spreadsheet and a worked example are available at: <http://civil.queensu.ca/people/faculty/rowe/pubreinforcement.htm>

"Seismic Stability of Preloaded and Prestressed Reinforced Soil Structures"

by Dr. Masahiro Shinoda, 2004 IGS Award Recipient

Editor's Note: Dr. Masahiro Shinoda received a 2004 IGS Award at GeoAsia 2004 in Seoul, Korea, for his contributions to "Seismic Stability of Preloaded and Prestressed Reinforced Soil Structures." The following article was contributed by Dr. Shinoda upon request.

I am very honoured to be awarded a 2004 IGS Award. This IGS Award was given for contributions to the development of techniques to improve the seismic stability of geosynthetic-reinforced bridge piers using novel systems of preloading and prestressing. These techniques hold great promise to reduce deformations of reinforced piers under traffic loading and during earthquakes. The work has been validated by both full-scale field structures and laboratory model tests using a shaking table.

The preloading and prestressing (PLPS) procedure was originally developed to substantially decrease the residual settlement at the top of backfill subjected to long-term live loads such as traffic loads. Furthermore, a novel aseismic system of the preloaded-prestressed reinforced soil method was proposed and validated. Using this method, it is now possible to construct reliable and critical civil engineering structures such as geosynthetic-reinforced soil structures (i.e., bridge abutments and bridge piers).

In this procedure, a sufficiently large vertical preload is applied to the reinforced backfill by introducing tension into metallic tie rods that penetrate the reinforced backfill with the ends fixed to the bottom and top reaction blocks (Figure 1). In addition, the stiffness and strength of the backfill, while the structure is in service, is always kept sufficiently high by maintaining sufficiently high prestress. By this preloading and prestressing construction

procedure, the transient deformation of reinforced backfill subjected to traffic loads could become very small and essentially elastic and, thereby, the long-term residual deformation could become minimal.

In the summer of 1996, the first prototype preloaded and prestressed geosynthetic-reinforced soil (GRS) bridge pier was constructed to support two railway bridge girders in Fukuoka City, Japan. The pier was 2.7 m high and the backfill was well-compacted, well-graded crushed gravel that was reinforced with geogrid layers with an average vertical spacing of 15 cm. The residual settlement of the pier after approximately 120 train passings/day from the beginning of August 1997 (train service started) to the end of March 2001 (end of train service) was very small. The train usually consisted of two coaches, each weighing about 350 kN without passengers.

Long-term measurements of the tie rod tension and the compression of the pier backfill was started immediately before applying the preload on 5 September 1996. The maximum transient compression of the backfill caused by each train passing was only approximately 0.025 mm and was measured using a pair of sensitive displacement transducers. This minimal amount of compression translates to a vertical strain in the backfill of as little as 0.001%.

It is important to note that the deforma-

tion of gravel (and sand) is essentially elastic, when the strain is smaller than this order of strain amplitude. Therefore, for superior performance of PLPS reinforced soil structures, it is critical to keep the transient strain in the backfill as small as 0.001% by attaining a high backfill stiffness.

When a PLPS reinforced soil structure such as the one described above is slender and the initial prestress is too low, the structure may exhibit large bending deformations when subjected to high-level seismic loads (Figure 2a). In this case, the height of the backfill at both sides of the PLPS reinforced soil structure may significantly increase and decrease cyclically.

When the height of the backfill increases significantly, the vertical stresses in the backfill zone may become temporarily very low or approximately zero. Then, the shear strength and stiffness of the backfill zone may become very low, resulting in excessive shear deformation of the backfill. For this reason, it is necessary to keep the

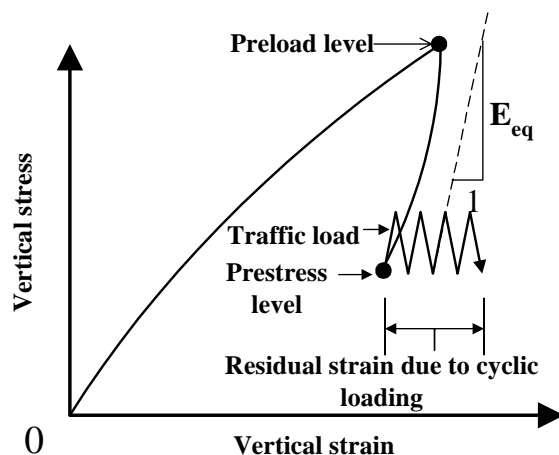


Figure 1. Schematic diagram showing the behaviour of backfill during preloading, unloading, and cyclic loading at a prestressed state.

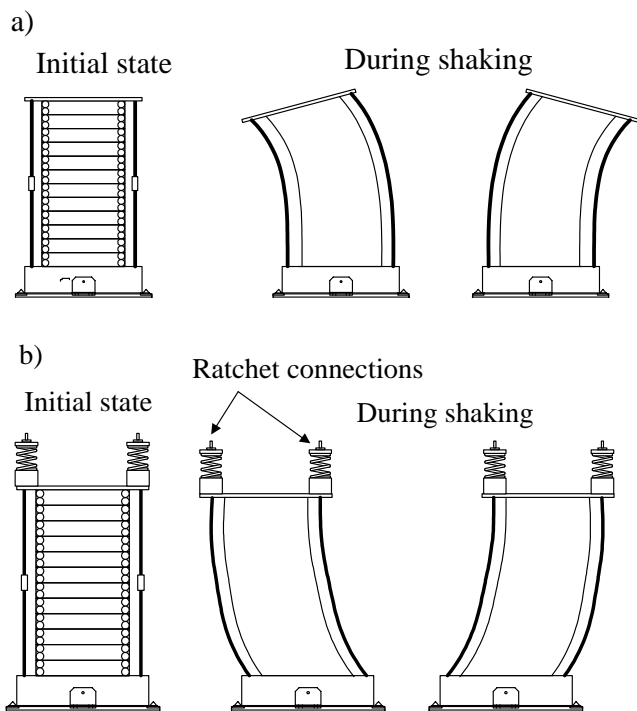


Figure 2. Typical deformation of PLPS reinforced soil structure: (a) bending deformation after prestress has decreased to a very low level; and (b) restraining of bending deformation by using ratchet connections.

bending deformation of the PLPS reinforced backfill structure sufficiently small during seismic loading by using particular measures (Figure 2b).

A newly developed aseismic system called a 'ratchet system' was originally proposed, which has the following two functions. First, when the backfill exhibits vertical compression, such as creep deformation and transient and residual compression by shaking-induced shear and bending deformation, the ratchet system is unlocked while a relatively long and relatively soft spring that is attached between the top end of each tie rod and the top reaction platen extends according to the vertical compression of the backfill (Figure 3b). In this way, the stiffness of each tie rod system becomes very low while the prestress level is kept high and close to the initial level.

Second, when the

backfill exhibits dilatancy or expansion, or both, by backfill bending deformation, the ratchet system is locked, which makes the stiffness of the tie rod system very high, exerting the original stiffness of the tie rods (Figure 3c). In this way, the tie rod tension increases largely in response to the trend of increasing backfill height. These two functions of the ratchet system described above effectively restrain large bending deformations as well as large shear deformations of the backfill.

A series of laboratory model shaking table tests were performed to evaluate the improvement of the dynamic performance of mechanically reinforced soil structures that are vertically preloaded and prestressed by using a ratchet connection for the tie rods. For relatively slender reinforced backfill structures, the maintenance of high prestress is particularly important to restrain the occurrence of

large backfill bending deformation. For these purposes, it is proposed to fix the top end of the tie rods to the crest of the structure by using a ratchet connection, which allows free compression of the backfill at nearly constant prestress, while mechanically not allowing any expansion of the backfill.

To avoid a resonant or near-resonant state during seismic loading, it is suggested that the initial natural frequency value of a given structure be designed sufficiently higher than the anticipated predominant frequency of the given seismic load while the natural frequency during dynamic loading is maintained higher than the anticipated predominant frequency using a ratchet connection.

I have many people to thank. I had the opportunity to work for one year with Prof. Bathurst and his colleagues at the Royal Military College of Canada after successfully defending my Ph.D thesis. Their many and significant contributions to the development of reinforced soil structures has incited me to further my research efforts. I would like to thank Prof. Bathurst for making this opportunity possible.

Finally, I would also like to thank my colleagues at the University of Tokyo and, especially, Prof. Tatsuoka, Prof. Koseki, and Dr. Uchimura at the University of Tokyo who have always helped and provided me with much advice.

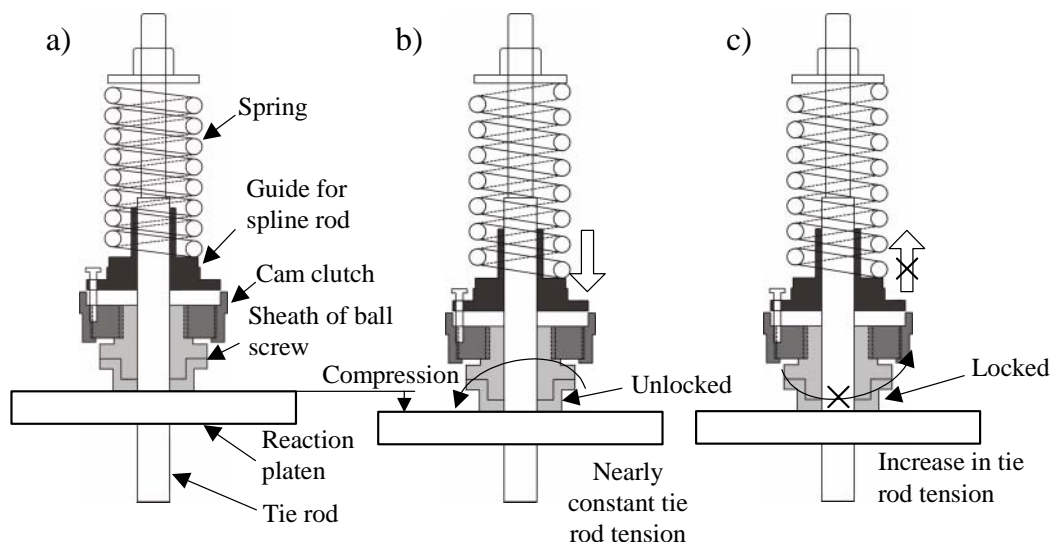


Figure 3. Two different functions of the ratchet connection for tie rods.

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Dec. 1969: First production of polyester fiber

1997: Launched TRIGRID®

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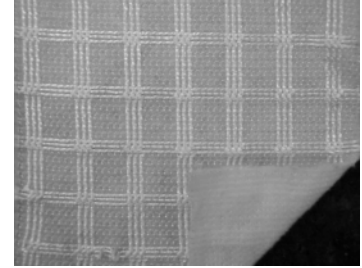
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