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IGS NEWS

NEWSLETTER OF THE INTERNATIONAL GEOSYNTHETICS SOCIETY

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

VOLUME 11 NO. 1 **MARCH 1995**

A MESSAGE FROM THE PRESIDENT
Professor Colin J.F.P. Jones

It is the practice of the IGS Council to have an annual meeting. This year the Council meeting was held in Nashville in the United States before the Geosynthetics '95 Conference. As always, the North American Chapter of IGS (NAGS) organized a major event with the usual (apparently) effortless skill. Over 1,600 delegates attended the three day event, and I should like to express the appreciation of the Society to the organizers of Geosynthetics '95 for all the work which made the Conference such a success.

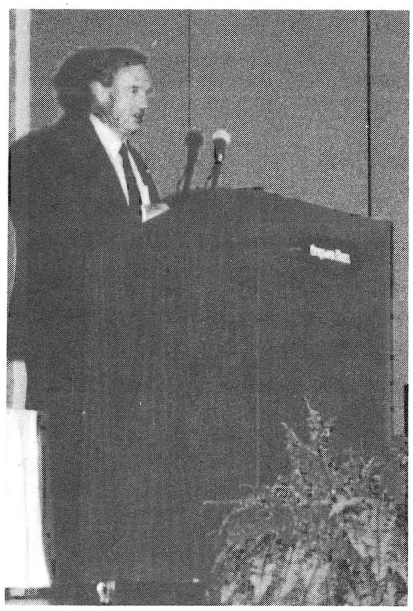
Much of the work of the IGS Council has a timeless quality such as the work undertaken by the Secretary and the Treasurer. I am pleased to report that the change-over in duties between Peter Stevenson, the Secretary and Wim Voskamp, the Treasurer has been achieved in a nearly seamless manner and that the day to day running of the Society and its finances are sound. This provides an essential base for the other work of the Society.

The main reason for holding the annual Council meeting of the Society so soon after the election of the new Council had been elected at the 5th International Conference in Singapore last September was to provide an opportunity to review how the IGS could best serve the needs of the members in the next four years.

The IGS is a truly international society and it is apparent that the needs of the members can vary across the world. One method of bringing the members closer together is good communication. I am pleased to report that the IGS is setting up an electronic bulletin board via the World Wide Web on the Internet. Details of how to access and contribute to this service will be forthcoming in the next issue of IGS News.

One area of need which has been identified is education. The demand for education is growing not only amongst the members of the Society but also in the construction and environmental industries which use geosynthetics in ever growing volumes. The IGS has a clear and central role in addressing the education problem. A major part of the Council meeting in Nashville was devoted to this issue. The IGS has been active in respect of education and the landfill video has been completed and is now available; details of how to obtain this video are given on page 9 of this newsletter. A second video devoted to the use of geosynthetics in highways has been commissioned.

A significant finding of the education debate was that a number of groups around the world have been active in resolving specific problems. Just identifying and publishing details of the educational material available would result in a major advance. However, the work involved would be extensive and it is necessary to be realistic in what can be achieved. Identifying a set of realistic and achievable targets with respect to education is the task currently being undertaken by the Education Committee led by Prof. Robert Holtz. When complete, it is the wish of the Council that the Education Committee's proposals should be presented to the IGS members through the Newsletter.



IGS President Jones at Geosynthetics '95

IN THIS EDITION:

Highlights of the IGS Council Meetings - Singapore 4, 7 and 9 September 1994

Peter Stevenson, Secretary of the IGS and Wim Voskamp, Treasurer of the IGS

Several IGS Council meetings were held during the 5IGC (International Geosynthetics Conference) in Singapore, in September 1994. The meetings were held in conjunction with the 3rd Ordinary General Assembly (OGA) of the IGS, and election of new council members.

Council Meeting of 4 September, prior to 5IGC.

Reports during the meeting included:

1. Membership for 1994 was reported as 1644 regular members, 59 corporate members and 81 student members.

2. The 1995 budget was approved. Financial support of the chapters was approved. The IGS emergency account holds US$100,000. This account was established to ensure the Society could always meet its obligations. Use of these funds requires the declaration of an emergency by the council.

3. The council unanimously approved the NAGS proposal for the 6IGC, which will be held in Atlanta, Georgia, USA, in 1998.

4. The European Activities Committee has organized a European conference. This event will be held in the fall of 1996, and is expected to be the first of a series. The intent is to complement the successful US conferences held by NAGS.

5. The "IGS Codes of Practice" pamphlet has been produced. It will be distributed at the 5IGC and is available to the membership via the Secretariat.

6. IS Kyushu '96 will be held with the support of the IGS.

7. The council will investigate if postal ballots can be produced in the local language of the chapter members together with an explanation about the ballot procedures, also in the local language. The chapters will be asked to assist with translation.

8. The report of the Awards Committee was discussed. In the future, designers of construction projects will be actively solicited for nominations and entries. The Awards Committee was thanked.

9. Prof. Ramaswamy reported on the 5IGC progress. He anticipated good attendance. President Rowe expressed thanks for the job the organizing committee had done.

10. IGS lapel pins have been produced and will be distributed to conference attendees, and, later, to other IGS members.

11. A motion of J.P Giroud was accepted - a unanimous vote of thanks for the tremendous efforts of Past-president R.K. Rowe.

Council Meeting of 7 September

Reports during the meeting included:

1. This was the first meeting of the new council members elected during the 3rd OGA. Council membership includes: C.J.F.P. Jones (President); R.J. Bathurst (Vice-president); R.K. Rowe (Past-president); W. Voskamp, G. Heerten, R. Holtz, C. Lawson, P. Rimoldi, J. Collin, D. Cazzuffi, T. Akagi, M. Fukuoka, F. Tatsuoka, R. Jewell, J-P. Gourc.

2. Prof. Karunaratne, from Singapore, was co-opted to the council.

3. W. Voskamp was elected treasurer.

4. P. Stevenson was co-opted to the council and elected secretary.

5. *Geosynthetics International* was accepted as an official journal of the IGS.

6. Peter and Rosemary Stevenson were thanked for all the work they had done in the preparation and setting up of the IGS booth at the 5IGC.

7. Ideas were discussed to collect valuable lectures etc. on CD ROM or videos for educational purposes.

8. The IGS landfill video is ready and available for sale.

Council Meeting of 9 September

Reports during the meeting included:

1. Committee chairs were elected, as follows:

European activities: G. Heerten, chair; C. Lawson, vice-chair
Technical: B. Christopher, chair; C. Lawson, vice-chair
Education: R. Holtz, chair; J-P. Gourc, F. Tatsuoka, vice-chairs
Chapters: R.J. Bathurst, chair; P. Rimoldi, K. Karunaratne, vice-chairs
Promotion: P. Stevenson, chair; R. Jewell, vice-chair
Standards: D. Cazzuffi, chair; J. Collin, vice-chair
Publications: R.J. Bathurst, chair
Corporate: C.J.F.P. Jones, chair

2. P. Rimoldi was invited to draft a code of ethics for the IGS.

3. D. Elton, Auburn University, Auburn, Alabama, USA, was appointed editor of IGS News; associate editors are T. Akagi and J-P. Gourc.

4. The official address of the IGS Secretariat is: P.O. Box 347, Easley, SC, 29641, USA.

5. D. Cazzuffi proposed to complete and print a document on geomembrane standards.

6. Volume 2 of the *Geosynthetics Bibliography* is available. R.J. Bathurst and J.P. Giroud are willing to work together on Volume 3, a continuation of the earlier volumes.

7. The Technical Committee presented the new IGS "Codes of Practice Bibliography". This is available free to IGS members. It was suggested that a similar booklet, "Terms and Terminology", be produced.

Please Check Your Entry in the New 1995 IGS Directory

IGS members will shortly receive the new 1995 IGS Directory. Mr. Peter Stevenson, Secretary of the IGS, is responsible for maintaining a current directory of the IGS membership. If members change employers or otherwise change their address or titles, it is important that the IGS Secretary be informed. An accurate mailing list is an important activity of the IGS so that we can keep in touch with the membership.

This article is a special request for IGS members to take a moment to check that their entry in the new 1995 IGS Directory is current. Please inform Mr. Stevenson of any corrections by fax, telephone or writing to his address given on page 19 of this newsletter. Members will be asked to submit their email addresses as part of the 1996 Directory.

A Review of Guidelines for Local Conferences and Related Events held *"WITH THE SUPPORT OF THE IGS"* or *"UNDER THE AUSPICES OF THE IGS"*

The IGS has guidelines for national and regional conferences on geosynthetics that wish to be "held under the auspices of the IGS". However, the officers of the IGS are often asked to lend the support of the IGS to local conferences, symposia, workshops and related events organized by chapters or other groups dedicated to the promotion of our geosynthetics discipline. The observation that these requests are becoming more frequent is evidence of the growth of our discipline and the growing size of the audience that is interested in attending these events. Given the recent increase in the number of enquiries, it is appropriate to review the IGS guidelines in order to clarify the conditions that must be met in order to gain the support of the IGS and also to identify the benefits of this support to potential organizers of these undertakings.

1. The IGS is prepared to cooperate with organizers of technical events related to geosynthetics such as: conferences, symposia, seminars, workshops, short courses, training courses, technical exhibitions, experimental applications, and test projects.

2. The cooperation of the IGS is limited, in general, to granting the organizing committee of the event the right to present the event as held "with the support of the IGS" or "under the auspices of the IGS". This does not mean that other forms and levels of the IGS cooperation may not be considered.

3. In order to grant its support to an event, the IGS must be fully informed of the aims, scope, programs, participation, and sources of funds for the event. The organizing committee of the event must send to the IGS Secretary a proposal including this information at least six months prior to the event.

4. Events held "under the auspices of the IGS" are primarily the International Conference on Geosynthetics and the National and Regional Conferences on Geosynthetics organized by IGS Chapters. The conditions for these conferences are part of the terms and conditions describing the mandate and operating regulations agreed to by the chapters of the IGS and are not repeated here. Events organized by the IGS chapters have typically been the primary candidates for IGS support. However, IGS support is not restricted to these events that are routinely organized by the chapters.

5. The IGS will decide on a case by case basis, the level and extent of IGS involvement in an event to be presented as "held under the auspices of the IGS". Depending on the type of event, the IGS involvement may include: suggestions to the organizing committee, right to deliver an official speech by an IGS Officer, access to details of the venue and event program and the right to participate in the dissemination of the event results, etc.

6. The IGS will decide, on a case by case basis, if the conditions exist for suggesting a donation to the IGS by the organizing committee of the event organized "with the support of" or "under the auspices" of the IGS.

7. If the event includes an exhibition, the IGS may request free exhibition space in a prominent location.

8. A copy of the event proceedings, if any, shall be provided at no charge to the IGS Secretariat by the organizing committee of the event.

The advantages of IGS involvement to the organizers of events granted IGS support are:

- Attendees are assured that the event meets a high standard of technical excellence, is non-commercial or otherwise biased in favor of specific products or companies, and is consistent with the mandate of the IGS which is to disseminate information on geosynthetics, related products and associated technologies.

- The IGS can provide a wealth of experience and information to the organizers on how to run a successful event based on a proven record of prior successful events.

- The IGS can suggest knowledgeable and recognized experts who may be willing to give keynote and special lectures.

- The IGS can recommend individuals who may be willing to serve on the organizing committee of an event and/or act as reviewers of proposed technical contributions.

- The IGS will advertise the event in the calendar of events of the IGS News and may promote the event through special articles submitted to this newsletter and on the IGS World Wide Web (Internet) page.

- IGS News will accept review articles after the event for possible inclusion in the newsletter. Information on how to purchase conference proceedings, if any, can also be announced.

Individuals wishing to be receive the support of the IGS, as described in this article, are invited to contact the IGS Secretary, Mr. Peter Stevenson, at the address given on page 19 of this newsletter.

reported by R.J. Bathurst
Vice-president, IGS

IGS Chapter Reports

Editor's Note: Once per year, the IGS News publishes the activities of its chapters. The following report is a summary of the information submitted to the IGS News by the chapter officers. Reports are listed alphabetically. Additional chapter reports will appear in subsequent issues of IGS News.

Chinese Chapter Report

I. Activities

A symposium on soil reinforcement was held at Chong-Qing, Si-dhuan Province, China on 20-23 October 1994. The attendees viewed a retaining wall with heights of 18-32m along the Yangtze River. A symposium on geomembrane applications was held at Ha-Er-Bin, He-Long-Jiang Province, China on 20-23 December 1994.

A meeting discussing technical specifications of plastic vertical drains was held in Tianjin, China on 12-13 January 1995.

II. Publications

A "Handbook of Geosynthetic Engineering" (in Chinese), comprised of sixteen chapters, will be published in January 1995.

reported by Liu Zong Yao, President, Chinese chapter

Dutch Chapter Report

I. General

All NGO/IGSN activities follow the framework that is given in a chapter policy plan. Policy plans are established for five years and reviewed and renewed every three years. During the board meetings, which take place six times a year, activities undertaken are evaluated on the basis of the policy plan.

II. Lectures and Seminars

A new concept for lectures, seminars, etc., has been implemented this year. Until last year, the NGO used to give two seminars per year, each with a central theme about which lectures were given and discussions took place. Results from a survey among the members indicated, however, that, in addition to the informative aspects of the seminars, the informal contacts and "socializing" were found to be very important as well. Beginning in 1994, three informal meetings and two information seminars will be held each year.

Seminars and meetings held in 1994 were:

-A seminar on 8 April with speaker Prof. R.M. Koerner on "Geosynthetic containment systems for landfill liners and covers".

-An informal meeting on 28 April with themes related to geotextiles from natural fibers.

-The General Meeting of the chapter on 28 April.

-A seminar "Spin-off from Singapore" on 11 October.

-Informal meeting with the same theme on 11 October.

-An informal meeting on 22 November with the theme: soil reinforcement.

III. Newsletters

Newsletters are published regularly to keep the members informed about current developments in the field of geosynthetics and about activities of the chapter. Two special newsletters have the same themes as the two seminars organized each year and appear in the same period as the seminars.

IV. International Activities

Through its daughter foundation SOGC, a few members went to Singapore for the 5th International Conference on Geotextiles, Geomembranes and Related Products. In 1994, the IGS designated the SOGC as the organizer of the First European Conference on Geosynthetics in 1996.

V. Publications

The NGO publication "Geotextiles and Geomembranes in Civil Engineering", which first appeared in 1983, was revised in 1994. The update was presented during the 5th International Conference on Geotextiles, Geomembranes and Related Products in Singapore.

VI. Education

To promote the awareness of the existence and possibilities of geosynthetics among students, the NGO/IGSN develops educational material for technical students. In the same context, a short introductory film (about twenty minutes) has been taped on video. The film shows the production of several types of geosynthetics and their applications. The tapes have been distributed among corporate members of the chapter and are available on request at no charge for individual members.

VII. Research and Normalization of Standards

On a continuous basis, members of the NGO/IGSN support research and normalization of geosynthetics standards, both financially and through expertise, manpower and time. Presently supported research subjects include geomembrane welding, tensile testing and functional requirements for geotextiles made of natural fibers.

VIII. Annual Meeting

During the third general assembly, held on 28 April 1994, the results of the second year of the chapter of the IGS, called IGSN, were discussed. The IGSN cooperated very closely with the NGO, the National Dutch Geotextile Organization, whose members are the same as those of the IGSN. Therefore, this report covers joint activities of the NGO and IGSN.

IX. Members

The IGSN does not have corporate members. In 1994, there were 136 individual members.

X. Board Meetings and Officers

The officers of the IGSN met six times in 1994: on 25 January, 14 March, 2 June, 25 August, 11 October, and 18 December. For 1995, six meetings are scheduled.

The IGSN officers for 1994 were:

President:	K.A.G. Mouw
Vice-president:	W. Voskamp
Secretary General:	P.C. Mazure
Treasurer:	M.J.M. van den Elzen

reported by K.A.G. Mouw, President IGSN

German Chapter Report

I. The German Chapter of the IGS

The chapter started officially on 1 January 1994. The organi-

zation is administered by the secretary of the German Society of Geotechnique (DGGT). The leadership is carried out by the same persons as the technical section "Fachsektion Kunststoffe in der Geotechnik" (FS-KGEO) of the DGGT. Prof. Dr. -Ing. R. Floss is the current president.

II. Major Activities

The last national conference of the FS-KGEO and general meeting were held in Munich, March 1993. The proceedings are available from the DGGT.

A meeting of the FS-KGEO with representatives of the producers was held in September 1993. Another meeting of the FS-KGEO and the German chapter with the producers combined within the IGV (Interessenverband Geokunststoffe) was held in December 1994.

III. Internal Committees

Within the FS-KGEO three technical committees are at work.

AK14A: Geosynthetics in Geotechnical Engineering and Hydraulic Applications
AK14B: Calculation and Design Methods for Earth Reinforcement with Geosynthetics
AK14C: Application of Geosynthetics in Road Construction

IV. Future Plans

Dr. G. Heerten is the appointed chairman of the European Activities Committee and represents the German chapter in the preparation of the European Conference of the IGS. Other conferences (e.g. Geotextiles '95 sponsored by Elsevier) are not supported by the German chapter due to time conflicts with the European Conference of the IGS and the next ISSMFE conference in Hamburg.

reported by R. Floss, Chairman, German Chapter

Indian Chapter Report

I. General

The Committee for International Geotextile Society (India) - CIGSI was established in June 1992 as a Registered Society. It also acts as the Indian Chapter of the International Geosynthetics Society (IGS). The main aim of the committee is to create awareness about the use of geosynthetics in Civil Engineering in India.

II. Workshops Held

A workshop on the role of geosynthetics for hill area development was held at the Institution of Engineers, Assan State Center, Guwahati during 9-11 November 1994. The need for organizing more workshops on soil stabilization, geotextiles, geosynthetics, etc., in the region for the benefit of engineers in the region is recognized by the chapter.

A three day workshop on engineering with geosynthetics was held 29-31 December 1994 at the A.P. State Center, Khairatabad, Hyderabad. A total of 64 delegates attended. The following recommendations were made:

1. Geosynthetics appear to be the eminently suitable for solving the problems being faced in water resources, road structures, in applications such as chimney drains, under rip rap canal lining, and slope protection.

2. There should be more events dealing with detailed designs of water resource structures that incorporate geosynthetics.

3. Manuals need to be prepared by Central Board of Irrigation and Power and others for use of geosynthetics in design and construction.

4. Model/demonstration structures should be constructed to gain first-hand experience and confidence.

III. Publications of CIGSI

1. Proceedings "Workshop on Role of Geosynthetics in Hill Area Development".

2. Proceedings "Workshop on Engineering with Geosynthetics".

IV. News Bulletin Of CIGSI

The CIGSI is publishing a News Bulletin twice a year. The last issue was in January 1995.

V. Forthcoming Events

1. One day seminar on Geosynthetics Materials and their Applications to be held April 1995 in New Delhi.

2. A three day workshop on the Use of Geosynthetics in Civil Engineering Applications in May 1995 in Bangalore.

3. Third International Workshop on Geosynthetics in November 1997 at Bangalore.

4. Two to three local workshops on Geosynthetics at regional centers are proposed to be organized.

VI. Membership

The membership has increased from 46 to 57.

reported by A.R.G. Rao, Treasurer

Indonesian Chapter

The Indonesian Chapter of the IGS has just published its first bulletin: "*BULETIN GEOSINTETIK*" to promote geosynthetics. The chapter hopes to publish several more issues.

The chapter is also planning a three day workshop on geosynthetics during the second quarter of 1995. The program will introduce the attdendees to geosynthetics applications and design. The current president is Ir. Soekriano Rammelan, and the Secretary is K. Oetomo.

reported by K. Oetomo, Secretary, INA-IGS

Southeast Asian Chapter Report

The main activity of the SEAC-IGS was the organization of the 5th International Conference on Geotextiles, Geomembranes and Related Products held in September 1994. A separate report will be prepared for the IGS by the General Secretary of the conference.

Off-prints of the conference papers were dispatched to those authors who were unable to attend the conference. The chapter is handling the sale of the bound and CD-ROM formats of the proceedings. Currently, the Scientific Committee is working on the production of the Discussion Volume.

The annual general meeting (AGM) of the chapter was held on 22 December 1994 at the Westin Stamford Hotel with Dr. S. D. Ramaswamy acting as Chair. In his report, the president gave an account of the events during the year. The attendees were advised of proposed future seminars, symposia and short courses on geosynthetics.

The officers of the chapter will remain the same until the next AGM, scheduled to be held in the middle of 1995.

reported by S. D. Ramaswamy, President, SEAC-IGS

IGS Awards for 1992-95: Call for Submissions

(deadline for nominations: 31 January 1996)

(deadline for submissions: 31 March 1996)

Purpose

IGS Awards will be granted in 1996 to individuals or groups of individuals who have made an outstanding contribution to the development and use of geotextiles, geomembranes, related products or associated technologies through their scientific and technological achievements. Awards will be made for the recognition of achievements completed and/or the validity of which has been demonstrated during a four-year period preceding the year of the award (i.e. 1992 through 1995 inclusive).

There are two types of awards: the **Young IGS Member Achievement Award** for IGS members who are less than 36 years of age on 31 December 1995, and the regular **IGS Award** (independent of age). A maximum of five IGS Awards will be granted. Each award will consist of a specially commissioned medal and a diploma. The winning entries will also be featured at the IGS booth at any conference held under the auspices of the IGS and will be publicized in IGS News, in special press releases, the IGS World Wide Web (Internet) page, and in other publications.

Candidates

All candidates must be members of the IGS. All members of the IGS are eligible with the exception of the President of the IGS and the members of the Awards Committee. In the case of a group submission to the Young IGS Member Achievement Award all members of the group must satisfy the age requirement. Any individual or group that is a candidate for the Young IGS Member Achievement Award is automatically considered for both award categories (unless requested otherwise by the candidate). However, a candidate may only receive one award for the 1992-95 period.

Nominations

Nominations of candidates should be typed in English on plain paper (not letterhead) and submitted to the Secretary of the IGS, Mr. Peter Stevenson at the address given on page 19 of this newsletter. The nomination should include:

- a clear statement of the contribution of the candidate that is to be considered (e.g. if a product - provide a clear definition of the product; if a paper(s) or book, give a full reference of the paper(s)/book; if a report - a full reference to the report; if a construction method - a clear description of the method and any references, etc.),

- a statement indicating the originality, and significance of the candidate's contribution to the field of geotextiles, geomembranes, related products and/or associated technologies.

Nominations may be made by any IGS member except members of the Awards Committee, including nominating oneself. The Publications Committee, Education Committee, Corporate Members Committee and IGS Chapters will be invited to make nominations. Nominated candidates will be contacted by the IGS Secretary. Candidates will be asked to agree to stand for an award and will be required to submit materials as requested by the Awards Committee. All nominations and award entries will be executed with the strictest confidence by the IGS Secretary and the Awards Committee.

IGS Awards Committee

The Awards Committee will comprise five regular members including its chairman (all members will be selected by the IGS President from a list approved by the IGS Council). The members will be selected so as to represent a broad cross-section of geosynthetic-related technologies and experience. The Secretary of the IGS will attend all meetings of the Committee as an observer and coordinator. Complete IGS Awards rules can be obtained from the Secretary of the IGS, Mr. Peter Stevenson, at the address given on page 19.

reported by R.J. Bathurst
Vice-president of the IGS

Geosynthetics '95 - a Geosynthetics Success

The Geosynthetics '95 conference was held 21-23 February 1995 in Nashville, TN, USA. It was sponsored by the Industrial Fabrics Association International (IFAI) and the North American Geosynthetics Society (NAGS) and was the largest geosynthetics conference ever held in the world, with 1673 attendees and 99 exhibitor booths. There were 90 papers presented on the state-of-the-practice using geosynthetics from an international assembly of authors. The papers were presented in twenty-one technical sessions. Sessions covered: Civil and Geotechnical Engineering, Environmental Engineering, and Testing and Performance. The major work on the conference was done by Dr. R. J. Bathurst (Chair, Organizing Committee) and Dr. Y.G. Hsuan (Chair, Technical Review Committee). Their tireless efforts resulted in a solid, well planned, and well executed technical conference. The IFAI did an outstanding job with the details of the conference, including the outstanding exhibition.

The Geosynthetics '95 agenda was quite varied, encompassing many different activities in the geosynthetics arena. There were short courses before and after the conference, the NAGS General Assembly, and a plant tour in addition to the fine technical sessions and panel discussions (see related articles, p.7,8,9,10). The conference resulted in a three volume proceedings, which included the technical papers and the keynote lecture by Dr. Robert Koerner. A unique feature of Geo '95 was the Student Paper Competition. NAGS promoted the session to encourage university student participation in geosynthetics and the conference. The papers were presented and judged in an independent technical session (see related article, p.9).

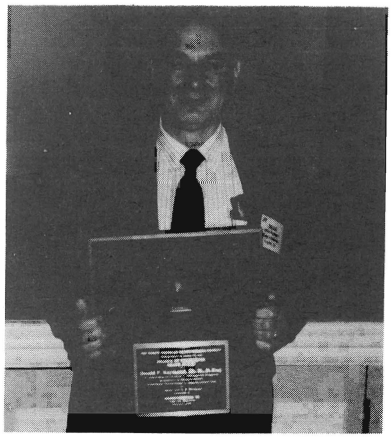
The plant tour was sponsored by Reemay, Inc., in Old Hickory, TN, USA (near the conference site). Mr. Bill Hawkins (Reemay) provided tours of the Reemay facilities.

Ryan Berg presented a post-conference course, "FHWA geosynthetic engineering workshop". More than 40 professionals attended the course which included drainage, erosion control, roadway, and reinforcement applications.

Representatives of more than 50 geosynthetics installers met briefly during Geo '95. They voted to form an international installers association. The mission of the association is to promote the interest of installers. Officers have yet to be elected. The meeting was convened at the instigation of Mr. Robert Denis, who may be contacted at Tel.: 1 (514) 449-1234 ext. 214 or Fax: 1 (514) 449-1228.

Geo '95 Conference proceedings are available from IFAI (Tel.: 1 (612) 222 -2508 or Fax: 1 (612) 222-8215)

S. Meeker Bradford and D. Fettig are thanked for their contributions to this article, submitted by D. Elton
Editor, IGS News



Dr. G.P. Raymond receives Grand Award as co-author of best paper at Geosynthetics '95.

Geosynthetics '95 Organizing Committee Members - Mr. J. Dieltz, Secretary, Dr. Y.G. Hsuan, Technical Chair, and Dr. R.J. Bathurst, Chairman of the Organizing Committee.

NAGS Treasurer Mr. J. Paulson with Award Winner Dr. T.C. Kinney at Geosynthetics '95.

Failures: a Success

report of a short course at Geosynthetics '95

"Geosynthetics engineering has now all the attributes of a full-fledged discipline, including failures", as pointed out by Dr. J.P. Giroud in his opening remarks at the short course "Geosynthetics: Lessons Learned from Failures" held in Nashville, USA, on 20 February 1995, the day before the opening of the Geosynthetics '95 conference. As Dr. Giroud was speaking, a first failure became apparent: seating was not sufficient for all the last-minute registrants. Additional chairs and tables had to be brought in. Clearly, the organization had failed to plan for such a success!

More than 100 attendees spent the entire day listening to the presentation of 22 case histories by experts from North America and overseas, and participating in lively discussions. The cases presented included a wide variety of geosynthetics applications such as: reinforced walls, embankments on soft soil, roads and railroad tracks, drainage and filtration, erosion control and bank protection, canals and dams, landfills, and liquid impoundments.

The title of the short course, "Geosynthetics: Lessons Learned from Failures", indicates that all the cases presented involved geosynthetics, but certainly does not indicate that all the failures were caused by geosynthetics. In fact, in a number of cases, the geosynthetic was not the direct cause of the failure. Even when the geosynthetic was directly involved in the failure mechanism, the origin of the failure was not the geosynthetic itself, but the design of the structure, the selection of the materials, and/or the construction method. Therefore, one of the lessons learned at the short course was that geosynthetics should not be taken as scapegoats when a structure fails.

The purpose of the short course was to learn lessons, and indeed many were learned, which allowed Dr. Giroud to conclude the short course by stating that "the main lesson we learned is that many lessons can be learned". A number of the failures discussed led to the conclusion that more should be learned about geosynthetics properties, which requires that more research be done on certain properties, but also a greater effort be made to educate engineers who design with geosynthetics. The latter is important, because a number of the failures presented at the short course were due to the fact that some design engineers are not aware of important aspects of geosynthetics properties which are well known to researchers.

Inadequate design details, or design details that were ignored by contractors who did not understand how important they were, appeared to have caused a number of failures. From this observation, several lessons were learned, such as: design engineers should not be concerned exclusively with design concepts and calculations but should also pay attention to design details; design engineers should understand that contractors may not be familiar with design details regarding geosynthetics and, therefore, should explain these design details clearly in construction specifications; and an effort should be made to educate contractors who are not familiar with geosynthetics.

Clearly, from the number and the importance of the lessons learned, the short course "Geosynthetics: Lessons Learned from Failures" was a success. To give all those interested in geosynthetics a possibility to learn those important lessons, a book titled "Geosynthetics: Lessons Learned from Failures" is being prepared. This book will include the 22 papers presented at the short course in Nashville, 6 papers received after the short course, plus approximately 35 papers that are presently being prepared. If you know of a failure of a structure incorporating one or more geosynthetics and you think the case should be described in the book, please contact Dr. Giroud immediately (see the Calls for Papers on page 11 for details).

The book "Geosynthetics: Lessons Learned from Failures" will be the first book devoted to failures of structures incorporating geosynthetics. Recognizing the importance of the subject and the international nature of the effort (as authors from various parts of the world are involved), the IGS Council has decided that the book will be published "under the auspices of the IGS". Prof. R.J. Bathurst and Ing. D.A. Cazzuffi have been designated to review the book manuscript on behalf of the IGS. As a result of the quality of the papers, the variety of subjects covering all categories of applications of geosynthetics, the importance of the lessons learned, the careful editing in progress, and the IGS label, the book "Geosynthetics: Lessons Learned from Failures" can be expected to be a milestone of the geosynthetics discipline.

reported by J.P. Giroud
Past-president, IGS

Perspectives on Durability - Geosynthetics '95 Panel Discussion

A moderated panel discussion on durability of geosynthetics was held as part of Geosynthetics '95, in Nashville, TN, on 22 February 1995. The panel discussion commenced with opening comments from eight invited experts, who shared their perspectives on a broad range of issues relating to the manufacture, fabrication, and installation of geosynthetics, and to aspects of analysis, design and associated research and development using these materials. The short, opening contributions were received from:

Bob Denis	Solmax Geosynthetics (installer)
Bob Koerner	Geosynthetic Research Institute (researcher)
Frank Nagy	Mobil (manufacturer)
Ron Marsh	Geocomposites (fabricator)
Ryan Berg	Ryan Berg Consultants (design consultant)
Tony Allen	Washington State DOT (regulator)
Alberto Scuero	CARPI (manufacturer, installer and owner)
John Workman	Laidlaw (owner, operator)

Participation was then opened to the audience, under the moderation of Dr. Ian Peggs (Chair). Comments first addressed the design life of structures and the durability of polymeric materials, and went on to a discussion of extrapolation of test data to assess long-term behavior. The essence of these comments, in turn, raised the issue of appropriate test methods, their development, and bounds to their interpretation. The use of, and application of, such tests were challenged. Further comments then explored the role of a performance guarantee from the manufacturer, and who should take (or share?) responsibility for issues of durability.

Discussion progressed to recognize the role of existing field and case history experience, and the lessons to be drawn from some projects involving geosynthetics that were constructed up to 35 years ago. It was stressed that the value of these performance data to an improved understanding of material behavior over time, and in different thermal and chemical environments, should not be overlooked.

Although the audience placed emphasis on waste containment applications, and related issues of geosynthetic/waste compatibility, some comments were also made on the long-term strength of reinforced soil structures. A general appeal was made on the subject of durability to ensure that, in evaluating geosynthetics for any construction application, all decisions must be placed within a context of project economics. Allied concerns were raised about the extreme performance criteria that geosynthetics are expected to meet, compared to conventional construction materials.

Tom Coyle, AIG/Commerce & Industry (insurer), was invited to make a short closing contribution, and provided observations on the implications of the discussion for both professional and product liability insurance.

A common theme emerged in these discussions: the value of working together as professionals to further advance our understanding, and the need for open dialogue. Dr. Jonathan Fannin (Co-Chair) summarized the flow of ideas, thoughts, and comments made during the panel discussion. Clearly, good communication between all parties is the key to proper selection of a geosynthetic, designing with confidence, and satisfying performance requirements throughout the service life of a project. Broad consensus was achieved on the need for appropriate continuing education and training in the field of geosynthetics to meet these goals.

reported by J. Fannin and I. Peggs

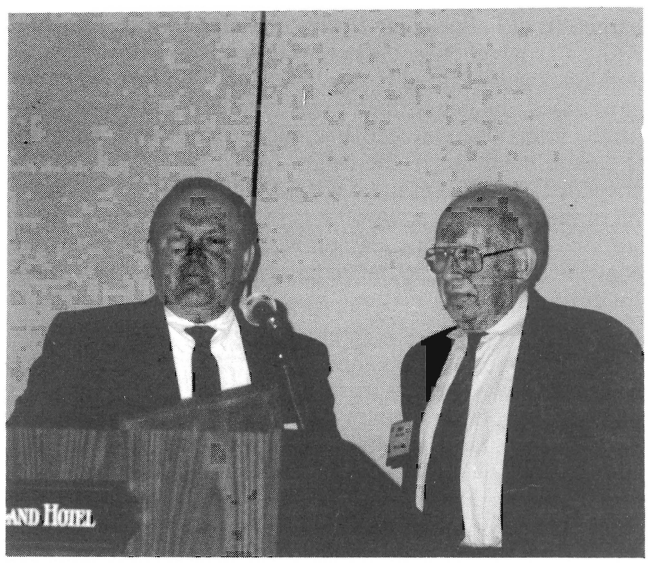
NAGS Honors Haxo with Lifetime Achievement Award

Dr. Henry E. Haxo, Jr., was honored with the Lifetime Achievement Award from the North American Geosynthetics Society (NAGS). Dr. Haxo has worked for more than 30 years - much of his career concerned with polymers. His wide-ranging work included service in the private sector, where he began his career. Much of his work focused on constantly improving and expanding knowledge of rubber science and technology. Dr. Haxo went on to serve in consulting firms.

Dr. Haxo has had contracts for geosynthetics-related work with the U.S. Federal Highway Administration, Electric Power Research Institute, and the U.S. Environmental Protection Agency. So thorough and fundamental was some of this work that many of the resulting research reports are still in demand. His work on durability of geomembranes was particularly significant in advancing the field.

The award was presented at the NAGS General Assembly in Nashville, TN, USA, during Geosynthetics '95, on 22 February 1995. Mr. Robert Landreth made the award.

reported by R. Landreth



Dr. Henry E. Haxo, Jr. (right) receives NAGS Lifetime Achievement Award from Mr. Landreth.

Student Papers Session and Awards Program at Geosynthetics '95 - a Great Success

Students in graduate programs are recognized by the IGS and the North American Geosynthetics Society (NAGS) as the future of our discipline and society. In order to promote student participation in NAGS conference activities, a Student Papers Session and Awards program was launched by the Organizing Committee of Geosynthetics '95 chaired by Dr. R.J. Bathurst. The program was a great success and this article describes the program details and recognizes the winners.

A call for student papers from North America was announced in IGS News (Vol 10 No 1 March 1994) and Geotechnical News. In addition, the call for papers was sent to all civil engineering departments at universities in the United States and Canada. An email user's group was used to contact many geotechnical professors, and advise them of the call for papers. The call for papers was organized by Dr. David J. Elton at Auburn University.

Full time graduate students enrolled in North American universities were invited to submit original papers to the Organizing Committee of Geosynthetics '95. To be eligible the papers were required to have a strong geosynthetics theme but were otherwise unlimited in scope. The authorship of submitted papers was restricted to students.

A total of eleven papers were submitted by the due date of 31 August 1994. A total of nine papers were accepted for publication in the conference proceedings after a thorough review by a panel of judges taken from the academic community. Professors from schools submitting papers were excluded from the judging panel in the interests of fairness.

NAGS and the Industrial Fabrics Association International (IFAI) provided funds for an expenses-paid trip for one author of each of the top six papers to attend Geosynthetics '95 for presentation and final judging at the Student Papers Session.

The original plan called for the author(s) of the best paper to receive a US$500 prize from funds donated by NAGS and the IFAI. The best paper was selected using a scoring system that weighted each paper based on originality of the submitted manuscript, technical content and written presentation (75%) and presentation of the work during the student papers session at Geosynthetics '95 (25%). The session presentations were chaired by Dr. J. Lafleur and Dr. D. Elton and the presentations were judged by a panel of four academics.

The presentations by the students were all excellent. Each of the presenters had obviously gone to great efforts to prepare excellent slides and their lectures. In fact, many members of the audience could not help but remark that some of the presenters in the regular sessions could learn from the polished delivery of the students. The uniformly high quality of the papers and lectures made it very difficult to select a winner and, after careful deliberation, the judges decided that there were two "best" papers. Consequently, a meeting of NAGS officers and the IFAI was held and they decided that the sponsoring organizations would award *two* $500 prizes!

The winners of the Geosynthetics '95 Student Papers Award Program are:

T.Y. Soong, Geosynthetic Research Institute, Drexel University, for his paper: *Effects of Four Experimental Variables on the Stress Relaxation Behavior of HDPE Geomembranes*

S.R. Boyle, University of Washington, for his paper: *Unit Cell Tests on Reinforced Cohesionless Soils*

Congratulations to Mr. Soong and Mr. Boyle. The winners were presented with their prizes at a special ceremony held during the closing banquet of the conference. Each of the authors of the six papers presented at the Student Papers Session was also given a commemorative plaque.

This program is a model that will be followed at future NAGS biennial conferences and one that other IGS chapters should consider for their regional conferences.

reported by R.J. Bathurst
President-elect of NAGS

Geosynthetics Videos Available

The video "Geosynthetics in Landfills" is available. This high quality video has been produced by the IGS in cooperation with ASCE. It costs US$100.00. Technical editors: J.P. Giroud and J. Fluet. Sponsors: Akzo Nobel Geosynthetics Co., CETCO Colloid Environmental Technologies Company, GeoSyntec Consultants, Gundle Lining Systems Inc., Hoechst Celanese Corporation, Huesker Inc., International Geosynthetics Society, National Seal Company, Polyfelt America, Polyflex Inc., Serrot Corporation, Synthetic Industries - Construction Products Division, and Tensar Environmental Systems. Order through IFAI, Ms. Palmer, 345 Cedar St., Suite 800, St. Paul, MN, USA, 55101 (Tel: 1 (612) 222-2508. Fax: 1 (612) 222-8215).

The PVC Geomembrane Institute has developed an educational video titled "Performance Characteristics of PVC Geomembranes". Dr. Ian Peggs, I-CORP International is the narrator of the video. Complimentary copies are available by contacting the Executive Director of the PVC Geomembrane Institute (Tel: 1 (612) 450-5660. Fax: 1 (612) 451-9901).

Geosynthetics '95
Awards of Excellence Winners

Authors of five papers presented at Geosynthetics '95 were named winners in the Awards of Excellence program sponsored by the North American Geosynthetics Society (NAGS). The program is designed to recognize innovation, creativity, and outstanding contributions in engineering, design, testing, technology, research and development of geosynthetics. The Awards of Excellence program was established by NAGS in 1989. The first awards were given at Geosynthetics '91 (see IGS News Vol 7. No.1 1991) and the second series at Geosynthetics '93 (see IGS News Vol 9. No.2 1993). The winners of the 1995 awards were announced at the closing banquet held on 23 February as part of Geosynthetics '95. They are:

Environmental Technology award category:
G.R. Koerner and R.M. Koerner for their paper: *Temperature Behavior of Field Deployed HDPE Geomembranes.*

The other finalists in this category were:
J.K. Park, J.P. Sakti, and J.A. Hoopes- *Effectiveness of Geomembranes as Barriers for Organic Compounds.*
K.S. Henry, C.M. Collins and C.H. Racine- *Use of Geosynthetics to Prevent White Phosphorous Poisoning of Waterfowl in Eagle River Flats, Alaska.*

Research and Development award category:
T.C. Kinney and Y. Xiaolin for their paper: *Geogrid Aperture Rigidity by In-Plane Rotation.*

The other finalists in this category were:
M.K. Yegian, Z.Y Yee and J.N. Harb- *Response of Geosynthetics Under Earthquake Excitations.*
M. Koutsourais- *Correlating the Creep-Strain Component of the Total Strain as a Function of Load-Level for High-Tenacity Polyester Yarns, Geogrids and Geotextiles.*

State-of-Practice Technology award category:
S.M. Merry, J.D. Bray and P.L. Bourdeau for their paper: *Stress-Strain Compatibility of Geomembranes Subjected to Subsidence.*

The other finalists in this category were:
L.W. Well- *Successful Performance of a CSPE Cover on Water Reservoir.*
R. Yazdani, J.L. Campbell and G.M. Koerner- *Long- Term Insitu Strain Measurements of a High-Density Polyethylene Geomembrane in a Municipal Solid Waste Landfill.*

Geotechnical Engineering Technology award category:
S.M. Bemben and D.A. Schulze for their paper: *The Influence of Testing Procedures on Clay/Geomembrane Shear Strength Measurements.*

The other finalists in this category were:
R.M. Mattox and D.A. Fugua- *Use of Geosynthetics to Construct the Vera Cruz Access Ramp of the Bridge of the Americas, Panama.*
I. Ismail and G.P. Raymond- *Geosynthetic Reinforcement of Granular Layered Soils.*

GRAND AWARD category:

The grand award for the best overall paper in the conference proceedings was awarded to:

I. Ismail and G.P. Raymond for their paper: *Geosynthetic Reinforcement of Granular Layered Soils.*

The judging of award winning papers was carried out by an independent panel of NAGS members that reviewed all papers accepted for publication in the proceedings. Entries were judged on the scope of the project, the benefits of using geosynthetics, the basis for geosynthetic selection, and engineering rationale.

A grant of $10,000 will be given to a research institute of each award winner's choice for geosynthetics research.

This special NAGS program is funded by contributions from leading geosynthetics manufacturers, distributors, related organizations, and individuals. In addition, a special contribution of $10,000 towards the Awards of Excellence program was made by the Opryland Hotel which was the venue for the conference and exhibition.

reported by R.J. Bathurst
President-elect, NAGS

The First European Conference on Geosynthetics

The IGS has formed a European Activities Committee to coordinate activities between the European chapters. This committee has decided that the first European Conference on Geosynthetics, to be held every four years in Europe, will be organized by the Dutch Chapter to the IGS, the Nederlandse Geotextielorganisatie (NGO). The first European Conference on Geosynthetics will be held under the auspices of the IGS in the city of Maastricht in The Netherlands, from 30 September until 2 October 1996.

Key words of the first European Conference will be *practical use* and *active participation.* The sessions will be organized around themes that are user oriented, such as geosynthetics in roads, hydraulic applications or waste containment. A session will consist of a lecture addressing the design and one of the installation aspects. Further case studies will be presented. Also, practical sessions on material characteristics, etc., will be held. Active participation of attendees is expected in these sessions. Lectures, workshops and poster sessions will be used to enable participants to get as much practical, directly applicable information as possible.

In addition to invited lectures, papers will be presented on European use, legislation, developments and applications of geosynthetics. A call for papers indicating the subjects will be sent to members of the European IGS chapters and others interested in the subject. The submitted papers will have to comply with the European and practical scope of the conference. Conference languages will be English (main conference language), French, and German. Simultaneous translation will be provided whenever practically possible.

Immediately following the first European Conference on Geosynthetics, the third RILEM conference on reflective cracking will be held at the same location. Exhibitors are invited to both conferences (see Calendar, p.18 for details).

reported by A. Bakker
Secretary, NGO

The 7th International Conference on Geosynthetics (7IGC) To Be Held In 2002

Conference Sponsors Sought

The IGS invites chapters and interested organizations to express their interest in organizing the Seventh International Conference on Geosynthetics which will be held in 2002. The history of the conferences is as follows:

First IGC, Paris, France 1977
Second IGC, Las Vegas, USA 1982
Third IGC, Vienna, Austria 1986
Fourth IGC, The Hague, The Netherlands 1990
Fifth IGC, Singapore, Singapore 1994
Sixth IGC, Atlanta, USA 1998
Seventh IGC, 2002

The IGS Secretary will provide a detailed information package that informs and instructs interested parties on the proper procedure to prepare a bid to host the conference. Interested chapters and organizations should contact the IGS Secretary, P.O. Box 347, Easley, SC, 29461, USA.

Calls For Papers

1. The International Symposium on Earth Reinforcement, IS Kyushu '96 will be held in Fukuoka, Kyushu, Japan, 12-14 November 1996, under the auspices of the Japanese Society of Soil Mechanics and Foundation Engineering. This symposium is held under the auspices of the International Geosynthetics Society.

The aims of this symposium are to discuss various problems and topics on earth reinforcement for the benefit of collecting and exchanging knowledge concerning recently developed techniques and to spread this knowledge to all the countries of the world for further development.

The conference will cover earth reinforcement techniques for the following construction practices: embankments, wall structures, foundations, slopes and excavations. Emphasis will be placed on the following topics: standardization of testing methods; standardization of design methods; numerical methods for designs; case histories; monitoring systems; and performance under earthquakes.

Authors are invited to submit abstracts of about three hundred words in English, on any of the topics relevant to the conference themes. A one page abstract with a paper title, authors' names, mailing address and telephone and facsimile numbers should be provided at the top of the page. Abstracts should clearly state the purpose and conclusions of the full paper. Both abstracts and papers will be reviewed by the technical committee of IS Kyushu '96.

Important Deadlines:

Submissions of abstracts:	30 September 1995
Acceptance of abstracts:	30 November 1995
Submission of papers:	28 February 1996
Final acceptance:	30 April 1996

Correspondence should be directed to :
Professor Hidetoshi Ochiai
Kyushu University
6-10-1, Hakozaki, Higashi-ku
Fukuoka 812 JAPAN
Tel: 81 (92) 641-1101 ext. 5232
Fax: 81 (92) 641-5195
iskyushu@civil.kyushu-u.ac.jp

2. "Geosynthetics: Lessons Learned from Failures" This book, presently being edited by Drs. J.P. Giroud and K.L. Soderman, will be published under the auspices of the IGS in 1995. At this time, 28 papers have been received and are being edited. Also, approximately 35 papers are being prepared. Additional papers will be accepted, but prompt action is required. The papers must describe the total or partial failure of a structure or system incorporating geosynthetics. The considered structure must be an actual structure (i.e., laboratory models are excluded, but full-scale experimental structures may be considered).

If you want to write a paper or know of an interesting failure, please contact Dr. Giroud or Dr. Soderman immediately. Tel: 1 (407) 995-0900, Fax: 1 (407) 995-0925 or 995-0995.

3. Geofoam Papers Solicited. *Geotextiles and Geomembranes*, an official journal of the International Geosynthetics Society, is planning an issue dedicated to **geofoam.** Papers dealing with both material properties as well as applications are solicited. Authors interested in preparing a paper for this special issue should first submit a one-page abstract to :

Prof. John S. Horvath, P.E.
Guest Editor, *Geotextiles and Geomembranes*
c/o Manhattan College
Civil Engineering Department
Bronx, NY 10471
USA
Tel: (1) 718-920-0177 Fax: (1) 718-796-9812
jhorvath@mcs1.rlc.mancol.edu

Abstracts are due 1 September 1995. Papers will be subjected to the normal peer-review process. Anyone interested in peer reviewing manuscripts, please contact Prof. Horvath.

A Geomembrane Lining System for the World's First Seawater Pumped-Storage Power Plant Okinawa, Japan

by Junya Takimoto
The Electric Power Development Co., Ltd., Japan

The world's first seawater pumped-storage power plant (30 MW) is being constructed on the main island of Okinawa by the Agency of Natural Resources and Energy of Japan's Ministry of International Trade and Industry (MITI). Compared with conventional river-water pumped-storage power generation, which uses both an upper and lower reservoir, costs will possibly be less for seawater pumped-storage power generation, which uses an upper reservoir, with the sea serving as the lower reservoir. In the future, this type of generation will allow increased siting flexibility for pumped-storage power generation plants. EPDC has undertaken research and feasibility studies since 1981, and began supervising construction in March 1990 after making detailed designs on behalf of MITI. The system will be tested for five years after construction to evaluate materials, structures, environmental impact, operational performance, and economic feasibility.

The plant is located in the northern part of the main island of Okinawa, and faces the Pacific Ocean 600m from the shore. The plant rests on a plateau 150m above sea level. There, an embankment will enclose an upper reservoir. Power is generated by the water travelling through a penstock, an underground powerhouse, and a tailrace tunnel. Many new technologies, based on years of research and testing on the use of seawater, have been used in this pilot plant. For example, the upper reservoir is covered with a newly designed lining structure using geomembranes. The penstock is made of fiberglass reinforced plastic (FRP) pipes. The turbine is made of specially developed stainless steel (two-phase type: martensite and austenite). Epoxy-resin-coated reinforcing bars are used in the concrete lining of the tailrace.

The upper reservoir lining is composed of special materials, and has a special structure. The permeability of the liner should be low enough to minimize seawater infiltration into the surrounding ground. Alternatively, asphalt concrete and synthetic materials had been considered for the impervious lining system. While asphalt concrete can form a stable liner, the cost of asphalt paving on sloped surfaces is quite high. For this reason, a geomembrane liner with an appropriate structure was adopted for this pilot plant.

Upper Reservoir Design

For the upper reservoir design, a shape composed of flat surfaces was selected to facilitate liner installation. The final configuration was octagonal, with side slopes of 1V:2.5H. Excavated materials were used for the dam embankment. A layout was arranged that would minimize the amount of earthwork, while providing an effective storage capacity of 564,000 m^3. The reservoir has a perimeter of 848m (252m across) and a maximum depth of 25m.

Material Selection

For the liner, a surface-exposed structure was selected to facilitate maintenance and repairs. Because the lining is exposed, however, a fail-safe system against damage to the lining must be included. This system consists of sea water-leakage-detection sensors and pipelines with pumps which return leaked seawater to the reservoir. Public access to the area around the reservoir must be controlled.

The main points for liner material selection were:

(1) Must have long-term stability with respect to properties and strength characteristics

(2) Must be resistant to material deterioration caused by ozone and/or ultra-violet rays

(3) Must be resistant to strength deterioration by the adhesion of marine organisms (acorn barnacles, etc.)

(4) Must have stability against strong winds when the reservoir is empty.

During material selection, importance was placed on elongation performance. It was deemed important that the liner be resistant to the relative displacements between the liner and the dam body, power intake, inspection gallery, and sheet anchors. These structures are subject to cyclic water pressure, which is a particular problem for pumped-storage power generation. Candidate materials included an EPDM (Ethylene Propylene Diene Terpolymers) rubber, a thermal plastic rubber, a high-elasticity polyvinyl chloride, and a spun-bonded fabric and asphalt based compound product. A comprehensive evaluation resulted in the selection of EPDM after tests on static strength, strength after cyclic loading, creep characteristics, weather resistance (ozone, sunlight), changes in properties caused by temperature, resistance to bacteria, resistance to seawater, strength after acorn barnacle adhesion, and other tests.

Lining Structure

A transition layer is constructed below the liner to minimize the deformations due to rock foundations and embankments. The transition layer is needed to release the back pressure caused by ground water coming from the subgrade, to drain residual air, and to drain seawater in the event of leakage. A transition layer consists of compacted crusher-run materials (20mm or less) with laboratory permeabilities of $4.8*10^{-1}$ cm/s (at 95% compaction), and air permeability of 45 cm/s (at 500 Pa).

Construction at the site is proceeding while density tests and permeability tests are being performed at an appropriate frequency. An 800g/m^2 layer of nonwoven, spun-bonded

polyester fabric is placed between the transition layer and lining sheet as a cushion. An inspection gallery has been installed in the bottom of the upper reservoir. The gallery includes pipelines and pumps for returning leaked seawater.

Concrete blocks are being used to anchor the geomembrane panels. The spacing of panel anchors is 8.5 m wide in sloped sections, and 17.0 m x 17.5 m on the bottom. The spacings for anchors were determined based on the studies of:

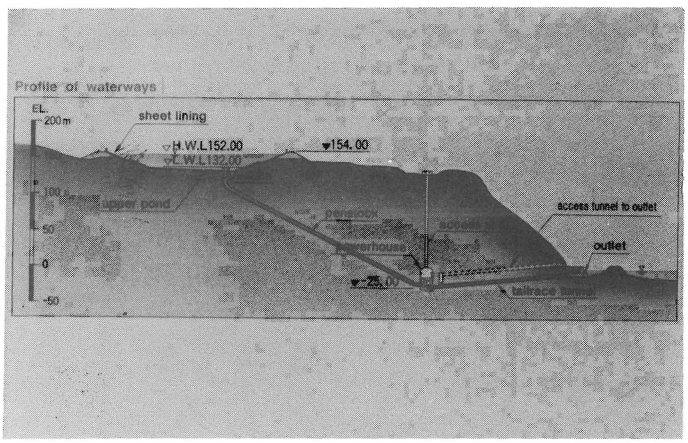
i) possible manufacturing widths;

ii) negative pressure during strong winds when empty; and

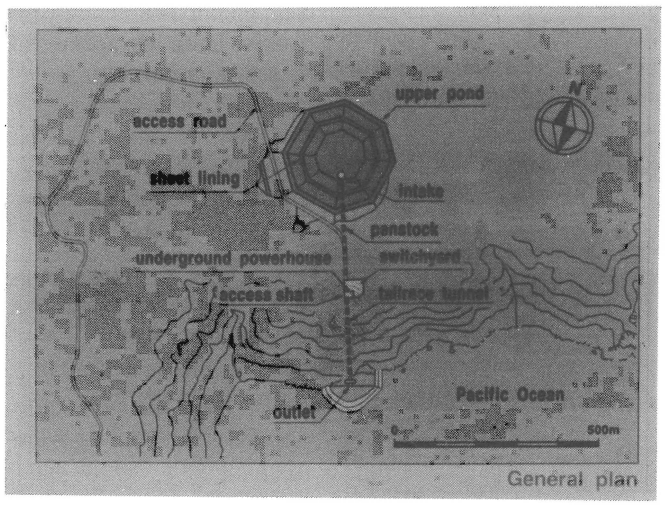
iii) zoning for leakage detection.

This design involved on-site adhesion joints between the panels and a stable structure for anchoring the panels with U-shaped concrete blocks filled with concrete. A full-scale field test has been conducted to verify this lining structure. The test structure remained stable against actual typhoon winds of 41 m/s. Having many anchors, increases the risk of reducing watertightness. For this reason, a cover sheet of the same material as the geomembrane is adhered to the main geomembrane liner. The results of cyclic water pressure tests on adhered parts of a cover sheet showed that a watertight joint can be created by using a butyl tape, which slowly vulcanizes after application.

Excavation and dam construction were completed in August 1994. Placement of the gallery concrete was completed thereafter. Lining work commenced in November 1994, and should be finished by the end of 1995. Plant operation is currently scheduled for 1998.



Profile view of sea-water pumped storeage project.



Plan view of sea-water pumped storeage project.

Geosynthetics '97 Planning Underway for Long Beach, California, USA

Geosynthetics '97 will be held in Long Beach, California, USA in 1997. Because it will precede the 7th International Geosynthetics Conference by only one year, the organizers will not hold an open call for papers. Instead, the subject matter for the conference will be predetermined by the organizers, and speakers invited to address the attendees on a number of themes.

Suggestions for session themes may be submitted to the Organizing Committee Chairs, Mr. Larry Well (Tel: 1 (503) 235-5033), or Mr. Rick Theil (Tel: 1 (916) 928-3300). They may also be contacted with suggestions, and offers to assist with the conference.

General information on the conference may be obtained from Mr. Joseph A. Dieltz, IFAI, 345 Cedar St., Suite 800, St. Paul, MN, 55101-1088, USA (Tel: 1 (612) 222-2508, Fax: 1 (612) 222-8215).

Geosynthetics Bibliography Available

Volume 2 joins Volume 1 of the Geosynthetics Bibliography - now available from the Industrial Fabrics Association International. This comprehensive bibliography contains listings from books on geosynthetics, papers in over 400 different technical publications, research reports, as well as special listings of publications by over 100 prolific authors of geosynthetic literature. Volume 1 and Volume 2 are both available. Either volume costs US$79.00 for IGS and IFAI members or US$99.00 for all others. Shipping costs per volume are ($US):

USA $5.00
Canada $10.00
Central America $17.00
Europe and South America $30.00
all other locations $42.00

Orders may be placed with IFAI, 345 Cedar St., Suite 800, Minneapolis, MN, 55101-1088, USA (Fax 1)612) 222-8215).

IGS Lifetime Membership Awarded to Gert den Hoedt

Mr. Gert den Hoedt has been awarded the Lifetime Honorary Membership in the International Geosynthetics Society. Mr. den Hoedt received the award for his significant contributions to the IGS and to the discipline over the previous 25 years. Mr. den Hoedt has been a member, supporter and tireless worker for the IGS for many years. His contributions are very much appreciated. The award was presented by then-IGS President R. Kerry Rowe. The presentation was made at the 5th International Conference on Geosynthetics, in Singapore, in 1994. Mr. den Hoedt resides in The Netherlands.

This award is one of the highest honors that the IGS bestows on its members. Only Professor Charles Schaerer (Switzerland) in 1987, and Professor Masami Fukuoka (Japan) in 1989 have previously been awarded honorary membership.

Mr. den Hoedt (l.) receives his award from Dr. Rowe.

photo courtesy of S. Meeker Bradford

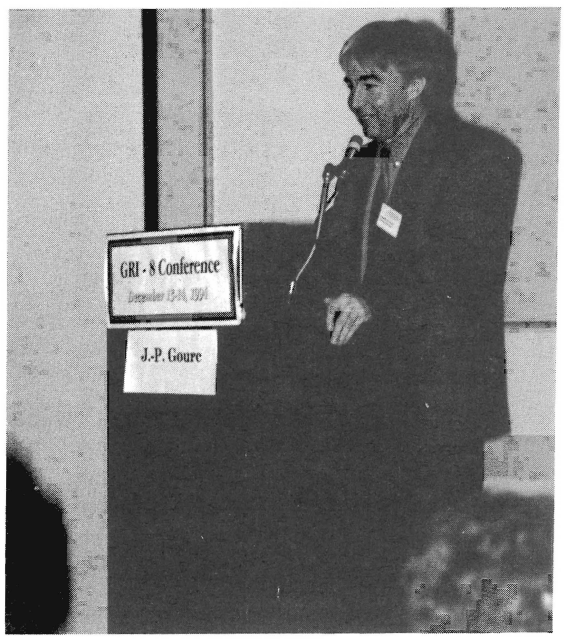
The 1994 Mercer Lecture

Dr. J-P. Gourc was the 1994 Mercer Lecturer. Dr. Gourc, of the University of Grenoble, France, delivered the three lectures that constitute the Mercer Lecture. His topic was "Geosynthetics and Environmental Engineering".

The first lecture was delivered at the 13th International Conference on Soil Mechanics and Foundation Engineering in New Delhi, India, in January 1994. The second took place at the Pollutec exhibition and seminar program in Lyon, France (October 1994). The third and final lecture was given in Philadelphia, Pennsylvania, USA (December 1994).

Dr. Gourc's double-screen lecture was a wide-ranging review of the applications of geosynthetics in environmental applications including landfills, erosion control, off-shore sediment control, and aesthetically pleasing facings on steep slopes and walls. Dr. Gourc was given a comprehensive introduction at Drexel by Dr. J.P. Giroud, and a standing ovation by more than 200 attendees.

reported by
J. Paul and G. Koerner



Dr. Gourc delivering the Mercer Lecture at Drexel University

Engineering and Science Award Winner: Alice Comer

Alice I. Comer, a Materials Engineer for the U.S. Bureau of Reclamation in Denver, is the recipient of the 1995 Engineer Achievement of the Year award for the Women in Engineering and Science program. Competition for this prestigious award is very high, with only one federal employee selected nationwide in the Engineer Achievement category. She specializes in the use of geosynthetic materials to conserve water, contain hazardous waste, and provide erosion protection and control.

Comer was presented her award at a national conference held in Washington, D.C. on 27 March 1995.

Ms. Comer, award winner.

Development of European Standards for Geosynthetics and Harmonization of Standards in EU Countries

Dr. John Greenwood, ERA Technology Ltd., UK

A recent marketing survey identified the lack of harmonized standards and classification systems as the cause of over forty percent of problems experienced in relation to the export of geotextiles from EU countries. These polymeric products are used increasingly to resolve filtration, separation, drainage and soil reinforcement problems that civil engineers have vexed engineers.

European Standards committee CEN TC 189 has been working intensively for four years on the development and harmonization of geotextile standards for use throughout Europe. Some of this work has met with problems that can only be overcome by experimental testing, whether it be the development of a new method, setting of parameters, validation of an accelerated test or simply gaining international credibility for a national standard.

This new project, which is supported by the Measurement and Testing Program of the European Union with a total budget of over 600,000 ecus, aims to resolve these problems by a series of nine tasks involving twenty-eight organizations in nine European countries. Co-ordinated by ERA Technology of the UK, the project will run for two and a half years, although many of the tasks will be completed earlier. Each task aims at recommending a new or revised procedure as the basis for a European Standard. Particular attention is being given to "index tests". These apply to all geosynthetics, are independent of the individual site conditions and, in the case of durability, can either be extrapolated or will ensure a certain minimum level of long-term environmental resistance.

The first task, led by the German institute tBU, will examine the parameters necessary to design a harmonized test for tensile creep, in particular the minimum width of the specimen that will give a result representative of a full width sample, of "technically representative width". This can vary widely from one type of a geosynthetic to another.

The second task, led by Maunsells of the UK in collaboration with RDP (Tenax) in Italy and Akzo in The Netherlands, will examine the compressive creep test for typical drainage materials. They will study, in particular, the sensitivity of the method to specimen shape and size, to the addition of shear force, and to a liquid or air environment. They will also optimize the test duration.

Task three, led by the Universite Joseph Fourier at Grenoble, in France, together with tBU, will compare the direct shear and inclined plane methods for measuring friction between different types of geotextiles and geomembranes and their sensitivity to six experimental parameters.

The Belgian Research Station for Agricultural Engineering will lead the fourth task which will test the reproducibility of the permeability test and its sensitivity to parameters such as temperature and water quality. Mr. W. Dierickx, leader of this task, is also chairman of CEN TC 189.

Drainage materials will also be examined in Task 5, led by the UK's British Textile Technology Group. They will work with CEMAGREF in France and the Portuguese National Civil Engineering Laboratory (LNEC). The proposed test for in-plane water flow or transmissivity will be examined with reference to the apparatus used, form type, time, temperature and water quality.

Now that the wet sieving test has been proposed as the sole method for determining the filtration opening size or porometry of a geotextile filter, Task 6 also led by Grenoble University, will evaluate the test parameters which give the best reproducibility, and will advise on the method of interpretation.

Tasks 7 and 8 will both be led by the German Federal Institute for Materials Research and Testing (BAM). In Task 7, performed together with the corresponding Swiss Institute (EMPA), an accelerated weathering test will be chosen and optimized. It will then be compared with natural weathering tests on both stabilized and unstabilized materials in the south of France. The program for developing tests for chemical resistance, Task 8, in which ERA, Akzo, and Dutch laboratory TNO participate, is the most complex of all. It includes the exposure of a variety of geotextiles to acid, alkaline, and oxidizing environments at elevated temperatures in an attempt to derive a suitable short-term screening test that will ensure a minimum level of long-term resistance to soil environments. Particular attention is being paid to the resistance of polyesters to hydrolysis, and of polyolefins to oxidation. Longer term exposure at lower temperatures will assist in validating the accelerated tests.

In Task 9, led by German Laboratory LGA working with the small UK company Euro Laboratories, the soil burial method, already in use to test the resistance of plastics to microorganisms in the soil, will be tried out on geotextiles and advice given on its applicability and interpretation.

Several of the tasks described are followed by "intercomparison tests" in which a wider group of laboratories will perform the method developed and compare their results. The results of the work will be communicated first to the standards committees and will then be published in the open literature.

Any questions should be directed to the coordinator, Dr. John Greenwood, ERA Technology Ltd., Cleeve Road, Leatherhead, Surrey KT22 7SA, UK. Tel.: 44 (0) 372-367005, Fax: 44 (0) 372-367099.

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Instructions to authors are available from Dr. Nigel John.

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Calendar of Events

IDEA '95; Philadelphia, PA, USA, 25-27 Apr 1995
The International Nonwovens Conference and Exhibition
Contact: Association of the Nonwoven Fabrics Industry, 1001 Winstead Dr., Suite 460, Cary, NC 27513, USA
Tel: 1 (919) 677-0060 Fax: 1 (919) 677-0211

Geotechnica 1995; Cologne, Germany, 2-5 May 1995
Contact: Georg Breer, Messe-und Ausstellungs GmbH Koln
Postfach 21 07 60, D-50532 Koln, GERMANY
Tel: (416) 598-3343 Fax: (416) 598-1840

The Practice of Soil Reinforcing in Europe; London, UK, 18 May 1995
Contact: Dr. S. S. Dikran, PO Box 111, Tunbridge Wells, Kent, TN4 0PZ, UK
Tel: +44 1892 547055 Fax: +44 1892 531116

Symposium on Recent Developments in Geotextile Filters and Prefabricated Drainage Composites; Denver, Colorado, USA, 20 Jun 1995
Contact: Bob Held, ASTM, 1916 Race St., Philadelphia, PA 19103-1187, USA
Tel: 1 (215) 299-5504 Fax: 1 (215) 299-2630

Geossinteticos '95 - 2nd Brazilian Conference on Geosynthetics; Sao Paulo, Brazil, 26-28 Jun 1995,
Contact: Secretariat ABMS, IPT-Predio da Geotechnica, Caixa Posta 7141, 01064 Sao Paula-SP, BRAZIL
Fax: 11-55 (11) 815-2285

Canadian Geotechnical Conference - Trends in Geotechnique; Vancouver, British Columbia, Canada 25-27 September 1995
Contact: Bryan D. Watts, Chair, 10200 Shellbridge Way, Richmond, BC V6X 2W7, CANADA
Tel: 604 279-4325 Fax: 604 279-4300

Rencontres '95 - Geotextiles et Geomembranes; Beaune, France, 27-28 Sep 1995
Contact: Secretariat Rencontres '95, BP 100, 9 rue Marcel Paul, 95873 Bezons Cedex, FRANCE
Tel: (1) 34 23 53 73 Fax: (1) 34 23 53 70

Sardinia '95 Fifth International Landfill Symposium; Cagliari, Sardinia, Italy, 2-6 Oct 1995
Contact: G.M. Motzo, CISA - Environmental Sanitary Engineering Centre, Via Marengo 34, 09123 CAGLIARI, ITALY
Tel: 39 (70) 271-652 Fax: 39 (70) 271-371

Bengt B. Broms Symposium in Geotechnical Engineering; Singapore, 13-16 Dec 1995
Contact: Ms. Annabel Ooi, Bengt B. Broms Symposium Secretariat, c/o Center for Continuing Education, Nanyang Technological University, Nanyang Avenue
SINGAPORE 2263.

Geosynthetics in Infrastructure Enhancement and Remediation; Philadelphia, Pennsylvania, USA, 12-13 Dec 1995
Contact: Geosynthetic Research Institute, Drexel University, West Wing - Rush Bldg., Philadelphia, PA, USA, 19104
Tel.: 1 (215) 895-2343, Fax: 1 (215) 895-1437.
Philadelphia, PA, USA

Geofilters '96 Second International Conference on Filtration and Drainage in Geotechnical Engineering; Montreal, Quebec, Canada, 29-31 May 1996
Contact: Conference Secretariat GEOFILTERS '96, c/o Service des Congres, Ecole Polytechnique, Campus de l'Universite of Montreal, C.P. 6079 Succursale Centre Ville, Montreal, Quebec, CANADA
Tel: 1 (514) 340-3215 Fax: 1 (514) 340-4440

Third International Symposium on Environmental Geotechnology; San Diego, California, USA, 10-12 Jun 1996
Contact: H.Y. Fang, Lehigh University, Department of Civil and Environmental Engineering, Fritz Engineering Laboratory, 13e Packer Ave., Bethlehem, PA 18015-3176, USA
Tel: 1 (610) 758-3566 Fax: 1 (610) 758-4522

First European Conference on Geosynthetics; Maastricht, The Netherlands, 30 Sep-2 Oct 1996
Contact: NGO, Hoofdstraat 2, 2351 AJ Leiderdrop, THE NETHERLANDS
Fax: 31 (71) 896663

IS- Kyushu '96 Third International Symposium on Earth Reinforcement; Fukuoka, Kyushu, Japan, 12-14 Nov 1996,
Contact: Prof. Ochiai, Dept. of Civil Engineering, Kyushu University, 6-10-1 Hakozaki, Hagashi-ku, Fukuoka 812, JAPAN
Tel: 81 (92) 641-1101 Fax: 81 (92) 641-5195

Sixth International Conference on Geosynthetics; Atlanta, Georgia, USA, 25-29 Mar 1998
Contact: Joseph Dieltz, IFAI, 345 Cedar St., Suite 800, St. Paul, MN 55101-1088, USA
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(2) to improve communication and understanding regarding geotextiles, geomembranes, related products, and associated technologies, as well as their applications;
(3) to promote advancement of the state of the art of geotextiles, geomembranes, related products, and associated technologies;
(4) to encourage through its members the harmonization of test methods, equipment and criteria for geotextiles, geomembranes, related products and associated technologies.

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- Provides a forum for designers, manufacturers, and users, where new ideas can be exchanged and contacts improved.

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"GEOSYNTHETIC" REVIEW OF OFFICIAL DOCUMENTS ISSUED BY INTERNATIONAL ASSOCIATIONS

by

D. Cazzuffi, ENEL Spa – CRIS, Milano, Italy

R. Jappelli, University of Roma Tor Vergata, Italy

Introduction

Over the last several years a number of international associations have seen an evolution in the design and construction methods employed in civil/geotechnical engineering applications due in part to the use of geosynthetics.

International working groups comprising members of these associations have been routinely tasked to prepare or update state-of-the-art technical documents for a variety of applications. Examples are: the Permanent International Association of Navigation Congresses (PIANC) for bank protection, both for inland waterways and marine environments; and the International Commission on Large Dams (ICOLD) for hydraulic retaining structures such as dams and reservoirs.

Each of these documents is focused on specific fields of civil engineering such as river banks, dams, canals, roads, landfills and so on. These documents are not specifically concerned with geosynthetics and hence are not generally known to the geosynthetics community. However, many of them contain important information on theory, design, construction and specification of geosynthetics in different applications.

The authors reviewed a majority of these international association documents and presented their summaries at the Fifth Italian Conference on Geosynthetics for Earth Structures held in Bologna. Subsequently, the Council of the International Geosynthetics Society (IGS) asked the IGS Standards Committee, chaired by D. Cazzuffi, to translate the original Italian document by R. Jappelli and D. Cazzuffi into English.

This supplement to IGS News is an abbreviated version of the original Italian document and has been specially prepared for IGS members.

Organization

Each document was reviewed with respect to each of the following principal *function* categories for geosynthetics: drainage, filtration, reinforcement, separation, erosion control and fluid barrier. Where applicable, secondary functions were also identified. A summary of the reviewed documents is given in **Table 1**.

CIRIA (1991) – DRAINAGE

Geosynthetics for drainage are the main subject of the specifications issued by the Construction Industry Research and Information Association (CIRIA) in 1991. This document is a state-of-the-art report for the design of vertical drains. These drains are installed in foundation soils to accelerate soil consolidation. Design methods consider anisotropy in soil permeability which is typical in clay deposits.

General design criteria based on site soils and applications are reviewed and advantages and disadvantages of different treatments are discussed. Simple graphs are provided to establish distances between drain centres. The graphs are based on the degree of consolidation or consolidation time and soil boundary conditions.

Practical recommendations based on published case studies from around the world are included. The influence of gradual application of surface loads, secondary consolidation effects, typical composition of the subsoil, and resistance to movement along the vertical drain axis on drain performance are addressed. Experimental methods for prediction of surface settlements are provided.

A rational comparison of granular drains and prefabricated vertical drains manufactured with synthetic materials is particularly valuable. This comparison is important when the designer must consider geometrical and mechanical properties of the drain. It is noted, for example, that the synthetic drainage medium can reinforce the drain which may be important during installation. In addition, synthetic drains can limit soil disturbance when compared to traditional granular drainage columns. However, prefabricated drains may degrade due to environmental agents and hence may have a short design life when compared to granular drains. Nevertheless, degradation is not as great a concern for polymeric synthetic drains as compared to drains that incorporate paper filter elements. The choice of drain is strongly dependent on the time required to achieve the design degree of consolidation.

Emphasis is placed on the need for: adequate site investigations; care during installation; and performance monitoring of drains. The report identifies the need to set up project-specific qualification and acceptance standards for the many commercially available synthetic drain systems on the market.

Finally, the document stresses that rational design of vertical drains requires further research and experimental study both in the laboratory and in the field.

ICOLD (1986) – FILTRATION

Bulletin 55, published by the International Commission on Large Dams (ICOLD) in 1986, offers a comprehensive state-of-the-art review of geosynthetics for filtration applications.

The document begins with an overview of the possible location of filters in a typical embankment dam and summarizes the principles of filter design. The effects of variations in porosity, and other factors along discontinuities and, more generally, in the vicinity of flow concentrations are described. The influence of the duration and direction of flow on potential clogging is described. The influence of flow reversals are also mentioned. In the absence of rigorous methods, practical criteria for defining the service limit states of a filter are proposed.

The ultimate limit state of suffusion is illustrated with regard to the most significant factors upon which this phenomenon depends.

In order to protect non-cohesive materials, the Bulletin recommends that a geotextile be used with a minimum opening size corresponding to the d_{85} particle size of the surrounding soil. The use of geotextiles with smaller openings is suggested for well-graded materials in order to minimize particle migration which may occur before stabilization. Caution is also required to select the appropriate geotextile to protect gap-graded granular soils and when there are reversing fluid flows through the geotextile. The recommended ratio of the permeability of the geotextile to the permeability of the base material is 100. This value is at least one order of magnitude greater than the value normally recommended when the filter consists of traditional granular materials.

The Bulletin examines design considerations that are often overlooked when comparing geosynthetic filters and traditional granular filters in permanent dam applications. When geotextiles are used, the designer must consider homogeneity, continuity, thickness, creep resistance, and durability of the geotextile, as well as, its resistance to seismic action and installation damage. Care must be taken during transportation and installation to avoid tears or damage to the geotextile that could trigger piping phenomena.

In conclusion, the recommendations for filtration design are based on widely accepted practice. According to ICOLD, current practice for geotextile filters in temporary structures and in non-critical locations within permanent structures is acceptable. However, more experience is required before geotextile filters can be used in more critical structures.

The General Report on the Q67 at the ICOLD Congress in Vienna (1991) stated:

"Geotextiles have only been in use within the construction industry for about twenty years. In view of the long service life of a dam, this relatively brief period explains the reservation with which these materials have so far met in dam construction".

However, the prospects for the use of geotextiles as filters in dams must be rationally evaluated in relation to the consequences of failures and to the possibility of repair or replacement work.

Finally, the Bulletin requires updating in order to take into consideration the research performed on the subject in recent years.

Table 1

DRAINAGE

CIRIA (1991) – Prefabricated vertical drains: Design and performance

FILTRATION

ICOLD (1986) – Geotextiles as filters and transitions in fill dams

REINFORCEMENT and SEPARATION

OECD (1989) – Ground engineering applications of geotextiles in road construction and maintenance

EROSION CONTROL

PIANC (1987) – Guidelines for the design and construction of flexible revetments incorporating geotextiles for inland waterways (PTCI–WG4)

PIANC (1992) – Guidelines for the design and construction of flexible revetments incorporating geotextiles in marine environment (PTCII–WG21)

PIARC (1991) – Soil erosion during and after roadway construction

FLUID BARRIER

ICOLD (1991) – Watertight geomembranes for dams. State-of-the-art

ICID (1990) – Use of flexible geomembranes for irrigation canal and reservoir lining

ISSMFE (1991, 1993) – Geotechnics of landfills. Design and remedial work

Legend:

CIRIA:	Construction Industry Research and Information Association
ICID:	International Commission on Irrigation and Drainage
ICOLD:	International Commission on Large Dams
ISSMFE:	International Society of Soil Mechanics and Foundation Engineering
OECD:	Organisation for Economic Cooperation and Development
PIANC:	Permanent International Association of Navigation Congresses
PIARC:	Permanent International Association of Road Congresses

OECD (1989) – REINFORCEMENT and SEPARATION

This document was prepared by a special working group of the Organisation for Economic Cooperation and

Development (OECD). It deals with applications of geotextiles in highway structures and focuses on design, construction and performance issues. The work can be considered a state-of-the-art report. In addition to the properties of geosynthetics, a summary of applications related to embankments, slopes and retaining structures is included. Applications related to drainage and waterproofing of road tunnels, and to road pavements are beyond the scope of the document.

Reference is made to the drainage, filtration, separation and protection functions of geotextiles, in addition to the main focus of the report which is reinforcement applications. A collection of case studies is contained in the appendix. The specification of geotextiles for separation applications are of particular interest. The document places appropriate emphasis on the use of geotextiles for road construction on marginal land.

Design methods are presented in a step-by-step format. Formulae and graphs, while not always clear, describe the ways in which geotextiles affect mechanical behaviour, particularly with respect to bearing capacity and settlements. Limit-equilibrium based design methods are the most common approach in this document. Consequently, the importance of properly evaluating the mechanical strength of geotextiles is emphasized. Nevertheless, the authors of the document express the hope that deformation based methods of design will be developed in the future.

At the end of document the economic benefits and the general advantages of using geotextiles are stated. However, the need for further research particularly on the topic of durability is noted.

PIANC (1987) – EROSION CONTROL

The guidelines proposed by the Permanent International Association of Navigation Congresses (PIANC) in 1987 (PTCI–WG4) on the subject of erosion control of inland waterways are clearly and thoroughly presented in this document.

The function of revetments in waterway applications is to protect the banks against the effects of wave action induced by boats. These structures may be complex in design and often incorporate a geotextile. The revetments must provide a stable interface between the natural soil and the moving water in the waterway. According to the authors of the report, several functions are performed by the geosynthetic materials– the most important is filtration. Drainage and separation functions are of secondary importance and reinforcement is not essential in this type of application.

The report provides an introductory section on the basic data required for the design of waterway revetments and illustrates the design stages which include defining performance objectives and specifying the hydraulic and geotechnical boundary conditions. Wave action by passing boats must be established first. This step is followed by close attention to soil-structure interaction and related design calculations. For example, the interface surface between a geosynthetic and the soil should not allow for sliding and the geotextile should remain in intimate contact with the soil during its service life.

The authors provide formulae to convert complex hydraulic actions, that occur during service conditions, into equivalent forces. The response of the foundation soil to these actions is evaluated with respect to pore water pressures and the resulting forces on the revetments. The latter depend on the characteristics of the impinging waves, and thickness and relative permeability of the protective layer compared to those of the substrate. The effect of repeated wave action is an important issue under normal operating conditions and strategies to mitigate the effects of repeated wave action are described. The defence functions that the revetment and the geotextile perform with respect to various overall and local mechanisms (breakage, deformation, alterations) which may occur in the soil-revetment system, are described.

A critical comparison of different design methods and construction specifications using geotextiles in waterway revetment applications is presented. The document recommends that products be specified using performance criteria and not by their commercial names. Finally, recommendations are given for drafting specifications for construction details, quality control and supervision. The importance of regular inspection during the life of the revetment is emphasized.

Potential topics of research identified in the report are: the analysis of pore water pressure generation in waterway banks during rapidly changing external hydraulic action; and a study of the criteria for evaluating the capacity of geocomposite structures in attenuating peak pore water pressures.

PIANC (1992) – EROSION CONTROL

The PIANC report, entitled "Guidelines for the design and construction of flexible revetments incorporating geotextiles in marine environment", published in 1992 by the PTCII–WG21, provides a clear and detailed treatment of the subject and goes beyond the narrow limits of the specific application. The document presentation is similar to the document published in 1987 by PIANC–PTCI–WG4 on inland waterways design. This later work extends the earlier document and includes revetments in marine environments.

The revetments under consideration are defined as systems of structures formed by natural or artificial materials, which are installed to perform an erosion control function in a natural coast or a coastal structure, subjected to the action of the marine environment. As in the PIANC document on inland waterways, rigid and impermeable revetments are excluded.

The essential components of a flexible revetment for maritime application are: the base layer in contact with the foundation soil or with the structure to be protected; the external protection; and the system of intermediate layers that perform a filtration function. The latter may include geotextiles which are often used in place of granular materials.

The report is divided into five parts. The first part describes the materials and the systems commonly used in

protecting coastlines. The filtration function of a flexible revetment is very important. This function can be performed either by granular materials or by geotextiles. Next there follows a detailed discussion of the design process, which includes: defining the essential requirements; identifying limit states; assessing mechanical response models; selecting between deterministic and probabilistic approaches; and performing risk analysis.

The next section includes a discussion of the fundamental data required for preparing design activity, the geometric, hydraulic and geotechnical properties of the site and the effects of corresponding hydraulic and geotechnical actions on the structure being designed. General comments are made related to issues of environmental impact. An important part of the guidelines is devoted to methods to predict the response of the revetment-soil system to wave action. The final part of the document deals with construction techniques, specifications, and cost-benefit analyses.

The report extends the scope of the previous PIANC report (1987) to effects of coastal winds, currents, tides, and waves on the geotechnical response of marine revetments. It presents an overview of the design criteria currently in use and identifies durability issues related to geotextiles in aggressive marine environments. Possible local and general failure mechanisms for revetments subjected to wave action are identified. Advanced soil mechanics and hydraulics theories that consider the geometry of the revetment are reviewed. Transition layers are explained. These may be used to cushion waves acting against the revetments in addition to performing a filtration function.

A detailed description is given of the phenomenon of soil particle movement due to high piezometric gradients brought about by wave action within a granular material and by the contact of the latter with external protection layers.

Comparison of solutions to revetment design problems using geotextiles and granular materials are presented. For example, a geotextile can perform the separation function as well as a granular material. However, the natural cushioning effect of a thick layer of granular material, during dynamic wave action is difficult to achieve with geosynthetic materials. In addition, the use of a geosynthetic in a marine environment requires a highly resistant and durable product. More generally, the advantages of granular materials compared to geotextiles are: the ability to self-seal; durability and high unit weight; excellent interface contact between underlying and overlying materials; and the possibility of easy repair work. The disadvantages are: the requirement for large thickness; the difficulty in placing materials below sea level and the relatively high cost in some situations.

While geosynthetics have the advantage of minimal thickness and high tensile strength they may have the disadvantage of being difficult to place in intimate contact with other materials and the possibility of damage during installation. The long-term performance of geosynthetics in a marine environment is still the subject of experimental research.

The ecological impact of different design solutions is addressed in part by reviewing the abilities of granular and geosynthetic materials to host marine flora and fauna.

The document concludes with a useful and detailed design check list including all design parameters that must be selected by the engineer. For example: the choice of the slope angle; berms; the thickness and relative permeability of the component layers; the roughness of the external surface; the properties of wave protection rip rap; the resistance to wear, fatigue, and more generally, resistance to ageing of exposed component materials. This checklist is followed by a long list of other questions of a political, economic and practical nature which nevertheless have an impact on project design.

Other topics contained in the document include risk analysis, monitoring, service, maintenance and environmental questions. Finally, the appendices include examples of design and the assessment of the performance of some existing structures.

PIARC (1991) – EROSION CONTROL

A section of this report prepared by the PIARC Technical Committee on Earthworks, Drainage and Subgrade is focused on the prevention of erosion caused by atmospheric precipitation on unprotected soils during and after roadway construction. This is a very widespread phenomenon and can cause considerable damage that may extend well beyond the construction site. The greatest percentage of total erosion of surface soil from earthwork projects usually occurs during construction.

Various types of erosion phenomena are classified and formulae are presented that can be used to estimate slope erosion. These formulae are derived largely from agricultural research and take into consideration the effect of: the energy and intensity of the rain; the intrinsic erosion potential of the soil; topographical factors, including the length and slope of the exposed surface; and the effectiveness of any existing surface protection. The solutions to formulae are presented as nomographs based on soil type.

Various methods which can be used to protect slopes from erosion are presented. Re-establishing the natural vegetative cover is the preferred approach. Where vegetation cannot take root, defence systems which involve temporary or permanent structures, such as berms, hedges, drains and sedimentation basins, may be required.

Geosynthetic materials are mentioned for both temporary and permanent erosion control applications. Examples are: three-dimensional nets (geomats); and cellular confinement systems (geocells). The selection of a particular product may be influenced by soil type, slope angle and climatic conditions. Regardless of the product type, the geosynthetic material is covered by organic soil to promote vegetation growth. The use of nonwoven geotextile sandwiches incorporating seeds is also recommended. However, some products may have a limited life, if exposed to ultraviolet radiation. Natural textile products, such as biodegradable geotextiles formed by filaments of jute, are also discussed.

ICOLD (1991) – FLUID BARRIER

A summary of the state of the art for geomembranes as they apply to waterproofing of dams is the subject of the Bulletin 78 published by ICOLD in 1991. This is a revision of Bulletin 38 published about ten years before.

Although geomembranes can also be used inside the dam, Bulletin 78 considers their use as an external facing only, where inspection, maintenance and possibly replacement are relatively easy. The development of this technology has been made possible by combining geomembranes (whose primary function remains as a fluid barrier) with other geosynthetics or granular materials that may provide drainage, reinforcement and/or protection functions.

The document illustrates the various types of geomembranes available. For example: polymeric or bituminous; prefabricated or prepared on-site. The mechanical properties and durability of the products can be modified during production by means of appropriate additives to give a project specific product.

The Bulletin also contains an overview of the test methods recommended for controlling the quality of the products and checking the resistance of a product to mechanical damage and environmental attack. Welding of geomembranes is recommended. It is pointed out that a geomembrane can be considered to be practically impermeable for dam surface applications, although permeability can increase considerably under conditions of stress relief. Therefore, significant losses may occur if the geomembrane is damaged or stretched.

The factors that influence ageing are listed and their relative significance identified. Long-term durability depends not only on the intrinsic properties of the geomembrane, but also on the installation techniques and the measures adopted to permanently protect the geomembrane. The document recommends that the possibility of replacement of the geomembrane during the service life of the dam must not be overlooked.

For major dams, a double fluid barrier system is recommended comprising two geomembranes separated by a drain with a controlled flow outlet.

Design calculations contained in the document address stability and deformations of the facing caused by mechanical actions. It is recommended that the design of the dam behind the surface fluid barrier consider the consequences of failure of the water proofing system.

Recommendations are given on how best to attach the geomembrane to the dam face. Mechanical protection of the geomembrane is advised in major structures and this may involve an overlying protection material. However, there may be a need at some time during the life of the barrier system to remove the protective layer in order to inspect, repair or even replace the geomembrane. Nevertheless, according to the authors of the Bulletin, the use of unprotected geomembranes will be more frequent in the future, particularly in those cases where they can be placed over relatively rigid and non-erodible surfaces. An underlying protection layer (cushion) is always recommended when a geomembrane is in direct contact with granular materials forming an embankment dam.

The many successful installations of geomembranes as surface fluid barriers has led ICOLD to express the important opinion that the 30 m height restriction contained in the 1981 edition is unnecessary. However, when there is a threat to public safety due to failure of a geomembrane, ICOLD recommends a second fluid barrier system. Regardless of the final selection of the number and type of fluid barriers, the dam should be designed and built to enable rapid repair.

It should be noted that geomembranes for dam waterproofing have been in use for about 30 years at some major sites. The first application was the ENEL Contrada Sabetta dam, built in Italy in 1959, for which waterproofing was provided by a system consisting of a polyisobutylene geomembrane protected by concrete slabs.

Finally, it should be noted that the ICOLD guidelines for large dams are also valid for small dams, basins and reservoirs.

ICID (1990) – FLUID BARRIER

The fluid barrier function performed by flexible geomembranes, applied to the banks of canals and small reservoirs for irrigation purposes, is the subject of a report prepared by a working group of the International Commission on Irrigation and Drainage (ICID).

This work is simple and clear in its presentation of the subject matter. Polymeric geomembranes, both elastomeric and plastomeric, are considered. A distinction is made between cases in which the geomembranes are directly exposed to the atmosphere and when they are protected by different materials (soil, precast or cast concrete). These protective materials provide protection from heat and ultraviolet radiation and from various forms of mechanical attack.

Consideration is also given to the case in which the subsoil (e.g. loess, chalk) is sensitive to the action of water and when the contacting liquid is a pollutant (e.g. from a landfill). In the latter case a more complicated system composed of two geomembranes incorporating a drain is recommended.

Ageing, exposure to high temperatures and to ultraviolet radiation, may bring about a reduction in resistance, loss of flexibility and elasticity of any geomembrane. The acceptance limits for these materials are therefore related to: the degree of exposure (ranging from fully exposed to completely protected); climate (torrid, hot, moderate, cold); and service life of the structure (e.g. less than 10 years, at least 30 years). In order to predict long-term performance, artificial ageing tests using specimens subjected to laboratory controlled ultraviolet radiation and temperature may be required. The design and installation of geomembranes around appurtenances is described in the document.

The standard points out that the specifications must focus on performance rather than constituent components of candidate products, so as to allow an objective comparison to be made between the different materials.

ISSMFE (1991, 1993) – FLUID BARRIER

Geosynthetic materials play an important role in solving liquid confinement problems in landfill applications. The primary function in landfill applications is to provide one or more fluid barriers (usually performed by geomembranes). A drainage function may also be required (usually performed by geonet or geocomposite drains).

The recommendations for the use of geosynthetic materials in landfills have been formulated by the European Technical Committee ETC8 of the International Society of Soil Mechanics and Foundation Engineering. The recommendations were first published by the Deutsche Gesellschaft for Erd– und Grundbau and were presented during the European Soil Mechanics Conference in Florence in 1991. A second edition was published in 1993.

The task of confining wastes from the surrounding environment is assigned to a geocomposite material, in which the waterproofing function is performed primarily by a geomembrane combined with fine-grained materials and/or other geosynthetics. This system should be designed to provide maximum safety against possible contamination of the environment due to any leachate.

The publication draws attention to the limit states which may occur in the short and long term in a porous material through which fluids with unusual chemical properties flow. These phenomena include possible modification of the solid phase due to leaching, variation in porosity due to solid deposits in the pores and contamination through diffusion.

As a result of exothermal chemical reactions, the temperature within a landfill may reach high values which may effect the ultimate strength and deformability of the geosynthetic materials comprising waterproofing and drainage systems. Sliding resistance is of particular importance in the vicinity of containment slopes.

Importance is also placed on the ability of a geomembrane to deform particularly when they are used to cap deposits of heterogeneous and highly deformable materials (landfill closure).

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