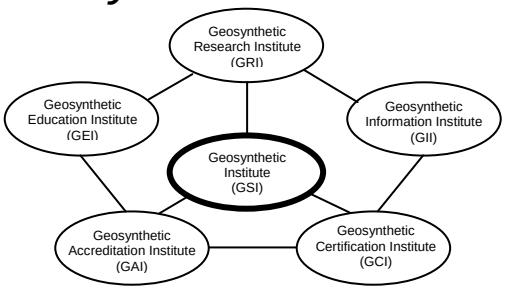
The GSI Newsletter/Report

Geosynthetic Institute



Vol. 18, No. 4 **December 2004**

This quarterly newsletter, now in its 18h year, presents the activities of GSI and its related institutes to all who are interested. It is available on the institute's home page at www.geosynthetic-institute.org. It also serves as a quarterly report to its member organizations. Details are available by contacting Robert M. Koerner or Marilyn Ashley at phone (610) 522-8440; fax (610) 522-8441 or e-mail at robert.koerner@coe.drexel.edu or mashley@dca.net.

Happy Holidays and a Healthy and Prosperous New Year

Activities of the GSI Board of Directors & Institute Director

1. Arrangements for GeoFrontiers in Austin, Texas are essentially complete with the GRI-18 Conference set for Wednesday, January 26, 2005. Seventy papers are on the CD, twenty will be orally presented, and two panels will have five speakers each. Please join us as we try to formulate future R & D needs in geosynthetics.
2. The GSI Annual Meeting will immediately follow the above noted conference. If you have agenda items please advise accordingly.
3. There will be four Focus Group Meetings in Austin; GCLs, consultants/test laboratories, geotextile/geogrid, and geomembrane/resin producers. Please see our GSI Website for specific details.
4. A new relationship with GMA insofar as a on-line E-mail answering service will be announced in GFR magazine this month. It will be immediately operational. [The venture should be interesting, to say the least].
5. Sincere congratulations to Dr. Rex Bobsein of Chevron/Phillips and Mr. Kent von Maubeuge of Naue Fasertechnik for being re-elected to the GSI Board of Directors representing the resin producers and international members, respectively. We are presently finalizing the position which represents Federal Agencies. Thus, the current board members are as follows:

NOTICE: This Newsletter/Report is mailed to the contact persons of the GSI member organizations (~ 100 total). Obviously, we wish you would share it with colleagues and friends. Please recognize, however, that it is always available on our Home Page at www.geosynthetic-institute.org in the open section under the heading "Newsletter/Report".

Term Ends 2005
Dick Stulgis - GeoTesting Express
Jim Olsta - CETCO
Dave Suits - NY State DOT
Term Ends 2006
Tony Eith - Waste Management Inc.
Boyd Ramsey (Chairman) -
GSE Lining Technology, Inc.
At Large; Sam Allen - TRI/Environmental, Inc.
Term Ends 2007
To be announced
Rex Bobsein - Chevron/Phillips Co.
Kent von Maubeuge - Naue Fasertechnik GmbH

IN THIS ISSUE

Overview of GRI Projects (Research)

Each issue of our Newsletter/Report provides a brief glimpse and update of current GRI research projects. Details and full briefings are available to member organizations at their request. Dr. Grace Hsuan, Associate Director of GRI can be contacted for additional information as can the other project managers listed in the write-ups. ***Projects marked with an asterisk have been written up as short "in-progress" papers.*** Grace can be reached at (610) 522-8440 or e-mail at <grace.hsuan@coe.drexel.edu>.

1. **Stress Cracking of Geomembranes*** - Dr. Grace Hsuan is project manager of our ongoing efforts to evaluate stress cracking of geomembrane resins, sheets and seams. In addition to her ongoing evaluations of HDPE geomembranes, Grace is now focusing on HDPE drainage and duct pipe. The goal for both geomembranes and geopipe is to include technically viable test methods and limiting values in generic specifications.
2. **Durability and Lifetime Prediction*** - This project is based on our previous 8-year long study on the lifetime prediction of HDPE geomembranes. George Koerner has set up 20 replicate columns each of which is subjected to a compressive stress equivalent to a 50-m high landfill. In each of the columns are the following:

   (a) 1.5 mm HDPE geomembrane with no antioxidants (Stage B and C degradation will be evaluated)
   (b) 140 g/m^2 needle punched nonwoven PP geotextile
   (c) 140 g/m^2 woven slit film PP geotextile
   (d) 90 kN/m woven multifilament PP geotextile
   (e) 175 kN/m woven multifilament PP geotextile

   Temperatures are being maintained at 85, 75, 65 and 55ºC and the samples are being removed on approximate 6-mo. intervals. Grace Hsuan and George Koerner are in charge of the project.
3. **Durability of Polypropylene Geotextile Fibers and HDPE Geogrid Ribs** - Incubation at temperatures of 75, 65 and 55°C in forced air ovens is ongoing using PP-woven geotextile fibers and HDPE geogrid ribs. This study periodically measures changes in density, dimensions, mass, morphology, strength, elongation, modulus, melt index, OIT and carbonyl content. Dr. Hsuan is in charge of the project.
4. **Durability of Polyester Geotextile Fibers and Polyester Geogrid Yarns -** PET geotextile fibers and coated geogrid yarns are being incubated at temperatures of 65°C, 55°C and 45°C while being immersed in deionized water. Additional parameter variations are crystallinity, molecular weight and CEG content. This study periodically measures changes in mass, diameter, morphology, strength, elongation, modulus, molecular weight, crystallinity and CEG content. Dr. Hsuan is in charge of the project.
5. **In-Situ Temperature Monitoring of Liner and Cover Geomembranes in Dry and Wet Landfills*** - Dr. George Koerner is evaluating the in-situ temperature behavior of geomembranes and has installed 60± thermocouples for long term measurements in both a wet and dry municipal solid waste landfill in Pennsylvania. Presently data for 10-years is available. This is clearly the longest in-situ measurement project in all of geosynthetics.
6. **Bioreactor (aka, Wet) Landfill Behavior and Properties*** - The above temperature monitoring has segued into a major effort under sponsorship of GSI and Waste Management, Inc. The wet cell under investigation is at field capacity, hence it is a true anaerobic bioreactor. Dr. George Koerner is in charge of considerable monitoring which includes the following:
   - waste moisture content
   - waste temperature
   - leachate chemical analysis
   - waste gas analysis
   - perched leachate within the waste

   Data is being collected on a quarterly basis. The timeline of the project calls for monitoring for 5 to 10 years.
7. **Flow Behavior of Fully Degraded Waste*** - A new field project under sponsorship of GSI and Waste Management investigates the drainage of highly degraded MSW placed directly on leachate collection systems. The leachate collection systems are both natural soils and geosynthetic drains. The project has commenced this summer at a landfill in the Philadelphia area.
8. **Hydrostatic Creep Puncture of Geomembranes*** - The effect of sustained long-term hydrostatic and geostatic pressures on the puncture strength of geomembranes is an ongoing project. A series of tests using 600 g/m^2 protection geotextiles on 1.5 mm thick HDPE geomembranes is being evaluated; the time is currently 8-years. The four-test setups use truncated cone simulations of coarse subgrade stones against the geotextile protecting the underlying geomembrane. The behavior of the geomembranes under these tests is a combination of creep and stress relaxation. Results are used in a puncture design method that has been published previously. The

purpose of these current tests is to better define the creep reduction factors used in the design method.

9. **Long-Term Benefits of Geotextile Separators*** - A full-scale field database of using geotextile separators on firm soil subgrades is being developed and maintained by Dr. George Koerner. Monitoring is proposed for up to 20-years. The target sites are paved highways, driveways, parking lots, etc., where control sections without geotextiles are also available for comparison purposes. This database will be national and perhaps even international in scope. Included are sites which meet the following criteria:
   - sites must have both geotextile and nongeotextile control sections
   - known type of geotextile(s)
   - known soil conditions
   - known traffic conditions
   - available hydrologic and environmental conditions
   - capability of quantifying the original condition of the pavement surface vs. the aged condition… this will be accomplished visually as well as by using falling weight deflectometers.

   There are currently 14-sites included in this program. If you have additional sites to add, please contact George at (610) 522-8440.
10. **UV Exposure of Geomembranes*** - GSI is using its new Xenon Arc device along with its two existing UV-fluorescent devices to evaluate the simulated outdoor lifetime of eight different types of geomembranes 2 HDPEs, LLDPE, 2 fPPs, 2 PVCs) and PE-R. The effort is considered as part of GSI's Center for Polymers in Hydraulic Structures (CPHyS), but has relevancy in many other applications as well.
11. **High Pressure Incubation for Lifetime Prediction*** - Dr. Grace Hsuan has an ongoing National Science Foundation project on this topic. Five high pressure cells are involved: four are at 2.1, 3.5, 4.9 and 6.3 MPa and one is the control at atmospheric pressure. In the cells are HDPE geogrids, needle punched nonwoven PP geotextiles, and woven slit film PP geotextiles. They will be periodically retrieved and tested for OIT and tensile strength. Comparison will then be made to nonpressure incubation to assess the acceleration factor.
12. **Generic Specifications** - A major effort is ongoing with respect to the development of generic geosynthetic specifications. As described at our recent annual meeting, the current status of these specifications is as follows:

<u>Completed</u>

GM13 – HDPE Geomembranes
GM17 – LLDPE Geomembranes
GM18 – fPP Geomembranes (Temporarily Suspended as of May 3, 2004)
GM21 – EPDM Geomembranes
GM19 – Geomembrane Seams
GT10 – Geotextile Tubes
GT12 – Geotextile Cushions
GT13 – Geotextile Separators (Newly Approved)

<u>Working Within Focus Groups</u>

GCXX – TRMs for Erosion Control
GNXX – Biplanar Geonet Drainage Composites
GCLXX – Geosynthetic Clay Liners

<u>Delayed or Off in the Distance</u>

GGXX – Biaxial Geogrids
GGXX – Uniaxial Geogrids
GCXX – Drainage Geocomposites

The completed specifications are available to everyone (members and nonmembers) on the open section of our Home Page. Please download and use them accordingly. Please note that this is where the latest modification will always be available.

Also, these specifications are available on a separate power point CD which shows photos of the test methods and can be used as a presentation to clients and customers, as well as being an in-house training vehicle… don't hesitate to ask for a copy.

13. **Technical Guidance Documents on QC/QA of Waste Containment Facilities** - Drs. David Daniel and Bob Koerner have completed the Second Edition of this EPA project by greatly updating the original 1993 report. It will be published by ASCE Press, but if you want a preliminary copy on CD (<u>~</u> 390 pages) contact us accordingly.
14. The 5th Edition of Designing with Geosynthetics was taken to the printers in August, 2005. It will be published in mid-2005. To those who are interested, here is the track-record of this textbook over the years.

Edition	Date	Books Sold	Units
1	1984	3197	English only
2	1990	2645	English, SI in paren.
3	1994	4194	SI, English in paren.
4	1998	3500	SI only
5	2005	?	SI only

Activities within GII (Information)

We are currently supporting 2-Home Pages. The first is the GRI Home Page which is accessed as follows:

<<http://www.drexel.edu/gri>>

This home page is very introductory as far as geosynthetics knowledgeable people are concerned, and is meant to be promotional (for prospective students and potential institute members). It is probably only of nominal interest to most readers of this Newsletter/Report.

The second home page is the GSI Home Page (which is "terrific") and is accessed as follows:

<<http://www.geosynthetic-institute.org>>

It has been reconfigured through the fine efforts of Marilyn Ashley. Everyone (members and nonmembers) can access the open part, which has the following menu:

- **Introduction to GSI**
- **Prospectus**
- **Associate Membership (Agencies)**
- **Members by Focus Groups**
- **GSI Publications**
- **GRI Specifications & Guides**
- **Laboratory Accreditation**
- **CPReS & CPHyS**
- **Laboratory Accreditation**
- **Product Certification**
- **Newsletter/Reports**
- **Internet Courses**
- **Winter 2005 Courses**
- **Geosynthetics Links**
- **GSI Member Meetings**
- **Next GRI Conference**

To go further one needs a members-only password. Your contact person (see the last section of this Newsletter/Report if you do not know who it is) must get a password from Marilyn Ashley. Marilyn can be reached by e-mail at marilyn.ashley@coe.drexel.edu. When you get into this section, a treasure-trove of information is presented. This includes:

- **GRI Test Methods**
- **GRI Reports (Summaries)**
- **GRI Technical Papers (Citations)**
- **Notes of GSI Meetings**
- **Links to the GSs World**
- **Keyword Search for Literature**
- **Example Problems**
- **Frequently Asked Questions (FAQs)**

The "Links to the Geosynthetics World" is exactly that. The following is the menu in this file and by clicking on any item you will find all organizations involved in that industry segment. Selecting any one of them will give you their respective Web Site.

Regulatory Agencies
Standards Societies
Resin & Additive Producers
Geosynthetics Products
Geosynthetic Installers
Consultants in Geosynthetics
Geosynthetic Test Laboratories
Geosynthetic Organizations; Centers and Institutes
Universities with Geosynthetic Programs

Both GSI members and nonmembers are included, as are organizations on a worldwide basis. It's a super addition… try it out and advise accordingly.

Progress within GEI (Education)

The following four (each 1-day long) courses will be offered at GSI in January, 2005. They are good and they are also cheap!

Course #1 - January 6, 2005

Geosynthetics in Transportation/Geotechnical Applications

Goal: This one-day course is focused on the design, testing and construction of geosynthetics used in transportation and infrastructure facilities such as paved highways, unpaved roads, railroads, walls, steep slopes, embankments, filters, drains, and erosion control. The geosynthetics utilized are the following:

- geotextiles,
- geogrids,
- geonets,
- geomembranes,
- GCLs, and
- geocomposites.

Course #2 - January 7, 2005

Geosynthetics in Reinforced Walls and Slopes incl. Computer Design

Goal: This one-day course is focused on the proper design and construction of reinforced retaining walls and steep soil slopes using geogrids or geotextiles. Included are the following:

- overview of concepts, aesthetics, costs, designs and performance,
- actual testing for tension, shear and transmissivity of geosynthetics,
- computer design using MSEWall® and ReSlope® - with Dr. Dov Leschinsky of the University of Delaware, and
- design of wall and slope drainage systems

Course #3 - January 13, 2005

Geosynthetics in Waste Containment Applications

Goal: This one-day course is focused on the proper design, testing, and construction of geosynthetics used in liner and cover systems for landfills, surface impoundments and waste piles. Included are the following geosynthetics:

- geomembranes,
- geotextiles,
- geonets,
- geogrids,
- geosynthetic clay liners,
- geocomposites, and
- geopipe.

Course #4 - January 14, 2005

Quality Control/Quality Assurance of Geosynthetics

Goal: This one-day course is focused on the quality control and quality assurance of geosynthetics as placed in permanent and/or critical applications. Specifications and testing are emphasized. It focuses on both the manufactured geosynthetics and on the installation processes. Applications are mainly in the waste containment area, i.e., landfills and surface impoundments, but applicability to walls, slopes, dams, canals, etc., will also be discussed. Included are the following geosynthetics:

- geomembranes,
- geosynthetic clay liners,
- geosynthetic drainage systems (geonets and geocomposites),
- vertical cutoff walls,
- ancillary materials & appurtenances.

All of these courses come with a complete set of notes, are fast-paced, extremely current, come with a great lunch, and are cheap! ($100 for GSI members; $200 for nonmembers). In addition, continuing education credits are given for each course!

Activities within GAI (Accreditation)

The Geosynthetic Accreditation Institute's (GAI) current mission is focused on a Laboratory Accreditation Program (LAP) for all geosynthetic test methods. George Koerner is in charge of the program. The GAI-LAP was developed for accrediting geosynthetic testing laboratories on a test-by-test basis. GAI-LAP suggests that laboratories use ISO 17025 as their quality system model.

It should be made clear, however, that GAI-LAP does not profess to offer ISO certification, nor does it "certify" laboratory results. GAI-LAP provides accreditation to laboratories showing compliance with equipment and documentation for specific standard test methods, usually ASTM or ISO standards. GAI-LAP verifies that an effective quality system exists at accredited laboratories by way of proficiency testing.

As of September 2004, the following laboratories are accredited by the GAI-LAP for the number of test methods listed in parenthesis. Contact personnel and telephone numbers are also listed.

1[A] - TRI/Environmental Inc. (110 tests)
Sam Allen -- (512) 263-2101

3[A] - Golder Associates (42 tests)
Henry Mock -- (770) 496-8280

4[C] - Geosynthetic Institute (114 tests)
George Koerner -- (610) 522-8440

5[A] - NTH Consultants, Ltd. (52 tests)
Debra Klinger -- (610) 524-2300

6[A] - GeoSystems Consultants (27)
Craig Calabria -- (215) 654-9600

7[B] - Synthetic Industries Inc., Chickamauga (10 tests)
Steve Thaxton -- (800) 258-3121

8[B] - Synthetic Industries Inc., Ringgold (19 tests)
Toni Ruppert -- (800) 258-3121

9[B] - Synthetic Industries, Inc., Alto (10 tests)
Melvin Wallace -- (770) 532-9756

11[A] - STS Consultants Ltd. (13 tests)
Bill Quinn -- (847) 279-2500

13[A] - Precision Laboratories (87 tests)
Ron Belanger -- (714) 520-9631

14[A] - Geotechnics (61 tests)
Rick Lacey -- (412) 823-7600

18[A] - EMCON/OWT (51 tests)
Rasheed Ahmed -- (845) 492-3170

19[A] - HTS Inc. (42 tests)
Larry McMichael -- (713) 692-8373

20[A] - GeoTesting Express, MA (44 tests)
Gary Torosian -- (978) 635-0424

22[B] - CETCO Arlington Heights (13 tests)
Jim Olsta -- (847) 392-5800

23[B] - CETCO Fairmount (8 tests)
Derek Reece -- (706) 337-5316

24[B] - CETCO Lovell (8 tests)
Suze Wilkerson -- (307) 548-6521

25[B] - TC Nicolon (10 tests)
Melissa Medlin -- (706) 693-2226

26[B] - Agru America Inc. (16 tests)
Grant Palmer -- (843) 546-0600

27[B] - Amoco Fabrics and Fibers Co. (14 tests)
Barbara Barr-Howell -- (770) 944-4718

29[C] - FITI Testing & Research Institute (70 tests)
Moon-Hyun Jeong -- (011-82-2-960-8034)

31[D] - NYS Dept. of Transportation (9 tests)
Dave Suits -- (518) 457-4704

32[A] - Vector Engineering (6 tests)
Ken Criley -- (530) 272-2448

33[D] - Arizona DOT (5 tests)
Oscar Mousaui -- (602) 712-8200

34[B] - GSE Richey Road (16 tests)
Jane Allen -- (281) 230-6726

35[B] - GSE Hardy St. (12 tests)
Jimmy Youngblood -- (281) 230-6726

37[B] - SL Limitada (16 tests)
Mauricio Ossa -- 56-2 6010153

38[C] - Sageos/CTT Group (54 tests)
Eric Blond -- (450) 771-4608

40[B] - GSE Lining Technology Inc. (14 tests)
Charles Miller -- (843) 382-4603

41[A] - SGI Testing Service, LLC (18 tests)
Robert Swan, Jr. -- (770) 931-8222

42[C] - NPUST (GSI-Taiwan) (32 tests)
Chiwan Wayne Hsieh -- 011-886-8-7740468

43[A] - Ardaman & Associates (18 tests)
George DeStafano -- (407) 855-3860

44[B] - BBA Fiber Web, Inc. (9 tests)
Ken McLain -- (615) 847-7575

45[B] - Polyfelt Geosynthetics SDN Bhd. (23 tests)
C. P. Ng -- (603) 519 28568

46[B] - Bentofix Technologies (13 tests)
Pat Thiffault -- (705) 725-1938

47[A] - Precision Laboratories (13 tests)
Ron Belanger -- (866) 522-0843
48[B] - Tenax Corporation (9 tests)
Tim Bauters -- (410) 522-7000

[A]Third Party Independent [C]Institute
[B]Manufacturers QC [D]Government

If you are interested in this program and would like a copy of the GAI-LAP directory, please advise accordingly. A directory is published annually in December, and is also kept current on GRI's Home page at http://www.geosynthetic-institute.org. For additional information on the GAI-LAP program contact:

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E-mail: gkoerner@dca.net

Conflict Resolution

The following conflict resolution (CR) activity deserves discussion. It involves both ASTM D5994 "Test Method for Measuring the Core Thickness of Textured Geomembranes" and GRI-GM12 "Asperity Measurement of Textured Geomembranes Using a Depth Gage". There has been a total of five CRs associated with these two tests within the past three months.

It is safe to say that both of these methods are problematic. The equipment used for each is delicate but used routine (often both methods are used as SPC by MQC labs using GM13 and GM17 for textured geomembranes). It has come to our attention that some labs are working without control equipment. The root causes of the five recent CRs are as follows:

ASTM D5994 Core Thickness;

a) Dull 60° conical points
b) Opposing points not in center line alignment
c) Gage would not zero routinely and IRM was out of control. Rack and pinion in dial gauge bent from abuse or excessive dirt covering mechanism friction.

GRI-GM12 Asperity Height

a) Wrong needle point (shape and size)
b) Same as "c" above but as a result of laterally moving the gauge over the surface of textured geomembrane while needle is engaged.

In addition, both methods address the manner and number of measurements to be taken which is not always followed by the CQA organization. This "interpretative" issue was addressed in the previous Newsletter/Report.

It is apparent to most that such errors are a result of tight schedules and poor quality. However, we as GAI-LAP labs must stop such practices in the future.

Thank You

GAI has the mandate of acting as the database control lab to run the tests that we accredit. Over the past year we have been the proud recipient of several very generous gifts in regard to equipment that either improves or adds to our capacity to carry out this mandate. We would like to sincerely thank the following organizations and individuals for their generosity and time in enabling us to better service the geosynthetic community.

Figure 1 - Grace Hsuan with the CRE donated by the U.S. EPA (Dave Carson). It is equipped with an environmental control chamber, video extensometer and process control creep software. It allows us to accredit ASTM D6992 SIM plus other routine tests.

Figure 2 - Bob Koerner with new transmissivity unit donated by Geotechnics (Rich Lacey). It is equipped with a precise machined specimen box which allows for monitoring of head in various locations. This box limits side wall leakage and has nice upstream

reservoir and downstream outlet works so that entrance and outlet losses are minimized. A radial transmissivity device was also donated so now we can run ASTM D6574 per the standard specimen size.

Figure 3 - George Koerner with new pullout unit donated by SGI Testing Services, LLC (Robert Swan and Zehang Yuan). This box replaces one that we were unable to move from Drexel. It is versatile and can run both ASTM D6638 connection strength and ASTM D6706 pullout resistance.

We are blessed to have friends who believe in the cause of advancing the geosynthetic industry as we do.

Thank you from all of us at GSI.

George Koerner, Ph.D., PE, CQA
Associate Director - GSI

Activities within GCI (Certification)

We have an ongoing product certification program for all geosynthetics which have a generic specification. The program has as its target, conformance to a specific GRI specification such as GRI-GM13 for HDPE geomembranes. This specification has been in use for approximately 4 years with generally good reviews and considerable exposure. The specification is seen referenced in many project plans, specifications and quality assurance documents around the world.

The GCI certification program using this specification is based on ISO 9000 audits conducted on a 6-month cycle wherein the manufacturer's quality control plan and statistical data base are evaluated, along with sampling of the product. Upon testing by an accredited laboratory, the results are assessed and certification is granted, postponed or rejected. Certification carries with it the right to identify products as "GRI- Certified"; in this case “GRI-GM13 Certified”.

We are delighted to report that SL Limitada of Chile is approved to mark its HDPE geomembrane.

GRI-GM13 Certified

Our sincere congratulations go to the following people who are the principals involved:

Enrique Saavedra - General Manager
Mauricio Ossa - Technical Manager
Michael Mathieson - N.A. Representative (WASEW Technologies Inc.)

The GSI Affiliate Institutes

It has long been realized that the information generated within the GSI group should have a timely outlet to all countries, and in all languages. To this end, GSI has created affiliated institutes in two countries (Korea and Taiwan), and potentially many others in the future. These affiliated institutes are full members of GSI and are empowered to translate and use all available information so as to create similar institutes and activities in their respective countries. We introduce these institutes to you in this Newsletter/Report and will present ongoing details of their respective activities.

GSI-Korea was formed on February 9, 1998 as a collaborative effort between FITI Testing and Research Institute (a quasi-government organization) and Chonnam National University (through its Department of Textile Engineering).

FITI is a 30-year old testing organization located in Seoul focusing on interlaboratory proficiency; environmental protection; safety and flammability; hazardous substances; in-house quality control; consumer protection; complaint analysis; quality marking; procurement; household and industrial applications; and materials approval. It employs 120 people (8 with doctoral degrees) and 42 engineers. The geosynthetics testing group within FITI has 12 people (2 with doctoral degrees) and 10 engineers. The geosynthetic laboratory is GAI-LAP accredited for 70 geosynthetic test methods. Dr. Jeonghyo Kim is the general manager within FITI’s geosynthetics activities.

Chonnam National University is located in Kwangju (southern Korea) and the geosynthetics laboratory within the Textile Engineering Department is led by Professor Han-Yong Jeon. Dr. Jeon has 10-students working on geosynthetic-related projects and is extremely active both nationally and internationally. The ongoing efforts of both FITI and Chonnam will be described in future Newsletter/Reports.

GSI-Taiwan was formed on August 18, 2000 and is wholly contained within the National Pingtung

University of Science and Technology in Nei Pu, Pingtung (southern Taiwan). It completely parallels GSI in that it has specific units for research, education, information, accreditation and certification. The Director is Dr. Chiwan Wayne Hsieh who is a Professor in the Department of Civil Engineering and Director of the Computer Center. GSI-Taiwan has an Taiwanese consortium of geogrid/geotextile manufacturers who work toward producing quality products according to the draft GRI geogrid specifications and the associated test methods. As such, GSI-Taiwan is a GAI-LAP accredited laboratory for 32 geosynthetic test methods. Dr. Hsieh has 10-students working on geosynthetic-related projects and is extremely active nationally and internationally. The ongoing efforts of GSI-Taiwan will be described in future Newsletter/Reports.

The Geosynthetic Institute Centers-of-Excellence

1. The Center for Polymeric Reinforced Structures (CPReS) was formed on Dec. 27, 2002 for the purpose of proper use of geosynthetics in walls, slopes, and foundation reinforcement. It involves Dov Leshchinsky of Delaware, Grace Hsuan of Drexel and George Koerner of GSI as Co-Directors. The mission statement and goals are available on the GSI Home Page at <geosynthetic-institute.org>. Ongoing projects are the following:

   (a) Dov Leshchinsky is modifying and incorporating two important aspects of reinforced walls into his widely-used computer program "MSEWall". They are; design to accommodate short reinforcement lengths when full space is unavailable, and the incorporation of drainage geocomposites in accommodating low permeability backfill soils. The first topic was presented at GRI-17 in Las Vegas and a paper and report to GSI is available.
   (b) Grace Hsuan is utilizing the Stepped Isothermal Method (SIM) for assessing the long-term behavior of various geosynthetic reinforcements including geofoam. Graduate student Sang-Sik Yeo, is performing the requisite research.
   (c) George Koerner has supervised the construction of a segmental retaining wall at GSI which has 3-different masonry block types. He is measuring the pH-values directly between block surfaces and will do so for many years into the future… the following photograph is of the "GSI Wall". Data is currently available. [As a comment, this wall has geogrid reinforcement between every block layer and is backfilled completely with AASHTO #57 stone. It will not collapse or even deform]!

2. The Center for Polymers in Hydraulic Structures (CPHyS) was formed on June 20, 2003 for the purpose of proper use of geosynthetics in dams, canals, reservoirs, tunnels, pipes and related hydraulic systems. Jorge Zornberg of the University of Texas at Austin, Grace Hsuan of Drexel, and George Koerner of GSI are Co-Directors. The mission statement and goals are available on the GSI Home Page at <<geosynthetic-institute.org>>. Initial projects are being decided upon, but two are certain.

   (a) Grace Hsuan will focus on exposed geomembrane durability and lifetime. (See Item 10 previously). This issue is critically important to gain confidence regarding polymer lifetime in the minds of owners, regulators, designers and specifiers in the focused application areas.
   (b) Jorge Zornberg's activity, via a GSI funded graduate student, Christine Weber, will focus on drainage behind exposed geomembranes on dams.
   (c) George Koerner's activities are within GSI and focus on the Xenon Arc and UV fluorescent devices.
3. In both CPReS and CPHyS, Bob Koerner will act in an advisory manner and as quality assurance! In both centers existing GSI Members and Associate Members are fully entitled to the information that is developed and their interaction is encouraged. No additional funding is anticipated. We will keep the membership advised as to progress in this regard. We sincerely hope that the membership is supportive of these initiatives and your comments/suggestions are always solicited.
4. There is a distinct possibility for additional centers of this type. Please contact Bob Koerner with suggestions and ideas.

Items of Interest

1. More Research Needed on Water Sources

A congressionally mandated report released by the National Academies' National Research Council concludes that the nation needs to renew its commitment to research on water resources. Water research is currently split among nearly 20 federal agencies, and the report recommends a more unified

approach. The report also recommends that the government improve its monitoring of water conditions and levels over the long term and that it archive the data thereby obtained. The report can be found online at www.nap.edu.
(Civil Engineering, August 2004)

2. Chicago Leases Its Skyway

Chicago City Council recently approved a proposal by Mayor Richard M. Daley to lease the "Chicago Skyway", a 7.8-mile toll road, to a Spanish-Australian consortium for the next 99 years.
When the deal closes early next year, it will bring the cash-poor city an immediate infusion of nearly $2 billion. And the private operator, the Cintra-Macquarie Consortium, will gain the right for the next century to collect tolls on a road that it believes has potential for growth in drivers.
Chicago believes its deal is the first in which a government authority in the United States has turned over maintenance and operations of a publicly built toll highway to a private entity.
(Philadelphia Inquirer, Dec. 12, 2004)

3. Worldwide Solid Waste Issues

The combined population of 26 European countires--about 760 million people--discard about 860,000 tons of MSW per day. The three North American countries with a combined population of 572 million discard about 650,000 tons of MSW per day. Now if one wants to know where the real problem is one should look at Asia. China, India, Indonesia, and Pakistan have a combined population of about 2.78 billion and discard over 1.5 million tons per day. While there are no reliable measurements in the world at large, one could estimate that every day open dumps receive at least 2 million tons of solid waste. That rate is growing daily while the waste-discard rate in the rich countries is becoming stable.
This is where the international Solid Waste Association (SWA) steps in to help others resolve their waste management problems. ISWA has currently 1,000-plus members from 65-plus countries with a website at www.iswa.org. The association is based in Copenhagen, Denmark, and plays a vital role in building a worldwide network of professionals engaged in improving solid waste management practices. SWANA is a national member of ISWA and represents US and Canadian interests in this body.
Congratulations to to N.C. Vasuka of Delaware Solid Waste Assoc., who is the new president of ISWA [Ed.]
(ref. MSW Management, Sept./Oct., 2004)

4. Dr.-Ing. Georg Heerten appointed honorary professor

On September 21, 2004, Dr.-Ing. Georg Heerten, Managing Partner of Naue GmbH & Co KG, Luebbecke, Germany, was appointed honorary professor by the president of the Rheinisch-Westafälische Technische Hochschule (RWTH) in Aachen, Germany. This action pays recognition to his many years of teaching "geosynthetics in geotechnical applications" for the chair of geotechnical engineering for civil engineering at RWTH-Aachen. Professor Heerten's lectures are directed at teaching young civil engineers about innovative construction methods using geosynthetic materials, e.g., in civil engineering, road construction, hydraulic engineering, as well as in environmental protection applications.
(Sincere congratulations go to Dr. Heerten- GSI)

5. Cut-Resistant Fabrics

In light of terror-related concerns, the idea of cut-resistant fabrics is provocative. An article entitled "The Cutting Edge" recently appeared which presents a number of industry-related products which could very well have applicability in critical applications.
(ref. Review Magazine, IFAI, December, 2003)

Commentary on Geosynthetic Reduction Factors
Part II - Filtration and Drainage Applications

Filtration and Drainage Reduction Factors

The usual equation for allowable flow (flow rate, transmissivity, or permittivity) is as follows:

$$q_{allow} = q_{ult}\left[\frac{1}{RF_{SCB} \times RF_{CR} \times RF_{IN} \times RF_{CC} \times RF_{BC}}\right] \quad (2)$$

where

- q_{allow} = allowable (or design) flow rate,
- q_{ult} = ultimate (or as-manufactured) flow rate,
- RF_{SCB} = reduction factor for soil clogging and blinding,
- RF_{CR} = reduction factor for creep reduction of void space,
- RF_{IN} = reduction factor for adjacent materials intruding into void spaces,
- RF_{CC} = reduction factor for chemical clogging, and
- RF_{BC} = reduction factor for biological clogging.

The numeric values for all of the above items are both site-specific and material-specific as they are for strength applications, but obviously they are different. The latest edition of *Designing with Geosynthetics* uses Table 2 for common application areas involving geotextiles, geonets, geospacers and drainage geocomposites. As with Table 1 presented in the previous edition of this Newsletter/Report all values are ranges and furthermore the ranges are broader than those given in Table 1. Thus, the designer has even more latitude for his/her selection. Commentary on each of the reduction factors follows:

Table 2 - Recommended Flow Reduction Factor Values for Use in Equation 2.

Application	Range of Reduction Factors				
	Soil Clogging and Blinding*	Creep Reduction of Voids	Intrusion in Voids	Chemical Clogging **	Biological Clogging
Retaining wall filters	2.0 to 4.0	1.5 to 2.0	1.0 to 1.2	1.0 to 1.2	1.0 to 1.3
Underdrain filters	2.0 to 10	1.0 to 1.5	1.0 to 1.2	1.2 to 1.5	2.0 to 4.0***
Erosion control filters	2.0 to 10	1.0 to 1.5	1.0 to 1.2	1.0 to 1.2	2.0 to 4.0
Landfill filters	2.0 to 10	1.5 to 2.0	1.0 to 1.2	1.2 to 1.5	2.0 to 5.0***
Gravity drainage	2.0 to 4.0	2.0 to 3.0	1.0 to 1.2	1.2 to 1.5	1.2 to 1.5
Pressure drainage	2.0 to 3.0	2.0 to 3.0	1.0 to 1.2	1.1 to 1.3	1.1 to 1.3
Underdrain filters	2.0 to 10	1.0 to 1.5	1.0 to 1.2	1.2 to 1.5	2.0 to 4.0***
Erosion control filters	2.0 to 10	1.0 to 1.5	1.0 to 1.2	1.0 to 1.2	2.0 to 4.0
Landfill filters	2.0 to 10	1.5 to 2.0	1.0 to 1.2	1.2 to 1.5	2.0 to 5.0***
Gravity drainage	2.0 to 4.0	2.0 to 3.0	1.0 to 1.2	1.2 to 1.5	1.2 to 1.5
Pressure drainage	2.0 to 3.0	2.0 to 3.0	1.0 to 1.2	1.1 to 1.3	1.1 to 1.3

*If stone rip-rap or concrete blocks cover the surface of the geotextile use either the upper values, or include a separate reduction factor.
**Values can be higher particularly for high alkalinity or high turbidity groundwater.
***Values can be higher for extremely high microorganism content and/or growth of organisms and plant/vegetation roots.

Soil Clogging and Blinding - This reduction factor attempts to compensate for upstream soil particles either embedding themselves in a thick geotextile and/or blocking flow above the geotextile's voids. This is a necessary response of the geotextile in "tuning" itself to the site-specific soil and hydraulic conditions. The values seen in Table 2 are the largest of reduction factors for flow applications. They were obtained by comparing permittivity flow rates of various geotextiles as-manufactured (i.e., in-isolation) with that of similar flow tests of different soils placed over the geotextiles in question. More specifically, the tests were short term flow tests via the GRI GT1 test method which was developed in 1986. The lower values generally apply to woven fabrics and cohesionless soils, while the higher values generally apply to nonwoven fabrics and fine-grained soils. Admittedly, there is considerable latitude in selection of a particular value. Of course, product-specific and site-specific testing can be performed if the situation warrants.

Creep Reduction of Voids - Since thick geotextiles compress under load and geocomposite drains (depending on the structure and composition) can actually deform, a reduction factor should be included to modify the as-manufactured product's flow value over time. It is a long-term phenomenon and the short term permittivity flow tests of GRI GT1 test method were run for times up to 1000-hours to obtain the reduction factors. Also included in this category are long-term transmissivity tests to evaluate flow reductions for in-plane drainage related applications. With both of these situations (permittivity and transmissivity), the option is always available to do the respective tests under product-specific and site-specific conditions.

Intrusion into Voids - This lowest of reduction factors is to compensate for geotextile deformation by itself or into the voids of a geonet or geocomposite drainage core. Nonwoven needle-punched geotextiles have the greatest tendency in this regard over woven, heat-bonded or burnished geotextiles.

Chemical Clogging - This reduction factor considers that the permeating liquid might carry or precipitate chemicals which can clog the geotextile filter or geocomposite drain. High alkalinity groundwater will readily precipitate calcium and magnesium in this regard. One might also consider suspended solids in the permeant as a similar phenomenon. Total suspended solids, or TSS, values of greater than 5000 mg/l require high reduction factors. It is difficult to model in laboratory testing and thus the values provided are somewhat subjective.

Biological Clogging - As with chemical clogging, the nature of the permeating liquid is at issue. Liquids high in microbial content, such as landfill leachates, agricultural wastewaters, and sewage biosolids, are all troublesome and result in high reduction factors. Values of biochemical oxygen-demand (BOD) greater than 5000 mg/l are considered high in this regard. This term could also includes plant and vegetative root growth through a geotextile or within a drainage geocomposite, but these are site-specific situations and are very difficult to quantify in this context. As with chemical clogging, these issues are also difficult to model in laboratory testing and thus the values provided are somewhat subjective.

Summary and Conclusion

It appears to the writer that the status of reduction factors in geosynthetic flow applications is not as definitive as it is with strength applications. The field scenarios which can be envisioned are much broader and unwieldy in this regard. That said, if load and reduction factor design (LRFD) methods are eventually employed in geosynthetic design it again will be seen that the load side of the equation is of a greater uncertainty than these "resistance" aspects of modifying an as-manufactured flow value into an allowable flow value using reduction factors. The paper on probability-of-failure referenced in the first part of this communication shows this clearly.

By way of conclusion of this two-part communication we offer Table 3 which addresses all of the strength and flow reduction factors that were presented and comments accordingly. While additional research can be profitably done on many of the items, a more direct approach is to simulate site-specific field conditions and perform the requisite tests on the candidate geosynthetic material. In the writer's opinion, too little project-specific testing is being done presently. There are several commercial laboratories which are well equipped to do such testing.

Table 3 - Critique of Geosynthetic Reduction Factors

Category	Confidence in Values	For Critical Applications
Strength-Related Applications		
• installation damage	high	use upper range value
• creep	high	use upper range value
• chemical/biological degradation	moderate	site-specific testing
• seams	high	use upper range value
Flow-Related Applications		
• soil clogging and blinding	moderate	site-specific testing
• creep reduction of voids	moderate	site-specific testing
• intrusion	high	use upper range value
• chemical clogging	low	go beyond table limits
• biological clogging	low	go beyond table limits

Bob Koerner

Upcoming Events

- One Day Courses at GSI:
  January 6, 2005 - GSs in Transportation
  January 7, 2005 - Walls and Slopes
  January 13, 2005 - GSs in Waste Containment
  January 14, 2005 - QA/QC in Waste Containment
  contact: <mashley@dca.net>
- January 24-26, 2005 – GeoInstitute's GeoFrontiers '05 Conference in Austin, Texas
  Contact:
  <www.asce.org/confernces/geofrontiers05>
- January 26, 2005 - GRI 18 Conference at GeoFrontiers in Austin, Texas.
  Contact: <mashley@dca.net>
- January 27-29, 2005 - ASTM D-35 Meeting in Atlanta
  Contact: <csierk@astm.org>
- March 23-25, 2005 - 21st Central Pennsylvania Geotechnical Conf. at Hershey, PA
  Contact: <cbeenenga@gfnet.com>
- March 30-31, 2005 - Engr. Society of Detroit (ESD) Short Course and Solid Waste Landfill Confernece in Lansing, MI
  Contact: <www.esd.org>
- June 16-17, 2005 - ASTM D-35 Meeting in Reno, NV
  Contact: <csierk@astm.org>
- December 14-16, 2005 - NAGS '05/GRI-19 Combined Conference in Las Vegas, NV
  Contact: <janeharris@nagsigs.com>

GSI's Member Organizations

We sincerely thank all of our sponsoring organizations. Without them, GSI simply could neither happen nor exist. The current GSI member organizations and their contact members are listed below. The newest member organizations are *STS Consultants* (Mark Sieracke), *GSE Europe* (Stefan Baldauf/Mike Everest), *Precision Geosynthetics Laboratory* (Ron Belanger), *Geotechnics Inc.* (Rich Lacey), *InterGeo Geosynehtics* (Archie Filshill) and Raven Industries (Gary Kolbasuk). We welcome each of them to our growing family of geosynthetic-interested organizations.

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IN THE NEXT ISSUE

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- Activities within GAI (Accreditation)
- Activities within GCI (Certification)
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