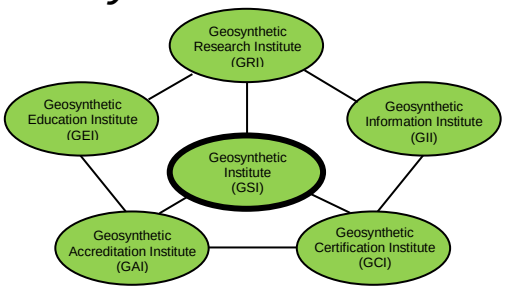
The GSI Newsletter/Report

Geosynthetic Institute



Vol. 32, No. 2 **June, 2018**

This quarterly newsletter, now in its 32nd 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 George R. Koerner or Marilyn Ashley at phone (610) 522-8440; fax (610) 522-8441 or e-mail at gsigeokoerner@gmail.com or mvashley@verizon.net.

Activities of GSI's Officers and Board of Advisors

1. A new White Paper on the status of geosynthetics use by U.S. State Department of Transportation is now available as White Paper #39 (see www.geosynthetic-institute.org/papers/paper39.pdf). Jamie Koerner was extremely active in getting the requisite information and arranging it accordingly.
2. In light of the above, the use of geotextiles as roadway separators between soil subgrade and gravel base courses continues to be vastly underutilized. A GSI activity is beginning.
3. The number of failed mechanically stabilized earth (MSE) walls with geosynthetic reinforcement continues to be problematic. A recently submitted paper reports on 320 such case histories is under review.
4. George Koerner's laboratory proficiency test program has essentially been completed and results will be forthcoming at the June ASTM meeting in San Diego, California. Details to the laboratories will be available shortly.
5. Webinars continue to be active with five having been given in May, plus a complete day-only course on QC/QA of landfill liner systems. A listing for 2018 is available. An agreement to have GMA/IFAI advertise these on-line webinars (and courses) is being finalized.
6. Your nine person GSI Board of Advisors (BOA) is as follows:

Term Ends 2018

- John Workman - Waste Management Inc. (Owners and Operators)
  e-mail: jworkman@wm.com
- Mark Wayne – Tensar Earth Technology (Geotextiles and Geogrids)
  e-mail: mwayne@tensarcorp.com
- Sam Allen – TRI Environmental Inc. (At-Large)
  e-mail: Sallen@tri-env.com

Term Ends 2019

- Kent von Maubeuge - NAUE GmbH & Co. KG (International-1)
  e-mail: kvmaubeuge@naue.com
- A. K. Mukhopadhyay – BTRA & GSI-India (Agencies)
  e-mail: btra@vsnl.com/btradirector@gmail.com
- Ashish Sukhadia – Chevron Phillips (Resin and Additives)
  e-mail: sukhaam@cpchem.com

IN THIS ISSUE

Term Ends 2020

- Tony Eith - CEC Consultants, Inc.
  (Consultants and Testing Labs)
  e-mail: teith@cecinc.com
- Jimmy Youngblood - GSE Environmental
  (Geomembranes and GCL's)
  e-mail: jyoungblood@gseworld.com
- Moreno Scotto - Maccaferri
  (International - 2)
  e-mail: moreno.scotto@gmail.com

Overview of GRI Projects (Research)

The following projects are all funded by GSI membership dues unless specifically noted. Most are long-term projects for which we are well positioned to accomplish. *Those projects marked with an asterisk have written papers available; please ask and we will send them accordingly.* Contact George Koerner (gsigeokoerner@gmail.com), Grace Hsuan (hsuanyg@drexel.edu) or Bob Koerner (rmk27@drexel.edu) for details and/or discussions.

1. **"Farewell to" In-Situ Temperature Monitoring of Liner and Cover Geomembranes in Dry and Wet Landfills*** - For 20-years George Koerner has been monitoring geomembrane temperatures at a landfill close to Philadelphia, our home base. It is the longest single project in GSI's history and has produced excellent and information results. (Papers are available.) However, the thermocouples and readout devices are so corroded that it is not possible to continue. That said, sincere appreciation to the landfill owner/operator for allowing us access over the many years.
2. **Field Exposed Lifetime of Geogrids Used at the Facing of Landfill Berms** - The facing of mechanically stabilized earth landfill berms (and other walls and slopes as well) often uses a wrap-around configuration leaving the geogrid exposed to the atmosphere. A project being conducted by George Koerner is presently investigating the behavior of two different geogrids and two erosion control materials over time. These four materials are also being exposed on the roof of the GSI carport. A 50-year time frame is envisioned! The long-term behavior will eventually be compared to UV laboratory predicted data as noted previously.
3. **Laboratory Exposed Lifetime of Geomembranes*** - GSI is using three UV-fluorescent devices to estimate the projected exposed lifetime of six different types of geomembranes. They are HDPE, LLDPE, fPP, EPDM, PVC (N.A.) and PVC (Euro.). They are being incubated at 60, 70, and 80°C until halflife of strength and elongation are measured. The goal is lifetime prediction. Incubation times are now over 60,000 light hours(8.2 years) and are not yet complete. Some will take at least 90,000 light hours (~ 12.3 years). GRI Report #44 is available on results to date and a webinar is also available. The information was made available to the public on April 6, 2016 at Orlando and was again presented in Peru on March 30. 2017. It has been republished in the International Geosynthetics Journal. A copy is available. (In this regard it should be noted that we have withheld the information before publication for well over a year which has been our custom.)
4. **HDPE Geomembrane Lifetime as a Function of Thickness** - This often encountered question is being evaluated by exposure at 80°C in a QUV weathering device per ASTM D7238. Formulations are exactly the same and only the sample thicknesses vary. These thicknesses are 2.76, 2.44, 1.58, 1.08, 0.77 and 0.48 mm. Parameters being evaluated in this decades long study are change in thickness and presence of crazing or cracking. Time will tell!
5. **Exposed Lifetime of Creased Geomembranes** - Stemming from a recent webinar on the effect of backfilled GM waves or wrinkles we have seven geomembranes which are purposely creased in double 180° bends being incubated at 80, 65, 55 and 25°C temperatures as of February 10, 2017. They are HDPE, LLDPE, LLDPE-R, fPP, fPP-R, EPDM and PVC. We are focused on if, when, and where, cracking might occur. The project promises to take many years but should be interesting.
6. **Laboratory Exposed Lifetime of PVC (European) Geomembranes** - We have been evaluating five different European formulations for four years using three dedicated UV-fluorescent devices and the results are very impressive. The study is being conducted for CARPI Tech, a GSI member organization. The project also allows us to distinguish between PVC geomembranes manufactured in North America versus Europe. The differences are in the type of plasticizers used in the formulations as well as thicknesses.
7. **Cable Tied Geonet Evaluations** - A study has just been completed on plastic cable ties used to connect the overlapped ends and edges of geonets and geospacers. The draft of a new GRI Test Standard is available as well as the draft of a technical paper to be published at the IGS Conference in Seoul, Korea in September, 2018..
8. **Retaining Wall Failure Evaluations* -** We have past GRI Reports 38, 39, and 40 addressing mechanical stabilized earth (MSE) walls using geosynthetic reinforcement which document 82-failures. Our data base has now grown to 141,

then 171, then 286 and now 322! *Readers, we have a very serious situation in this regard!* The failures are either excessive deformation or actual collapses. We have presented one-day courses on this topic along with inspector training and development insofar as a field inspectors certification program; see the certification section of this Newsletter/Report. A paper was published by the Journal of Geotextiles and Geomembranes in October, 2013 and the publisher (Elsevier) reports that 1400 requests have been made to date. An updated paper on 320 failures is under review presently. A GSI webinar is also currently available.

9. **pH Between Masonry Block Wall Units*** - George Koerner has been measuring the pH between three types of masonry blocks for over eight years to monitor the values. Concern here is over PET geogrids which are known to be sensitive to very high alkalinity environments. Indeed, the values started high, but over time they are now down to eight and lower. George has a paper in this regard.
10. **Landfill Failure Analysis** - Since our originally reported paper on ten landfill failures in a 2000 publication, we have accumulated ten more. All 20-failures have been analyzed using the ReSSA Code and are now available to members and associate members as GRI Report #41. There are two recent failures in this regard, both in Pennsylvania, and one resulted in a worker's death! A paper to be published by Dr. Rudy Bonaparte of Geosynthetic/Georgia Tech gives details of two of these failures and more.
11. **Slow Pressurization of HDPE Geomembranes in Axi-Symmetric Testing* - The** ASTM D5716 method of testing geomembranes in a 3-D axi-symmetric mode uses a pressure rate of 6.9 kPa/min (1.0 psi/min). While such a rate is appropriate for most geomembrane types, it is very fast for HDPE which is semi-crystalline and cannot readily stress relax so as to accommodate the applied pressure. To investigate slower rates we have initiated a project with rates as low as 6.9 kPa/month (1.0 psi/month)! The last test, just now begun, is at a rate of 6.9 kPa/six months (1.0 psi/six months) and it will take an estimated five years to conclude. A preliminary paper was presented at Geosynthetics '15 in Portland.
12. **PVD Strengthening of Soft Foundation Soils*** - A new project, conducted over the past summer, addresses the use of PVDs for drainage (as customary) plus tensile reinforcement (never recognized to date). An experimental device was developed and used to assess three different PVDs. This data was then used with the ReSSA soil stability code on an old foundation soil failure that did not have PVDs. The FS-values increased 4% and could go higher with closer spacing or stronger PVDs. A journal paper is available.
13. **Seams of Reinforced Geomembranes** - There are now five scrim reinforced geomembranes available and the properties are listed in our GRI Specifications. To compliment these sheet products a set of shear and peel tests are have been evaluated. A new specification designated GRI-GM19(b) has been developed… GRI-GM19(a) is presently solely for homogeneous geomembranes.
14. **Direct Shear Strength of Frozen Interfaces** - A new project of investigating geomembrane-to-soil interfaces under freezing conditions is now in progress. Maxwell Koerner is reconfiguring a 100 mm square shear box for controlled sub-freezing temperatures. The project stems from a case failure of a veneer cover and several requests for such information over the TechLine answering service. There is essentially no information to date on this topic.
15. **Generic Specifications** - A major continuing effort is ongoing with respect to the development and updating of GRI's generic geosynthetic specifications. The current status of these specifications is as follows. Incidentally, all 17 are currently presently copyrighted.

<u>Completed and Available on our Website</u>
GM13 – HDPE Geomembranes
GM17 – LLDPE Geomembranes
GM18 – fPP and fPP-R Geomembranes
GM19a – Geomembrane Seams-Homogeneous
GM19b – Geomembrane Seams-Fabric Reinforced
GM21 – EPDM and EPDM-R Geomembranes
GM22 – Scrim Reinforced PE Barriers
GM25 – LLDPE-R Geomembranes
GM28 – CSPE-R Geomembranes
GM30 – Coated Tape PE Barriers
GCL3 – Geosynthetic Clay Liners
GS15 – Geocells using HDPE Strips
GT10 – Geotextile Tubes
GT12 (a and b) – Geotextile Cushions
GT13 (a and b) – Geotextile Separators
GCL3 – Geosynthetic Clay Liners
GC14 – Turf Reinforcement Mats
GC16 – Prefabricated Vertical Drains

<u>Working; Available Upon Request</u>
GGXX – Bidirectional Geogrids (tabled)
GGXX – Unidirectional Geogrids (tabled)
GNXX – Geonet Drainage Composites (tabled)

The complete set of formalized specifications are available to everyone (members and nonmembers) on the open section of our Home Page. Please download and use them accordingly. There is a brief tutorial accompanying each specification. Also note that this is where the latest modification will always be available. They are updated/modified on an as-required basis.

16. **Guides and Practices** - GSI also develops standard guides and practices and these are available free on our website. There are 11 guides and 6 practices. They are modified on a regular basis and the latest version is updated regularly.
17. **Test Methods** - Since 1987 when we published our first test method on geogrid junction strength until the present we have developed 25 test methods which are still current.

    2 - geotextile 2 - GCL
    1 - geonet 11 - geocomposite
    4 - geomembrane 5 - geosynthetics

    Additionally, 31 have been co-opted by ASTM and we have depreciated our version. Incidentally, our test methods are for members only and are in the password protected portion of our website. We are delighted to report that ASTM has just announced that GSI will be given the David Suits Award for our cooperation in sharing GRI standards. Our appreciation is sincerely expressed.
18. **Other GRI Standards** - There are several GRI Standards in various forms of preparation. These include the following:
    - A practice on field seaming inspection emphasizing the electrical leak location system (ELLS).
    - Three standards on GCL joining so as to prevent/monitor panel separation.
    - A standard on GN joining with plastic cable ties… see Item #7.
    - A guide as to recommended testing of drainage geocomposites.
    - A practice explaining the use of MARV for geotextiles
    - A transverse rib bending test for homogeneous geogrids

Progress within GII (Information)

Our GSI Home Page is accessed as follows:

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

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

Newsletter
Prospectus
Specifications
White Papers
Bookstore
Keyword Search
Members Only
Research
Certification
Information
Education
Accreditation
Personnel Contacts
Upcoming Webinars

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 obtain a password from Marilyn Ashley. Marilyn can be reached by e-mail at mvashley@verizon.net. When you get into this section, the following information is available. This includes:

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

The Keywords Section contains about 35,000 citations which is the majority of the geosynthetics literature published in English. It is updated as each published paper is received. Citation retrieval is quite easy provided that you have a specific topic, or area, in mind. This is the section of the website that we (and others we are told) use the most in our daily activities.

Important Note: This keyword search is now available to everyone. It is on the open section of our website, however, there is a charge to non-GSI members, (www.geosynthetic-institute.org/keywordpay.html). The duplicate information is in the password protected section and is free for GSI members.

In addition to the information provided in our home page as just mentioned, Jamie Koerner (Special Projects Coordinator) performs various surveys on pertinent topics in geosynthetics. The latest is a survey by Jamie Koerner on the status of geosynthetic use by U.S. State Departments of Transportation. It is available on our website as White Paper #39. Also, if you have topics in need of the current status please advise accordingly.

Progress within GEI (Education)

GRI Reports

To date, we have 46 GRI Reports available to members and associate members. These reports vary in length from 30 to 200 pages and beginning with Report #25 they are on the password protected section of our home page. Prior to that date only the abstract is available online. All of them, however, are available in hard copy. Our most recent report is:

- #46 - Utilizing PVDs to Provide Shear Strength to Saturated Fine-Grained Foundation Soils

GSI Webinars (90 minutes long)

11:30 AM – 1:00 PM (Eastern Time Zone)
Registration at
www.geosynthetic-institute.org/webinar.htm

1.5 Professional Development Hours
Nonmembers Cost - $250; Members Cost - $200

Commentary on Webinars: Never in Bob K's long career has he "reached out" to so many people than when giving these webinars. For the single cost of $250 or $200 a feed is delivered over Adobe Connect to the requested site. This can be transmitted anywhere, e.g., office, conference room, hotel room, auditorium or even sent to additional offices and sites. For example, NY-DEC had the feed going into their Albany auditorium and then into the 13-regions of New York State. Clearly, hundreds of participants were involved! *Dear readers we feel that on-line distance learning, aka, webinars, is the way to communicate information to masses of people in an inexpensive and time efficient manner. Indeed, the future of distance learning is here!* The remaining 2018 schedule of GSI Webinars is as follows:

Date	GSI No.	Title
June 13	W-26	Applications and Design of Geotextile Tubes
July 11	W-23	Geotextile Filters; Concerns and Issues
August 15	W-15	In-Situ Stabilization of Soil Slopes Using Nailed (or Anchored) Geosynthetics
September 12	W-16	Sand Drains-to-Wick Drains-to-Sand Columns (Including a Major Case History Failure)
October 10	W-17	Geosynthetics in Erosion Control
October 24	W-24	Disposal of Coal Combustion Residuals (CCRs)
November 14	W-25	Soil Consolidation using Wick Drains, aka PVDs
November 28	W-14	Lifetime Predictions of Covered and Exposed Geosynthetics
December 12	W-27	Stability Design of Landfill Cover Soils

Courses

We are now abandoning our in-house, one-day, courses (which have been given for the past 30-years) and delivering two of them in six segments over three consecutive days, one each morning and then afternoon. They are the following:

1. Quality Assurance/Quality Control of Geosynthetic in Waste Containment Facilities
   (scheduled for October 16, 17, 28; 2018)
2. Construction Inspection of Mechanically Stabilized Earth (MSE) Walls, Berms and Slopes
   (scheduled for November 6, 7, 8; 2018)

The third and newest of these courses is an On-Line "Designing With Geosynthetics (DwG)" course. Please go to http://www.geosynthetic-institute.org/courses.htm and scroll down to Course #3. Here you will see the requisite details. The course itself is completely synchronized with the 6th Edition of the DwG textbook. It consists of 1540 slides with ~ 18 hours of voice over; about one minute for each slide. See the special writeup in this Newsletter/Report.

Contact Jamie Koerner at jrkoerner@verizon.net if you want information and details.

GSI Fellowships

A major change over previous years has been quite successful again this past year. We now offer fellowships for masters and doctoral students. The stipend is $5000 for a single year, rather than three multiple years. This change resulted in 20-proposals which were reviewed and graded by the GSI-BoD and ourselves. Eleven were accepted. The accepted proposals for the 2017-'18 A.Y. are as follows. Proposals for the 2018-'19 A.Y. are due on June 11, 2018. If a specific proposal is of interest please contact Jamie Koerner at jrkoerner@verizon.net.

No.	Name	University	Advisor	Topic
1-17	Cengiz, Cihan	TC Bogazici U Turkey	Erol Guler	Seismic behavior of soft clay foundations under embankments using geosynthetic encased columns
2-17	Dutta, Susom	U of Massachusetts - Lowell USA	Pradeep Kurup	Novel geotextiles for energy harvesting
3-17	Kermani, Behnud	Penn State USA	Ming Xiao	Numerical investigation on the effectiveness and durability of geotextiles against migration of subgrade soil to overlying granular layer in pavement systems
4-17	Lieske, Wolfgang	Ruhr-Universitat Bochum Germany	Tom Schanz	Polymer-modified bentonite for the application in geosynthetic Clay Liners (GCL)
5-17	Lin, Chuang	Missouri U of Science and Tech USA	Xiong Zhang	Analyzation of wicking fabrics used to remove capillary water in road embankments
6-17	Morsy, Mohamed	Queen's University Canada	Kerry Rowe	Selection of a realistic and representative stress crack resistance for use in design
7-17	Robey, Nicole	U of Florida USA	Tim Townsend	Landfill EGS wind uplift research: complementary field and wind tunnel assessments
8-17	Vahidi, Siavash	Drexel University USA	Grace Hsuan	Evaluation of wrinkle induced strains in geomembranes using a finite element method (FEM)
9-17	Valente, Rodrigo Borela	Georgia Inst. of Technology USA	David Frost	Numerical modeling of aggregate-geogrid composite behavior for multiaxial geogrids in pavement applications
10-17	Wang, Dongfang	U of Massachusetts Amherst USA	Guoping Zhang	Enhancement of geosynthetics with ultra-hydrophobic and long-lasting organogeopolymers
11-17	Williams, Thomas	U of Virginia USA	Craig Benson	Protecting geosynthetic in liner systems from atmospheric exposure by utilizing a surcharge layer

Education Activities in the United Kingdom

On May 31st, 2018 Naue Geosynthetics put on a very nice workshop on "Landfill Geosynthetics: The Latest Research on Both Geomembranes and GCL's" in Warrington, UK. The workshop was attending by 75 people mainly made up of engineers and geo-professionals from the UK. The workshop had four main speakers;

Richard Brachman (Queen's University, Canada): New insight into GCL permeability in Landfill Covers & Latest Development on selecting geomembrane protection layers

Kent von Maubeuge (NAUE GmbH, Germany): Use of GCLs in Groundwater Protection for road applications

Chris Quirk (Naue Geosynthetics, United Kingdom): Profiled Geomembranes

George Koerner (GSI, U.S.A.): Recent Developments and Events at Landfills

The group assembled was very well educated and asked great questions. There was much discussion of controlling installation and operational aspects of the long term particularly from Environment Agency personnel. There was also talk of how the entire processes could be managed more efficiently to try and maximize performance of the system as a whole. Optimism was expressed on new technology for integrating standard protocols for QA/QC such are computer based expert systems.

George, Kent, Chris and Richard

Education Activities in Germany

The IGS Technical Committees on Reinforcement (TC-R) chaired by Gerhard Bräu, and Barriers (TC-B), chaired by Kent von Maubeuge, organized the Hot Topics in Geosynthetic Workshops, on 04 through 07 June 2018 in Munich, Germany. As you can see by program below, the workshops were each divided into four half day sessions.

GEOREINFORCEMENT WORKSHOP PROGRAM
4 June 2018
Welcome and Introduction | 08:30
Workshop Chair: Gerhard Bräu (Technical University Munich)

Morning Session | 08:30 – 12:30
"Facings of Walls and Steep Slopes"
Chair: Ian Fraser (United Kingdom), ianfraser@tcs-geotechnics.co.uk

- Richard Bathurst (RMC-Queen's University) – Reinforcement loads and facing connection capacity in reinforced soil walls: Measured vs Predicted
- Lars Vollmert (BBG Bauberatung Geokunststoffe) – Stress conditions and connection requirements of reinforced soil block walls including the German EBGEO perspective
- Mike Dobie (Tensar International) – Incorporation of connection strength in design of reinforced soil block walls including seismic considerations
- Yassine Bennani Braouli (Terre Armee) – Facing and connection considerations for concrete panel wall systems

Afternoon Session | 13:30 – 17:30
"Use of Recycled and Amended Marginal Backfills in MSE and Reinforced Embankments/Slopes"
Chair: John Sankey (USA),
jsankey@reinforcedearth.com

- John Sankey (Terre Armee) – Overview of Reinforced Structure Design, Applications and Uses with Recycled and Amended Backfill
- ChaidoDoulala (Yuli) Rigby (Tensar) – Use of Polymeric Geogrids in Structures with Non-Standard Reinforced Fills
- Robert Lozano (The Reinforced Earth Company) – Treated Marginal Soils in MSE Structures
- Oliver Detert (Huesker) – Construction and Long Term Experiences with Marginal Fill in GRS Walls
- Castorina Silva Viera (University of Porto) – Use of Mixed Construction & Demolition Recycled Materials in Geosynthetic Reinforced Structures

5 June 2018
Morning Session | 08:30 – 12:30
"Design of Load-carrying MSE Bridge Abutments"
Chair: Jorge Zornberg (USA),
zornberg@mail.utexas.edu

- Jorge G. Zornberg (The University of Texas at Austin) – Growing worldwide emphasis on load-carrying MSE bridge abutments
- Presenter TBA – Design of load-carrying geosynthetic reinforced soil abutments following US guidelines
- Dimiter Alexiew (Consultant Geosynthetics & Geotechnics) – Design of load-carrying MSE abutments following some of the European codes
- Andre Ferreira da Silva (Huesker) – Experience on load-carrying MSE abutments in South America
- Masayuki Koda (Railway Technical Research Institute) and Antoine Duttine (Integrated Geotechnology Institute) – Design of load-carrying MSE abutments following Japanese guidelines
- Nicolas Freitag (Terre Armee) – MSE bridge abutments: Only one part of a bridge system – examples with steel and geosynthetic reinforcement

Afternoon Session | 13:30 – 17:30
"Reinforced Veneer Stability"
Chair: Pietro Rimoldi (Italy), pietro.rimoldi@gmail.com

- George Koerner (Geosynthetic Institute) – General approach to veneer stability, testing and monitoring
- Jorge G. Zornberg (The University of Texas at Austin) – Selection of design alternatives for water and seismic actions on reinforced veneer stability
- Jay McKelvey (Earth Engineering Inc.) – Effects of equipment on veneer stability
- Pietro Rimoldi (Consultant) – Semi-probabilistic approach to veneer stability according to EuroCodes
- Felix Jacobs (IGB IngenieurgesellschaftmbH) – EBGEO approach to veneer stability

Summary and Closing | 17:30
Workshop Chair: Gerhard Bräu (Technical University Munich)

GEOBARRIER WORKSHOP PROGRAM
6 June 2018
Welcome and Introduction | 08:30
Workshop Chair: Kent von Maubeuge (NAUE GmbH & Co.KG)

Morning Session | 08:30 – 12:30
Geomembrane Durability
Chair: George Koerner (USA)

- Andreas Woehlecke (BAM) – Agency perspectives on geomembrane durability, service life and end of life
- Helmut Zanzinger (SKZ) – Autoclave exposure to accelerate incubation for Arrhenius modeling
- Sam Allen (TRI) – Exposed Multi-component (layered) geomembrane durability
- Kerry Rowe (Queen's University) – Antioxidant depletion: Is higher HP-OIT the answer?

Lunch | 12:30 – 13:30

Afternoon Session | 13:30 – 17:30
"Geomembrane Protection"
Chair: Richard Brachman (Canada)

- Kerry Rowe (Queen's U) – Why we need to limit long-term strains
- George Koerner – Preventing puncture: A US Approach
- Uli Sehrbrock: Limiting strain – The German Approach
- Richard Brachman (Queen's U) – Why allowable strain depends on how its measured and calculated

7 June 2018
Morning Session | 08:30 – 12:30
"GCL Hydration and Controlling Factors"
Chair: Malek Bouazza (Australia)

- Malek Bouazza – Myths and facts about GCL hydration: what you need to know
- Kerry Rowe – How well do GCLs hydrate and self-heal: factors and effects
- Craig Benson – Hydration, Swelling, and Hydraulic Conductivity of Bentonite-Polymer Composite GCLs for Aggressive Leachates
- Gemmina Di Emidio – Wet and dry ageing of modified bentonites for GCLs under aggressive conditions

Afternoon Session | 13:30 – 17:30
"Standard Protocols for Construction/Installation"
Quality Assurance and Quality Control
Chair: Boyd Ramsey (USA) and Kerry Rowe (Canada)

- Boyd Ramsey – Statistical likelihood of leakage with various levels of CQA and inspection surveys
- Sam Allen – Historical leakage rates with various levels of CQA and inspection survey(s): the benefits of advanced preparation
- Piet Meyer & Walter Meyer – Case histories of successful and unsuccessful inspection surveys and digital CQC data management
- Kerry Rowe – Field observation and implications for leakage

Summary and Closing | 17:30
Workshop Chair: Kent von Maubeuge (NAUE GmbH)

The IGS welcomed over 100 civil and geotechnical engineering professionals from around the world to the TC-R workshop and about 70 to the TC-B workshop. This unique gathering combines high-level presentations from leading practitioners in the field with significant audience discussion time, enabling participants to share project experience, exchange technical concerns and solutions and network with colleagues who influence diverse applications (projects) containing geosynthetics.

GSI's involvement over the four days was significant. George Koerner's presentation on the "General approach to veneer stability, testing and monitoring," was well received. It set the stage for the rest of the session and was broad reaching in scope. The presentation opened with a discussion of destabilizing and stabilizing forces related to veneer stability. It then turned to a review of the three major performance test results needed for veneer stability design. Namely, direct shear, wide width tensile and transmissivity. The presentation then covered monitoring of veneer slope and steep walls. A systematic approach to monitoring as well as the purpose for specific instrumentation was discussed. The relatively new technology of LIDAR particularly interested the audience. The presentation ended with several case histories and a discussion of EC-TRMs, geogrids, geocells and finally exposed anchored geosynthetic covers with absolutely no soil cover needed. There are certainly many new and exciting areas to pursue in this field.

GSI's second task at the event was to chair the opening morning session of the TC-B workshop on durability. The agenda was stacked with heavy hitting presenters from Germany, USA and Canada.

Mr. Woehlecke started us off with an overview of the German regulation for geosynthetic used in waste disposal. The BAM mandates that only a relatively thick 2.5 mm HDPE be used in liner systems in Germany. The geomembrane is used in a single composite configuration and can only be made via the wide mouth die case process. It needs to be a monolithic layer of HDPE and cannot be a blended or layered material. The agency's perspectives on geomembrane durability, service life and end of life is that all materials used in lining system need to exhibit 100 year performance.

Helmut Zanzinger of SKZ was the next speaker in the session. He discussed an autoclave exposure technique to accelerate incubation for Arrhenius modeling. This work tied in nicely to the first presentation and answered the question of how the Germans verify 100 year performance of materials.

Sam Allen of TRI Environmental was next and threw the audience a major curve ball. He went against convention and discussed other materials than monolithic HDPE geomembranes. He delved into all kinds of issues (sampling, testing, seaming etc.) with multi-component (layered)geomembrane durability. He left the session with the question: There are many different geomembrane formulations that exhibit fantastic physical, mechanical, hydraulic and endurance properties, why don't designers consider broadening our options for containment?

Kerry Rowe of Queen's University ended the presentation portion of the session with a discussion on antioxidant depletion. He challenged the validity of both the standard and high-pressure DSC tests by contrasting predicted performance with actual field verifications. Much of his findings showed that performance is application specific where extreme environmental conditions will challenge commodity materials but can be managed by high performance geomembranes.

With the conclusion of the presentation phase of the session the discussion began. In true workshop fashion we opened the floor to 90 minutes of exchange. The Q&A's were fast and furious. Some of the better examples are listed below;

1. Should we restrict the comonomer used in the manufacturer of HDPE (oxtane, heptane, butane etc.)?
2. What are the risks if a GM fails?
3. Should we insist that the GM exhibit isotropic behavior?
4. Should we be making application specific materials (i.e. covers/liners, landfills, brine ponds, high chlorine)
5. Do all geomembrane pass a TCLP test?
6. Can someone explain how the AO package diffuses throughout the polymer cross section of a geomembrane with time?
7. How do geomembrane seams age? Are they as durable as the parent material?
8. What is the durability of textured versus smooth geomembrane?
9. What is the effect on durability of calcium carbonate or talc in the geomembrane formulation?

In all, the session was exciting and fun. The audience was great and energized the panel to stretch and give many suggestions for going forward and improving geomembranes.

Photograph of the organizing committee Gerhard, Terry, Dagmar and Kent

Our last task at the workshop was a presentation on the USA Approach to preventing GM puncture. The presentation was given in the afternoon of the first day of the TC-B session on Geomembrane Protection Chaired by Richard Brachman. The presentation explored the origins of index puncture testing in the USA. We discussed FTM 101C 2056 and three other ASTM Index puncture tests. It was pointed out that in all four cases the output was puncture strength where puncture toughness was probably a better indicator of performance. The presentation then went on explore the need for good puncture protection and then discussed ASTM D5514. A performance puncture test which was used for a 10 year study at the institute. We investigated the objective, benefits and finding of the study and contrasted this approach to the limiting long-term strain efforts that were circulating in the room. The results of our study were then validated with several actual case histories from field exhumed sites that had be functional well for 25 years. The presentation ended with the statement that "Good Geomembrane Performance requires a Systems Approach" which is outlined as follows:

- Good design by Professional Engineer
- Quality materials: i.e. GRI GM13 HDPE
- Accredited testing: i.e. CE mark, GAI-LAP
- Best Available Installation: IAGI-CWT
- Quality Assurance: GCI-ICP
- LIS prior to commissioning facility
- Careful operations and maintenance

If one follows this approach one can expect to experience secondary flows in the LCRS like that in NY state. They have 27 double lined composite system landfills that have experienced the following performance as of 2018, (Ave 0.7 lphd, min 0.05 lphd and max 2.6 lphd).

George R. Koerner
Director of the Geosynthetic Institute

Activities within GAI (Accreditation)

The Geosynthetic Accreditation Institute's (GAI) current mission is focused on a Laboratory Accreditation Program (LAP) for 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. In addition, the program uses the GSI lab as the reference test lab and operates as an ISO 17011 enterprise. *It should be emphasized that our GSI lab does not conduct outside commercial testing.*

It should also be made clear 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 training and documentation for specific standard ASTM or ISO test methods. In addition, GAI-LAP verifies that an effective quality system exists at accredited laboratories by way of proficiency testing.

There have been significant additions to the number of GAI-LAP tests. Presently, there are 252 GAI-LAP test methods available for accreditation. Please consult our home page for a current listing.

As of June, 2018, the following laboratories are accredited by the GAI-LAP for the number of test methods listed in parenthesis. Contact personnel, telephone numbers and e-mails are also listed.

1[A] - TRI/Environmental Inc. (155 tests)
Jarrett Nelson -- (512) 263-2101
jnelson@tri-env.com

3[A] - Golder Associates (43 tests)
Henry Mock -- (770) 492-8280
Henry_Mock@golder.com

4[C] - Geosynthetic Institute (109 tests)
George Koerner -- (610) 522-8440
gkoerner@dca.net

8[B] - Propex Operating Co., Ringgold (11 tests)
Todd Nichols -- 438-553-3757
todd.nichols@propexglobal.com

9[B] - Lumite (16 tests)
Rebecca Kurek -- (770) 869-1187
rkurek@lumiteco.com

13[A] - Precision Geosynthetic Labs (TRI Env.) (86 tests)
Cora Queja -- (714) 520-9631
cqueja@tri-env.com

14[A] - Geotechnics (51 tests)
J. P. Kline -- (412) 823-7600
JPkline@geotechnics.net

20[A] - GeoTesting Express, MA (60 tests)
Gary Torosian -- (978) 635-0424
gtt@geotesting.com

22[B] - CETCO Hoffman Estates (11 tests)
Barbara Gebka – (847) 851-1500
barbara.gebka@cetco.com

24[B] - CETCO Lovell (10 tests)
Stuart Yates -- (307) 548-6521
stuart.yates@mineralstech.com

25[B] - Ten Cate, Pendergrass (13 tests)
Darrell Scoggins -- (706) 693-2226
d.scoggins@tencategeo.com

26[B] - Agru America Inc. (27 tests)
Maria Coffey -- (843) 325-6119
mcoffey@AgruAmerica.com

29[e] - FITI Testing and Research Institute (84 tests)
Dong Whan Kim -- 82-2-3299-8071
dwKim@fitiglobal.com

31[D] - NYS Dept. of Transportation (9 tests)
Tom Burnett -- (518) 457-4704
tburnett@dot.ny.gov

34[B] - GSE Environmental Richey Road (29 tests)
Lana Hickman
Lhickman@solmax.com

38[C] - CTT Group (123 tests)
Eric Blond -- (450) 771-4608
eblond@GCTTG.com

40[B] - Solmax GSE (14 tests)
Thomas Harrelson -- (843) 382-4603
tharrelson@gseworld.com

41[A] - SGI Testing Service, LLC (18 tests)
Zehong Yuan -- (770) 931-8222
ZYuan@sgilab.com

42[C] - NPUST (GSI-Taiwan) (71 tests)
Chiwan Wayne Hsieh -- 011-886-8-7740468
CWH@mail.npust.edu.tw

43[A] - Ardaman & Associates (22 tests)
George DeStafano -- (407) 855-3860
gdestafano@ardaman.com

44[B] - Fiberweb, a Berry Global Inc. Co. (9 tests)
Devin Clem -- (615) 847-7299
devinclem@berryglobal.com

45[B] - Ten Cate Geosynthetics Malaysia SDN Bhd. (24 tests)
Boon Kean Tan -- (603) 519 28576
b.k.tan@tencate.com

46[B] - TAG Environmental Inc. (13 tests)
Colin Murphy -- (705) 725-1938
colin_murphy@tagenv.com

49[B] - Engepol Geossinteticos (15 tests)
Patricia Ferreira -- (55) 51 3303-3901
patricia@engepol.com

50[B] - ADS, Inc. Hamilton (7 tests)
Terry McElfresh -- (513) 896-2065
terry.mcelfresh@ads-pipe.com

51[B] - Solmax GSE (22 tests)
Claude Cormier -- (450) 929-1234
ccormier@solmax.com

53[B] - Polytex Autofagasta (19 tests)
Mario Contreras Cardenas -- 011 55-288-3308
mcontreras@polytex.cl

55[B] - Atarfil Geomembranes (21 tests)
Gabriel Martin Sevilla -- 34 958 439 200
gmartin@atarfil.com

56[B] - Polytex Santiago (13 tests)
Luedy Utria Caicedo -- 011 56-2-677-1000
Lutria@polytex.cl

57[B] - Ten Cate Cornelia (22 tests)
Melissa Medlin -- (706) 778-9794
m.medlin@tencate.com

58[B] - Propex Operating Co.Hazelhurst (16 tests)
Victoria Shoupe -- (912) 375-5406
Victoria.Schoupe@propexglobal.com

59[B] - Firestone (8 Tests)
Janie Simpson -- (864) 439-5641
SimpsonJanie@firestonebp.com

60[B] - TDM Geosintéticos S.A**.** (14 tests)
Roberto Diaz -- 051-1-6300330
rdiaz@tdmgeosinteticos.com.pe

61[B] - Raven Industries (18 tests)
Clint Boerhave -- (605) 335-0288
Clint.Boerhave@ravenind.com

62[B] - Solmax GSE (14 tests)
Pei Ching Teoh – (450) 929-1234
pcteoh@solmax.com

63[A] - TRI-SE Labs (4 tests)
Jay Sprague -- (864) 346-3107
Jesprague@tri-env.com

64[B] - Agru America (NV) (14 tests)
Ryan Steele -- (775) 835-8282
RSteele@AgruAmerica.com

65[C] - Bombay Textile Research Assoc. (BTRA) (23 tests)
Riyaz Shaikh
(0) 022-25003551
btra@vsnl.com

66[B] - Rowad International Geosynthetics Co. Ltd (13 tests)
Asad Ullah Khan -- +966-3-812-1360
asad@rowadplastic.com

68[B] - Glen Raven Technical Fabrics LLC (4 tests)
Chuck Hooper -- (336) 229-5576
chooper@glenraven.com

69[B] - GSE Lining Technology Co. (13 tests)
Siriporn Chayaporenlert – 6638-636638
siripornc@solmax.com

70[A] - RSA Geo Lab LLC (47 tests)
Rasheed Ahmed – (908) 964-0786
geolab13@yahoo.com

71[B] - Plasticos Agricolas y Geomembranas S.A.C. (24 tests)
Manuel Constantino Olivares Espinoza –
073-511814-511829
calidad@pgaperu.com

72[B] - Tensar Corp. GA (4 tests)
Lynn Cassidy-Potts (770) 968-3255
lcassidy@tensarcorp.com

73[B] - Gai Loi JSE (10 tests)
Paul Wong 84-650-362-5825
paul905677@gmail.com

74[B] - Agru Amercica Inc. (9 tests)
Mark Lockliear - (843) 325-6119
mlockliear@agruamerica.com

75[B] - GeoMatrix S.A.S. (29 tests)
Javier Diaz Cipagauta (571) 424-9999
jdiaz@geomatrix.com.co

76[B] - Tehmco (Chile) (15 tests)
Rodrigo Campoy 56-22-580-2852
rcampoy@techmco.cl

78[B] - PQA Mexico (15 tests)
Cesar Agusto Arcila (669) 954-8202
directorcalidad@payg.mx

79[A] - TRI Geosynthetic Testing and Services (32 tests)
Ping Wang 86-512-6283-1396
Pwang@tri-env.com

80[B] - Texel Technical Materials (10 tests)
André Parent (418) 387-4801
andre.parent@texel.ca

81[B] - Solmax GSE (18 tests)
Evelyn Kroeger 49-40-767420
ekroeger@gseworld.com

83[B] - Solmax GSE (13 tests)
Ahmed Abdel Tawab - 202-2-828-8888
atawab@solmax.com

84[B] - Interwrap India (14 tests)
Ashutosh Dixit - 1-778-945-2888
adixit@interwrap.com

85[B] - PAG Tacna (12 tests)
Manuel Constantino Olivares Espinoza –
073-511814-511829
calidad@pga.peru.com

86[B] - BOSTD China (29 tests)
Zheng Hong - 86-532-8780-6919
zhenghong@bostd.com

87[B] - Willacoochee Industrial (18 tests)
Jason Booth - 912-534-5757
jason@winfabusa.com

88[B] - Geosynthetic Testing Services Pvt. Ltd. (16 tests)
Ravi Kant - 02717-250019
rkant@gts-pl.com

89[B] - Megaplast India Pvt. Ltd. (13 tests)
Hermendra Behera - 91-937404-4620
geo.sqc@megaplast.in

90[B] - Techfab (India) Industries Ltd. - Daman (10 tests)
Jagdish Chandra Joshi - 91-22-2287-6224
nonwoven.qualitylab@techfabindia.com
Anant Kandi - anant@techfabindia.com

91[B] - Techfab (India) Industries Ltd. - Rakholi (3 tests)
Rajendra Chavan - 91-982-593-9922
geogrid.qualitylab@techfabindia.com

92[B] - Techfab (India) Industries Ltd. - Khadoli (2 tests)
Jagdeesh B.S. - 91-22-229-76224
geotxt.works@techfabindia.com

93[B] - Garware-Wall Ropes Ltd. (18 tests)
Rajendra K.Ghadge - 0-932-601-8083
rghadge@garwareropes.com

94[B] - Al Hoty Stanger Laboratory (2 tests)
K. H. Atiq Ur Rehman - 971-4-347-2201
atiq@alhotystanger.ae

95[B] - Mexichem Colombia (Pavco) (8 tests)
Juan David Lopez Torres - 57-1-782-5100 (ext. 1534)
juan.david.lopez@mexichem.com

96[B] - Tensar China (5 tests)
Zhu Shaolian - 86 (0)-27-8447-3277
zsl@tensar.com.cn

97[A] - TUV SUD PSB Singapore (16 tests)
Kyle Seet Yu Chin - 65-6885-1514
kyle.seet@tuv-sud.psb.sg

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

If anyone desires more information on the GAI-LAP, its test methods, the associated laboratories, etc., a directory is published in December of each year. It is available on GSI's home page at http://www.geosynthetic-institute.org (Accreditation).

New Lab Issues

There have been significant changes to the GAI-LAP this year. The most notable has been document and procedure updates required as a result of the revision to ISO 17025-2017; General requirements for the competence of testing and calibration laboratories. The pressing issues are the requirements of illustrating how the laboratory maintains impartiality and confidentiality per Section Four of the standard.

In the revised version of the standard, there is a new Section 4.1 dealing with impartiality emanating from ISO general requirements. In 4.1.1 it is stated "Laboratory activities shall be undertaken impartially and structured and managed so as to safeguard impartiality" and later in 4.1.3 "The laboratory shall be responsible for the impartiality of its laboratory activities". It is important for the laboratory to be sure that there are no commercial, financial or other pressures which may compromise impartiality and if there is any it has to eliminate or minimize the risk. Examples of such risks are ownership, governance, management, personnel, shared resources, finances, contracts, marketing, and payment of a sales commission or other inducement for the referral of new customers. In addition to the aforementioned, technicians should not be paid based on turnover time or result outcomes. The laboratory management shall be committed to impartiality. Two possible ways to show this are to implement an impartiality policy and to discuss impartiality on a regular basis at annual management review meetings. Furthermore, labs should make a risk analyses to assure impartiality exists at the laboratory.

Even though the new version of ISO 17025 includes a lot more detail about confidentiality, the basic requirements have not changed since the last revision of the standard. The main requirement is that the laboratory shall have policies and procedures to ensure the protection of its customers' confidential information and proprietary rights, including procedures for protecting the electronic storage and transmission of results. The laboratory shall legally commit itself to keep information obtained or created during the performance of an assignment for the client a secret. If any information will be made publicly available either by the end user, laboratory or customer the laboratory shall inform the customer in advance, unless it is prohibited by law. As a general rule, customer information shall be kept confidential.

The third big change is in regards to determining uncertainty for each test for which accreditation is sought. Before you dive in and begin calculating uncertainty, it is best to have a plan. The first part of the plan should be to identify the measurement system that you wish to evaluate. Start by answering the following questions;

- What are you measuring?
- How will you measure it?
- What equipment will you use?
- Who will perform the measurement?
- Where will the measurements be performed?
- What factors may affect the measurement results?

After answering these questions, the answers are then used to identify what measurement process are being evaluated. Once you have identified what you are evaluating, you identify the factors that influence uncertainty in measurement results. This process is not always easy and you may be surprised by how many influences can affect your measurement results. It should be noted that there are many resources on evaluating the measurement process within ISO and ASTM. They can help you in evaluation of measurement uncertainty. Over the years, many different approaches to evaluating and expressing the uncertainty of measurement results have been used. The uncertainty in the result generally consists of several components which may be grouped into categories according to the way in which their numerical value is estimated. Factors involved are generally considered, but not limited to, instrument differences, operator, sampling, time, and variation in the environment. These factors are subsequently grouped together to establish a repeatability limit carried out by a single laboratory and a reproducibility limit attainable between determinations performed in different laboratories. In the simplest of presentations, the uncertainty is then calculated as the square root of the sum of the squares of the repeatability (Sr) and reproducibility (SR) limits. It is currently a GAI-LAP and ISO 17025 requirement that all tests has a current best estimate of uncertainty.

Finally, GAI-LAP has a new policy of rejecting proficiency results beyond two standard deviations of reproducibility database average. As of 2018 it has re-defined the meaning of an "outlier". In short, there are no "Mulligans", (second chance-do overs) as in years past. As such, if a proficiency test result is an outlier, the test in question is subject to corrective action and root cause identification prior to relisting of the method in your repertoire of accredited tests. We understand that this is harsh and a hardship for many labs. However, GSI's Board of Advisors was not happy with the handling, management and resolution of nonconforming proficiency testing in the past. Going forward this new course of action should rectify the situation.

George R. Koerner
Director

Activities within GCI (Certification)

GSI presently has three separate inspector certification programs. One (begun in 2006) is focused on QA/QC of field inspection of waste containment geosynthetics and compacted clay liners. The second (begun in 2011) is focused on MSE Wall, Berm and Slope field inspection. The third on Geosynthetic Designer Certification was begun on September 1, 2016. See our website at www.geosynthetic-institute.org under "certification" for a description and information on all

three of them. They are similar in that a perspective candidate must…

- Be recommended by a professional engineer who knows, and can attest to, at least six months of acceptable experience performing professional services within the specific application area.
- Submit a completed application and be approved by the Geosynthetic Certification Institute to take the exam.
- Must successfully pass a written examination (70% of the questions is the passing grade) proctored by GCI or a GCI designated organization and graded by the Geosynthetic Certification Institute to become a certified inspector or engineer.
- Must pay a one-time fee which covers a five-year period upon completion of the above items. The fee is $500 for five-years of certification. It is renewable if so desired.

Program #1 - Inspection of Liner Systems for Waste Containment Facilities

This program now in its twelfth year has been recommended, and in some cases required, by solid waste owners, state regulators, and design consultants for proper QA/QC in field installation of both geosynthetic materials and compacted clay liners. The statistics to date are as follows. The examination has been gradually revised attesting to the changes occurring over the past years.

Inspector Certification Test Results for
Waste Containment Inspectors
2006 – 2018

Year	Geosynthetic Materials		Compacted Clay Liners	
	No. of people taking exam	No. of people failing exam	No. of people taking exam	No. of people failing exam
2006	141	5 (3%)	128	12 (9%)
2007	82	11 (13%)	73	12 (16%)
2008	95	25 (26%)	89	20 (22%)
2009	36	7 (19%)	36	2 (5%)
2010	59	12 (20%)	54	7 (13%)
2011	54	6 (11%)	53	3 (6%)
2012	34	5 (15%)	28	3 (11%)
2013	32	4 (12%)	30	1 (3%)
2014	45	1 (3%)	42	3 (7%)
2015	56	6 (11%)	51	6 (12%)
2016	36	3 (10%)	35	4 (14%)
2017	78	5 (6%)	66	3 (5%)
2018	39	4 (10%)	37	1 (3%)
TOTAL (to date)	**787**	**94 (12%)**	**722**	**76 (11%)**

The 5-year renewal periods for those having taken the exam before 2010 is ongoing and about 60% have renewed accordingly. This is felt to be encouraging from our perspective. The next on-line course is October, 16, 17, 18; 2018.

Program #2 - Inspection of MSE Walls, Berms and Slopes

While a field inspector cannot require proper design or direct a contractor how to build a wall, flaws can be identified for possible design modification or mitigation action. Furthermore, and at minimum, construction practices can be observed and corrected if inadequate or improper.

The official launch of this inspection program was on December 1, 2011 with a course and the examination afterward. A somewhat revised course on November 29, 2012 was presented. Presently, the corresponding course for this certification program has been transferred into a series of six presentations over a consecutive three-day period; the next being November 6, 7, 8; 2018. Contact Jamie Koerner at jrkoerner@verizon.net for details and arrangements.

The status of the program is shown in the following table.

Inspector Certification Test Results for
MSE Walls and Berms Inspectors
(2011-2017)

Year	Course Location	MSE Wall And Berms	
		No. of People Taking the Exam	No. of People Failing the Exam
2011	GSI Course	7	0
2012	GSI Course	6	0
2013	GSI Course	2	0
2014	GSI Course	3	0
2015	GSI Course	4	0
2016	GSI On-Line Course	2	2
2017	GSI On-Line Course	0	0
TOTAL		24	0

Program #3 - Geosynthetic Designer Certification

The "Geosynthetic Designer Certification Program (GDCP)" is also now available. Please go to http://www.geosynthetic-institute.org/gdcpintro.pdf for the requisite details. Included are introduction (rationale behind the program was given in a recent GSI Column called "We're Losing the Battle"), disclaimer, requirements, application, reference material, sample questions, proctor manual and proctor application. In the *requirements section* you will see that the applicant must;

- be a graduate of an accredited engineering program,
- have six-months geosynthetic designer experience,
- complete the application form,
- pay the $500 fee for 5-years certification, and
- take a 45-question numerical examination with ≥ 70% passing.

The *examination* itself is subdivided into 15-sections, each consisting of five questions. A candidate must answer any 3 questions in each section, making a total of 45 questions to be answered. Most of the questions are numeric, as is geosynthetic design practice in general. Unlike our other certification examination questions, however, this examination is of an open-book, open-notes format and does require a calculator so as to "crunch the numbers".

Lastly, please spread-the-word within your organization and to others as well. We sincerely hope that one, or all three, of the above programs will be beneficial in upgrading the technical base of geosynthetic design and installation so as to properly utilize all of our geosynthetic materials in all of their many applications. All three programs are on-going and if you have questions and/or comments please contact us accordingly.

Bob Koerner rmk27@drexel.edu
Marilyn Ashley mvashley@verizon.net
Jamie Koerner jrkoerner@verizon.net

The GSI Affiliated 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 three countries (Korea, Taiwan and India), and potentially 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.

GSI-Korea was formed on February 9, 1998 as a collaborative effort between FITI Testing and Research Institute (a quasi-government organization) and INHA University (through its Geosynthetics Research Laboratory). It is presently in the transition of being held entirely within INHA University.

INHA University is located in Incheon and the geosynthetics laboratory 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. His active participation at conferences worldwide is very admirable. He has provided research and development in many geosynthetic subjects including geotextiles, geomembranes, geocells, additives for GCLs, recycled plastics for improved formulations, etc.

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 Dean of the R & D Office. 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 59 geosynthetic test methods. Dr. Hsieh has 10-students working on geosynthetic-related projects and is extremely active nationally and internationally. GSI Taiwan has hosted three very successful internal conferences to date and has also held a much broader one, namely, GSI-Asia in Taichung, Taiwan.

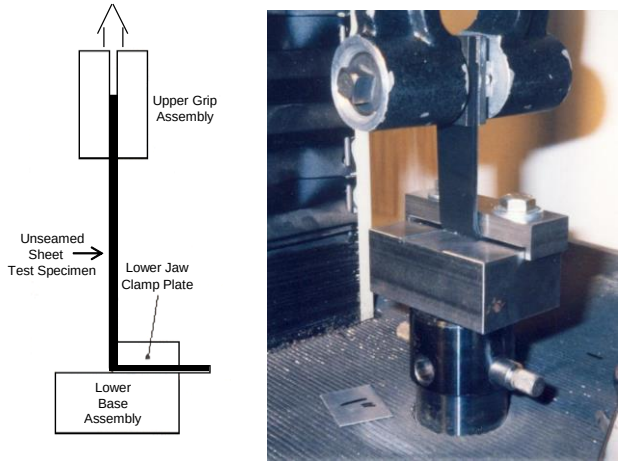
GSI-India under the new direction of Dr. A. K. Mukhopadhyay (who succeeds Dr. A. N. Desai) was formed in 2015. The hosting organization is the Bombay Textile Research Association (BTRA) which is world known for its excellence in textile R & D and is currently branching out into all forms of geosynthetics. We are delighted in this regard and, as a side-note, Dr. Mukhopadhyay has replaced Dr. Desai on GSI's Board of Directors to fill out his term.

Don't Be Afraid of Making Horizontal Geomembrane Seams on Side Slopes!

Over the years, there have been many discussions and questions regarding the concern over having geomembrane field seams located horizontally on side slopes. By not allowing such seams, it usually results in many short roll lengths that become either unused or difficult to tailor into the flat area of the project. *Stated differently, the installation costs increase accordingly.* It appears that the concern over such nonuse is a possible lack of seam strength somewhere along the side slope. While geomembrane seams in a shear mode typically approach the full strength of unseamed sheet geomembrane, it is the peel strength that is usually questioned. For example, in most specifications (including GRI-GM19a for the polyolefin geomembrane types HPDE, LLDPE and fPP) the shear strength is 95% of the unseamed sheet tensile strength, while the peel strength is 62% of the unseamed sheet tensile strength. This significantly lower peel value appears to be the central issue when considering side slope geomembrane seaming.

As will be shown, the lower peel strength percentage stated above is essentially an artifact of the manner of laboratory testing of the unseamed sheet strength that is used for comparison purposes. This is because the

peel strength test (necessarily in a 90° configuration) is usually compared to the unseamed sheet strength in its traditional linear configuration (aka, the specimen tensile forces are aligned with the upper and lower testing grips). As shown by F. Struve and G. Koerner in 2005, however, when the unseamed sheet tensile strength is measured in a 90° configuration (see Figure 1), the peel strength percentage is very much higher than when the sheet is tested in its linear configuration.



(a) Sketch of test setup (b) Photo of test apparatus

Figure 1. Test setup for measuring unseamed geomembrane strength at a 90° tensile force configuration.

Figure 2 shows the differences of unseamed sheet strength in both modes of tension testing for HDPE geomembranes of various thicknesses. Readily seen is that the 90° tension test results described herein are always less than the standard linear tension test results. The decreases with increasing thickness are 24%, 37%, 31%, 30% and 41%, respectively. Averaging these values gives 33%. This represents the average amount that unseamed sheet strength is lower in a 90° alignment than when the standard linear test is used. In comparing such lower sheet strength values to the actual seamed peel strength (which was hypothetically 62% of the linear configuration) it suggests that the actual percentage of peel strength now becomes 62% of the 90° unseamed sheet strength. Thus, 62% of (100-33) becomes 62/67 = 93% of the 90° sheet strength. As such, this percentage is quite comparable to the seam shear percentage of 95% as mentioned earlier.

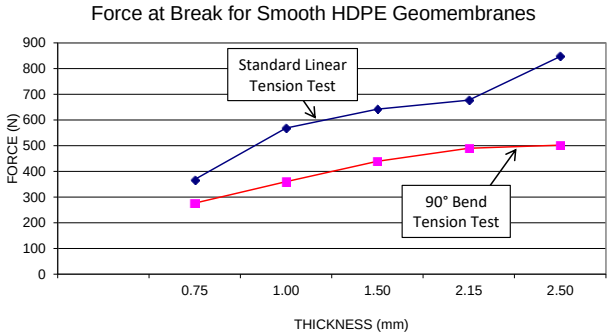


Figure 2. Tension tests on unseamed HDPE sheet at various thicknesses using a standard test specimen alignment versus a 90° bent test specimen as indicated in Figure 1.

The above said, there are three aspects of field geomembrane deployment, which should be considered so as to alleviate any remaining concerns over horizontal seams on side slopes. They are the following:

1. When a geomembrane is placed on a slope to be seamed to a continuation of one in a horizontal manner, the upper geomembrane must be shingled over the lower geomembrane. This will assure that the shear seam strength is being mobilized if tensile stresses arise in the sheets. In this regard, we believe that it is less likely for the seam to be challenged in a peel mode.
2. We also feel that horizontal seams should be staggered with respect to adjacent seamed sheets such that the seams do not communicate with one another in a straight line along the slope.
3. If the entire geomembrane sheet on the side slope does go into tension (e.g., due to inadequate frictional strength to the underlying soil or other geosynthetic) the tensile stress is minimum at the bottom of the slope and maximum at the top. This infers that horizontal seams should be located as low as possible on the slope. We believe that the longest possible sheets should be placed from the anchor trench at the top of the slope and come downslope as far as possible to be continued with shorter sheets, rather than short “filler” sheets located near the top of the slope.

The above said, we feel that the intransigence toward using horizontal field seams of geomembranes is largely unfounded. Furthermore, to have regulations promulgated against such seam orientation under any, and all, circumstances is far too restrictive and the design engineer should be allowed to assess the situation on a site-specific basis.

Ref. Struve, F. and Koerner, G. R. (2005), “Behavior of HDPE Geomembrane Sheet and Seams Subjected to a 90° Tensile Test,” Proc. GRI-18 Conference on Geosynthetic Research and Development In-Progress at GeoFrontiers, Austin, Texas, 8 pgs.

Acknowledgement
George and Bob Koerner sincerely thank Fred Struve for suggesting this topic many years ago. Fred is a world renown expert in geosynthetic manufacturing equipment and has wide experience in formulations, installation and performance as well. Thanks Fred!

Bob and George Koerner

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. **Our newest members INOVA Geosynthetics/AERO Aggregates with Archie Filshill; Sotrafa Agrualura y Geosinteticos of Spain with Jose Miguel Munoz Gomez; Kaytech Fabrics Co. of South Africa with Garth James; Interwrap Inc. with Clive Mills/Martin Vido; Borouge Pte. Ltd. of Singapore with *Mohamed Ali Jaber/Peter Malmros/Rick Cui,* and Thrace Group with Steven Lothspeich/Stella Karavasili. Thanks to all and welcome to GSI!!!**

GSE Environmental
Jimmy Youngblood [BoA]/Mark Harris
U.S. Environmental Protection Agency
David A. Carson
Federal Highway Administration
Silas Nichols/Daniel Alzamora
Golder Associates Inc.
Frank Adams/Paul Whitty
Tensar International Corporation
Mark H. Wayne [BoA]/Joseph Cavanaugh/Doug Brown
Low and Bonar PLC (formerly Colbond)
Richard Goodrum
TenCate Geosynthetics
John Henderson/Chris Lawson
CETCO
Davie Chiet/Michael Donovan/Rob Valorio
Huesker, Inc.
Sven Schröer/Andreas Elsing/Lilma Schimmel
NAUE GmbH & Co. KG
Kent von Maubeuge [BoA]
Propex Operating Company LLC
Drew Loizeaux
Berry Global Inc.
Brian H. Whitaker
TRI/Environmental Inc.
Sam R. Allen [BoA]/Joel Sprague
U. S. Army Corps of Engineers
Kevin Pavlik
Chevron Phillips Chemical Co.
Ashish Sukhadia [BoA]/Randy Moynihan/Jennifer Hicks
AECOM (formerly URS Corp.)
John Volk/John Bove
Solmax Géosynthétiques
Jacques Cote/Simon Gilbert St-Pierre
CARPI, Inc.
Alberto M. Scuero/John A. Wilkes
Civil & Environmental Consultants, Inc.
Tony Eith [BoA]
Agru America, Inc.
Nathan Ivy [BoD]/Markus Haager
INHA (GSI-Korea)
H.-Y. Jeon
Waste Management Inc.
Greg Cekander/John Workman [BoA]
NPUST (GSI-Taiwan)
Chiwan Wayne Hsieh
GeoComp/GeoTesting Express
W. Allen Marr/Gary T. Torosian
GEI Consultants
Michael A. Yako/Michael Ruetten
Atarfil, S. L.
Eladio Perez Lopez/Emilio Carreras Torres/ Tamara Jurado Corrasco
Republic Services Inc.
Joe Benco/Tony Walker
GSE Europe
Stefan Baldauf/Catrin Tarnowski
InterGEO Services Co.
Şükrü Akçay/Archie Filshill
Raven Industries, Inc.
Gary M. Kolbasuk
CTI and Associates, Inc.
Te-Yang Soong/Kevin Foye
Advanced Earth Sciences, Inc.
Kris Khilnani/Suji Somasundaram
Carlisle Syntec, Inc.
Paul Markel/Brinda Mehta
EPI, The Liner Co.
Daniel S. Rohe/Ryan Whalen
Geo-Logic Associates
Monte Christie
Weaver Consultants Group, Inc.
Mark Sieracke
Aquatan (Pty) Ltd.
Piet Meyer
Jones Edmunds, Inc.
George Reinhart/Tobin McKnight
Afitex-Texel
Pascal Saunier/Stephan Fourmont
EVAL Americas (Kuraray)
Edgar Chow
GeoProducts
Al Florez/PC Lauinger
BTRA (GSI-India)
Anjan K. Mukhopadhyay [BoA]
Watershed Geosynthetics LLC
Michael Ayers
Maccaferri
Moreno Scotto [BoA]/Sachin Mandavkar/Pietro Rimoldi
Jones & Wagener (Pty) Ltd.
Riva Nortje
Ardaman & Assoc.
Nadim Fuleihan/Thomas S. Ingra/Jan Wildman
Tecnologia de Materials (TDM)
José Ferreyros/Augusto Alza/Roberto Diaz
American Wick Drain
Scott Morris/Craig Phelps
INOVA Geosynthetics/AERO Aggregates
Archie Filshill
Sotrafa S. A.
Jose Miguel/Munoz Gomez/Rosa Ruiz
Kaytech Fabrics Group Ltd.
Garth James
Interwrap, Inc.
Clive Mills/Martin Vido
Thrace Group
Steven Lothspeich/Stella Karavasili

ASSOCIATE MEMBERS

Delaware Solid Waste Authority
Robin Reddy
Nebraska Department of Environmental Quality
Michael Behrens
New York State Dept. of Environmental Conservation
Robert J. Phaneuf
Maine Department of Environmental Protection
Victoria Eleftheriou
New York State Department of Transportation
Steve Heiser/Tom Burnett
California Water Resource Control Board
Scott Couch/Nadine Langley
New Jersey Dept. of Environmental Protection
Mary Anne Goldman
Pennsylvania Dept. of Environmental Protection
Jason Dunham
Florida Dept. of Environmental Protection
Cory Dilmore
U.S. Bureau of Reclamation
Mike Walsh/Peter Irey
Michigan Dept. of Environmental Quality
Margie Ring/Xuede (Dan) Qian
Environment Agency of U. K.
Darren Legge
Florida Dept. of Transportation
David Horhota
National Resource Conservation Service
Stephen D. Reinsch
Virginia Dept. of Environmental Quality
Donald Brunson
Massachusetts Dept. of Environmental Protection
Tom Adamczyk
Dept. of Water Affairs of South Africa
Kelvin Legge
Pennsylvania Dept. of Transportation
Kerry Petrasic

IN THE NEXT ISSUE

- Activities of the GSI Directors and Board
- Overview of GRI (Research) Projects
- Activities within GII (Information)
- Progress within GEI (Education)
- Activities within GAI (Accreditation)
- Activities within GCI (Certification)
- The GSI Affiliate Institutes
- The GSI Centers-of-Excellence
- Flood Abatement Using Geosynthetics
- GSI's Member Organizations