Profile of an Organization

Geosynthetic Research Institute

ROBERT M. KOERNER

The following article is part of an occasional series appearing in TR News in which transportation research organizations are profiled. The organization, activities, and goals of the Geosynthetic Research Institute at Drexel University are discussed here.

The Geosynthetic Research Institute (GRI) was created at Drexel University in 1986 after approximately 10 years of varied university research on and development of different types of geotextile and geomembrane materials. Since the establishment of GRI, research has been focused exclusively on geosynthetics—polymeric materials used in below-ground construction in the fields of transportation, environmental, and geotechnical engineering. Current research includes studies on geotextiles, geomembranes, geogrids, geonets, geocomposites, geosynthetic clay liners, and geopipe (buried plastic pipe). (See accompanying box for a general description of the use of these materials in transportation-related applications.) Activities under way at GRI include generic research projects, new-product evaluation, provision of temporary test methods and standards, professional courses, and a graduate degree program in geosynthetic engineering.

Organization and Operation

Compared with many research institutes, GRI is small. Three faculty, three full-time research associates, three doctoral students, four master's degree students, and two staff members are involved in its operation. The group occupies one wing of a four-story building on Drexel's campus in Philadelphia.

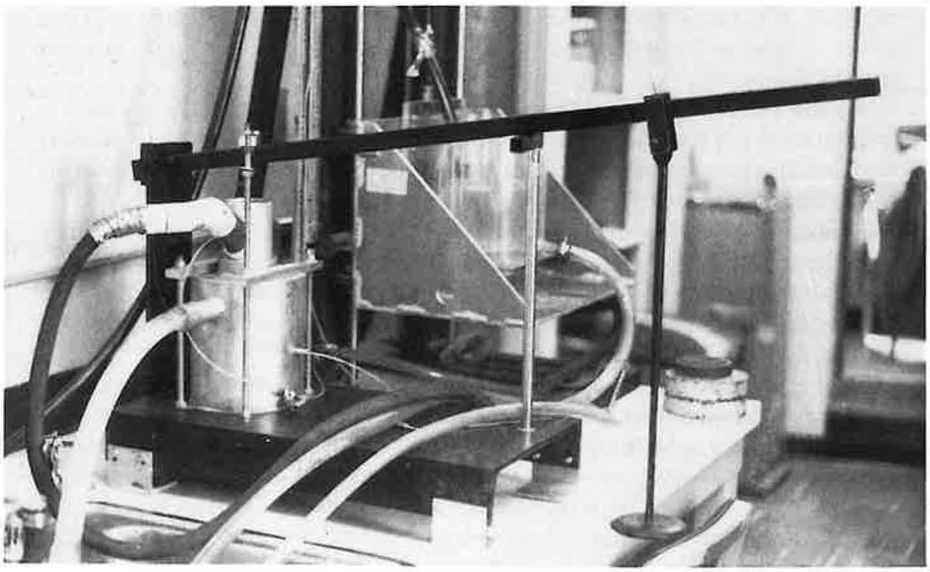
GRI is operated and maintained through three funding sources: a consortium of organizations, federal and state research contracts, and miscellaneous funds from courses, seminars, and publications. At this time the consortium comprises 47 organizations: 6 government agencies, 5 private facility owners, 8 geotextile manufacturers, 8 geomembrane manufacturers, 6 other geosynthetic manufacturers, 5 resin and raw material suppliers, and 9 design consultants and testing laboratories.

Current Activities

Generic Research Projects

Developing generic research is the major task at GRI. Research results are circulated initially to member organizations and are eventually published. Major research projects are described below.

- *Accelerated aging of polymeric materials.* In one test series polyvinyl chloride geomembranes are being evaluated under relaxed and constant tensile stress modes; in another, high-density polyethylene geomembranes are being evaluated under relaxed and constant compressive stress modes. The data for each test series are analyzed with an Arrhenius model to predict geomembrane lifetimes at site-specific service temperatures.
- *Evaluation of the analytic and experimental behavior of anchored geogrids used for stabilization of reinforced walls and steep slopes.* This evaluation has led to a finite element program and has been corroborated by many large-scale experiments. It is related to a joint project of the Pennsylvania Department of Transportation and the Federal Highway Administration.
- *Stress-cracking evaluation of semi-*



Permeability of geotextile as measured by laboratory test device at GRI.

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crystalline polyethylene. This project has led to a notched constant tension load test that is being considered by the geomembrane community. Use of the method should help avoid short-term failures of semicrystalline geomembranes. A related test under development is a seam constant load test to challenge long-term behavior in the seam region. This study is sponsored by the Environmental Protection Agency (EPA).

• *Stress relaxation behavior of geosynthetic materials.* In an area that traditionally has received little attention, this GRI study involves a constant strain test (instead of the customary constant stress, or creep, test) to provide insight into polymeric behavior for subsequent viscoelastic analysis.

• *Puncture protection of geomembranes on various types of soil subgrades.* A constant stress hydrostatic chamber is used for this evaluation. Various types of geotextile and geocomposite protection layers are used to note the efficiency and degree of improvement provided.

• *Filtration tests.* Various tests are being developed to rapidly assess the possibilities of geotextile clogging, soil retention (piping), or equilibrium behavior. Test methods include long-term test columns, fine fraction filtration, and dynamic filtration tests. The latter two methods are part of a National Cooperative Highway Research Program (NCHRP) project (see accompanying box).

• *Field exhuming studies.* Another major component of GRI's work, these studies are being conducted to investigate geosynthetic damage area, the biological clogging area, and the highway drainage area (see accompanying box on NCHRP project). In studies of highway drainage, the material is exhumed at the field site, and a complete characterization of the adjacent soil materials is performed.

New-Product Evaluation

GRI is not a commercial testing laboratory. Rather, it evaluates new materials for use by member organizations in development of their products. Among recent activities are enhancement of the anchorage behavior of geogrids, guidance in increasing the shear strength of geosynthetic clay liners, and characterization of the uniformity of textured surfaces on polyethylene geomembranes.

Provision of Temporary Test Methods and Standards

ASTM, the American Association of State Highway and Transportation Officials, EPA, and others are clearly the leading and authoritative agencies for the establishment of test methods and standards. However, in geosynthetics, an area in which technology is advancing rapidly, the time from inception to adoption of a test method or standard is often long. Consequently, GRI has embarked on an effort to establish temporary test methods and standards; 35 are currently available. When an established group, such as ASTM, adopts a method, GRI no longer distributes its version of that test or standard. For example, GRI ceased distribution of its biological clogging test for geotextile filters when ASTM standardized its version of the test (ASTM D1987-91).

Professional Courses

Because few practicing engineers have had formal classroom training in geosynthetics, professional courses are a viable part of GRI's activities. To date, more than 100 such courses (lasting from 1 to 3 days) have been offered. They often occur in conjunction with the technical meetings of professional societies, such as the American Society of Civil Engineers, ASTM, and the

Geosynthetics in Transportation-Related Applications

Since their introduction in the early 1970s, geotextiles have been evaluated, tested, installed, and monitored by every state transportation department in the United States. Most states have specifications for such standard uses as subsurface drainage (filtration), erosion control, sediment control, roadway separation, and roadway rehabilitation.

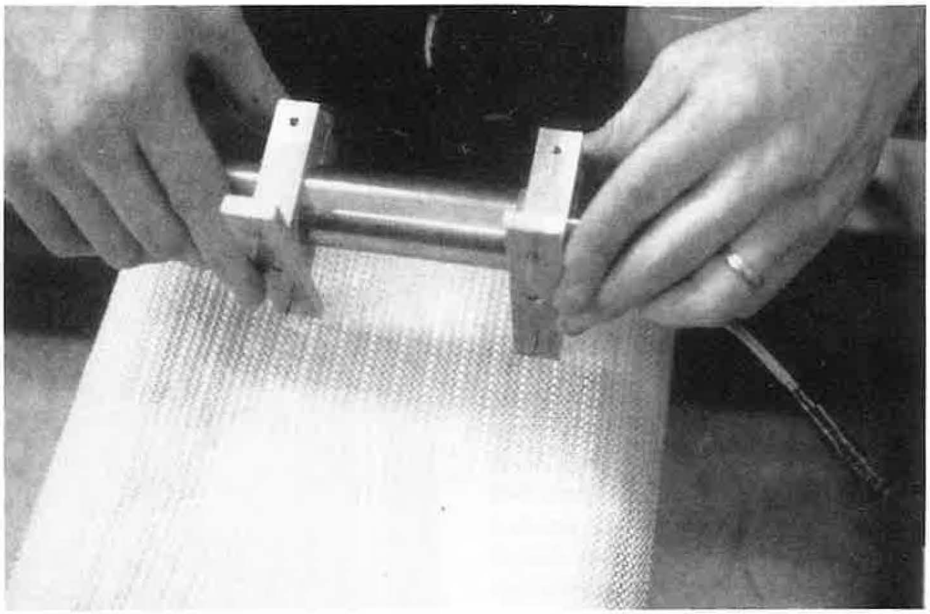
Investigative research and professional course training have been sponsored by the Federal Highway Administration for almost 20 years. The American Association of State Highway and Transportation Officials has developed test standards and formed task groups for specific purposes. For example, Task Group 25 has focused on geotextile specifications for the topics listed above, and Task Group 27 has detailed the procedures for use of geotextiles and geogrids in retaining-wall reinforcement and steep-soil-slope stabilization. Geotextiles and geogrids are fast becoming standardized engineering materials.

Geosynthetics for drainage applications, such as prefabricated wall drains, highway edge drains, vertical strip (wick) drains, and the like, are emerging rapidly. Their cost efficiency, in terms of materials, installation, and performance, makes their use compelling in times of budget limitations and cost consciousness for all public-financed facilities and systems.

Moisture barriers, such as geomembranes and impregnated geotextiles, are used in transportation applications for vertical and horizontal seepage control, groundwater modification applications, prevention of subsurface contamination at refueling depots and underground storage tanks, and isolation of contaminated soils.

Finally, the area of specialty geosynthetics for temporary and permanent prevention of soil erosion, flexible forming systems for remediation of bridge piers and pilings, noncorroding anchors and ties for reinforcement applications, and three-dimensional geosynthetic mattresses for roadway and embankment construction over soft soils are all being developed and used today.

Clearly geosynthetics have emerged as bona fide engineering materials in transportation engineering applications. Continued close cooperation of public and private facility owners, design consultants and testing organizations, geosynthetic manufacturers and representatives, basic polymer supply firms, and research and development organizations will ensure a tremendous future for geosynthetics. Perhaps most important, the use of geosynthetics in transportation systems will result in cost-effective applications that can be designed and constructed with confidence.



Typical of tests performed at GRI is attachment of electronic displacement gauge to high-strength geotextile.

North American Geosynthetic Society.

The newest effort in this type of outreach program is an inspection training course for the installation of geosynthetics. This offering is in conjunction with a forthcoming certification program of the National Institute for Certification in Engineering Technologies for field inspectors of geosynthetic installation activities.

Graduate Degree Program

GRI, as part of Drexel University, offers graduate courses in geosynthetics. The program has grown from a single course in 1982 to seven, including courses on test methods; designing with geotextiles, geogrids, and geonets; designing with geomembranes, geocomposites, and geopipe; and polymerization and processing.

Each course is worth 3 credits; together they provide 21 of the 45 credits necessary for a master of science degree in geosynthetics engineering. The balance of the required courses is available in related subjects (geotechnical engineering, environmental engineering, transportation engineering, and hydraulics) or in thesis work. Doctoral programs spring from this base and lead to specific research topics in geosynthetics.

GRI and the Future

Clearly there is no lack of research and development in the area of geosynthetics. Activities are planned for the near term in the following areas: aging, durability, and lifetime prediction; filtration, soil retention, and clogging evaluation; and tension creep and stress relaxation. These efforts will likely spin off related activities in compression creep, freeze/thaw behavior, and soil/geosynthetic composite behavior.

Long-term research and development could conceivably branch out into other aspects of polymeric materials in civil engineering. The use of polymer materials in bridge and building construction certainly could pose interesting and formidable challenges. Whatever the case, GRI will be positioned to play a meaningful role in the professional and academic development of polymeric materials in transportation, environmental, and geotechnical engineering.

NCHRP Project 15-13: Long-Term Performance of Geosynthetics in Drainage Applications

Under a National Cooperative Highway Research Program (NCHRP) project, the Geosynthetic Research Institute (GRI) at Drexel University is assessing the field performance of highway edge drains, erosion control systems, and wall drainage systems in transportation-related systems. The project is in its third and final year; the final report is due to NCHRP in March 1993. The major elements of the project are briefly described here.

Field exhuming of the geosynthetic components of the transportation applications mentioned above is the major focus of the project. In the 83 sites exhumed in 14 states there are 37 prefabricated highway edge drains, 12 geotextile wrapped pipe drains, 21 geotextile wrapped stone/pipe underdrains, 6 standard perforated pipe underdrains, 3 wall drain filter/separators, and 4 erosion control filter/separators.

The work consists of excavating a representative sample of the geosynthetic material(s) involved, sampling the surrounding soil materials, and epoxy-setting a Shelby tube sample of the unit wherever possible. The exhumed area is then repaired and backfilled, and responsibility for the area is returned to the cooperating state transportation agency. The exhumed materials are taken to the GRI geosynthetic or soils laboratory for analysis and complete forensic assessment.

Three interrelated laboratory efforts are under way to complement and aid in the understanding of the field findings: long-term flow tests, fine fraction filtration tests, and dynamic filtration tests. The latter two are accelerated tests; their purpose is to predict the performance of geotextile filters at each of the field sites. Filters are characterized as exhibiting excessive soil loss, excessive geotextile clogging, or long-term flow equilibrium. Obviously, the third category is the ultimate goal. A possible result of the NCHRP project is development of an accelerated test method to rapidly determine the appropriateness of a candidate geotextile with a given soil and under a given hydraulic condition.

For more information on this project contact Daniel W. Dearasaugh, Jr., NCHRP, Transportation Research Board (telephone 202-334-3236) or Robert M. Koerner, GRI, Drexel University (telephone 215-895-2343).