Geosynthetics

RYAN R. BERG, *Ryan Berg & Associates*
L. DAVID SUITS, *New York State Department of Transportation*

A geosynthetic has been defined by the American Society for Testing and Materials (ASTM) Committee D35 on Geosynthetics as "a planar product manufactured from polymeric material used with soil, rock, earth, or other geotechnical engineering related material as an integral part of a man-made project, structure, or system." The geosynthetics that are routinely used in the transportation industry are geotextiles, geogrids, geomembranes, erosion control blankets and mats, geosynthetic clay liners, geocomposite drainage materials, and geonets. Those concerned with the analysis, design, installation, and performance of geosynthetics employed in transportation facilities focus on specifications, design methodologies, construction techniques, long-term performance, and economics.

Geosynthetics have been and continue to be used in all facets of the transportation industry, including roadways, airports, railroads, and waterways. The principal functions performed by geosynthetics are filtration, drainage, separation, reinforcement, provision of a fluid barrier, and environmental protection.

TRANSPORTATION NEEDS

In designing and maintaining transportation facilities, designers attempt to provide facilities that will meet users' current needs without rapidly becoming obsolete, that will be safe, and that will be economical to construct and maintain. In the past, one or more of these objectives often had to be sacrificed. Geosynthetics have enabled innovative designs that can better meet all of these objectives.

There has been much discussion of the notion that standardization reduces opportunities for innovation. Another way of viewing the relationship between the two is to say that innovation, or the state of the art, must precede the adoption of technology, or its standardization (state of the practice). Quite often, however, the move from state-of-the-art technologies to the state of practice within transportation agencies lags behind that in other engineering communities. Some of this is due to economics; innovation tends to be costly until the technology becomes the standard of practice. Other factors, such as governmental conservatism, also play a role. With regard to geosynthetics, designers must become more willing to use these new materials in such applications as geosynthetic-reinforced earth structures. Doing so will allow the state of the art to become the state of practice, which in turn will lead to reduced project costs.

STATE OF PRACTICE

Certain geosynthetic materials are used routinely by some state transportation departments and local road authorities. These materials and their applications include geotextile roadway pavement separators, blankets and mats for erosion control, geotextile barrier asphalt overlays, geosynthetic composite drains, geotextile filters, and geotextile or geogrid reinforcement of embankments over soft foundations. The widespread use of geotextile separators between soft, wet subgrade and base course layers is expected to continue. The use of geosynthetics and synthetic-natural composites for erosion control is likely to increase in the future with stricter environmental regulations and enforcement.

Impregnated geotextile barriers are used routinely in asphalt overlays, but only in certain areas of the country and typically by local road authorities. Use of these barriers in asphalt overlays is expected to be limited in the future. Geosynthetic composites are widely used for pavement edge drains. Expanded use of these drains will likely occur as design and installation procedures continue to be refined, but their application can be significantly increased if more definitive economic benefits are demonstrated. The use of geotextile filters in drainage systems and of geosynthetic reinforcement beneath embankments over weak foundations should continue in the future.

The future use of geosynthetics in all of these applications, particularly asphalt overlays, can be enhanced with better documentation of immediate and life-cycle cost and benefits as compared with alternative methods. Use of geotextile separators over relatively firm subgrade could become routine if the economics and mechanisms of pavement improvement were better defined.

Design and construction of geogrid or geotextile-reinforced soil structures are common within some state transportation agencies. Mechanically stabilized earth wall and, to a more limited extent, reinforced soil slope structures are now being constructed. Initial cost and benefits have been established, though life-cycle costs have not been well documented to date. Use of geosynthetic-reinforced mechanically stablized earth wall and reinforced soil slope structures certainly should increase in the new millennium, although some existing practices may restrict this growth. Users are continuing to develop better methods and procedures for implementing these technologies.

STATE OF THE ART

Currently, geogrids and geotextiles are being used to a very limited extent to reinforce the pavement base course and to enhance performance over a soft subgrade of flexible pavement structures. These two applications are expected to be more widespread in the new millennium as they become easier for transportation engineers to implement. However, better definition of mechanistic design procedures, life-cycle costs, key material properties, and specifications is needed for geosynthetic pavement reinforcement to become the state of the practice within transportation agencies. Spurring this expected growth are the challenge of extending the pavement analysis period (i.e., design life) to 30 to 50 years and the growing cost of base course materials.

Another application that should increase is the use of geosynthetics to reinforce fill embankment edges. Reinforcement enhances soil compaction and soil shear strength, thus decreasing future maintenance costs associated with reinstating sloughing-type failures.

FUTURE DIRECTIONS

Much work will be required to advance geosynthetic applications currently viewed as state of the art and new (as-yet undefined) applications to the state of practice among state and local transportation agencies. The greatest future benefit of geosynthetic materials is likely to be realized in pavement structures. The new millennium is expected to bring definition of the mechanistic contributions of various geosynthetics used within a pavement structure, as well as a clearer valuation of immediate and life-cycle cost and benefits. Furthermore, future pavement design procedures are likely to incorporate geosynthetics for various functions, and perhaps will assume use of geosynthetics for some functions unless clearly eliminated by the design process.

Certainly, new highway applications of geosynthetics will emerge in the future, as will different geosynthetic materials and composites. Products may be developed for enhanced economics and performance of existing applications or for new applications. In addition, applications of geosynthetics will be improved as other technologies are refined. Geosynthetics are well suited to achieving better performance with less-select soil. The versatility and usage of geosynthetics will be enhanced as in situ and rapid soil testing procedures are developed, refined, and implemented by transportation agencies.

SUMMARY

Use of existing, state-of-the-practice geosynthetic applications by transportation agencies should expand in the new millennium with further implementation of life-cycle economics and mechanistic design practices. State-of-the-art geosynthetic applications will be advanced to the state of practice within transportation departments as design procedures and specifications are standardized. New geosynthetic materials and new applications of geosynthetics in transportation are anticipated.

It is expected that the use of geosynthetics will become increasingly routine, and that geosynthetics will be the standard material of choice for several applications. Use of geosynthetics in pavement structures (to perform the functions of separation, filtration, drainage, and reinforcement) should increase significantly in the new millennium as the benefits of these materials are quantified. In addition, the versatility and usage of geosynthetics will be enhanced with the development and adoption of in situ and rapid soil testing procedures.