Geosynthetics in new transportation applications

By Timothy D. Stark and David Paiko

Introduction

Geosynthetics are useful and versatile materials that have found a range of applications in transportation projects (Berg and Suits, 2000). Geosynthetic materials can decrease project costs and project time; increase design life, stability, and range of acceptable borrow material; and improve performance—important given the large backlog of infrastructure projects and limited funding.

This article explains a few relatively new uses and designs for geosynthetics in transportation applications since Berg and Suits (2000). The types of geosynthetics include: geotextiles, geogrids, geomembranes, geocells, and geonets.

The following applications will be addressed, with references that readers can review for additional details: deicing pads, load transform platforms, moisture barriers, underground stormwater management chambers, pavement separators, and tunnel liners

Applications

Deicing pads and ponds

Snow and ice can seriously affect aircraft operations, so federal regulations require all snow, ice, and frost to be removed from "any propeller, windshield, stabilizing, or control surface" prior to takeoff (FAA, 1989).

Deicing fluid (e.g., propylene glycol) is frequently used to remove these hazards and many airports are now using a single deicing facility to minimize environmental impact from deicing fluids.

Geomembrane or geosynthetic clay liner (GCL) liner systems (Petno and Athanassopoulos, 2008) can be used to minimize percolation of harmful chemicals into the subsurface and stormwater infrastructure. One example is covered ponds for containment of deicing fluid at Salt Lake City International Airport. These ponds are lined with 62,800 square meters (675,000 square feet) of factory fabricated geomembrane panels.

Figure 1 shows deployment of a factory fabricated panel and detailing for the cover system in one of the deicing fluid ponds at the Salt Lake City International Airport. **Figure 2** is an aerial view of the three completed deicing fluid ponds at this airport.

The liner system contains the deicing fluid while the cover system prevents evaporation of the chemicals and disturbance by trespassers.

Load transfer platform

Load transfer platforms (LTPs), in conjunction with column-supported embankments, are increasing in popularity (Collins et al., 2005) as an alternative to prefabricated vertical drains ("wick drains"), surcharge loading, and geosynthetic reinforcement on

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Photos courtesy Fabricated Geomembrane Institute (FGI) transportation projects underlain by soft, compressible foundation soils.

An LTP consists of one or more layers of geosynthetic reinforcement between layers of compacted sand or gravel and can be used as an alternative to a pile cap. The LTP is thicker than a continuous pile cap, so it dissipates more load than a pile cap and reduces the amount of piles needed to support the applied load.

Figure 3 shows some of the small circular concrete pile caps (left side of photograph) and concrete filled pipe piles driven (right side of photograph) before LTP construction for the new Mississippi River bridge approach in Hastings, Minn. The old bridge, similar to the Interstate 35W bridge that collapsed in Minneapolis in 2007, is visible in the background of **Figure 3**.

Figure 4 shows a layer of geogrid reinforcement being backfilled with fine sand to create the LTP for the Hastings bridge approach.

Moisture barrier

Moisture barriers have been used to mitigate pavement problems caused by water infiltrating moisture-sensitive soils such as expansive clays (Holtz et. al., 1998).

The pavement problems include settlement, heave, and/or susceptibility to frost. Moisture barriers can be used to control vertical or horizontal infiltration, depending on the needs of the project.

The typical application is a moisture barrier consisting of a geonet and geomembrane between the roadbase and subgrade to prevent subgrade wetting. Using a geomembrane as a moisture barrier was recently demonstrated to be effective in the Ardmore Basin of Interstate 35 near Ardmore in south-central Oklahoma, where cyclic wetting and drying of the expansive soils has caused pavement undulations and accelerated pavement deterioration.

A heavily traveled 11-km (7-mi) stretch of I-35 was constructed with a

FIGURE 1 Deployment of a factory fabricated panel and floats installed in cover system for deicing fluid ponds at Salt Lake City International Airport.

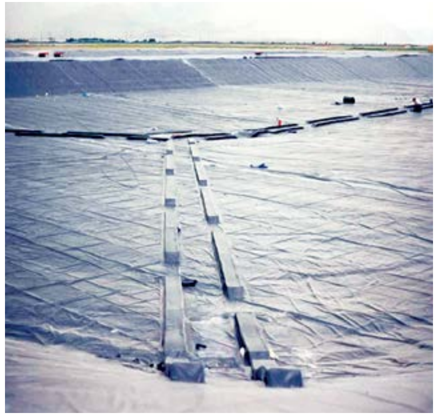

FIGURE 2 Completed liner and cover systems for deicing fluid ponds at Salt Lake City International Airport.

FIGURE 3 Some of the concrete pile caps (left side of photograph) and concrete filled pipe piles driven (right side of photograph) before construction of the LTP for the new bridge.

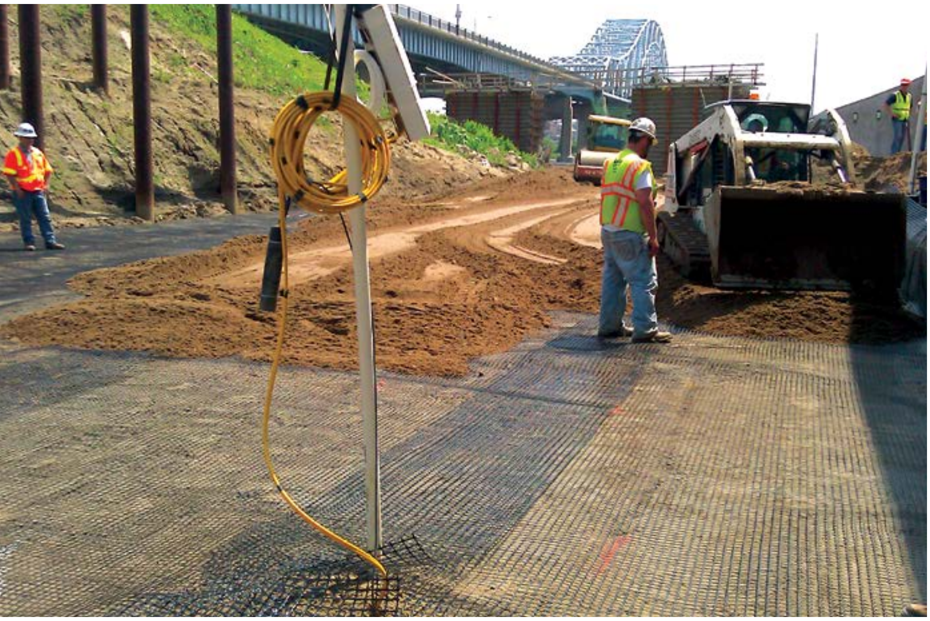

FIGURE 4 A layer of geogrid reinforcement is backfilled with fine sand to create the LTP for the new Hastings bridge approach.

FIGURE 5 The CRCP rolled and overlaying the nonwoven geotextile separator and the geomembrane that provides the moisture barrier.

moisture barrier system to control the swelling and contraction of the underlying clays. The moisture barrier consists of, from pavement to the subgrade:

- 0.3m (1ft)-thick continuously reinforced concrete pavement (CRCP).
- nonwoven geotextile separator.
- 0.1m (4in.)-thick open graded drainage material.
- 0.2m (8in.)-thick aggregate base layer of Type A crushed stone.
- 0.51mm (20mil)-thick reinforced geomembrane comprised of a 340g/m^2 (10oz/yd^2) reinforcement geotextile coated on both sides with low density polyethylene (LDPE), which is frequently referred to as a woven coated geomembrane.
- lime-stabilized subgrade.

Figure 5 shows the geomembranes underlying the crushed stone base course and the nonwoven geotextile separating the 0.1m (4in.)-thick open graded drainage material from the CRCP.

The geomembrane was factory fabricated into panels 15–18m (48–60ft) wide and 61m (200ft) long to facilitate field installation and reduce field seaming and testing. Each panel covered approximately 58,000 square meters (630,000 square feet).

Underground stormwater

Many municipalities are starting to assess a stormwater runoff fee to property owners because stormwater from their property has to be collected and treated. In some cases, the fee increases with increasing square footage, so property owners are trying to capture and store their stormwater for other purposes to avoid paying the fee.

Many older housing developments in the country have a combined sewer and storm drainage system. With these systems combined, there is a potential during large storms for the system to overflow, resulting in sewage into nearby bodies of water.

To limit this overflow, new housing developments need a better way to store stormwater. Lack of open space in urban environments is limiting use of traditional stormwater detention ponds, so geosynthetic-lined underground stormwater detention systems are increasing in use (Sheridan and Stark, 2010).

This system includes a large storage chamber, usually lined with a geomembrane and geosynthetic-reinforced stone walls to support a precast concrete roof. In cases where the native soil conditions allow percolation of stormwater into the groundwater, a nonwoven geotextile can be specified instead of a geomembrane.

FIGURE 6 Construction of underground stormwater detention pond (Sheridan and Stark, 2010).

Pavement separator

One of the oldest applications of geosynthetics in transportation projects is a material separator (Berg and Suits, 2000). Pavement separators are usually nonwoven geotextiles placed between the subbase and subgrade to create a permeable surface that prevents filtration of fines into the subbase.

Although little quantitative performance data is available, pavement separators allow for a reduction in the base course thickness due to separation from intrusive fines and a reduction in maintenance costs. Nonwoven geotextiles are usually used for this application, which can involve miles of geotextile installation along a roadway, as described in the moisture barrier application above.

Secondary containment

To protect against leakage from fuel tanks **(see Figure 7)** or hydrocarbon development activities, secondary containment is usually required.

For above-ground tanks, geomembranes or GCLs are frequently used in secondary containment liner systems, while only geomembranes are typically used for underground storage tanks.

FIGURE 7 Geomembrane system used for temporary secondary containment of a fuel tank.

FIGURE 8 Field-seamed fabricated geomembrane panels used to create tunnel liner system (Geosynthetics.com).

Tunnel liners

Tunnels beneath the groundwater surface or near sewer- and storm-water pipes require leak protection. Geomembranes have been used for many years to waterproof tunnels.

Frequently, geomembranes are used with geotextiles or a GCL as a leakage protection system **(see Figure 8),** facilitating construction and reducing the project time line. Because of urban space constraints, underground tunnels and construction are increasing, which provides an increased opportunity for the use of geosynthetic materials.

Conclusion

This article has identified some of the newer applications of geosynthetics in and designs for transportation projects. As demonstrated, geosynthetics can improve constructability and performance while reducing transportation project costs. This is important because transportation infrastructure spending is likely to increase to upgrade the U.S.'s aging infrastructure and to stimulate the stagnant economy.

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