

# DESIGNER'S FORUM

## Geotextiles in roadway separation applications

By Gregory N. Richardson

**B**EFORE WE MOVE ON TO OTHER design topics, I want to cover one final soil-related application of geotextiles in roadway systems—namely, as a separator between a plastic subgrade and roadway base stone. This is probably the one application that affects me the most, since the three-quarter mile of gravel road on my farm has a geotextile separator. While my neighbors have had to re-gravel their roads every third year, I am finally re-graveling after nearly 11 years of service. This is particularly impressive, since much of the re-graveling is needed because of damage that happened when Hurricane Fran ran over the farm in 1996.

Being a tad mischievous at heart, I have told most of my neighbors that they obviously are buying stone at the wrong quarry—they don't know geotextiles exist. The use of a geotextile separator is, in my opinion, the best bang for the buck a designer can achieve with a geosynthetic in a paved or unpaved roadway.

The classic separation role for a geotextile typically is related to seasonal trauma, such as freeze-thaw, which causes degradation of a *plastic subgrade* beneath the roadway. If the base course of a road section does not drain rapidly, or if fines from a plastic subgrade pump into the base stone, the resilient modulus of the base stone is dramatically reduced; stress from traffic loadings is transferred to the subgrade with little or no reduction, resulting in acceler-

ated road failure. In such cases, the retained soil is always a plastic soil with  $3 < \text{CBR} < 8$ , meaning the flow of water is limited in both volume and duration.

Soils softer than a CBR of 3 (approximately a cohesion of 1,800 psf) should be treated as a stabilization problem, as discussed in the May Designer's Forum. This means we assume the separator geotextile is not being installed on sites with standing water or soft-soil conditions. Typically, suitable subgrade soils can be proof-rolled with a loaded dump truck without developing excessive rutting. Don't design for separation and then try to install in the field under stabilization conditions! I'll explain why this distinction is important later, but the subgrade's condition at the time of installation is critical.

A geotextile's separation role requires it to allow the slow removal of water from the impacted subgrade. At the same time, the geotextile must restrain movement of fines from the subgrade to prevent the fouling of the base stone. The April Designer's Forum discussed the general design of geotextile-soil filter systems. Geotextile separators are a simple subset of geotextile-soil filter systems.

### Geotextile requirements

A geotextile separator must be designed to satisfy both the survivability and the hydraulic requirements for a particular instal-

lation. Both requirements are addressed in the new American Association of State Highway and Transportation Officials (AASHTO) M 288-96 design specifications, and have been discussed in previous Designer's Forum columns. My separation designs differ slightly from those used by M 288-96; I'll explain why in the following sections.

### Survivability requirements

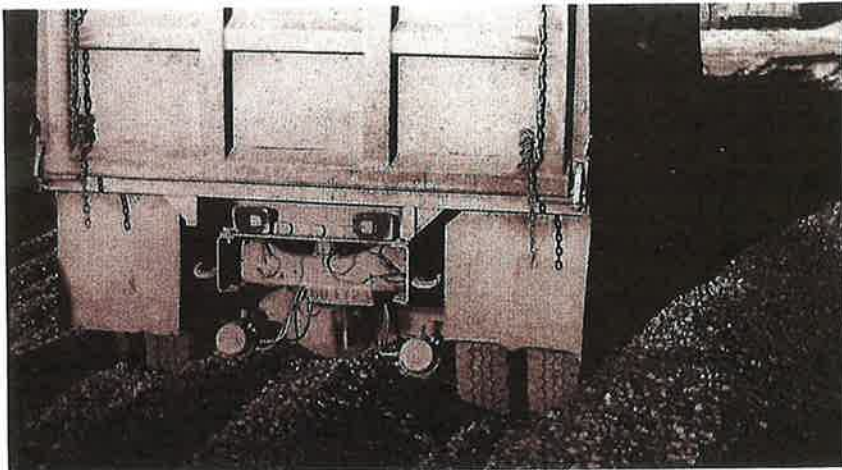
Keep in mind that installation day usually is the most difficult in the life of a geotextile. Installation damage may result from trafficking by construction equipment and from stone drainage layers being placed over the geotextile. In general, the stronger the geotextile, the greater its resistance to installation damage, and the greater its potential for survivability. A geotextile's ability to survive installation damage is difficult to quantify using design equations—you have to base it on past experience.

I recommend using the survivability criteria in AASHTO M 288-96 (Table 1, page 24). The guidelines define three categories of geotextile strength required for survivability under typical installation conditions for different geotextile functions. M 288-96 recommends a Class 2 geotextile for typical separator applications. A designer may opt to increase the survivability class if unusually aggressive stone will be placed immediately adjacent to the geotextile or if he or she anticipates dealing with the contractor from hell.

### Hydraulic requirements

Geotextiles used to protect stone-base coarse from fine contamination by CH-CL-MH-ML subgrade soils during periodic wetting of these soils must not handle a large flow of water through the geotextile. Thus, the M 288-96 permittivity requirement for a separator geotextile is  $0.02 \text{ sec}^{-1}$  for all applications. This is a very low permittivity and should only be used if construction will occur when the subgrade is not wet. The M 288-96 apparent opening size (AOS) of the geotextile is 0.60 mm. Both woven and nonwoven geotextiles can be used in this application.

My designs differ from M 288-96 only in the level of acceptable permittivity. Many of the field problems related to the



**Photo 1.** The contractor's mistake here was placing a low-permittivity geotextile over a wet subgrade. As the stone placement was being completed, the stone foundation pad began to move like a waterbed and trucks began to sink into the stone.

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"pumping" of separators are caused by installing a very low-permittivity geotextile under very wet field conditions. My practice has been to require a minimum permittivity of  $0.05 \text{ sec}^{-1}$ , even for a separation application. This level of flow capacity is provided by all needed nonwovens and most woven geotextiles that use monofilament or fibrillated yarns. My requirements may eliminate many woven slit-film geotextiles and some heat-calendered nonwovens that have been successfully used in such applications.

The reason I'm conservative dates back to 1985, when I was asked to look at a site in Greensboro, N.C. Construction of a convalescent home had been halted by pumping of the stone base placed in preparation for a slab foundation. The subgrade was a typical Piedmont Saprolite (ML) that normally would not require a geotextile for such a nontraffic application. At this site, however, rain had filled the foundation ex-



**Photo 2.** A geotextile was placed after rain filled the foundation excavation at this Greensboro, N.C. site. An excavation showed that water trapped beneath the geotextile was released only when the fabric ruptured.

cavation and the contractor assumed placing a geotextile would allow him to resume construction sooner.

A slit-film woven geotextile was placed over the wet subgrade (and probably standing water). Next, 45.7 cm (18 in.) of clean

coarse stone were placed over the geotextile. As the stone placement was being completed, the stone foundation pad began to move like a waterbed and trucks began to sink into the stone. **Photo 1** (page 22) shows a truck attempting to cross this "foundation" pad—clearly, not a good time to be contemplating placement of concrete! **Photo 2** shows an excavation down to the geotextile. Water trapped beneath the geotextile was released only when the fabric actually ruptured. The contractor would have been better off without the geotextile.

This particular geotextile has been successfully used for many years and has a permittivity less than  $0.05 \text{ sec}^{-1}$ . My use of a greater permittivity, therefore, results from concern about the inability to control actual field conditions at the time of installation. This certainly will warrant comments from manufacturers.

As a follow-up on my paranoia about low permittivities, I contacted David Suits of the New York State Department of Transportation. David's extensive background with geotextile permittivity testing and roadway construction makes him an expert, in my opinion. For years, New York has had a minimum permittivity requirement of  $0.02 \text{ sec}^{-1}$  in its geotextile-separator specifications. In a review of geotextiles tested during the past decade in New York, David observed that they consistently had permittivity values greater than  $0.05 \text{ sec}^{-1}$ . Although this is no doubt due to chance, it does indicate that the validity of the  $0.02 \text{ sec}^{-1}$  cannot be based on its historic presence in many specifications.

I also was curious about ASTM D 4491's ability to accurately measure such low flow rates. The round-robin testing performed in 1991 to establish precision and bias for the test indicated a significant potential for problems at this lower limit of flow. Comments?

**TABLE 1. AASHTO M 288-96 GEOTEXTILE SURVIVABILITY REQUIREMENTS**

Property	ASTM test method	Units	Geotextile class					
			Class 1		Class 2		Class 3	
			<W 50%	>NW 50%	<W 50%	>NW 50%	<W 50%	>NW 50%
Grab strength	D 4632	N (lb)	1400 (315)	900 (205)	1100 (250)	700 (160)	800 (180)	600 (115)
Seam strength	D 4632	N (lb)	1260 (280)	810 (185)	990 (220)	630 (140)	720 (165)	450 (100)
Tear strength	D 4533	N (lb)	500 (115)	350 (80)	400 (90)	250 (55)	300 (70)	180 (40)
Puncture strength	D 4833	N (lb)	500 (115)	350 (80)	400 (90)	250 (55)	300 (70)	180 (40)
Burst strength	D 3786	kPa (psi)	3500 (510)	1700 (255)	2700 (400)	1300 (200)	2100 (305)	950 (140)

• Elongation at break as measured in accordance with ASTM D 4632

**TABLE 2. MINIMUM STRENGTH VALUES NEEDED FOR STEP 2 OF THE SEPARATION EXAMPLE**

Property	ASTM test method	Units	Woven geotextiles	Nonwoven geotextiles
Grab	D 4632	N (lb)	1100 (250)	700 (160)
Seam	D 4632	N (lb)	990 (220)	630 (140)
Tear	D 4533	N (lb)	400 (90)	250 (55)
Puncture	D 4833	N (lb)	400 (90)	250 (55)
Burst	D 3786	N (lb)	2700 (400)	1300 (200)

## Separator design

You can design a geotextile separator in four easy steps.

### Step 1

Evaluate the soil to be separated and determine if it is a CH-CL-ML-MH soil. As a minimum, this evaluation should include a visual classification (ASTM D 2488).

### Step 2

Determine the minimum survivability requirements for the separator geotextile using the AASHTO M 288-96 survivability guidelines in Table 1. The guidelines recommend a Class 2 geotextile.

### Step 3

The minimum hydraulic requirements for the geotextile, based on AASHTO M 288-96 guidelines, are a minimum permittivity of  $0.02 \text{ sec}^{-1}$  and a maximum AOS of 60. Again, I prefer to use a minimum permittivity of  $0.05 \text{ sec}^{-1}$ .

### Step 4

Select the geotextile in accordance with Steps 2 and 3.

## Geotextile separator design example

Here's an example of how to use the previous steps to design a geotextile separator for a roadway constructed over a fine-grained subgrade. A limited site investigation indicates that the subgrade soil is clayey.

### Step 1

Visual identification and classification indicate that the soil to be separated is a low-activity silt (ML).

### Step 2

Determine the geotextile's minimum survivability requirements by using the AASHTO M 288-96 guidelines in Table 1. It should be a Class 2 geotextile with the minimum (MARV) strength values in Table 2.

### Step 3

Determine the geotextile's minimum hydraulic requirements using the AASHTO M 288-96 guidelines, which specify a geotextile permittivity greater than  $0.02 \text{ sec}^{-1}$ , and an AOS of less than 0.6 mm. I prefer a minimum permittivity of  $0.05 \text{ sec}^{-1}$ .

### Step 4

Select a suitable geotextile in accordance with Steps 2 and 3. My geotextile specifications would be written as follows:

- The geotextile shall have MARV strength properties meeting the requirements of a AASHTO M 288-96 Class 2 geotextile.
- The geotextile shall have a permittivity greater than  $0.05 \text{ sec}^{-1}$ , and an AOS of less than 0.6 mm. (Alternatively: the geotextile shall have MARV hydraulic properties meeting the requirements of AASHTO M 288-96 geotextile criteria for separation—permittivity greater than  $0.02 \text{ sec}^{-1}$ , and an AOS of less than 0.6 mm.)

Designers can prepare concise specifications using the M 288-96 guidelines. My own geotextile specifications, for example, have been reduced from one page in length to slightly more than a quarter page. I encourage comments about the very low permittivity values that M 288-96 recommends for separation and stabilization applications. Many of the geotextiles that I eliminate by using a minimum  $0.05 \text{ sec}^{-1}$

permittivity are big sellers because of their low cost. Details are particularly encouraged from users who have experienced "pumping" during the installation of a separator or stabilizer geotextile.

Our next column will leave the safe world of roadways and present the design of stabilized final covers over sludge lagoons. I will review my design for the X-611A lagoon at the Gaseous Diffusion Plant in Pikeron, Ohio. This is a typical application of geotextiles over soft soils. I am hoping it will draw out a column on similar application on extremely soft soils, such as the recent design by The Tensar Corp., Atlanta, that won an International Achievement Award last year from the Industrial Fabrics Association International, St. Paul, Minn. **GFR**

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## Feedback

### Heat-bonded nonwoven geotextiles

In the April Designer's Forum on "Geotextiles in Drainage Systems," the authors presented a "simplified design method" that categorically excluded heat-bonded nonwoven geotextiles without an explanation as to why. The use of all nonwovens, including needlepunched and heat-bonded, is covered by the criteria presented in the AASHTO design specs. Any basis for exceptions, such as "problem soils," is covered in AASHTO M 288-96, and is meant to be applied independent of the type of nonwoven.

The AASHTO M 288-96 spec is designed to be all-inclusive. Any exceptions are referenced in the document.

In the May Designer's Forum on "Swamp Roads and Ramblings," the author refers to nonwovens, in general, throughout the article—until Step 4 (page 26), where the spec becomes specific (needlepunched) without explanation. There is no reason given as to why a heat-bonded nonwoven should not be used as long as it meets the appropriate AASHTO spec.

Typar, a heat-bonded nonwoven, has been effectively and successfully used in drainage and separation applications for more than 25 years. It was one of the first nonwoven geotextiles produced in the United States (beginning in 1972) and has been used worldwide ever since.

If you have questions or desire more information, please contact me at Reemay Inc., 70 Old Hickory Blvd., Old Hickory, TN 37138-3651 USA; 800/382-8467, 615/847-7000, fax 615/847-7068.

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