LONG-TERM PERFORMANCE USING SEPARATION GEOTEXTILES

Prepared by:
TenCate™ Geosynthetics North America
365 South Holland Drive
Pendergrass, GA 30567
Tel. (706) 693 – 2226
Fax (706) 693 – 2044
www.tencate.com

May 18, 2010

Moisture damage to rigid pavements may manifest itself as pumping, faulting, and D-cracking. Flexible pavements can suffer from loss of support, asphalt stripping, alligator cracking, potholes, etc. The detrimental effects of saturation in the pavement system are significant.

AASHTO reports:

• Water in the asphalt surface can lead to moisture damage, modulus reduction, and loss of tensile strength. Saturation can reduce the dry modulus of the asphalt by as much as 30% or more.

• Added moisture in unbound aggregate base and sub base is anticipated to result in a loss of stiffness on the order of 50% or more.

• Modulus reduction of up to 30% can be expected for asphalt-treated base and increase erosion susceptibility of cement or lime treated bases.

• Saturated fine-grain roadbed soil could experience modulus reductions of over 50%.

According to AASHTO pavement design methodology, the more free draining the aggregate base, the higher the strength assigned to it. An AASHTO excellent draining base will have twice the structural contribution per inch as compared to a poor draining base.

If a clean aggregate with low fines content is used in construction of a pavement system, the remaining source of an increase in the fines content would be from a fine-grained subgrade layer. A base course typically rests on soil subgrade. While a base course layer consists of coarse aggregate, a subgrade soil may be composed of sand, silt, or clay. There can be many orders of magnitude difference in particle size of base course and subgrade soils. This wide gap in particle size distributions creates conditions that are ideal for mixing of the subgrade soil and the base course aggregate. The two can be separated from each other to prevent this intermixing and the corresponding decrease in transmissivity of the base course layer. Separation is accomplished easily through the use of geotextiles at the subgrade — base course interface.

Separation function

The separation function can be described for this purpose as the use of a geotextile to prevent the mixing of two adjacent material layers. A geotextile is a flexible, planar, and porous structure consisting of a network of fibers, filaments, or yarns. A geotextile's structure and properties are ideally suited to ensure separation of granular materials without compromising the movement of fluids between layers. In fact, geotextiles of various types perform separation function in many different applications. In geotechnical engineering, the alternative to utilizing a separation geotextile is to incorporate an additional soil layer, which can be cost-prohibitive.

The requirements for a separation geotextile at the subgrade-base course interface are well documented and can be listed as follows:

Retention: The separation geotextile must have an opening size small enough to prevent the migration of subgrade fines into base course under dynamic vehicle loads.

Permeability: The number of openings and their size in the separation geotextile must be large enough not to adversely affect the flow of liquid or air in either a downward or an upward direction.

Survivability: The geotextile must possess adequate strength and a construction suitable to survive installation and in-service conditions.

Retention and permeability requirements relate to the geotextile opening size and distribution. Survivability, on the other hand, is a function of the strength and flexibility of geotextile. Geotextile manufacturers offer products with wide ranges of physical, mechanical, and hydraulic properties.

Performance

A limited number of studies on the performance of separation geotextiles have been reported. Most of the studies fall into one of the following two categories concerning the performance of separation geotextiles:

- The ability of geotextiles to preserve layer separation under simulated or actual traffic loads.

- The improvement in long-term pavement performance as a result of the layer separation.

The first item above has been studied extensively through both laboratory and field tests. A compilation of 20 laboratory studies indicates that geotextiles are successful in preventing migration of fines under dynamic vehicular loads provided the retention and survivability requirements are met and the load bearing capacity of the base is sufficient. Empirical proof of performance is also provided by over 300 million square yards of geotextile being used in the world every year in this application. To put that number in perspective, that is equivalent to about 40,000 lane miles of road per year.

Very few scientific studies on the improvement in pavement performance have been reported in the literature despite the fact that separation geotextiles are used extensively all over the world and have been for more than 35 years. The reason certainly is the expense, time, and effort involved. To quantify or even just demonstrate the improvement in pavement performance resulting from separation geotextiles requires a minimum 10 years of a controlled study of pavement sections with and without geotextiles. Such studies demonstrate that while geotextiles do provide performance improvement, placing an exact value in terms of percent of improvement in design life of a pavement may be very challenging. But it takes very little improvement in pavement performance to justify the minimal cost of including the geotextile. Fortunately, the Geosynthetic Institute is currently performing a very comprehensive study including sites from all over the United States. To date, the study includes 14 sites, the oldest being initiated in 1997. Much about the long-term performance improvement is expected to be known as the sites approach the end of their design life of 10, 15, and 20 years.

Cost/benefit determination

The long term cost/benefit ratio calculation for using separation geotextiles can be performed in several ways. One technique compares the cost of geotextile to the life-cycle cost of the pavement. Such a comparison is based on an increase in the life of a pavement structure incorporating a separation geotextile. For example, assume that a pavement without a geotextile requires an overlay layer within 10 years; however, the use of a separation geotextile increases this time to 20 years. Then the cost of installed geotextile is directly comparable to the cost of overlay layer.

Another technique compares the cost of contaminated base layer with the cost of geotextile used to prevent contamination. . For example, assume that 1 inch of base layer stone gets contaminated with fine soil from subgrade. Then the cost of geotextile can be compared to the cost of 1 inch of lost base course layer. Such a comparison can be extended to the whole depth of base course depending on the severity of contamination. When comparing aggregate and geotextile costs, the cost of the installed geotextile is very close to the cost of 1 inch of base course aggregate. As the depth of contamination increases, however, the cost of geotextile remains constant while the cost of aggregate increases linearly.

A common example of the effectiveness of a geotextile used for separation is its application under an unpaved gravel road. You must add 4 to 6 inches of gravel every few years without a geotextile. However, with a geotextile, the road will last for many years without any additional gravel requirement.

A separation geotextile prolongs pavement performance by preventing the contamination of base course layer. The actual pavement performance improvement in terms of the lifetime of a pavement will vary and is being currently evaluated by the Geosynthetic Institute. However, the cost of geotextiles is less than the cost of 1-inch base course aggregate; and separation geotextiles typically prevent contamination of several inches of base layer. Therefore, benefit significantly outweighs the cost of using a separation geotextile in pavements.

Written by: Dhani Narejo, Mark Marienfeld, Bill Hawkins, and Bruce Lacina.
Dhani Narejo represents GSE Lining Technology, Houston, Texas; Mark Marienfeld represents Amoco Fabrics and Fibers, Austell, Georgia; Bill Hawkins represents BBA Nonwovens, Old Hickory, Tennessee; Bruce Lacina represents Mirafi, Pendergrass, Georgia