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"Moving Advancements into Practice"

MAP Brief 7-1:

Describing promising technologies that can be used now to enhance concrete paving practices

Use of Nonwoven Geotextiles as Interlayers in Concrete Pavement Systems

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ROAD MAP TRACK 7
High-Speed Concrete Pavement Rehabilitation and Construction

PRIMARY SOURCE
Nonwoven Geotextile Interlayers for Separating Cementitious Pavement Layers: German Practice and U.S. Field Trials. **May 2009**
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Moving Advancements into Practice (MAP) Briefs describe promising technologies that can be used now to enhance concrete paving practices. MAP Brief 7-1 provides information relevant to Track 7 of the CP Road Map, High-Speed Concrete Pavement Rehabilitation and Construction.

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This document describes the potential use of nonwoven geotextile materials as interlayers in concrete pavement systems, particularly unbonded overlays, in the United States. It briefly discusses Germany's experience, availability and cost of nonwoven geotextiles in the United States, specifications, recent field tests, recommended construction practices, and issues requiring additional research.

The Need

In the United States, hot-mix asphalt (HMA) is the material traditionally used to separate cementitious pavement layers. In the case of unbonded concrete overlays on existing concrete pavements, a 1-in. thick HMA interlayer is typically required.

Although HMA interlayers provide adequate cushioning and layer separation, HMA can have some drawbacks.

For example, using HMA as an interlayer requires setting up two separate paving operations, one for concrete and one for asphalt, which can be expensive and time consuming.

Some HMA mixes do not provide adequate drainage and can be subject to stripping under heavy truck traffic.

The 1-in. typical HMA interlayer depth for unbonded overlays on concrete pavements can be problematic in tight vertical clearance situations, particularly in urban areas.

Because of these shortcomings of HMA interlayers, contractors and roadway agencies could benefit from an alternative to HMA.

A Potential Solution

As part of a May 2006 scanning tour of long-life concrete pavements in Europe[1], participants examined German pavement systems. For 25 years, German engineers have been using nonwoven geotextile materials as interlayer material between new cement-treated bases and jointed concrete surface layers (figure 1). These pavement systems are of excellent quality and have long lives, despite carrying significant traffic loads.

German engineers also use nonwoven geotextiles as interlayer material on occasion when they construct unbonded concrete overlays. Before they place the geotextile interlayer, however, the existing pavement is either rubblized or cracked-and-seated, which is not common U.S. practice.

German engineers have steadily improved the following characteristics and functions of nonwoven geotextiles for use as interlayer materials:

Figure 1. Core from Germany showing nonwoven geotextile interlayer between surface concrete (left) and cement-treated base (right)

[1] In 2006, U.S. public and private sector representatives participated in a European scanning tour on long-life concrete pavements sponsored by the Federal Highway Administration, the American Association of State Highway Transportation Officials, and the National Cooperative Highway Research Program. The final report of the scanning tour can be found at http://international.fhwa.dot.gov/pubs/pl07027/

1. **Separation**. Prevents joints or cracks from reflecting to the surface layer. Needs to prevent bonding and accommodate the normal movements of the two cementitious layers.

2. **Drainage**. Allows infiltrated water between layers to drain to the pavement edge. Must be terminated next to adjacent drainage layer or daylighted. Needs a degree of permeability that allows minimum flow in three dimensions.

3. **Bedding**. Provides a degree of cushion that reduces bearing stresses while providing adequate support stiffness.

As a result of what they learned in Germany, scanning tour participants recommended that field tests be conducted in the United States to examine the effectiveness of nonwoven geotextile material as an interlayer between cementitious pavement layers.

The participants particularly recommended that the material be evaluated as an alternative to HMA as an interlayer material between existing concrete pavement and new concrete overlays—but without cracking-and-seating or rubblizing the existing pavement.

Availability and Cost

Several U.S. manufacturers produce nonwoven geotextile materials that are used for a variety of purposes. However, until very recently, none of the U.S.-produced materials was marketed specifically for use as an interlayer in cementitious pavement systems, and most U.S.-produced materials do not conform to German specifications for such use.

Recently, agencies and contractors have expressed an increased interest in using nonwoven geotextiles as interlayers in pavement systems in the U.S. As a result, some U.S. manufacturers now produce materials that meet specifications.

Costs of U.S.-produced materials can vary, but estimators should assume $1.50 to $2.50 per square yard for the material and installation.

German-made nonwoven geotextiles are available through many U.S. suppliers. They can also be imported directly from Germany at a slightly lower source cost than U.S.-produced material, but organizations should expect additional freight costs of $0.05 to $0.10 per square yard. Importing directly from Germany will likely increase project lead time by six to eight weeks.

Specifications and Testing

Nonwoven geotextile interlayers were first standardized in Germany in 2001, and the specifications have evolved over time to reflect continuing improvements by German engineers.

Table 1 shows proposed interim U.S. specifications for nonwoven geotextiles used as interlayers in cementitious pavement systems, based on German concrete pavement guide documents.

Until the proposed U.S. specifications are finalized and test standards (e.g., ASTM) are verified for use with nonwoven geotextile materials, use of the German specifications and test standards (e.g., ISO, EN, DIN) is recommended.

Table 1. Summary of proposed specifications for nonwoven geotextiles (derived from German guide documents)

Property	Requirements[1]	Test Procedure
Geotextile Type	Nonwoven, needle-punched geotextile, no thermal treatment (calendaring or IR)	EN 13249, Annex F (Manufacturer Certification of Production)
Color	Uniform/nominally same color fibers	(Visual Inspection)
Mass per unit area	≥ 450 g/m² (13.3 oz/yd²) ≤ 550 g/m² (16.2 oz/yd²)	ISO 9864 (ASTM D 5261)
Thickness under load (pressure)[2]	[a] At 2 kPa (0.29 psi): ≥ 3.0 mm (0.12 in.) [b] At 20 kPa (2.9 psi): ≥ 2.5 mm (0.10 in.) [c] At 200 kPa (29 psi): ≥ 1.0 mm (0.04 in.)	ISO 9863-1 (ASTM D 5199)
Wide-width tensile strength[3]	≥ 10 kN/m (685 lb/ft)	ISO 10319 (ASTM D 4595)
Wide-width maximum elongation[4]	≤ 130%	ISO 10319 (ASTM D 4595)
Water permeability in normal direction under load (pressure)	At 20 kPa (2.9 psi): ≥ 1×10^{-4} m/s (3.3×10^{-4} ft/s)	DIN 60500-4 (mod. ASTM D 5493 or ASTM D 4491)
In-plane water permeability (transmissivity)[5] under load (pressure)	[a] At 20 kPa (2.9 psi): ≥ 5×10^{-4} m/s (1.6×10^{-3} ft/s) [b] At 200 kPa (29 psi): ≥ 2×10^{-4} m/s (6.6×10^{-4} ft/s)	ISO 12958 (mod. ASTM D 6574 or ASTM D 4716)
Weather resistance	Retained Strength ≥ 60%	EN 12224 (ASTM D 4355 @ 500 hrs. exposure)
Alkali resistance	≥ 96% Polypropylene/Polyethylene	EN 13249, Annex B (Manufacturer Certification of Polymer)

[1] Requirements must be met for 95% of samples; compared to MARV requirements commonly specified for geotextiles in the United States, which require a 97.7% degree of confidence (see AASHTO M 288).

[2] Old thickness requirement was ≥ 2.0 mm (0.08 in.) at 20 kPa (2.9 psi) only (ZTV Beton, StB 01).

[3] Note that other measures of tensile strength are commonly reported in product literature that are not comparable to the results of this test procedure.

[4] A maximum elongation of ≥ 60% is recommended as a better practice.

[5] Old transmissivity requirement included only testing at 20 kPa (2.9 psi) (ZTV Beton, StB 01).

Field Tests in the United States

Two notable field tests using nonwoven geotextile interlayers have been conducted recently in Missouri and Oklahoma.

Missouri

The first field test was conducted on Route D south of Kansas City, Missouri, in 2008. Nonwoven geotextile material was used as an alternative to a 1-in. HMA interlayer in an unbonded concrete overlay.

Before placing the nonwoven geotextile interlayer, the existing concrete pavement was thoroughly cleaned, and deteriorated areas were patched with flowable mortar to create a uniform surface (figure 2).

The nonwoven geotextile was placed dry (figure 3) and fastened to the underlying concrete pavement with pins (nails) air-driven through 2.25-in.galvanized discs spaced 2 to 6 ft apart (figure 4).

Two U.S.-manufactured nonwoven geotextiles, Propex Geotex 1201 and 1601, were used. Neither was fully compliant with German specifications.

As a rule of thumb, a nonwoven geotextile interlayer between an existing concrete pavement and a concrete overlay should bond to the overlay but not to the existing pavement. If the nonwoven geotextile is too thin, it has the potential to become saturated by mortar from the overlay and bond to the underlying pavement surface.

Initially, Geotex 1201 was placed. After the thinness of the Geotex 1201 was observed, the contractor switched to the thicker Geotex 1601 for the remainder of the project.

A core sample of the Missouri overlay field test revealed that the nonwoven geotextile material had bonded with the overlay but not with the existing concrete pavement, as desired. Therefore, the installation was considered a success.

The ongoing performance of the interlayer material and the overlay pavement system will continue to be evaluated.

Figure 2. Repair/replacement of damaged concrete with flowable mortar

Figure 3. Application of nonwoven geotextile materials

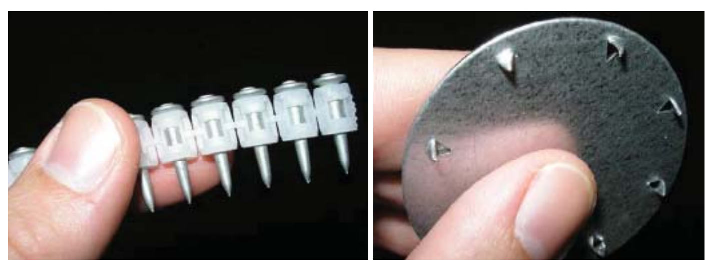

Figure 4. Collated pins (left) and galvanized discs (right) used to secure the fabric

Oklahoma

In 2008 a second field test was conducted on a new construction project on I-40 in Oklahoma. This project was typical of a standard German application in which nonwoven geotextile material is used as an interlayer between a new cement-treated base and a new concrete pavement.

A German material, HaTe nonwoven B 500, was imported to ensure compliance with German specifications.

The galvanized discs used to secure the nonwoven geotextile to the cement-treated base were approximately 1 in. in diameter (smaller than German specifications).

Paving was conducted as in any normal project. Haul trucks were driven on the geotextile material as they were backed up to deposit fresh concrete in advance of the spreader. The nonwoven geotextile material was not damaged by the haul trucks or the paving machine, as long as the vehicles did not turn on the geotextile. The material appeared intact behind the paving train.

A core sample revealed that the nonwoven geotextile material had bonded slightly to the new pavement and not at all to the cement-treated base, making this installation a success.

Installation Practices

The two U.S. field tests conducted in 2008 provide encouragement that nonwoven geotextile fabric may be an efficient and cost-effective alternative to HMA as an interlayer in cementitious pavement systems in this country. In general, the following construction practices have resulted in successful installations:

- Place the material as shortly before paving as possible (ideally no longer than 2 to 3 days) to reduce the potential for it to be damaged.
- Before placing the nonwoven geotextile material, repair the existing pavement to correct any significant cracking or faulting, and sweep the pavement surface clean.
- Roll the material onto the base or other surface, keeping the nonwoven geotextile tight with no wrinkles or folds.
- Roll out sections of the material in a sequence that will facilitate good overlapping, prevent folding or tearing by construction traffic, and minimize the potential that the material will be disturbed by the paver.
- Overlap sections of the nonwoven geotextile material a minimum of 6 in. and a maximum of 10 in., and ensure that no more than three layers overlap at any point (figure 5).
- Ensure that the edge of the material along drainage areas extends at least 4 in. beyond the pavement edge and terminates above, within, or adjacent to the pavement drainage system.
- Secure the material with pins (nails) punched through 2.0–2.75 in. galvanized discs placed 6 ft apart or less, depending on conditions (figure 6).
- Lightly dampen the nonwoven geotextile prior to concrete placement to prevent its drawing water from the mix.
- If concrete is being delivered in front of the paver, place no more than 650 ft of nonwoven geotextile material ahead of the paver at any time (figure 7).
- Avoid driving on the nonwoven geotextile material unless necessary, and never make sharp turns on the material with vehicles. Avoid having the nonwoven geotextile exposed to heavy turning traffic until paving is completed.

Figure 5. Overlap of nonwoven geotextile material sections

Figure 6. Fastening nonwoven geotextile fabric to existing concrete pavement

Figure 7. Paving on top of nonwoven geotextile materials

Implementation Recommendations

Research is recommended to determine if nonwoven geotextile interlayers prevent reflective distress in concrete overlays when the existing pavement is not rubblized or cracked-and-seated. This and other ongoing performance questions will be monitored on the Missouri overlay and other upcoming projects. In addition, research is needed to determine ease of removal of concrete placed on nonwoven geotextile materials.