Nonwoven Geotextile Interlayers for Separating Cementitious Pavement Layers: *German Practice and U.S. Field Trials*

INTERNATIONAL TECHNOLOGY SCANNING PROGRAM

SPONSORED BY

U.S. Department of Transportation
Federal Highway Administration

IN COOPERATION WITH

American Association of State Highway
and Transportation Officials

National Cooperative Highway
Research Program

MAY 2009

NOTICE

Nonwoven Geotextile Interlayers for Separating Cementitious Pavement Layers: *German Practice and U.S. Field Trials*

PREPARED BY THE INTERNATIONAL SCANNING STUDY TEAM:

Robert Otto Rasmussen and **Sabrina I. Garber**

for

Federal Highway Administration
U.S. Department of Transportation

American Association of State Highway and Transportation Officials

National Cooperative Highway Research Program

MAY 2009

Acknowledgments

The authors wish to express their gratitude toward the numerous individuals who helped contribute the information in this report.

The following provided key source information about the German practice:
Dipl.-Ing. Stefan Höller, *BASt*
Dr.-Ing. Walter Eger, *University of Applied Sciences, Munich*

The following worked on the Missouri and Oklahoma demonstration projects and provided additional information:
John Donahue, **Jason Blomberg**, and **Matt Killion**, *Missouri DOT*
Pat Weaver, *Clarkson Construction*
Todd LaTorella and **Matt Ross**, *MO/KS ACPA*
Jim Duit and **Mike Lipps**, *Duit Construction*

Early in this project, an expert technical group was formed. In addition to many of the individuals previously mentioned, the following people also offered their time and assistance:
Andy Gisi, *Kansas DOT*
Georgene Geary, *Georgia DOT*
Sam Tyson, *FHWA Office of Pavement Technology*
Suneel Vanikar, *FHWA Office of Pavement Technology*
(cochair of long-life concrete pavements scan)
Jim Grove *and* **Jagan Gudimettla**, *FHWA Office of Pavement Technology*
Tom Cackler *and* **Paul Wiegand**, *National CP Technology Center*
Dale Harrington, *Snyder & Associates*
Jerry Voigt, *ACPA*
Rich Rogers, *CCT*
Dr. James Cable, *Cable Concrete Consultation LLC*
Dan Dawood, *The Transtec Group*
(formerly Pennsylvania DOT, cochair of long-life concrete pavements scan)
Ted Ferragut, *TDC Partners*

Finally, the following geotextile representatives assisted in the preparation of this report:
Fred Chuck *and* **Brett Odgers**, *TenCate*
Frank Pace *and* **Scott Manning**, *Propex, Inc.*
Jörg Klompmaker, *NAUE GmbH & Co.*
Cameron Gallamore, *Huesker, Inc.*
Björn Grote *and* **Roland Wittmann**, *BECO Bermüller & Co. GmbH*

Contents

FIGURES

TABLES

Nonwoven Geotextile Interlayers for Separating Cementitious Pavement Layers: *German Practice and U.S. Field Trials*

Executive Summary

Pavement engineering is traditionally a conservative field, but successful pavement engineers will constantly seek out proven innovative concepts with potential to improve pavement performance while reducing costs. Many pavement structures in the United States consist of more than one cementitious layer that requires separation. This could be a new concrete pavement (jointed or continuously reinforced) atop a cementitious base or, becoming increasingly popular, an unbonded concrete overlay. In both cases, an interlayer is often required for separation. While hot-mix asphalt is commonly used for this purpose, associated constructability, cost, and performance issues need to be recognized.

The German highway community has more than 25 years of experience using an alternative interlayer made of a nonwoven geotextile. With proper selection and placement, these interlayers have resulted in excellent performance in separating new concrete pavement layers from the cementitious bases commonplace on the German motorway system. While this application also exists in the United States, the possibility of using the nonwoven geotextile as a separation interlayer in an unbonded concrete overlay system has also generated significant interest because of the potential cost savings involved.

This report documents the German experience and gleans better practices for using nonwoven geotextile interlayers between cementitious layers in the United States. The report covers field trials in Missouri and Oklahoma along with other information so that pavement engineers can make an informed decision on the viability of this innovative but proven alternative.

Background

In May 2006, a team of public and private sector representatives participated in a scanning study of long-life concrete pavements sponsored by the Federal Highway Administration (FHWA), the American Association of State Highway and Transportation Officials (AASHTO), and the National Cooperative Highway Research Program (NCHRP). During this scan, the team learned about the German use of nonwoven geotextile as an interlayer between lean concrete bases and concrete pavement surfaces.[1]

As a result of the scan, the team concluded that nonwoven geotextile has potential benefit in U.S. practice as an interlayer between cementitious layers. It was decided that field trials should be undertaken with a geotextile interlayer—not just as the Germans had demonstrated it, but also to separate old concrete pavement from new concrete overlays.

This report documents the state of the practice in Germany, along with the results of two field trials in the United States, including an unbonded concrete overlay project in Missouri and a project in Oklahoma that used the geotextile to separate a cement-treated base from a new concrete pavement.

State of the Practice in Germany

Cementitious bases are commonly used throughout Germany. For decades, they have served as part of the pavement structures for jointed concrete pavements. It was clearly demonstrated during the long-life concrete pavements scan that the German highways are of high quality and have sustained long lives under significant traffic.[1]

Until about 20 years ago, no particular effort was made to encourage or break the bond that may have developed between the two cementitious layers. Reflection cracking that would otherwise occur in some instances was controlled by notching the surface of the cementitious base during its construction. These notches were matched with the saw cuts that defined the joints of the overlying concrete surface. Like nearly all highway systems, though, some areas on the German network experienced premature failures.

On the German motorway A5 in 1981, during the course of a pavement repair contract, an idea was born.[2] Several slabs had experienced cracking failure because of what appeared to be a loss of support. Further investigation determined that the cementitious base had partially pulverized because of hydraulic pressures caused by infiltration and collection of water at the interface between the base and the surface. The pulverized fines pumped to the surface, which led to the loss of support. In turn, the void that had formed between the two cementitious layers caused the cracking. Recognizing that poor drainage contributed to this failure, the Germans decided to place a nonwoven geotextile atop the existing cementitious base before replacing the concrete slabs. The edges of the geotextile terminated on top of an existing longitudinal drainage system.

After this test section had proven to be a success, additional trials of this technique were used in other locations throughout Germany, including application during new construction. Over time, the Germans found that the geotextile served as an ideal replacement for the practice of notching the cementitious base and made its use a standardized practice.

Critical Material Properties of Geotextile Interlayers

The theory behind the use of nonwoven geotextile interlayers is based on three critical functions:(3)

- **Separation** keeps discontinuities (cracks or joints) in the underlying cementitious layer from reflecting to the surface layer. This requires a material that possesses a degree of compliance that can accommodate the anticipated movements in the base layer.

- **Drainage** channels away water that infiltrates into the pavement structure at the surface. The concept is that water should drain into the interlayer and then along the (cross-) sloped surface to the pavement edge. Because of this, German practice requires that the geotextile either terminate next to a drainage layer or be daylighted (allowing the egress of water). The drainage function also requires that the geotextile have enough permeability to allow a minimum flow rate in three dimensions.

- **Bedding** reduces bearing stresses and the effects of dynamic traffic loads. This function also requires a geotextile material that has some degree of compliance, but not so much that inadequate support stiffness results.

Over the years, the Germans have learned what properties of the nonwoven geotextile material can improve one of these three functions. They have also learned the tradeoffs that sometimes exist when improvements made to one function compromise another. As a result, the evolution of German specifications reflects the optimization of the material.

Specification and Design Procedures

Use of the geotextile interlayer was first standardized as a national practice in Germany in 2001 through the pavement catalog (*Richtlinie für die Standardisierung des Oberbaues von Verkehrsflächen,* RStO 01).(4,5) An excerpt of the RStO is illustrated in figure 1, which shows the use of the interlayer for all concrete pavement sections containing a cementitious base layer. The RStO does include options for asphalt treated and unbound aggregate bases, but the interlayer is not used in those instances.

Standard details and methods for the geotextile were published as part of the concrete pavement guide document, *Zusätzliche Technische Vertragsbedingungen und Richtlinien für den Bau von Fahrbahndecken aus Beton* (ZTV Beton–StB 01).(6) This has recently been revised as ZTV Beton–StB 07. Additional material properties for the interlayer are also published in the companion standard, *Technische Lieferbedingungen für Baustoffe und Baustoffgemische für Tragschichten mit hydraulischen Bindemitteln und Fahrbahndecken aus Beton* (TL Beton–StB 07).(7)

Given the rapidly expanding knowledge base on the use of these interlayers, the Germans decided to develop a separate standard. A committee of practitioners in Germany is developing a draft of the standard, which is expected to be published in mid to late 2009.

Table 1 (see page 4) includes a summary of materials specifications derived from the guidance in TL Beton–StB 07 and ZTV Beton–StB 07, along with the result of numerous discussions with German practitioners. This table should be considered a starting point for the specification of nonwoven geotextile interlayers in the United States. It should be stressed, however, that while preliminary attempts have been made to find test standards more commonly used in the United States (e.g., ASTM), the original (e.g., ISO, EN, DIN) tests should be considered the standard until full equivalency can be verified. In the interim, a list of accredited laboratory facilities capable of conducting these tests is on the Geosynthetic Institute Web site (www.geosynthetic-institute.org).

Available Products

The critical properties of separation, drainage, and bedding require that the geotextile material possess a number of critical material properties. While nonwoven geotextile materials are commonly used in the United States for a multitude of applications, there is no known demand for materials used in the same manner as the German interlayer. As a result, nonwoven geotextiles are not yet marketed domestically for this purpose, so they do not necessarily meet all of the recommended interim specifications.

Based on a series of Internet searches and discussions with industry representatives in the United States and Germany, table 2 (see page 5) includes a list of products that have been used or have potential for use for interlayer application in a manner similar to what is specified in Germany.

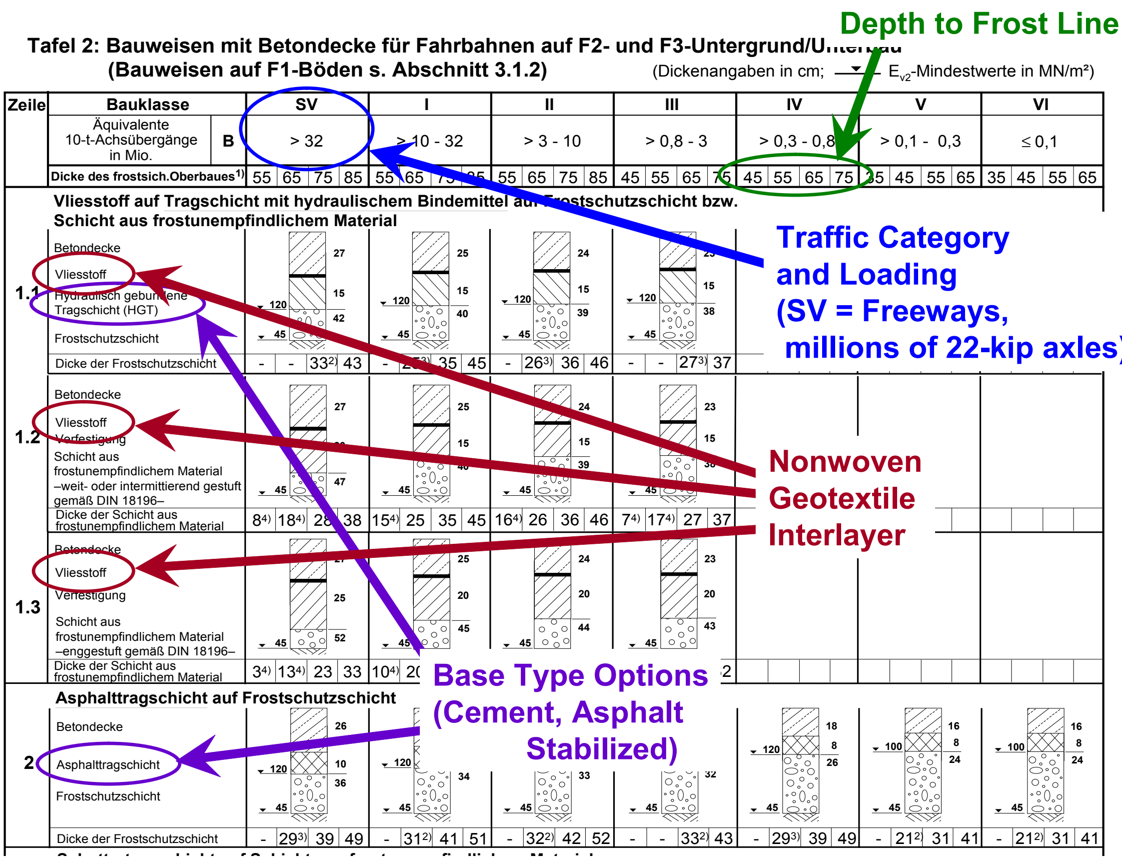

Figure 1. *Highlighted excerpt of German pavement design catalog (RStO).*

In addition to materials manufactured in the United States, materials can be imported from Germany. This option reportedly was exercised on the Oklahoma field trial described in this report.

In the end, market forces will drive the availability and cost of fully compliant materials. Meanwhile, both domestic and imported sources appear to be viable options. Worth noting is that importation of the geotextile can increase lead time, reportedly by 6 to 8 weeks.

Construction Installation Practices

Pavement construction using the nonwoven geotextile interlayer has been a reported a success in U.S. field trials so far. In addition, the Germans report ease in construction. The following is a summary of better construction practices reported in various German guidelines and related publications:

- If the geotextile is used in an unbonded concrete overlay application, ensure that any potential for mechanical keying of the two cementitious layers is minimized through proper repair techniques. Furthermore, excess slab movements should be stabilized before placement of the geotextile and overlay. Better practices for these and other relevant items can be found in the *Guide to Concrete Overlays (2nd Ed.)*, developed by the National Concrete Pavement Technology Center.[(8)]
- Sweep the underlying surface to remove loose debris before applying the interlayer.
- Roll the geotextile out on the underlying layer. The geotextile should be tight and without excess wrinkles and folds. No process is specified for rolling out the layer; numerous techniques have been used based on available equipment and labor.
- If construction traffic is expected on the grade in front of the paver, no more than 200 meters (m) (650 feet (ft)) of geotextile should be installed in advance of the paving operation at any given time. This will minimize the potential for damage before paving.
- The interlayer should be placed no more than 1 month ahead of concrete paving to minimize damage or contamination from weather and traffic. Ideally, the geotextile should be installed no more than 2 to 3 days before placement of the concrete.
- Driving on the interlayer should be kept to a minimum.

Table 1. *Proposed interim specifications for geotextile interlayer material.*

Property	Requirements[1]	Test Procedure[2]
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)[3]	[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[4]	≥ 10 kN/m (685 lb/ft)	ISO 10319 (ASTM D 4595)
Wide-width maximum elongation[5]	≤ 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)[6] 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 percent of samples, compared to minimum average roll value (MARV) requirements commonly specified for geotextiles in the United States, which require a 97.7 percent degree of confidence (see AASHTO M 288).

[2] All test procedures shown in (parentheses) are tentatively suggested for U.S. practice, but their replacement of the corresponding ISO/DIN/EN specifications should be further reviewed by geosynthetic industry experts.

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

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

[5] A maximum elongation of ≤ 60 percent is recommended as a better practice.

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

Tight-radius turns and excessive accelerations and braking should be avoided.

- Do not place the geotextile on areas subject to excess traffic (e.g., crossovers). Installation of the geotextile should be delayed on these areas until immediately before concrete placement.
- The geotextile should be secured to the underlying layer with pins or nails punched through 50- to 70-millimeter (mm) (2- to 2.75-inch (in)) galvanized washers or discs every 2 m (6 ft) or less. Smaller washers or discs can increase the likelihood that the geotextile will separate from the underlying layer during subsequent placement of the concrete.
- Additional fasteners can be used as needed to ensure that the geotextile does not shift or fold before or during concrete placement.
- Where it occurs, edges of the geotextile should overlap by 20 ± 5 centimeters (cm) (8 ± 2 in).
- No more than three layers of geotextile should overlap at any location. This requires staggering of transverse seams of adjacent rolls to prevent four layers from coinciding at any location.
- Care should be taken to roll out the geotextile in a sequence that will facilitate good lapping practice and prevent folding or tearing by construction traffic. For example, the end of a roll laid in the direction of paving should lie atop the beginning of the next roll, minimizing the potential for being disturbed by the paver.
- The free edge of the geotextile should extend beyond the edge of the new concrete and into a location that facilitates drainage by 10 cm (4 in) or more. More specifically, the geotextile must terminate in or next to a drainable pavement

layer, or be exposed in such a way that free drainage of water within the geotextile is not impaired.

- Some in Germany report that the geotextile should be slightly damp, but not saturated, before concrete placement. This is not universally practiced, however.

Cost

The installed cost of a nonwoven geotextile interlayer appears to range from $1.50 to $2.50 per square yard ($yd^2$). The in-place cost in Germany has been reported to be as little as $1.10 per yd^2.

In 2006, it was reported that the material cost in Germany was about $1.00 per yd^2. Recent discussions (in 2009) with German vendors verified a material price of about $0.90 to $1.00 per yd^2 FOB source/origin. If material is ordered from Europe, sea freight costs of $0.05 to $0.10 per yd^2 can be expected. Additional costs will apply for taxes or tariffs (possibly 10 to 15 percent) and for transport between the port terminal and the project site.

Installation costs can vary, but costs of $0.10 to $0.50 per yd^2 are believed reasonable based on information reported from German practitioners and from the field trials to date in the United States.

Quality Assurance Concepts

Quality assurance of the nonwoven geotextile should be achieved through periodic sampling and testing. As a starting point for a proposed sampling plan, the first samples should be collected after placement of about 1,000 m^2 (1,200 yd^2), a second sample after 10,000 m^2 (12,000 yd^2), and additional samples collected every 10,000 m^2 (12,000 yd^2) thereafter. Each sample is typically 1 m^2 (1.2 yd^2) in size and should not be taken from the first or last two "windings" on the roll. A specific testing schedule for the various items reported in table 1 will require further investigation. This should include additional consultation with the Germans, who continue to formalize this in their standard practices.

Worth noting is footnote 1 in table 1, which states that the material in Germany is required to comply with the specifications for 95 percent of the samples tested. This requirement contrasts with minimum average roll value (MARV) requirements commonly specified for geotextiles in the United States, which require a 97.7 percent degree of confidence (see AASHTO M 288).

Table 2. *Summary of known vendors of nonwoven geotextile interlayer material.*

Vendor	Contact Information (as of March 2009)	Material
BECO Bermüller & Co. GmbH	Björn Grote +49-911-64200-22 info@beco-bermueller.de	Betex TP 50
Heusker, Inc.	Cameron Gallamore (704) 588-5500 cgallamore@hueskerinc.com	HaTe B 500
NAUE GmbH & Co.	Jörg Klompmaker +49-57-43-41-0 jklompmaker@bbgeo.com	Secutex R 501 (PP white)
Propex, Inc.	Scott Manning (800) 621-0444 scott.manning@propexinc.com	Geotex 1601[7] Geotex 1341[8]
TenCate	Brett Odgers (913) 909-7150 b.odgers@tencate.com	Polyfelt P 50 Mirafi 1160N[7,8] Mirafi S1400[8]

[7] Compliance with the recommended interim specification may require modification of the manufacturing process to eliminate thermal treatment.

[8] Unconfirmed compliance with German specification, as of the date of this report.

Preliminary Field Trials in the United States

As part of this project, the project team evaluated two projects—one in Missouri and one in Oklahoma—that used a nonwoven geotextile interlayer. This section summarizes the trials.

Missouri, Route D, Cass and Jackson Counties

During summer 2008, an unbonded concrete overlay project was constructed on Route D (Holmes Road) spanning the border of Cass and Jackson Counties south of Kansas City, MO (see figure 2 on page 6). On this project, nonwoven geotextile interlayer was specified as an alternative to the conventional 1-in (25.4-mm) hot-mix asphalt (HMA) interlayer. The intent was to separate the 22-year-old, 8-in (203-mm) existing concrete pavement surface from the proposed 5-in (127-mm) unbonded concrete overlay. While the interlayer does separate two cementitious-bound layers, this application differs from the typical German practice of separating a cementitious base from a new concrete pavement. In the few instances in Germany in which a nonwoven geotextile was used to separate two concrete layers, the existing concrete pavement was rubblized first.

Construction of the project was highlighted at an open house sponsored by the Missouri-Kansas Chapter of the American Concrete Pavement Association (ACPA), Missouri and Kansas Departments of Transportation (DOTs), FHWA, and National Concrete Pavement Technology Center. The August 13, 2008,

COURTESY OF GOOGLE

Figure 2. *Map of Missouri Route D project.*

Figure 3. *Undesirable thinness and partial melting of isolated areas of the Geotex 1201 compared to a thicker geotextile known to fully comply with German specifications.*

event and included a half-day of presentations followed by an onsite field review of the project, which was about half paved. During the open house, those attending were introduced to the German practice, along with the specific design and construction elements of the Route D project.

In theory, as an overlay interlayer, the nonwoven geotextile must prevent reflection of the distress of the existing concrete pavement while providing a stable and drainable platform for the overlay. Following these principles, two nonwoven geotextiles were used for various parts of the project, including Geotex 1201 and Geotex 1601, manufactured by Propex. It was recognized that these geotextiles did not fully comply with the German specifications, but because they were immediately available and complied with some of the more critical aspects of the German specification, they were considered viable for use on this project.

Some concern was raised initially with the lighter geotextile (Geotex 1201) about what appeared to be areas of the geotextile that were thinner than the German specification. As shown in figure 3, the material not only appeared thin, but also had areas that appeared to be partially melted. Further investigation confirmed that the Geotex geotextile is normally exposed to heat (calendared or infrared (IR)) to partially fuse one side of the material. What was observed was likely material from the end of a production run, where excess heat was inadvertently applied.

Subsequent discussions of this phenomenon with experts in Germany did not yield significant concern, but did underscore the German practice of discouraging the use of geotextiles with thermal treatment. While firsthand observations were not made of the subsequent use of the Geotex 1601 material, it is believed that the denser material would be more likely to partially mitigate potential drawbacks of the thermal treatment. Furthermore, subsequent testing of the 1601 material has confirmed compliance with all but the thermal treatment requirements in the proposed interim specifications.

The Route D overlay project is believed to be typical of upcoming projects in Missouri. As illustrated in figure 4, the existing concrete pavement is experiencing severe durability cracking (D-cracking), defined by the significant deterioration of the concrete near the pavement joints. Investigation of the structural capacity of the pavement, however, led to the possibility of an unbonded concrete overlay as a viable rehabilitation. As part of the project, the Missouri DOT offered an option to use a nonwoven geotextile interlayer in lieu of a 1-in (25.4-mm) HMA bond breaker. This option was selected by the low bidder, Clarkson Construction.

Before placement of the overlay, patching and repair of the damaged concrete near the joints was undertaken unless an

Figure 4. *Typical existing pavement condition along Route D before overlay.*

existing patch appeared intact and flush with the existing pavement surface. Where applied, the repair technique used on this project included removal of all existing patch and loose material from these areas. This was followed by placement of a flowable (cementitious-based) fill. The completed repairs are shown in figure 5.

Figure 5. *Repair and replacement of damaged concrete with flowable fill.*

The geotextile material was delivered to the project on 300-ft (91-m) rolls, 15 ft (4.5 m) wide. As illustrated in figure 6, a telescopic forklift was used to transport the rolls from the yard to the roadway and to assist with application.

On the Route D project, a Hilti gas-powered system was used to drive the fasteners (collated pins) into 2.25-in (57 mm) metal discs, through the geotextile, and into the underlying concrete pavement. This is illustrated in figure 7 (see next page). A string of pins and underside of the disc are shown in figure 8 (see next page).

COURTESY OF MO/KS ACPA

Figure 6. *Transport and application of geotextile from rolls along Route D project.*

As part of the installation process, two rolls of geotextile were used to span the width of the pavement. As a result, both longitudinal and transverse lapping of the geotextile were necessary, as illustrated in figure 9.

Immediately before construction, the geotextile material was wetted using a tanker truck, shown in figure 10. The surface was reportedly saturated, and it was later concluded that less water would ensure more ideal moisture content.

Figure 7. *Fastening geotextile to existing concrete pavement along Route D project.*

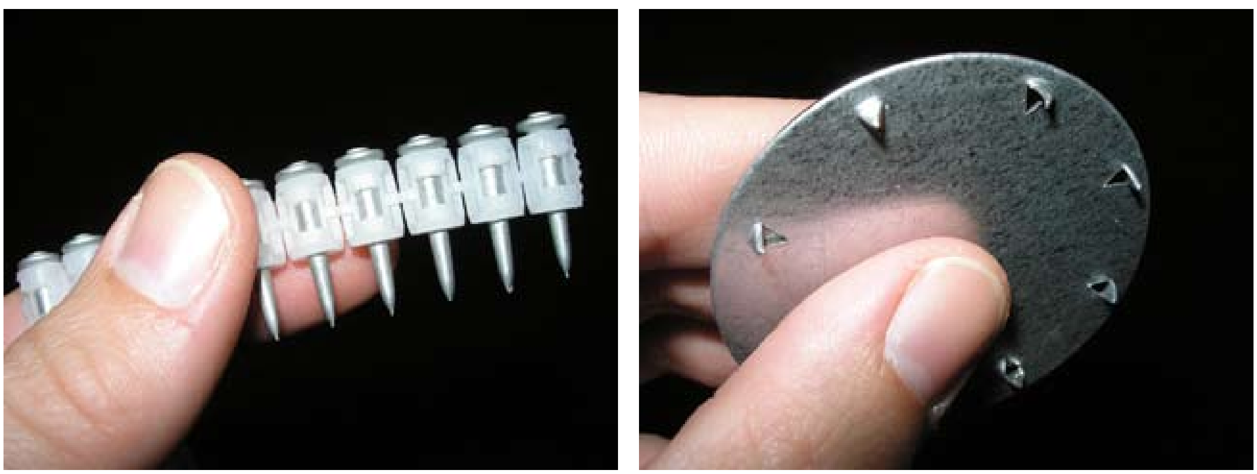

Figure 8. *Hilti X-GN/X-GHP fasteners (collated pins) and discs used for Route D project.*

COURTESY OF MO/KS ACPA

Figure 9. *Overlap of geotextile on Route D project.*


COURTESY OF MO/KS ACPA

Figure 10. *Prewetting of geotextile before paving Route D project.*


COURTESY OF MO/KS ACPA

Figure 11. *Overlay placement along Route D project.*

Construction of the overlay is illustrated in figure 11. No problems were reported with the geotextile during the paving process. In general, the project proceeded as it would have using a conventional interlayer.

After construction, cores were extracted from the pavement structure. As shown in figure 12, the geotextile was found to have bonded to the fresh concrete. Bonding did not occur between the geotextile and the underlying concrete pavement, which is ideal considering the necessity for separation from this layer.

Overall, the Route D project appears to be a success. It has been reported that the long-term performance of this section will be monitored.

Oklahoma, Westbound I-40, Warner

In fall 2008, a new concrete paving project along westbound Interstate 40 in Oklahoma provided a second opportunity to evaluate the German interlayer. In this case, the project was similar to the typical German application with the interlayer used to separate a new cement-treated base (CTB) from a new concrete pavement. A map of the project, constructed by Duit Construction, Inc., is shown in figure 13 (see next page).

On this project, the geotextile selected was imported from Germany. The product, HaTe nonwoven B 500, is manufactured and distributed by the U.S. subsidiary of Huesker Synthetic GmbH.

COURTESY OF MATT KILLION, MISSOURI DOT

Figure 12. *Core of Route D project showing overlay bonded to geotextile interlayer (underlying pavement not bonded, so core cannot be extracted).*

Figure 14 shows the rolls of geotextile delivered directly to the project and placed atop the new CTB. Immediately before the paving, a modified backhoe loader was used to lift the rolls and assist in the installation. A crew of three to five people installed the geotextile, as shown in figure 14 and figure 15. The wrinkles observed to the right of figure 15 should be minimized to the greatest extent practical.

COURTESY OF GOOGLE

Figure 13. *Map of Oklahoma I-40 project.*

Figure 14. *Delivery and installation of geotextile rolls on I-40 project.*

Figure 15. *Geotextile installation on I-40 project.*

The geotextile was fastened to the underlying CTB using a Hilti powder-actuated system with X-DNI fasteners (consisting of integrated pins and washers), as shown in figure 16 and figure 17. The washers used on this project are smaller than those recommended in German practice. Additional care may be necessary to ensure that the geotextile does not tear free of these fasteners during subsequent concrete placement.

The 5-m-wide (5.4-yd-wide) geotextile rolls were placed two across, resulting in a need for both longitudinal and transverse laps as shown in figure 18.

The majority of the geotextile appeared to be in good to excellent condition. Two haul roads flanked the project, limiting the need for vehicle maneuvering atop the installed geotextile. As figure

Figure 16. *Fastening geotextile to CTB on I-40 project.*

Figure 17. *Hilti X-DNI fasteners used on I-40 project.*

Figure 18. *Lapping seams of geotextile on I-40 project.*

19 shows, however, an isolated instance of shoving was observed, likely because of a short-radius turning maneuver. The severity of the shoving does not appear to be significant enough to warrant replacing the geotextile, but it underscores the need to avoid the potential for its occurrence.

Paving on the geotextile appeared to proceed with no variance from normal construction procedures. As shown in figure 20, haul trucks traveled on the geotextile, backed up to the paver, and deposited the fresh concrete onto the geotextile in advance of the spreader. As illustrated in figure 21, the edge of the geotextile was not damaged by the paver and appeared behind the paving train intact.

Figure 22 shows a core sample removed from the I-40 project. It shows the separation of the two cementitious layers, along

Figure 19. *Localized shoving of geotextile due to short-radius truck turning maneuver.*

Figure 20. *Paving new concrete pavement on geotextile on I-40 project.*

with a slight bonding of the geotextile to the new concrete pavement.

The project in Oklahoma appeared to be a success. The contractor believed it saved money and time without compromising performance.

Conclusions and Recommendations for Further Evaluation

It appears from both the literature and firsthand field observations that the use of a nonwoven geotextile interlayer between cementitious layers is not only viable, but also potentially a superior alternative to more conventional interlayer materials. Benefits of the nonwoven geotextile interlayer include the following:

- Lower cost for material and installation
- Equivalent performance, at least for separation of cementitious bases and new concrete pavements
- Ease of installation, requiring a minimum of training and equipment
- Rapid installation, with firsthand observations revealing installation rates exceeding that of paving

While nonwoven geotextiles are used routinely as an interlayer between concrete pavements and cementitious bases, more performance data are needed to demonstrate their use in unbonded concrete overlay applications. Experience to date in Germany for the latter has included rubblization or crack-and-seat of the existing concrete pavement before placement of the geotextile and overlay.

The fundamental properties of the nonwoven geotextile make it a likely candidate as a viable alternative to a hot-mix asphalt interlayer, however. This is particularly true if measures are taken to minimize the potential for mechanical "keying" of the two concrete layers. In Missouri, for example, distressed concrete at the joints was removed and replaced with a flowable fill. Theoretically, this measure should help reduce the potential for reflective distress. Monitoring of this and other unbonded concrete overlays is warranted, especially because of the significant potential benefits the nonwoven geotextile interlayer offers for this type of application.

Another question raised is on the process of eventual removal of concrete pavement placed atop the geotextile. The Kansas DOT reported one experience with this on a short section of concrete placed on a thin nonwoven geotextile interlayer employed as a "bond breaker." Years later, the pavement had experienced high-severity D-cracking, and during panel replacement the concrete, which had bonded securely to the geotextile, was difficult to remove. As shown in figure 23 (see next page),

Figure 21. *Geotextile terminating under shoulder on I-40 project.*

COURTESY OF DUIT CONSTRUCTION

Figure 22. *Core of I-40 project showing new concrete bonded to geotextile interlayer (underlying CTB not bonded).*

COURTESY OF KANSAS DOT

Figure 23. *Removal of concrete pavement from a thin nonwoven geotextile in Kansas.*

full-depth segmenting of the panels was necessary to remove the concrete with conventional heavy equipment.

It should be stressed, however, that the material used in Kansas was reported to be significantly thinner than the material recommended for use. As a result, it is likely that the material was more completely saturated with the mortar, thus leading to increased bonding.

German practice and the projects documented in this report do not show this propensity for bonding when the thicker nonwoven geotextile is used. The Germans continue to seek more effective methods to separate the geotextile from concrete pavements since it is German practice to crush and reuse the concrete layer as recycled concrete aggregate.

One last item identified during this effort was the idea of using an adhesive in lieu of mechanical fasteners to secure the geotextile to the underlying cementitious layer. German practice does specify the use of an approved adhesive when the geotextile is placed atop a waterproofed bridge deck (presumably since the fasteners would compromise the waterproofing layer). The approval process appears to be based on the experience of the project engineer, so additional information needs to be collected about specific materials and practices that could be used for this purpose.

Endnotes

(1) Hall, K., et. al., *Long-Life Concrete Pavements in Europe and Canada*, FHWA-PL-07-027, Federal Highway Administration, Washington, DC, August 2007.

(2) Sulten, P., and W. Wilmers, "Use of Geotextiles in Concrete Pavement Construction," Proceedings of the Second European Geosynthetics Conference, Bologna, Italy, 2000, pp. 437–442.

(3) Wilmers, W., "Geosynthetics in Road Construction–German Regulations," Proceedings of the Seventh International Conference on Geosynthetics, Nice, France, 2002.

(4) *Forschungsgesellschaft für Straßen- und Verkehrswesen Arbeitsgruppe Betonstaßen, Richtlinie für die Standardisierung des Oberbaues von Verkehrsflächen* (RStO), 2001.

(5) Leykauf, G., and D. Birmann, "Concrete Pavements with Geotextile Interlayer in Germany–Measurements and Long-Term Behaviour," Proceedings of the Tenth International Symposium on Concrete Roads, Brussels, Belgium, Sept. 8–22, 2006.

(6) *Forschungsgesellschaft für Straßen- und Verkehrswesen Arbeitsgruppe Betonstaßen, Zusätzliche Technische Vertragsbedingungen und Richtlinien für den Bau von Fahrbahndecken aus Beton* (ZTV Beton–StB), 2001 (updated 2007).

(7) *Forschungsgesellschaft für Straßen- und Verkehrswesen Arbeitsgruppe Betonstaßen, Technische Lieferbedingungen für Baustoffe und Baustoffgemische für Tragschichten mit hydraulischen Bindemitteln und Fahrbahndecken aus Beton* (TL Beton–StB), 2007.

(8) Harrington, et. al., *Guide to Concrete Overlays–Sustainable Solutions for Resurfacing and Rehabilitating Existing Pavements*, National Concrete Pavement Technology Center, ACPA Publication TB021.02P, Ames, Iowa, 2008.

OFFICE OF INTERNATIONAL PROGRAMS

FHWA/US DOT (HPIP)

1200 New Jersey Ave., SE

Washington, DC 20590

Tel: (202) 366-9636

Fax: (202) 366-9626

international@fhwa.dot.gov

www.international.fhwa.dot.gov