PERFORMANCE ASSESSMENT OF

NONWOVEN GEOTEXTILE MATERIALS USED AS THE SEPARATION LAYER FOR UNBONDED CONCRETE OVERLAYS OF EXISTING CONCRETE PAVEMENTS IN THE US

IOWA STATE UNIVERSITY
Institute for Transportation

AUGUST 2018

National Concrete Pavement Technology Center
Tech Center

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The mission of the National Concrete Pavement Technology (CP Tech) Center at Iowa State University is to unite key transportation stakeholders around the central goal of advancing concrete pavement technology through research, tech transfer, and technology implementation.

Notice

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16. Abstract

Geotextile fabrics have been used by pavement engineers for many years as a separation layer between full-depth concrete pavements and stiff cement-treated bases. Because of that success, pavement engineers have recently been evaluating nonwoven geotextiles as an alternative to hot-mix asphalt (HMA) separation layers in unbonded concrete overlay applications.

This report:

- Summarizes the performance of unbonded concrete overlays constructed in the US since 2008 using geotextile separation layers
- Provides an overview of lessons learned
- Highlights ongoing efforts to optimize the design and construction requirements for the use of geotextile fabrics in concrete overlay applications

To obtain detailed performance information on overlays built with geotextile separation material, nine projects were identified. A summary for each case history is included in this report, followed by the conclusions.

After nearly 10 years of positive project performance, it was found that nonwoven geotextile fabric separation layers work very well when used on existing pavements that have received the appropriate level of pre-overlay repairs. The fabric acts as a separation material to prevent cracks and other distresses in the underlying pavement from compromising the performance of new unbonded jointed concrete overlays placed over existing jointed and continuously reinforced concrete pavements. The fabric has also been shown to provide sufficient drainage to unbonded concrete overlay systems.

It was also found that the use of geosynthetic fabrics as a separation layer can provide significant cost and time savings when compared to traditional asphalt separation layers. State highway agencies are engaged in continuing research efforts to optimize the use of geotextile fabric separation layers.

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Performance Assessment of Nonwoven Geotextile Materials Used as the Separation Layer for Unbonded Concrete Overlays of Existing Concrete Pavements in the US

Summary Report
August 2018

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Acknowledgments

The National CP Tech Center thanks the Federal Highway Administration (FHWA) for their partnership and support in developing these technology transfer materials to help address technical barriers and enable the broader use of nonwoven geotextile materials as the separation layer for unbonded concrete overlays of existing concrete pavements in future projects.

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Introduction

Geotextile fabrics have been used by pavement engineers for many years as a separation layer between full-depth concrete pavements and stiff cement-treated bases (see Figure 1).

Because of the success of using geotextiles in this application, pavement engineers began evaluating nonwoven geotextiles as an alternative to hot-mix asphalt (HMA) separation layers in unbonded concrete overlay applications in the US in 2008 (Hall et al. 2007). The application has been very successful.

The purpose of this document is as follows:

- Summarize the national performance experience of unbonded concrete overlays constructed since 2008 using geotextile separation layers
- Provide an overview of lessons learned
- Highlight ongoing efforts to optimize the design and construction requirements for the use of geotextile fabrics in concrete overlay applications

Cackler 2017, National CP Tech Center

Figure 1. Placement of nonwoven geotextile separation layer

Background

As part of the May 2006 International Technology Scanning Program, 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), participants conducted an international scanning tour of long-life concrete pavements in Europe and Canada, and examined German pavement systems (Hall et al. 2007).

For more than 30 years, German engineers have been using nonwoven geotextile material as a separation material between new cement-treated bases and jointed concrete surface layers (see Figure 2).

These pavement systems are of excellent quality and have long lives, despite carrying significant traffic loads.

German engineers also sometimes use nonwoven geotextiles as a separation material when they construct unbonded concrete overlays. However, before they place the geotextile separation interlayer, the existing pavement is either rubblized or cracked and seated. These are not common US practices.

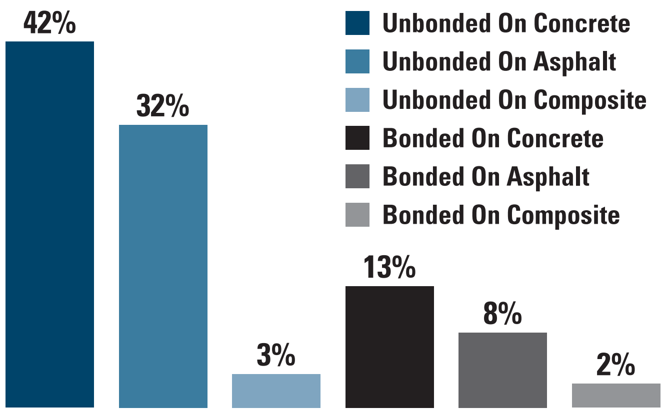
National CP Tech Center 2009

Figure 2. Core from Germany showing nonwoven geotextile interlayer between surface concrete (left) and cement-treated base (right)

Nonwoven geotextile separation materials were first standardized in Germany in 2001. The specifications have evolved over time to reflect continuing improvements by German engineers. As a result of what was learned in Germany, the scanning tour participants recommended to the FHWA that field tests be conducted in the US to examine the effectiveness of nonwoven geotextile material as a separation between cementitious pavement layers.

The participants strongly recommended that the material be evaluated as an alternative to HMA. It could be used as a separation material between existing concrete pavement and new concrete overlays—but without cracking and seating or rubblizing the existing pavement.

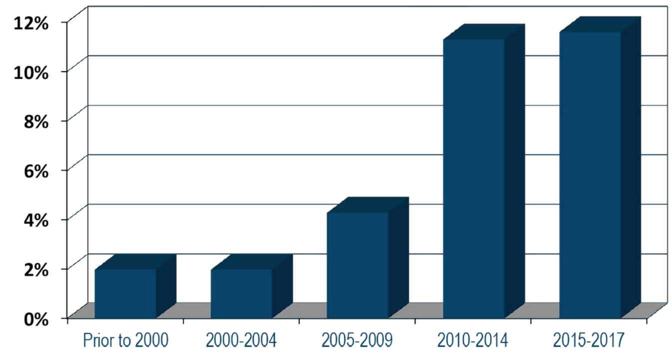
Furthermore, as shown in Figure 3, unbonded concrete overlays on concrete (UBCOCs) have historically been the most common application of unbonded overlays. Therefore, any potential for performance improvements from using nonwoven geotextiles as a separation material could be very significant.



After Cackler 2017, National CP Tech Center, based on data from National Concrete Overlay Explorer (ACPA 2014)

Figure 3. Percentage of bonded and unbonded concrete overlays by pavement type constructed from 1900–2010

Also, in addition to UBCOCs being the most common overlay type, the number of concrete overlay projects has grown steadily over the last few years as shown in Figure 4.



After Voigt 2017, ACPA, used with permission

Figure 4. National concrete overlay growth as of November 2017

This is largely the result of recently developed technical resources and project-level technical support on concrete overlay project selection, design guidance, and construction requirements.

Separation Layers in Concrete Overlays

The separation layer in an unbonded concrete overlay system provides a shear plane that helps prevent cracks from reflecting up from the existing pavement into the new overlay. In addition, it prevents bonding of the new pavement with the existing pavement, so both are free to move independently. Finally, a separation layer can provide drainage that improves the longevity of the concrete overlay materials.

Separation layer design is one of the primary factors influencing the performance of UBCOCs. The *Guide to Concrete Overlays* (Harrington and Fick 2014) provides excellent design and construction guidance on the separation layer requirements for unbonded concrete overlays over existing concrete pavements. This document is available as a free download from the National Concrete Pavement Technology (CP Tech) Center's website at http://www.cptechcenter.org/technical-library/documents/Overlays_3rd_edition.pdf.

The guide provides detailed information on the selection, design details, and construction of concrete overlays using geotextile separation layers. Additional details on specifications are contained in the *Guide Specifications for Concrete Overlays* (Fick and Harrington 2016), which is also available as a free download from the National CP Tech Center, at http://www.cptechcenter.org/technical-library/documents/overlay_guide_specifications.pdf.

Three properties should be considered in the selection and design of the separation layer:

- Isolation from movement of the underlying pavement—a shear plane relieves stress, mitigates reflective cracking, and may prevent bonding with the existing pavement
- Drainage—the separation layer either must be impervious, so that it prevents water from penetrating below the overlay, or it must channel infiltrating water along the cross slope to the pavement edge
- Bedding—a cushion for the overlay to reduce curling, warping, and bearing stresses, and the effects of dynamic traffic loads, as well as to prevent keying from existing joint faulting

The most common separation layer has historically been a nominal 1 in. thick well-drained asphalt surface mixture, which provides adequate coverage over irregularities in the existing pavement. The separation layer is not intended to provide significant structural enhancement. Thus, the placement of an excessively thick layer should be avoided.

Unfortunately, stripping of a dense-graded asphalt separation layer has led to premature failure of some unbonded concrete overlays. The failure consists mainly of concrete cracking due to the loss of support from the stripping of the asphalt binder. In locations where water and heavy-truck traffic will be present, adequate drainage of the separation layer system is important to reduce such tendencies.

Due to observations such as stripping of asphalt separation layers, interest has developed in the use of nonwoven geotextile fabrics for such applications. The benefits of using geotextile materials include reduced materials cost, improved drainage between the overlay and the underlying pavement, and an increase in the speed of construction. The use of fabric eliminates the possibility of interlayer stripping, which can lead to faulting, panel cracking, and failure of the overlay at the joints.

An additional observed benefit of nonwoven geotextile fabrics is the reduced risk of differential panel movement. Because the overlay bonds to the fabric, the panels are held in position (see Figure 5). The ability of the fabric to maintain panel alignment results in reduced internal pressures within the overlay and reduced likelihood of pavement blowups.

Dan DeGraaf, Michigan Concrete Association

Figure 5. Lack of panel movement shown on 4 in. UBCOC overlay with geotextile separation layer after 6 years of urban traffic

Conversely, panel movement has occurred on some UBCOC overlays with HMA separation layers (see Figure 6).

Dan DeGraaf, Michigan Concrete Association

Figure 6. Panel movement on UBCOC overlay with HMA separation layer

Geotextile Separation and Drainage Specifications

Most current US-based specifications either refer to the nonwoven geotextile requirements of AASHTO M 288, with a Class 2 degree of survivability, or to Table 1 included here. Table 1 includes the recommended geotextile specifications presented in the FHWA Scan Tour final report. AASHTO M 288 does not include the drainage testing specified nor the recommendations for weight and thickness required for the geotextile bond breaker.

Current guidance on the typical weight of the nonwoven geotextile for various overlay thickness is as follows:

- Overlays < 5 inches thick = 13.3 oz/yd^2
- Overlays ≥ 5 inches thick = 14.7 oz/yd^2
- 16.2 oz/yd^2 is typically not used except for very thick overlays

Table 1. Geotextile separation layer material requirements

Property	Requirements	Test Procedure
Geotextile Type	Nonwoven, needle-punched, no thermal treatment to include calendering*	EN 13249, Annex F (Certification)
Color	Uniform/nominally same color fibers	(Visual Inspection)
Weight (mass per unit area)	≥ 450 g/m^2 (13.3 oz/yd^2) ≥ 500 g/m^2 (14.7 oz/yd^2) ≤ 550 g/m^2 (16.2 oz/yd^2)	ISO 9864 (ASTM D5261)
Thickness under load (pressure)	[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): ≥ 0.10 mm (0.04 in.)	ISO 9863-1 (ASTM D5199)
Wide-width tensile strength	≥ 10 kN/m (685 lb/ft)	ISO 10319 (ASTM D4595)
Wide-width maximum elongation	≤ 130 percent	ISO 10319 (ASTM D4595)
Water permeability in normal direction under load (pressure)	≥ 1 x 10^{-4} m/s (3.3 x 10^{-4} ft/s) at 20 kPa (2.9 psi)	DIN 60500-4 (modified ASTM D5493)
In-plane water permeability (transmissivity) under load (pressure)	[a] ≥ 5 x 10^{-4} m/s (1.6 x 10^{-3} ft/s) at 20 kPa (2.9 psi) [b] ≥ 2 x 10^{-4} m/s (6.6 x 10^{-4} ft/s) at 200 kPa (2.9 psi)	ISO 12958 (ASTM D6574) or ISO 12958 (modified ASTM D4716)
Weather resistance	Retained strength ≥ 60 percent	EN 12224 (ASTM D4355 @ 500 hr exposure for gray, white, or black material only)
Alkali resistance	≥ 96 percent polypropylene/polyethylene	EN 13249, Annex B (Certification)

** Calendering is a process that passes the geotextile through one or more heated rollers during the manufacturing process. The surface of the geotextile is modified during this process. Calendering may reduce the absorption properties of the geotextile on the calendered side.*

Sources: Harrington and Fick 2014 (also in Fick and Harrington 2016), National CP Tech Center; originally modified from the Transtec Group, no date, and now online with ©2017 at http://www.thetranstecgroup.com/nonwoven-geotextile-interlayers-concrete-pavements/material-specifications/.

US Project Experience

Since 2008, geotextile separations have been used on more than 10 million square yards of concrete overlays and have proven to be effective at satisfying the separation layer requirements. Minnesota, for example, has adopted geotextiles for widespread use, and more than 3 million square yards of nonwoven geotextiles have been used in UBCOC applications since 2010 (personal communication, Matt Zeller, Concrete Paving Association of Minnesota). Many other states are also using geotextile separation layers routinely, while others are considering the practice (see Figure 7).

Overall Performance

Nonwoven geotextile separation layers have worked effectively when overlaying either a jointed plain concrete pavement (JPCP) or continuously reinforced concrete pavement (CRCP) with a JPCP overlay. There have been no known or documented performance failures attributed to a geotextile separation layer.

Only one project has experienced a minor acoustical issue and that was observed on a 4 in. thick UBCOC overlay constructed in Michigan in 2011. On that project, it appeared that a relatively thick nonwoven geotextile (14.7 oz/yd^2) was used as a separation layer for a thin (4 in.) overlay, which resulted in noise from the concrete panels moving relative to each other at the joints under traffic.

Although the noise was audible over the normal traffic noise for a two-week period, the biggest concern was the loss of some aggregate interlock in the transverse joints due to grinding action from vertical movement. Within two weeks following construction, the noise subsided and overall performance has been good.

However, it should be noted that because of the differential vertical movement of the slab relative to abutting new driveways due to the compression of the thicker geotextile interlayer under traffic, cracking of the overlay near the outside wheelpath occurred at some locations.

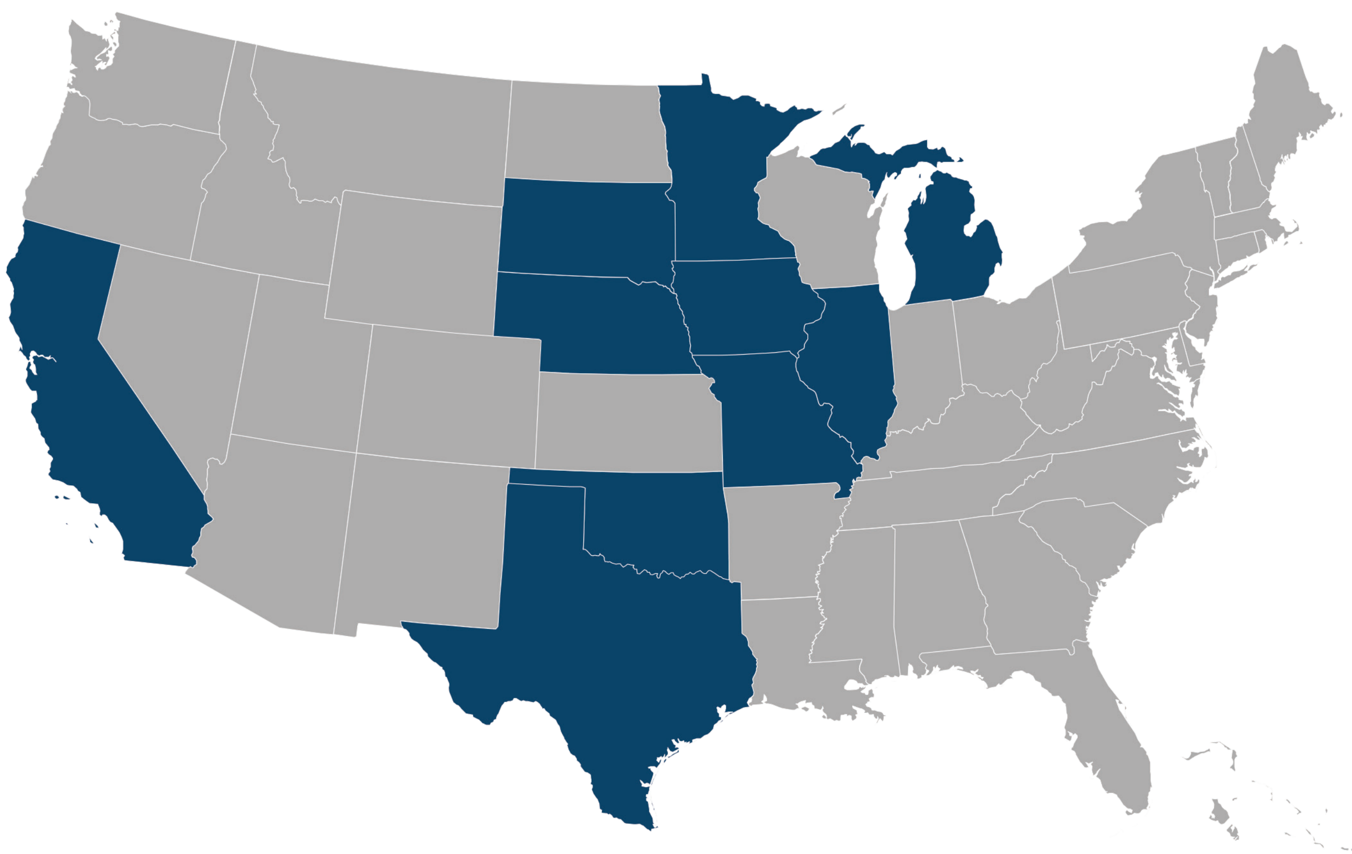


Figure 7. States known to use nonwoven geotextile separation layers on unbonded concrete overlays on concrete since 2008

Lessons learned from this early project are to select the appropriate fabric thickness for the overlay thickness and traffic and to provide an isolation joint or a full-depth saw cut of the overlay when placing driveways abutting the overlay. Also, the engineer should not rely on the geotextile to stop cracks from developing in the overlay due to differential movement of the underlying pavement. This condition needs to be addressed by proper pre-overlay repairs.

The *Guide to Concrete Overlays* (Harrington and Fick 2014) and the *Guide Specifications for Concrete Overlays* (Fick and Harrington 2016) both currently recommend a thinner 13.3 oz/yd^2 geotextile when the overlay thickness is ≤ 4 in. The Minnesota Department of Transportation (MnDOT) is conducting research at their MnROAD Research Facility to further optimize fabric thickness on thinner overlays and is evaluating an 8 oz/yd^2 nonwoven geotextile under a 3 in. concrete overlay.

Pavement Design Considerations

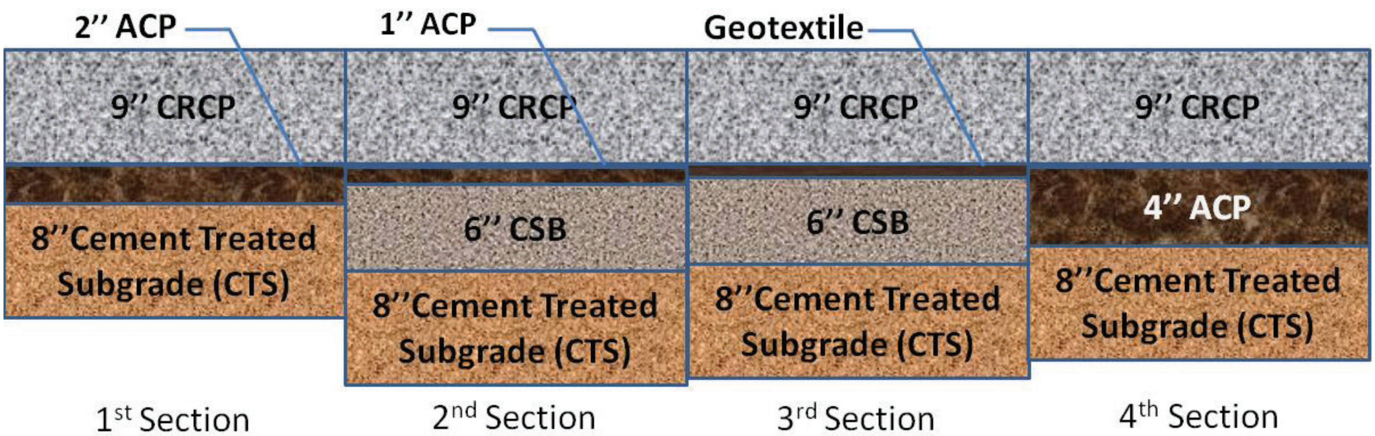
One topic of interest from a pavement design consideration is whether the nonwoven geotextile will result in more deflection under traffic and shorten the performance life of the overlay due to increased fatigue under traffic loading. National experience to date indicates that this is not the case.

One laboratory study and one documented in situ evaluation have indicated that geotextile separation layers provide an equal or better structural response when compared to HMA separation layers. In addition, the geotextile fabrics provide a path for water to escape from between the overlay and the old pavement. For additional details, see the discussion under the Ongoing Research, Development, and Optimization section later in this report.

It is worth noting that geotextile separation layers are not recommended when placing a continuously reinforced concrete overlay over a CRCP (Zollinger et al. 2014). The Texas DOT (TxDOT) has evaluated the use of a geotextile between CRCP and subbase layers through work conducted by the Texas A&M Transportation Institute (TTI) (see Figure 8).

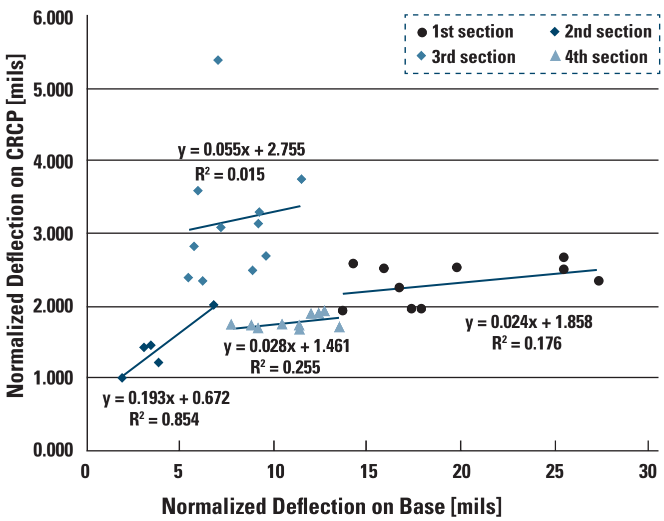
Although this work was conducted on a new full-depth CRCP section and not a CRCP overlay, the research concluded that this is a questionable application of geotextiles and may not result in the desired pavement performance (Zollinger et al. 2014). This is likely due to the reduced interlayer friction from the geotextile, which resulted in longer, undesirable crack spacing.

It was also noted on the sections being evaluated that the magnitude and variability of the deflections, measured using a falling weight deflectometer (FWD) on the test section with a geotextile interlayer, was considerably higher than the other sections (see Figure 9).



Zollinger et al. 2014, TTI

Figure 8. TTI test section layout showing four different test sections with different subbase types



Recreated from Zollinger et al. 2014

Figure 9. FWD deflections on base and CRCP

Larger deflections in a CRCP are not desirable. The recommended separation layer for CRCP is a dense-graded or permeable HMA (Zollinger et al. 2014).

Construction Best Practices

The *Guide to Concrete Overlays* (Harrington and Fick 2014) provides details and suggestions for the successful installation of geotextile separation material. Important considerations include the following:

- Overlap sections of the nonwoven geotextile material a minimum of 6 in. and a maximum of 10 in. and ensure that no more than 3 layers overlap at any point (see Figure 10).

National CP Tech Center 2009

Figure 10. Overlap of nonwoven geotextile material section

- The geotextile should either extend past the edge of the pavement a minimum of 4 in. over a drainable material, be daylighted past the edge of the shoulder, or be tied into a longitudinal underdrain system to provide positive drainage.
- When faulting greater than 0.25 in. (or an amount specified by the engineer) is present, it should be reduced by milling.
- Fabric Placement
    - Sweep the pavement surface clean before placing the geotextile.
    - Place the fabric just prior to paving (ideally no earlier than 2 to 3 days before) to reduce the potential for damage.
    - Roll out the fabric onto the existing surface, pulling the nonwoven geotextile tight to minimize 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. (If an unavoidable wrinkle or fold occurs, it may be cut, laid flat, and secured to the pavement.)
- Thermal considerations
    - White or light-colored fabric can be used in hot and sunny weather conditions to help prevent heat buildup in the underlying pavement.
- There are several options for anchoring the geotextile, such as using nails and washers at 6 ft center-to-center (c/c) in each direction or applying an approved adhesive (see Figures 11 and 12). Several states have also been experimenting with using liquid hot-pour asphalt (tack).

National CP Tech Center 2009 and montage from Cackler 2017, National CP Tech Center

Figure 11. Securing geotextile (pins/nails) with washer

Montage from Cackler 2017, National CP Tech Center

Figure 12. Securing geotextile with spray adhesive

- Construction traffic on the geotextile should be limited to what is necessary to facilitate concrete paving. Leave temporary gaps in the geotextile where trucks are crossing and making sharp turns. Reduce the travel speed of construction vehicles. If the geotextile is damaged due to haul trucks, it should be cut out and replaced.

Economics

There appear to be significant time and cost savings when geotextile material is used for the separation layer when compared to the more traditional HMA separation layer. Factors contributing to the net savings include material cost, speed of installation, and typically the elimination of a subcontracted item for placing the HMA separation layer.

To highlight the potential differences in costs, actual bidding results from two projects are summarized below.

Illinois – I-72

The 3.2-mile UBCOC overlay of an existing CRCP pavement was bid (March 6, 2015) using a 1.25 in. thick HMA separation layer in the eastbound lane (EBL), and a 15 oz/yd^2 nonwoven geotextile in the westbound lane (WBL). The EBL with HMA separation cost $506,450.12 versus the WBL with the geotextile separation cost of $339,564.37, a difference of $166,886.75, or $3.70 per square yard.

North Carolina – Greensboro Eastern Loop

On March 8, 2017, the North Carolina DOT (NCDOT) approved the use of a 15 oz/yd^2 geotextile fabric separation under a value engineering proposal (VEP) resulting in construction cost savings of $555,969.31 over the original design of a permeable asphalt drainage layer. A total of 210,600 yd^2 of geotextile fabric was used on this five-mile project.

Additional cost information from other states also supports the potential for significant cost savings.

Iowa – 2015 to 2017 Bid Prices

Iowa bid results from 2015 through 2017 ranged from $2.07 to $2.45 per square yard for installed geotextile. Using Iowa bid prices during this same period, the cost for a 1 in. thin asphalt separation layer would be $4.86 per square yard.

2016 Survey on Concrete Overlay Costs

A survey was conducted by the National CP Tech Center in 2016 involving eight states (Colorado, Illinois, Iowa, Michigan, Minnesota, Missouri, Oklahoma, and South Dakota) to determine current costs to build concrete overlays. As part of the survey, four of the states (Illinois, Iowa, Missouri, and South Dakota) had constructed concrete overlays using geotextile separation material. The average cost was $2.72/yd^2 installed (Gross 2017).

Case Histories

Ten states were identified as having built unbonded concrete overlay projects with geotextile separation material. Detailed project histories and information were obtained for nine of them to include in this document.

These nine projects are summarized in Table 2, with more detailed information included in a summary for each project that follows.

Table 2. Overview of case history project examples

State	Route	Existing Pavement Type	Year Overlaid	Functional Classification	Traffic (AADT)	Overlay Thickness (in.)	Overlay Quantity (yd^2)	Fabric Weight (oz/yd^2)
Illinois	I-72	CRCP	2015	Interstate/Freeway	24,000	6	160,000	15
Iowa	CR G-24	JPCP	2013	County Road	1,600	7	66,000	15
Michigan	Little Mack	JPCP	2011	Major or Minor Collector	13,000	4	40,000	15
Minnesota	I-94	JPCP	2013	Interstate/Freeway	47,000	9	272,500	15
Missouri	Route D	JRCP	2008	Principal or Minor Arterial	9,300	5	45,000	12 and 15
Nebraska	CR 4	JPCP	1991	County Road	400	6	90,000	15
Oklahoma	I-40	JPCP	2009	Interstate/Freeway	39,000	10	600,000	15
South Dakota	I-90	CRCP	2014	Interstate/Freeway	3,500	8	680,000	15
Texas	Lubbock International Airport	JPCP	2011	Airport Runway	24,000 annual departures	8	100,000	14

CRCP = continuously reinforced concrete pavement, JPCP = jointed plain concrete pavement

Illinois Case History Information

Project Information

Route: I-72

Application: Interstate

Year of original construction: 1976

Existing pavement type: CRCP with HMA overlay, which was removed prior to overlay placement

Faulting (in.): None

Transverse cracking (%): CRCP; therefore, not applicable

Spalling (%): CRCP; therefore, not applicable

Corner breaks (%): CRCP; therefore, not applicable

Longitudinal cracking (%): There were some, but they were not measured as they were covered with the existing HMA overlay

CRCP-Punchouts (#/mile): There were a few, but they were not measured as they were covered with the existing HMA overlay

Information on the Overlay

Overlay type: unbonded concrete overlay (UBCOC)

Year constructed: 2015

Project size: 160,000 yd^2 (3.2 miles both directions including shoulders. EBL used HMA separation and WBL used geotextile separation.) *Note: There was a substantial cost savings between the HMA and geotextile separations. The EBL with HMA separation cost $506,450.12 versus the WBL with the geotextile separation cost of $339,564.37.*

Thickness: 6 in.

Dowels: No dowels – Structural fiber reinforcement used. #4 tiebars on a 36 in. spacing were used in the longitudinal construction joint at centerline only.

Joint spacing: Mainline 6×6 ft with shoulders at 5×5 ft and 6×6 ft

Joint sealing: Longitudinal shoulder and centerline joints only

Integral widening: No widening of the mainline pavement, but shoulders were placed integrally with the overlay

Contractor: Illinois Valley Paving

Owner: Illinois DOT

Performance concerns related to the separation layer: Geotextile section had initial problems with fabric snagging on the side forms of the paver starting out and at a few other locations during construction, until the contractor made adjustments.

Overlay repairs to date: None (One header panel will need repair likely due to a wrinkle in the fabric. Fastening procedures were changed to eliminate the concern.)

Information on the Geotextile Fabric

Fabric Used: Propex Geotex 1341NH

Weight: 15 oz/yd^2

Color: Black

Anchored with pins or adhesive: Pins used on the overlap with tack coat on the remainder. This worked very well.

Moisture outlet: None

Performance Information

Traffic volume (AADT): 14,000 vpd

Truck traffic (%): 21%

Current condition:
New 2015 - IRI EB 48, IRI WB 62.

Randy Riley, formerly Illinois ACPA

Figure 13. Illinois – Before overlay placement

Randy Riley, formerly Illinois ACPA

Figure 14. Illinois – Current condition

Iowa Case History Information

Project Information

Route: County Road (CR) G-24
(From US 69 west 5 miles to CR R-57)

Application: Secondary county road

Year of original construction: 1976

Existing pavement type:
6 in. PCC pavement with 40 ft transverse joints

Ride quality:
- IRI = 175 in/mi
- Faulting data:
  - Left wheelpath:
    - 339 joints at severity level 1 (0.12 to 0.24 in.)
    - 88 joints at severity level 2 (0.24 to 0.35 in.)
    - 36 joints at severity level 3 (0.35 to 0.47 in.)
    - 26 joints at severity level 4 (0.47 in. and greater)
  - Right wheelpath:
    - 293 joints at severity level 1 (0.12 to 0.24 in.)
    - 118 joints at severity level 2 (0.24 to 0.35 in.)
    - 38 joints at severity level 3 (0.35 to 0.47 in.)
    - 38 joints at severity level 4 (0.47 in. and greater)

Transverse cracking (%): ~29%
69 low severity transverse cracks, 242 medium severity, 75 high severity

Spalling (%): ~ 5% spalled and 7% D-cracked
- 33 medium severity spalled joints, 33 high severity spalled joints
- 65 medium severity D-crack joints, 32 high severity D-crack joints

Corner breaks (%): Not measured

Longitudinal cracking (%): ~1.7%

CRCP-Punchouts (#/mile): N/A

Information on the Overlay

Overlay type: UBCOC

Year constructed: 2014

Project size: 5.1 miles (66,435 yd^2)

Thickness: 7 in.

Dowels: None

Joint spacing: 12 ft

Joint sealing: Yes

Integral widening: No

Contractor: Manatts, Inc.

Owner: Warren County, Iowa

Performance concerns related to the separation layer:
None

Overlay repairs to date: None

Information on the Geotextile Fabric

Fabric Used: AASHTO M 288

Weight: 14.7 oz/yd^2

Color: Black

Anchored with pins or adhesive: Pins

Moisture outlet: Daylighted (4 in. or more)

Performance Information

Traffic volume (AADT): 1,600 vpd

Truck traffic (%): Estimate 10–20%

Current condition: Excellent condition with no signs of reflective cracking from the underlying pavement

Performance metrics (2015):

PCI = 89, IRI = 78 in/mi, 7 transverse cracks (0.2%)

Dan King, Iowa Concrete Paving Association

Figure 15. Iowa – During overlay placement

Dan King, Iowa Concrete Paving Association

Figure 16. Iowa – Current condition

Michigan Case History Information

Project Information

Route: Little Mack Ave., 10 Mile Rd. to 12 Mile Rd., St. Clair Shores

Application: Local street–minor arterial

Year of original construction: 1995

Existing pavement type: 9 in. non-reinforced jointed

Faulting (in.): 0

Transverse cracking (%): 0

Spalling (%):
At year 5, diamond-shaped spalls appeared where the transverse and longitudinal joints meet

Corner breaks (%): 0

Longitudinal cracking (%): A small amount (500–800 ft) of longitudinal cracks occurred on the project near the curb line where a water main was placed below

CRCP-Punchouts (#/mile): 0

Information on the Overlay

Overlay type: Thin UBCOC

Year constructed: 2011

Project size: 40,000 yd^2 (2 mi of 5 lanes – 11 ft wide)

Thickness: 4 in.

Dowels: No

Joint spacing: 5.5×5.5 ft

Joint sealing: Hot pour

Integral widening: No, but new curb head was constructed integrally with the pavement

Contractor: Florence Cement Co.

Owner: City of St. Clair Shores, Michigan

Performance concerns related to the separation layer: Originally, the pavement was experiencing a noise, a thumping sound, but appeared to stop and this was likely due to panel movement related to fabric thickness

Overlay repairs to date: None

Information on the Geotextile Fabric

Fabric Used: Tencate 1450BB

Weight: 14.7 oz/yd^2

Color: Black

Anchored with pins or adhesive:
Hilti nails and washers

Moisture outlet:
1×2 ft deep drainage trench at back of curb designed to allow water to reach outer edge drain

Performance Information

Traffic volume (AADT): 13,400 vpd (2010)

Truck traffic (%): 2.3%

Current condition: Good performance, some minor cracking at gaps and off some structures and one isolated location with a few shattered panels; the concrete pieces are held in place by the fabric, there is no faulting, and these panels will need to be replaced at some point

Dan DeGraaf, Michigan Concrete Association

Figure 17. Michigan – Current condition

Minnesota Case History Information

Project Information

Route: I-94

Application: Interstate

Year of original construction: 1973

Existing pavement type: 9 in. JPCP

Faulting (in.): Concrete Joint Repair performed in 1982 and 1991; micro-surfacing in 2006

Transverse cracking (%): Concrete Joint Repair performed in 1982 and 1991; micro-surfacing in 2006

Spalling (%): Concrete Joint Repair performed in 1982 and 1991; micro-surfacing in 2006

Corner breaks (%): Concrete Joint Repair performed in 1982 and 1991; micro-surfacing in 2006

Longitudinal cracking (%): Concrete Joint Repair performed in 1982 and 1991; micro-surfacing in 2006

CRCP-Punchouts (#/mile): Concrete Joint Repair performed in 1982 and 1991; micro-surfacing in 2006

Information on the Overlay

Overlay type: UBCOC

Year constructed: 2013

Project size: 7.5 miles (272,500 yd^2)

Thickness: 9 in.

Dowels: 1.25 in.

Joint spacing: 15 ft

Joint sealing: Yes, hot pour

Integral widening: Yes

Contractor: Knife River Corp./PCI Roads, Inc.

Owner: MnDOT

Performance concerns related to the separation layer: None

Overlay repairs to date: None

Information on the Geotextile Fabric

Fabric Used: Propex

Weight: 15 oz/yd^2

Color: White

Anchored with pins or adhesive: Adhesive

Moisture outlet: Daylighted 1 ft beyond edge of pavement

Performance Information

Traffic volume (AADT): 2012 (two way) = 46,800 vpd

Truck traffic (%): 2012 HCADT (two way) = 6,020, Design ESALS = 74,131,000

Current condition: Performing well

Robert Golish, MnDOT

Figure 18. Minnesota – Current condition

Missouri Case History Information

This was the first project built in the US after the FHWA/AASHTO international scanning tour of long-life concrete pavements (Hall et al. 2007). Even though the nonwoven geotextile did not fully comply with current specifications, the pavement is performing very well.

Project Information

Route: Route D

Application: Secondary state highway

Year of original construction: 1986

Existing pavement type: JRCP

Faulting (in.): Severe D-cracking

Transverse cracking (%): Severe D-cracking

Spalling (%): Severe D-cracking

Corner breaks (%): Severe D-cracking

Longitudinal cracking (%): Severe D-cracking

CRCP-Punchouts (#/mile): N/A

Information on the Overlay

Overlay type: UBCOC

Year constructed: 2008

Project size: 45,000 yd^2 (3.5 centerline miles)

Thickness: 5 in.

Dowels: No

Joint spacing: 6 ft

Joint sealing: Unsealed

Integral widening: No

Contractor: Clarkson Construction Co.

Owner: Missouri DOT

Performance concerns related to the separation layer: None

Overlay repairs to date: Minor full-depth patching at transition

Information on the Geotextile Fabric

Fabric Used: Propex Nonwoven Geotextile (Gortex 1201 and Gortex 1601; both had thermal treatment, which is not recommended by current specifications but were used due to availability)

Weight: ~ 12 oz/yd^2 and 15 oz/yd^2

Color: Black

Anchored with pins or adhesive: Nails and washers

Moisture outlet: Daylighted

Performance Information

Traffic volume (AADT): 9,300 vpd

Truck traffic (%): 5%

Current condition: The overlay is in excellent condition; November 2015 survey indicated only 69 of the 9,768 panels were cracked or spalled for a 0.7% failure rate after 7 years of service; no faulting observed

Todd LaTorella, ACPA, MO/KS Chapter

Figure 19. Missouri – Before overlay placement 1

Todd LaTorella, ACPA, MO/KS Chapter

Figure 20. Missouri – Before overlay placement 2

Todd LaTorella, ACPA, MO/KS Chapter

Figure 21. Missouri – After overlay placement

Note: Both the 12 oz/yd^2 and 15 oz/yd^2 separations appear to be performing equally at this point.

Todd LaTorella, ACPA, MO/KS Chapter

Figure 22. Missouri – Current condition

Nebraska Case History Information

Project Information

Route: County Road 4

Application: Rural county highway

Year of original construction: Approximately 1991, no as-builts were available

Existing pavement type: 8 in. concrete on subgrade

Faulting (in.): Very little faulting observed, typically less than 1/4 in.

Transverse cracking (%): < 10%

Spalling (%): See Notes

Corner breaks (%): See Notes

Longitudinal Cracking (%): >80%

CRCP-Punchouts (#/mile): NA

Notes: Repair areas were estimated at 4,500 yd^2 or about 5% of the total project resurfacing quantity. Full panel failures, corner breaks, spalling, and longitudinal cracking were abundant. The existing 8 in. concrete had all the signs of alkali-silica reactivity (ASR) and exhibited durability cracking at nearly every control joint.

The road was in poor condition with a serviceability index well beyond the end of pavement life. The county had posted "Pavement breaking up ahead" signs and was investing considerable time and money in maintenance/patching with intermittent closures of the roadway for repairs.

Information on the Overlay

Overlay type: UBCOC

Year constructed: 2017

Project size: 7 miles of 22 ft wide paving (90,000 yd^2)

Thickness: 6 in.

Dowels: None

Joint spacing: 12 ft

Joint sealing: Hot poured

Integral widening: No

Contractor: A&R Construction, Plainview, Nebraska

Owner: Washington County Roads Department

Performance concerns related to the separation layer: None

Overlay repairs to date: None

Information on the Geotextile Fabric

Fabric Used: Propex Nonwoven Geotextile

Weight: 15 oz/yd^2

Color: White

Anchored with pins or adhesive: Adhesive

Moisture outlet: Granular subdrains

Performance Information

Traffic volume (AADT): 400 vpd

Truck traffic (%): Assumed 25% trucks

Current condition: New

Washington County, Nebraska

Figure 23. Nebraska – Before overlay placement

Washington County, Nebraska

Figure 24. Nebraska – Geotextile fabric placement during overlay placement

Oklahoma Case History Information

This was the second project built in the US. The nonwoven geotextile used on this project was actually imported from Europe.

Project Information

Route: I-40

Application: Interstate

Year of original construction:
1969 with CPR project in 1992

Existing pavement type: 9 in. JPCP over 4 in. fine aggregate bituminous base (FABB)

Faulting (in.):
Previously diamond ground, faulting < ½ in.

Transverse cracking (%): < 5%

Spalling (%): <10%

Corner breaks (%): <10%

Longitudinal cracking (%): ~50%

CRCP-Punchouts (#/mile): N/A

Information on the Overlay

Overlay type: UBOC

Year constructed: 2009 and 2010

Project size: 681,000 yd^2 (107,355 yd^2 UBCO)

Thickness: 10 in.

Dowels: Yes

Joint spacing: 15 ft

Joint sealing: Yes, silicone

Integral widening: Yes

Contractor: Duit Construction Company, Inc.

Owner: Oklahoma DOT

Performance concerns related to the separation layer:
None

Overlay repairs to date: None

Information on the Geotextile Fabric

Fabric Used: AASHTO M 288

Weight: 15 oz/yd^2

Color: Black

Anchored with pins or adhesive: Pins

Moisture outlet: Daylighted

Performance Information

Traffic volume (AADT): 39,000 vpd

Truck traffic (%): 28%

Current condition: Excellent

Brent Burwell, ACPA, Oklahoma/Arkansas Chapter

Figure 25. Oklahoma – Before overlay placement

Brent Burwell, ACPA, Oklahoma/Arkansas Chapter

Figure 26. Oklahoma – Current condition

South Dakota Case History Information

Project Information

Route:
I-90 westbound lane from W. Murdo exit to County Line

Application: Interstate

Year of original construction: 1970

Existing pavement type: 8 in. CRCP

Faulting (in.): None (CRCP)

Transverse cracking (%): None due to surface type

Spalling (%): 11%

Corner breaks (%): 0.5%

Longitudinal cracking (%): Minimal but not measured

CRCP-Punchouts (#/mile): < 10 per mile

Information on the Overlay

Overlay type: UBCOC over CRCP

Year constructed: 2014

Project size: 15.5 mi

Thickness: 8 in. for overlay

Dowels:
- UBOC Overlay
  - 12 bar assembly (1.25 in.) Driving lane
  - 9 bar assembly (1.25 in.) Passing lane

Joint spacing: UBOC is 15 ft

Joint sealing:
Silicone in transverse and hot pour in longitudinal joints

Integral widening: Yes, to 13 ft

Contractor: Knife River Corporation

Owner: South Dakota DOT

Performance concerns related to the separation layer:
None

Overlay repairs to date: None

Information on the Geotextile Fabric

Fabric Used: Propex - Reflectex

Weight: 15 oz/yd^2

Color: White

Anchored with pins or adhesive: Pins and washers

Moisture outlet: Daylighted

Performance Information

Traffic volume (AADT): 3,100 vpd

Truck traffic (%): 21.3%

Current condition: Excellent

Jason Reaves, South Dakota Chapter, ACPA

Figure 27. South Dakota – Before overlay placement

Jason Reaves, South Dakota Chapter, ACPA

Figure 28. South Dakota – Current condition

Texas Lubbock Preston Smith International Airport Case History Information

Project Information

Route: Runway 08/26

Application: Airport

Year of original construction: Mid 1970s

Existing pavement type: JPCP (14 in.)

Faulting (in.): N/A

Transverse cracking (%): Estimated 10 to 20%

Spalling (%): Estimated 10 to 20%

Corner breaks (%):
Estimated 10 to 15% (includes D-cracking)

Longitudinal cracking (%): Estimated 30 to 40%

CRCP-Punchouts (#/mile): N/A

Information on the Overlay

Overlay type: UBCOC (2 in. asphalt plus, fabric and 8 in. jointed, unreinforced concrete?)

Year constructed: 2011

Project size: ~ 6,000×150 ft

Thickness: 8 in.

Dowels: Dowels at joints align with existing joints; Deformed bars at intermediate joints

Joint spacing: 12.5×12.5 ft

Joint sealing: Yes, with self-leveling silicone

Integral widening: Of joints, yes

Contractor: JD Abrams of Austin, Texas

Owner: City of Lubbock, Texas

Performance concerns related to the separation layer:
None to date

Overlay repairs to date: Limited crack seal and spall repair and pending joint seal replacement

Information on the Geotextile Fabric

Fabric Used: Nonwoven geotextile

Weight: 14 oz/yd^2

Color: Black

Anchored with pins or adhesive: Pins

Moisture outlet: Daylights to edge drain along both sides of the runway

Performance Information

Traffic volume: See Table 3

Table 3. Calculated Texas Lubbock Preston Smith International Airport traffic analysis

Aircraft	MTOW (lbs)	Landing Gear Configuration	Average Annual Departures
ERJ 135	21,100	Dual	210
ERJ 140	21,100	Dual	622
ERJ 145, CRJ 50	21,100	Dual	4,899
CRJ 70	10,000	Dual	981
MD 80	140,000	Dual	5
B 737 200	108,218	Dual	193
B 737 500	149,710	Dual	1,418
B 737 300/700	149,710	Dual	2,872
LEARJET INC 31A	17,000	Dual	253
GATES LEARJET CORP 35A	18,300	Dual	415
DASSAULT-BREGUET FALCON 10	18,740	Dual	262
CESSNA 560XL	20,000	Dual	253
GATES LEARJET CORP 55	21,000	Dual	271
LEARJET INC 45	21,500	Dual	199
LEARJET INC 60	23,500	Dual	256
BRITISH AEROSPACE HS 125-700A	25,500	Dual	213
RAYTHEON AIRCRAFT HAWKER	28,000	Dual	145
BRITISH AEROSPACE BAE 125-800A	28,000	Dual	172
FAIRCHILD DORNIER	30,942	Dual	189
CESSNA 750	35,700	Dual	179
DASSAULT AVIATION FALCON 2000	35,800	Dual	135
CANADAIR LTD CL-600 CHALLENGER	40,125	Dual	235
GULFSTREAM AEROSPACE G-IV	73,200	Dual	99
A 310-300	314,041	Dual Tandem	1,698
Turbos	19,773	Dual	696
T 37	4,056	Single	484
T 38	12,500	Single	2,176
T 1	16,100	Single	2,176
T 43	115,000	Dual	1,644
KC 135	322,500	Dual Tandem	484
C 17	585,000	12 wheels	193
C 5	840,000	24 wheels	97

MTOW = maximum takeoff weight

Source: Mark Haberer, Parkhill, Smith & Cooper, Inc.

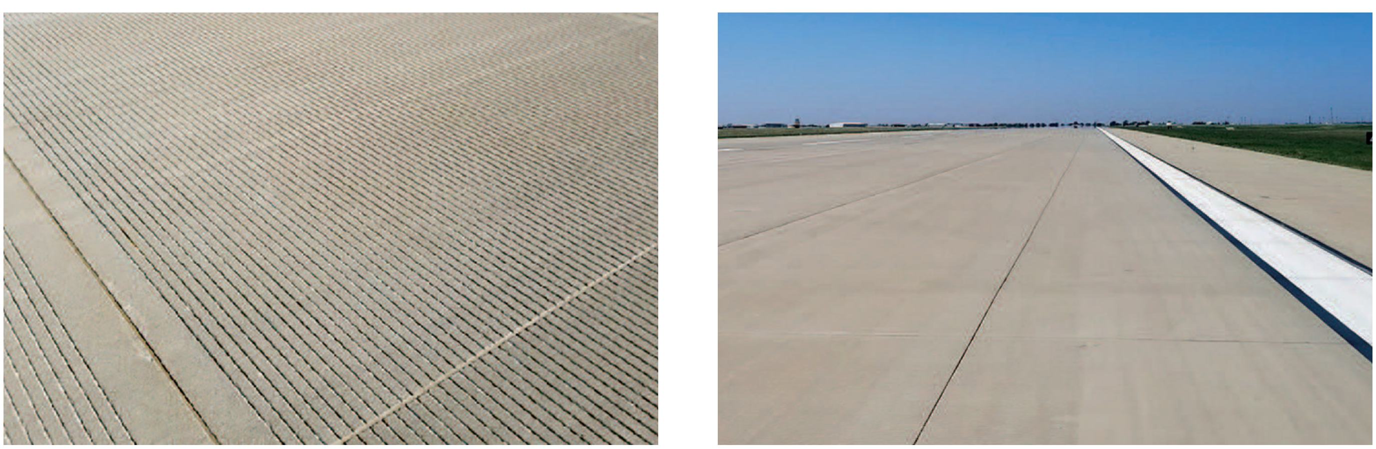
Current condition: As of October 2017, the unbonded overlay appears in good condition, and minimal damage was noted during a vehicular inspection. Most panels exhibit no fatigue or material-related distress. Joint sealant has been damaged by equipment in multiple locations, and slight joint spalling will need to be addressed during a re-seal. There are two areas where multiple panels exhibit corner cracking. The first is at the taxiway G intersection near the west end of the runway, south of the centerline. The second is approximately 3,500 ft east of the west Runway 8 threshold, to the north of the centerline. In all, these two areas contain approximately 20–25 corner breaks. It is not known what caused the corner breaks. There were only one or two mid-panel transverse cracks noted throughout. Of the 5,800 panels constructed as part of the overlay section, fewer than 1% are in need of repair.

Mark Haberer, Parkhill, Smith & Cooper, Inc.

Figure 29. Texas Lubbock Preston Smith International Airport – Before overlay placement

Mark Haberer, Parkhill, Smith & Cooper, Inc.

Figure 30. Texas Lubbock Preston Smith International Airport– During overlay placement



Mark Haberer, Parkhill, Smith & Cooper, Inc.

Figure 31. Texas Lubbock Preston Smith International Airport – Current condition

Ongoing Research, Development, and Optimization

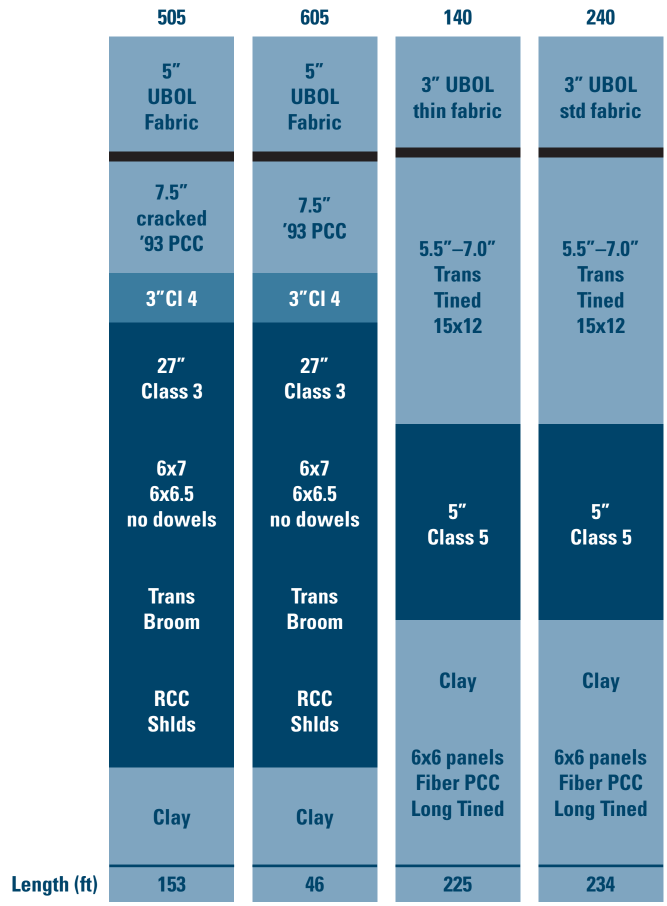
The initial success of using nonwoven geotextiles as a separation layer in UBCOC has resulted in growing interest in optimization of design, specification, and construction procedures for this application. Specifically, ongoing research and development have focused on optimizing the following properties:

- Geotextile thickness requirements for varying overlay thicknesses, especially thinner designs
- Panel size and joint development, especially for lower volume applications
- Quantification of drainage requirements
- Construction procedure for adhering the geotextile to the existing pavement
- Thermal properties
- Material optimization for end-of-life recycling

An overview of ongoing and recent research follows.

Geotextile Fabric Separation Related Research and Implementation at the MnROAD Research Facility

MnDOT has been experimenting with and implementing the use of geotextile fabric as a separation for unbonded concrete overlays since 2010. While the larger scale projects using a fabric separation have been primarily standard thickness concrete overlays (i.e., > 7 in. overlay thickness), research projects have focused on its use in thinner unbonded concrete overlays (see cell maps in Figure 32 for selected sample section details).



PCC = Portland cement concrete
RCC Shlds = Roller Compacted Concrete Shoulders
Trans Broom = Transverse Broomed Surface Texture
Trans Tined = Transverse Tined Surface Texture
UBOL = unbonded concrete overlay

Figure 32. Structural designs for four unbonded overlay test sections at MnROAD Facility

Thin Overlays with Heavy Traffic

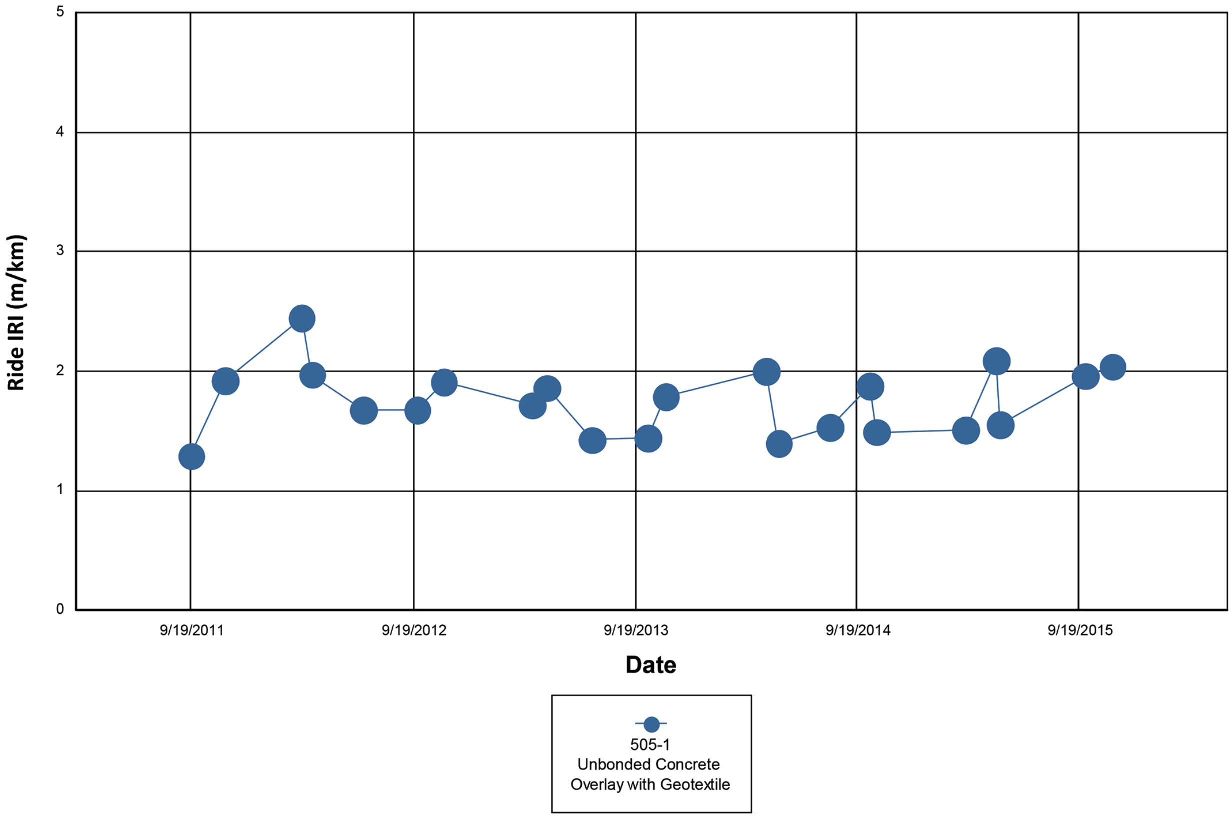
In 2011, two thin unbonded concrete overlay test sections containing a geotextile fabric separation were constructed at the MnROAD facility (sections 505 and 605 in Figure 26). Both sections consist of 5 in. thick concrete panels placed on a 15 oz nonwoven geotextile fabric, placed on an existing 7.5 in. thick concrete pavement. Panel sizes range from 6 ft long by 6.5 ft wide in the passing lane, to 6 ft long by 7 ft wide in the driving lane. Subjected to interstate traffic levels of more than 1 million equivalent single axle loads (ESALs) per year, as well as the extreme climate of central Minnesota, these test sections have performed exceptionally well. As of 2017, only 1 of the 192 panels has a crack, and transverse joint faulting is minimal. See Figures 33 through 36.

Tom Burnham, MnDOT

Figure 33. MnROAD Test Section 505 – 5 in. UBOL on standard fabric – June 2016

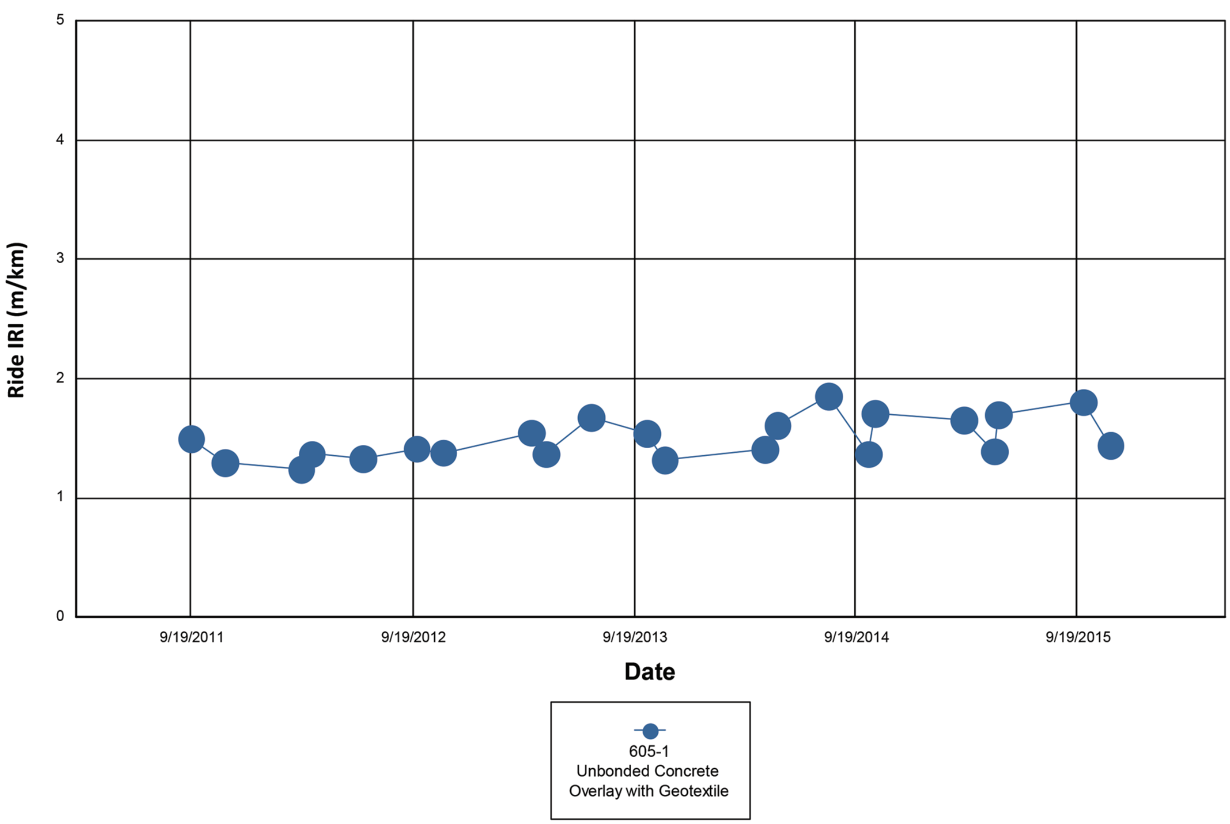
Tom Burnham, MnDOT

Figure 34. MnROAD Test Section 605 – 5 in. UBOL on standard fabric – June 2016



Tom Burnham, MnDOT

Figure 35. MnROAD Pavement Performance (Ride-IRI) Report: Test Section 505



Tom Burnham, MnDOT

Figure 36. MnROAD Pavement Performance (Ride-IRI) Report: Test Section 605

Thin Overlays with Low Traffic

In 2013, two ultra-thin unbonded concrete overlays test sections containing a geotextile fabric separation were constructed at the MnROAD facility on the low-volume road (sections 140 and 240 in Figure 32). Both sections consist of 3 in. thick, fiber-reinforced concrete panels, with one section placed on a standard 15 oz nonwoven geotextile fabric (section 240), and the other section on an 8 oz nonwoven geotextile fabric (section 140). The support layer was an existing 5.5 in. (centerline) to 7 in. (edge) thick "thickened edge" or trapezoidal designed concrete pavement. Panel size for both sections is 6 ft by 6 ft. These sections are subjected to MnROAD low-volume road truck loadings averaging 30,000 ESALs per year.

The concept for conducting trials of different weight fabrics came from the idea that the ultra-thin panels, with significantly lower weight than more standard concrete overlays, would not compress the standard weight fabric enough to prevent "excessive" deflections that might lead to audible sounds coming from the transverse joints during heavy loadings. Such sounds have been reported as occurring in some thin concrete overlays in Illinois. The solution adopted in Illinois was to use a much thinner fabric separation (too thin to be considered drainable). This became the seed idea for the thin, but potentially drainable, fabric experimental design at MnROAD.

Since construction of these MnROAD test sections, noticeably greater audible sounds have been emanating from the transverse joints in the section with the standard weight fabric compared to the section with the thin fabric. Research efforts are underway to quantify the difference in sound intensity from each section.

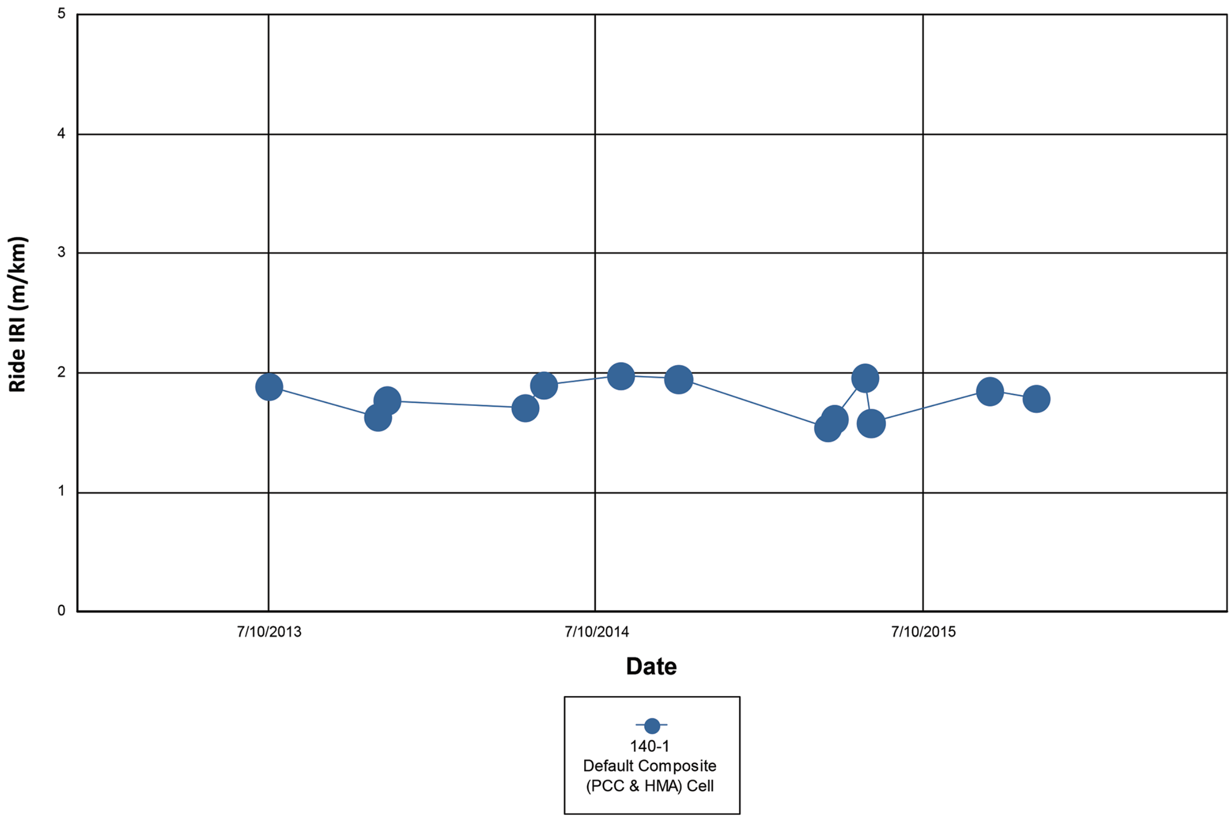
Performance of these sections remains very good, with minimal numbers of transverse and longitudinal cracks appearing in both sections. These cracks have remained tight, likely due to the fiber-reinforced concrete in the overlay. Despite the seemingly excessive deflection of the panels, particularly on the standard weight fabric, faulting of the transverse joints remains minimal as of 2017. See Figures 37 through 40.

Tom Burnham, MnDOT

Figure 37. MnROAD Test Section 140 – 3 in. fiber-reinforced concrete UBOL on thin fabric – August 2015

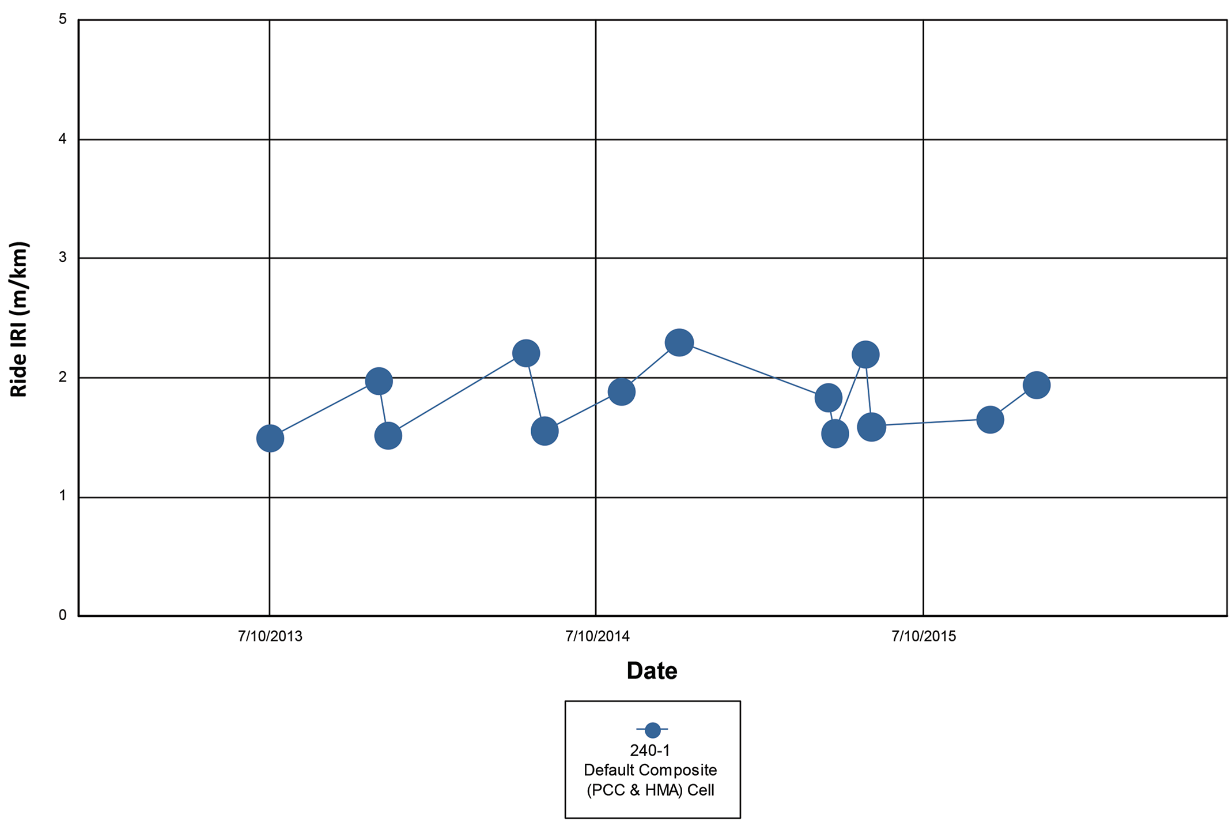
Tom Burnham, MnDOT

Figure 38. MnROAD Test Section 240 – 3 in. fiber-reinforced concrete UBOL on standard fabric – June 2016



Tom Burnham, MnDOT

Figure 39. MnROAD Pavement Performance (Ride-IRI) Report: Test Section 140



Tom Burnham, MnDOT

Figure 40. MnROAD Pavement Performance (Ride-IRI) Report: Test Section 240

Drainage Characteristics

A laboratory study involving the evaluation of the drainage capabilities of geotextile fabric as a separation layer in an unbonded concrete overlay system was concluded at the University of Minnesota in 2012 (Lederle et al 2013). This study concluded that geotextile fabric, as specified in MnDOT specifications, should provide adequate drainage to the overlay system, as well as prevent reflective cracking from an underlying concrete layer.

Limiting Potential for Joint Faulting

Recent and current unbonded concrete overlay studies have identified the potential for asphalt-based separation layers to develop transverse joint faulting. As demonstrated so far by the MnROAD sections, the use of thin geotextile fabrics may be one solution for limiting this behavior, provided long-term durability of the concrete overlay is not compromised by insufficient drainage over time. Continued monitoring of the performance of the MnROAD sections and other large-scale projects in Minnesota will identify if these are future concerns.

Options to Secure the Fabric during Construction

While it is may be too early to evaluate the true long-term performance of the more standard (thicker) unbonded concrete overlays constructed in Minnesota utilizing a fabric separation, there have been a number of interesting developments in how they have been constructed.

The early practice of nailing the fabric to the existing concrete or milled asphalt (composite pavement), has been largely replaced with the use of spray adhesives. This practice was first evaluated during the 2013 MnROAD test section construction. More recently, some contractors have utilized hot-pour asphalt sealant as the adhesive. The adhesive or asphalt must not penetrate the geotextile to the point of diminishing the lateral transmissivity of the geotextile.

Other concepts, such as steel dowel basket retaining hoops (Figure 41) have been successfully tested on large-scale projects.

Matt Zeller, Concrete Paving Association of Minnesota

Figure 41. Steel dowel basket retaining hoop

Successful anchorage of dowel baskets on the fabric is critical to long-term performance of the overlay. Several projects in Minnesota have had issues when poorly anchored dowel baskets tipped during paving, resulting in severely deteriorated joints within 6 months after installation.

Deflection Testing of HMA and Geotextile Separation Layers to Determine Load Response

From a design perspective, one of the questions that arises is whether the geotextile separation material's response to traffic loading will result in additional pavement deflection compared to HMA separation layers. If additional deflection occurs, this could potentially result in shortened fatigue life of the overlay. Based on a search of available literature, it appears there have only been two limited studies to address this question. A summary of each is provided, however, it appears from these studies, that geotextile separation layers have not resulted in increased fatigue in the overlay. This also seems to be confirmed by the excellent performance experience of the overlays in service to date.

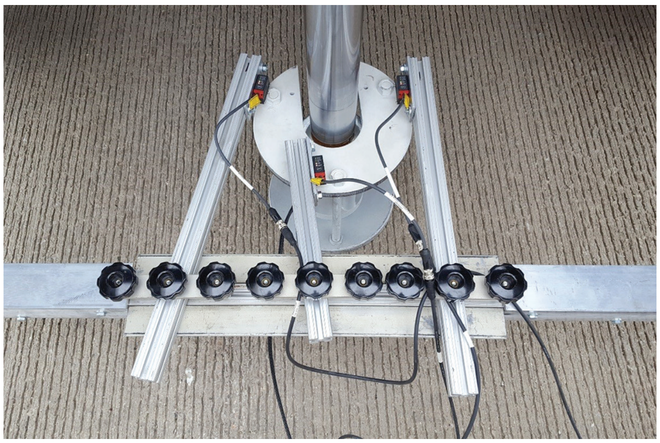
- In 2016, the National CP Tech Center conducted an in situ evaluation of geotextile and HMA separation layers using automated plate load testing (APLT) on a project built in 2008–2009 on CR V-18 in Poweshiek County, Iowa (White 2018) (see Figure 42).

White 2018, National CP Tech Center

Figure 42. APLT equipment setup on the Poweshiek, Iowa CR V-18 project

Two separate material suppliers were used for this project. The first material, HATE B 500-PP, was supplied by Huesker of Charlotte, North Carolina. The alternative material, Tencate Mirafi, 1450 BB, was supplied by Tencate Geotextiles of North America.

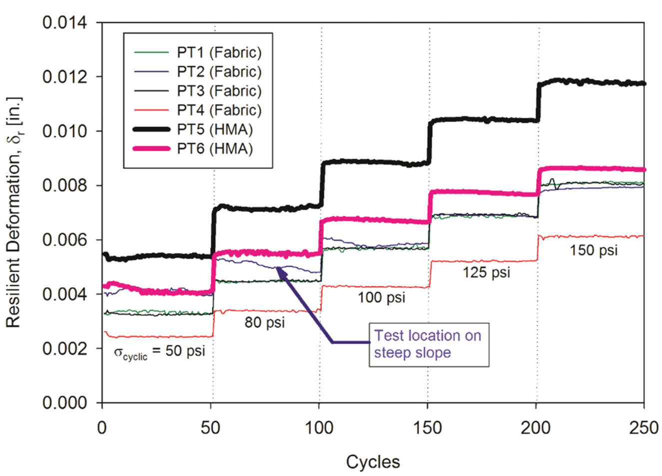
Using cyclic APLT at five stress levels (50 psi to 150 psi), measurements were taken on four test locations where geotextile fabric was used and on two locations with an HMA interlayer (see Figure 43).



White 2018, National CP Tech Center

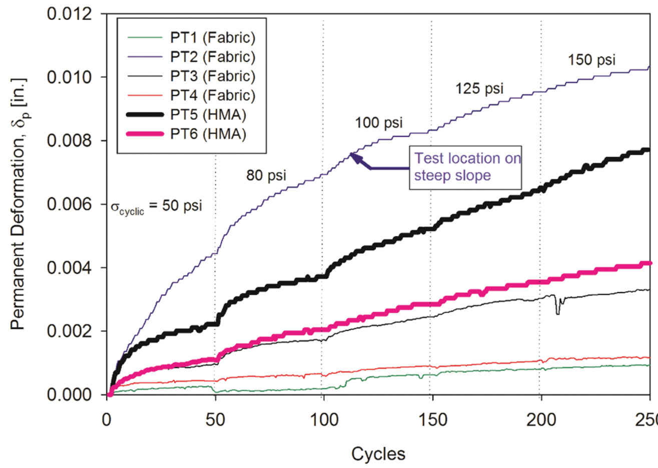
Figure 43. 12-in. diameter plate setup with reference beam for plate deflection measurements

The results indicated that the composite resilient modulus was 40% higher and the permanent deformation was lower in the geotextile sections than in the HMA layer sections (see Figures 44 and 45).



White 2018, National CP Tech Center

Figure 44. Resilient deformation (δ_r) results for the five stress sequences at all test points



White 2018, National CP Tech Center

Figure 45. Permanent deformation (δ_r) results for the five stress sequences at all test points

Note: PT2 data was collected on a section with steep slope and the testing condition likely influenced the test results. The analysis was done with and without PT2.

- MnDOT is the lead state agency on FHWA Transportation Pooled Fund study TPF-5(269), Development of an Improved Design Procedure for Unbonded Concrete Overlays, which has eight state partners: Georgia, Iowa, Kansas, Michigan, Minnesota, Missouri, North Carolina, and Oklahoma. The overall goal of the project is to develop a much improved and unified mechanistic-empirical-based design procedure for unbonded concrete overlays.

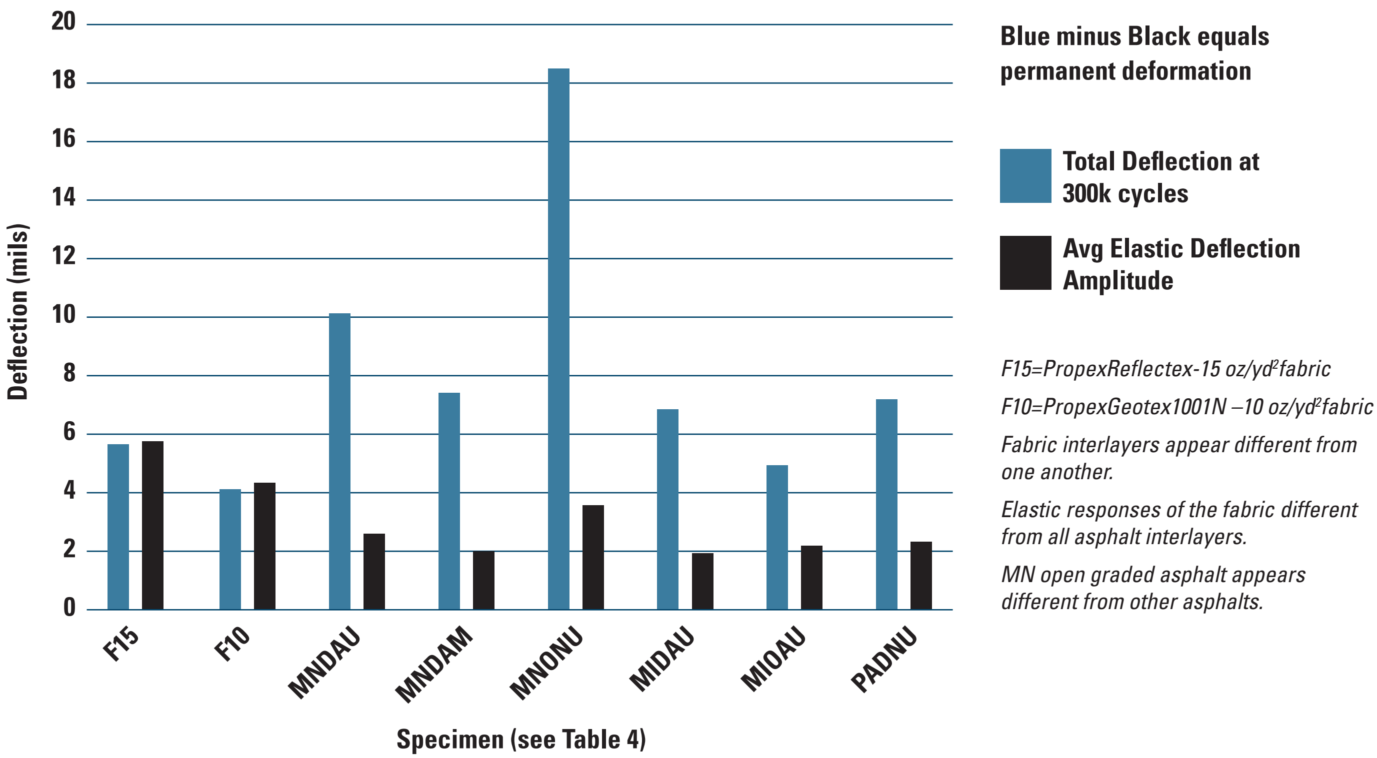
The overall project is nearing completion with the design software currently being beta tested. A summary of Task 2 in the report published in October 2015 looked at interlayer characterization, field performance assessment, and guidelines on drainage (Vandenbossche et al. 2015). This task covered stiffness of the interlayer, friction along the interlayer system, ability to prevent reflective cracking, and vertical resistance to uplift on typical HMA interlayers used in Michigan and Minnesota, as well as nonwoven geotextile fabrics with 10 oz/yd^2 and 15 oz/yd^2 weights.

The results of the laboratory testing indicated that the deflections of the overlay with the geotextile separation layers (both 10 oz/yd^2 and 15 oz/yd^2) were approximately equal to the response of the better HMA systems and, in addition, there was no accumulated permanent deformation. See Table 4 and Figure 46.

Table 4. TPF-5(269) interlayer testing

Specimen Designation	Roadway	Asphalt Description	Avg Asphalt Thickness
MIDAU	US 131, MI	Old, dense graded	1 in.
MIOAU	US 131, MI	Old, open graded	2 in.
MNDAM	I-94, MnROAD	Old, dense graded, milled	0.875 in.
MNDAU	I-94, MnROAD	Old, dense graded, unmilled	2.75 in.
MNONU	US 169, MN	New, open graded	1.75 in.
PADNU	SR-50, PA	New, dense graded	1 in.

Source: Vandenbossche and Sachs 2016



After Vandenbossche and Sachs 2016

Figure 46. TPF-5(269) elastic deflection and permanent deformation test results

The results for this work would tend to be consistent with the in situ test results from the Poweshiek CR V-18 overlay project in Iowa. Obviously, this is a limited data set, but it would also tend to be consistent with performance observed on many projects in the field.

Evaluation of Thermal Behavior

The *Guide to Concrete Overlays*, 3rd Edition (Harrington and Fick 2014), makes the following recommendation regarding the choice of geotextile fabric color:

"In colder weather (spring and fall) a black-colored separation layer helps maintain a warmer temperature for the placement of the overlays because it has carbon molecules that absorb ultraviolet energy. This is not, however, desirable in hot weather conditions, particularly when the fabric reaches 110°F or greater. Cooling the fabric with a water mist is then required under this condition. To prevent heat absorption, white-colored fabric has been developed recently to help reflect ultraviolet energy in hot and sunny weather (see Figure 47).

Larry Engbrecht, formerly with South Dakota Chapter, ACPA

Figure 47. Light-colored geotextile fabric used as a separation layer for an unbonded overlay

In the fall or spring, however, white fabric is not the best choice to prevent heat transfer from the concrete overlay to the fabric."

In an attempt to better understand the thermal behavior in Portland cement concrete (PCC) pavement when nonwoven geotextile is placed as a separation layer, Propex Geosolutions sponsored a field investigation by the Transtec Group to help quantify the effect (Ruiz et al. 2013). The following were among the findings from the report:

- When the white geotextile was used in hot weather, it decreased early-age stresses in the new PCC as much as 10%.
- In cooler conditions, the black geotextile worked equally well compared to the white at reducing stresses and may have an advantage of trapping more heat in existing pavement layers.

Optimal Panel Size for Low-Volume Applications with Thinner Overlay Thicknesses (4 to 6 in.)

Through the Iowa Highway Research Board, the National CP Tech Center is currently investigating the optimal joint spacing for thinner (4 to 6 in.) overlays on routes with lower traffic volumes (Gross et al. 2017).

Many concrete overlays in Iowa originally were built with longer panel sizes, typically in the 15- to 20-ft range with no mid-panel longitudinal joints, and have performed well, particularly on lower traffic volume roadways. Longer joint spacing is more desirable because it reduces the number of joints, which in turn reduces the cost of joint installation and maintenance. However, longer joint spacing can also result in mid-panel cracking, increased maintenance requirements, or rougher pavements due to curling and warping.

For thinner overlays (4 to 6 in.), the current design approach of determining the spacing of longitudinal and transverse joints results in smaller panel sizes, normally in the range of 5.5 by 5.5 ft or 6 by 6 ft. However, some field observations have documented that for pavements with shorter joint spacing, some joints may not be working effectively (lack of crack deployment under the saw cut), particularly on lower volume roadways.

Analytical investigation and field testing are being performed to determine the optimum joint spacing for thin concrete overlays based on the following testing parameters: concrete overlay type, thickness, joint spacing, and the use of synthetic macrofibers (see Figure 48).

Jeff Roesler, University of Illinois

Figure 48. Lack of crack deployment at a sawed contraction joint (left) and ultrasonic pulse echo imaging of concrete overlays to analyze crack deployment (right)

Conclusions

After nearly 10 years of positive project performance, it appears that nonwoven geotextile fabric works very well when used on existing pavements that have received the appropriate level of pre-overlay repairs. The geotextile fabric acts as a separation material to prevent cracks and other distresses in the underlying pavement from compromising the performance of a new unbonded jointed concrete overlay over existing jointed and continuously reinforced concrete pavements.

There also appears to be significant cost and time saving from using the geosynthetic fabrics when compared to the traditional asphalt separation layer. Because of the successful performance of more than 10 million square yards of concrete overlay placed using geotextile separation since 2008, state highway agencies are continuing efforts to optimize material and construction practices for increased value in the future.

A summary of lessons learned includes the following:

- Geotextile separation has worked well for a wide range of overlay thicknesses and loading conditions.
- Fabric thickness should be matched to the overlay thickness.
- Use of geotextile separation material eliminates the possibility of stripping developing in an HMA separation layer.
- Use of geotextile separation material appears to reduce the possibility of panel migration.
- Light colored fabric should be considered for use in hot and sunny weather conditions.
- A separation joint or saw cut full depth of the overlay should be provided between the overlay and abutting concrete driveways and entrances.
- Geotextile separation is not recommended for CRCP overlays.
- Adhesives work effectively for holding the fabric in place during construction as an alternative to mechanical fasteners.
- Geotextile separation material can provide significant cost and time savings compared to traditional HMA separation.
- Geotextile fabrics with proper outlets provide adequate drainage under the overlay.
- Concrete delivery trucks driving on the geotextile should avoid sharp turns and quick stops and accelerations to prevent movement of the fabric.

References

ACPA. 2014. National Concrete Overlay Explorer. American Concrete Pavement Association, Rosemont, IL. http://overlays.acpa.org/webapps/overlayexplorer/index.html.

Cackler, T. 2017. *MAP Brief December 2017: Performance Assessment of Nonwoven Geotextile Materials Used as Separation Layer for Unbonded Concrete Overlay of Existing Concrete Pavement Applications in the US*. CP Road Map. National Concrete Pavement Technology Center, Iowa State University, Ames, IA. http://www.cproadmap.org/publications/MAPbriefDec2017.pdf.

Fick, G. and D. Harrington. 2014. *Performance History of Concrete Overlays in the United States*. National Concrete Pavement Technology Center, Iowa State University, Ames, IA. http://www.cptechcenter.org/technical-library/documents/Performance%20History_FHWA%20acknowledgment_tagged.pdf.

———. 2016. *Guide Specifications for Concrete Overlays*, 3rd Edition. National Concrete Pavement Technology Center, Iowa State University, Ames, IA and American Concrete Pavement Association, Washington, DC. http://www.cptechcenter.org/technical-library/documents/overlay_guide_specifications.pdf.

Gross, J., D. King, D. Harrington, H. Ceylan, Y-A. Chen, S. Kim, P. Taylor, and O. Kaya. 2017. *Concrete Overlay Performance on Iowa's Roadways*. Field Data Report. National Concrete Pavement Technology Center, Iowa State University, Ames, IA. http://www.intrans.iastate.edu/research/documents/research-reports/Iowa_concrete_overlay_performance_w_cvr.pdf.

Hall, K., D. Dawood, S. Vanikar, R. Tally, Jr., T. Cackler, A. Correa, P. Deem, J. Duit, G. Geary, A. Gisi, A. Hanna, S. Kosmatka, R. Rasmussen, S. Tayabji, and G. Voigt. 2007. *Long-Life Concrete Pavements in Europe and Canada*. Federal Highway Administration Office of International Programs, American Association of State Highway and Transportation Officials, and National Cooperative Highway Research Program, Washington, DC.

Harringon, D. and G. Fick. 2014. *Guide to Concrete Overlays: Sustainable Solutions for Resurfacing and Rehabilitating Existing Pavement*, 3rd Edition. National Concrete Pavement Technology Center, Iowa State University, Ames, IA and American Concrete Pavement Association, Washington, DC. http://www.cptechcenter.org/technical-library/documents/Overlays_3rd_edition.pdf.

Lederle, R., K. Hoegh, T. Burnham, and L. Khazanoavich. 2013. Drainage Capabilities of a Nonwoven Fabric Separation in an Unbonded Concrete Overlay. Paper presented at the Transportation Research Board 92nd Annual Meeting, January 13–17, Washington, DC. http://docs.trb.org/prp/13-4107.pdf.

National CP Tech Center. 2009. *MAP Brief 7-1: Use of Nonwoven Geotextiles as Interlayers in Concrete Pavement Systems*. CP Road Map. National Concrete Pavement Technology Center, Iowa State University, Ames, IA. http://publications.iowa.gov/13482/1/MAPbrief7-1.pdf.

Ruiz, J. M., S. I. Garber, and M. Pittman. 2013. *Field Investigation of Thermal Behavior in New PCC over Nonwoven Geotextile Interlayers*. The Transtec Group, Inc., Austin, TX.

Transtec Group. no date/2017. Geotextile Interlayers: Material Specifications. http://www.thetranstecgroup.com/nonwoven-geotextile-interlayers-concrete-pavements/material-specifications/.

Vandenbossche, J. M. and S. G. Sachs. 2016. Development of the Faulting Model for Unbonded Concrete Overlays of Existing Concrete Pavements (UBOLs). FHWA Transportation Pooled Fund TPF 5-269 Technical Advisory Panel Meeting, December 20. University of Pittsburgh, PA.

Vandenbossche, J., S. Sachs, K. Alland, M. Snyder, L. Khazanovich, D. Tompkins, K. Hoegh, and A. Booshehrian. 2015. *Interlayer Characterization, Field Performance Assessment, and Guidelines on Drainage*. FHWA Transportation Pooled Fund TPF 5-269 Task 2 Report. University of Pittsburgh, PA.

Voigt, G. 2017. Nationwide Concrete Overlays Growth. Slide from presentation at the American Concrete Pavement Association 54th Annual Meeting, November 28–30, San Diego, CA.

White, D. 2018. *Automated Plate Load Testing on Concrete Pavement Overlays with Geotextile and Asphalt Interlayers: V-18, Poweshiek County*. National Concrete Pavement Technology Center, Iowa State University, Ames, IA.

Zollinger, D., M. Won, T. Ley, K. Riding, A. Wimsatt, W. Zhou, S. Ryu, and P. Choi. 2014. *Implementation of Curing, Texturing, Subbase, and Compaction Measurement Alternatives for Continuously Reinforced Concrete Pavement*. Texas A&M Transportation Institute, College Station, TX. https://static.tti.tamu.edu/tti.tamu.edu/documents/5-6037-01-1.pdf.

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