Non-Woven Geotextile Interlayers for Concrete Overlays
Eric Littel, Technical Sales Engineer
Propex Operating Co., LLC.
Concrete Interlayer Applications

- Used over existing Portland Cement Concrete (PCC), Asphalt Concrete (AC), or composite pavements to create an **unbonded** concrete overlay.

- Used over crack and seated existing pavement beneath an **unbonded** PCC overlay.

- Used over cement or lime treated bases, as a separator/interlayer in new or full-depth rehabilitated concrete pavements to prevent reflective shrinkage cracking.
Why use an Interlayer?

Separates or isolates new overlay and the existing slab from distress in the underlying pavement

- Allows slight slab movement without cracking apart
- Serve as a shear plane (stress absorption) that helps prevent cracks from reflecting up from the existing pavement
- Must channel infiltrating water along the cross-slope to the outside the pavement – to prevent stripping
- Must provide a cushion for the overlay to reduce bearing stresses and the effects of dynamic traffic loads and prevent keying from the existing pavement
Concrete Interlayer Types

• Geotextile Interlayer
  – 13 to 16 oz/yd² Nonwoven
  – High loft (fuzziness) w/no heat treatment
  – Rolls are custom widths to accommodate various paving widths - (17’ Maximum Roll Width)
  – Roll lengths of 300’, 450’ & 600’ depending on mass
  – Either Black or Solar Reflective White

• Traditional Hot Mix Asphalt (HMA) Interlayer
  – Preferable new, optimum HMA, often open-grade permeable mix
  – Less effective asphalt concrete interlayers
    – Existing asphalt concrete layers in composite pavements
    – Placement over a milled surface – Can cause increased friction/bonding to stressing layer
## Unbonded Concrete Interlayers Comparison

<table>
<thead>
<tr>
<th>Hot Mix Asphalt (HMA) Interlayer (1”-3”)</th>
<th>Geotextile Interlayer Fabric</th>
</tr>
</thead>
<tbody>
<tr>
<td>multiple contractors &amp; large machines</td>
<td>Single contractor installation</td>
</tr>
<tr>
<td>$5-15/yd.² installed ($8.63 National Average)</td>
<td>$2-3/yd.² installed</td>
</tr>
<tr>
<td>climatic conditions affect installation</td>
<td>installation in more diverse conditions</td>
</tr>
<tr>
<td>grade control &gt; 1”</td>
<td>grade control ≤ 0.25”</td>
</tr>
<tr>
<td>material transport = 48 loads/4 lane mi</td>
<td>material transport = 1 load/4 lane miles</td>
</tr>
<tr>
<td>accepted performance</td>
<td>comparable or better performance</td>
</tr>
<tr>
<td></td>
<td>• Increases lateral transmissivity</td>
</tr>
<tr>
<td></td>
<td>• Reduces slab restraint-friction</td>
</tr>
<tr>
<td></td>
<td>• Can reduce temperature fluctuations</td>
</tr>
<tr>
<td></td>
<td>• Increased stress absorption</td>
</tr>
</tbody>
</table>
Geotextile Interlayer History

Practice in Germany
- Over Existing pavement – (Typically crack and seat)
- 30 years of Successful Applications
- Use of Geotextile Interlayer – Standardized in 2001
- Standardized Geotextile Specifications

Practice in U.S.
- Asphalt Interlayer market share – 95%
- 30% increase in PCC overlay projects – 2006 to Present
- Used over Cement Treated Base (CTB) or new PCC Pavement

FHWA Scan Tour & Case Study – 2006
- Propex products – Geotex 1201 and 1601 trialed
- Oklahoma and Missouri
- Developed Installation Guidelines
# FHWA Geotextile Interlayer Specifications

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

Drainage

Stress

Absorption

Stress

Absorption

Drainage
Construction – Geotextile Installation

- **Surface Preparation**
  - Clean surface with power broom
  - Fill in holes to create even surface – prevent mechanical keying
  - 3/8” Maximum Faulting

- **Geotextile Interlayer Placement**
  - Use equipment or labors to roll fabric out – No Wrinkles!!
  - Maximum Distance of 1000’ in front of paver – End of day
  - 8” overlap
  - Stagger rolls so that there is no more than 3 layers at any one point
  - Free edge should extend to point that facilitates drainage

- **Fastening Geotextile to Existing Pavement**
  - Use gas actuated concrete nail gun (Ex. Hilti GX 120)
  - Use ¾” or higher length concrete nails with 2” to 2.75” washers

- **Paving**
  - Control concrete in front of paver
  - Clean extended fabric edge to tie into shoulder or extra lane material

Installation Guidelines available at www.propexglobal.com
Construction – Geotextile Installation
Geotextile Interlayer

• Will bond to new overlay
  – 20% Penetration into the interlayer
  – Drainage = 1000+ ft./day
  – Will not strip due to pore pressure
  – Shear Plane/Stress Absorber
  – Elongation properties decreases friction reducing early age cracking risk

• Will not bond to existing pavement

Asphalt Stripping
Color of Fabric
Two Predominant Colors Used
Black and Reflective White

• Black - Carbon molecules which absorb Ultra-Violet (UV) energy
• Requires damping to reduce heat below 110 F.
• Suggested use in early spring and fall

• 100% polypropylene resin with reflective modifiers reflects UV energy by 80%
• Does not require damping to reduce heat
• Suggested use in spring & summer months
Reflective White Geotextile - Development

Development of reflective white geotextile interlayer

- Partnered with The Transtec Group – Dr. Robert Rasmussen, Mauricio Ruiz, and Sabrina Garber
- 2 Separate Studies
  - Initial Pilot Study in Austin, TX
    - Investigated different colored geotextiles with asphalt control
    - Used HIPERPAV III Modeling for results
  - Large Scale Study in Aberdeen, SD
    - Investigated black geotextile interlayer, reflective white geotextile, and asphalt control
    - Used HIPERPAVE III Modeling for results
    - Evaluated crack occurrence and joint movement
    - Evaluated crack width
- Reflective white geotextile proved to reduce early age cracking up to 10% based on temperature only during high heat
- Reflective white geotextile provides good drainage and reduces friction during early age curing as does the black geotextile
**Geotextile Interlayer**

**Advantages over Traditional HMA Interlayers**

<table>
<thead>
<tr>
<th>Interlayer Functions</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decreased Friction - Reduces concrete curling and warping stresses during early age curing cycle (First 72 hours)</td>
<td></td>
</tr>
<tr>
<td>Provides distress protection/stress absorption from existing pavement</td>
<td></td>
</tr>
<tr>
<td>Decreases mechanical stress on treated base</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Drainage</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased Transmissivity under a load</td>
<td></td>
</tr>
<tr>
<td>Pumping Hydraulics for rapid water evacuation</td>
<td></td>
</tr>
<tr>
<td>No stripping potential for HMA interlayer or underlying layers</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Temperature (Reflective White)</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduces surface temperature by 50°F</td>
<td></td>
</tr>
<tr>
<td>Reduces solar radiation absorption into base layers</td>
<td></td>
</tr>
<tr>
<td>Reduces concrete critical stress-strength by 8-10% during early-age maturity (72 hours)</td>
<td></td>
</tr>
<tr>
<td>Minimal to no surface cooling water usage</td>
<td></td>
</tr>
</tbody>
</table>
Contractor Benefits

Solar Reflective Geotextile saves time, money, and resources

- Reduces surface temperature up to 50 degrees
- Reduces surface cooling water usage by 75%
- Improves worker safety
- Decreases heat stresses, therefore increasing daily output
- Decreases the need for night concrete pours (daytime pay scale, worker safety, and decreased equipment rental)
- Custom roll widths (Maximum Truck Loading & Decreased Handling)
Drainage for freeze/thaw locations

Increased drainage through static and dynamic loading
- 1000+ ft./day flow
- 0.13 cm/s compared to 0.02 cm/s
- 200 kPA loading at 1% grade
Rural Drainage Design

Asphalt shoulder

Concrete pavement
Geotextile
Base (bound)

Planum

Base (unbound)

End of Geotextile

Joint

100

q ≥ 4%
q ≥ 2.5%
Rural Drainage Design

- Concrete pavement
- Asphalt shoulder
- Planum
- End of Geotextile
- Joint
- Geotextile
- Base (bound)
- Concrete pavement
- Base (unbound)
- q ≥ 4%
- q ≥ 2.5%

Source: TU München (Eger)
Urban Drainage Design
(Replaced Curbs)

- Construct 12' Wide x 26' Deep Porous Drainage Trench Adjacent to the Existing Subgrade Underdrain Trench
- Excavation
- Thin Concrete Unbonded Overlay
- Interlayer
- Existing Concrete Pavement
- Existing Lane Tie Bars
- Existing Granular Subbase

Existing Subgrade Underdrain 6' in a 1.0' x 1.0' Trench, Backfilled with CL-II Granular Material.
Surface Cooling during Installation

- HMA or Black Geotextiles require cooling water for surface temperatures above 110 °F

Reflective Geotextile Solution
- Decreases surface water cooling by 75-100%
- Minimized watering decreases chance of concrete bleed through
- Compressive strengths are not compromised due to wicking of water from hydrating concrete
Moisture for Geotextile

- Black fabric should be dampened before concrete is applied if surface temperature of fabric reaches 110 degree F.

- Do not saturate fabric!

- No free water should show!

- Reflective white fabric should not need watering.
Engineering Concern & Solution #3

Potential Increased Deflection Measurements with FWD Test

- Thicker overlays along with load transfer bars compress fabric and provide stability reducing FWD values
- Thinner overlays without load transfer bars are under investigation with the MnRoad Facility Project
- MI/DOT US 10 Project also investigating deflection values
Engineering Concern & Solution #4

Driving on fabric – Geotextile damage

Geotextile’s high durability decreases rips and tears
Minimize sharp turns and hard breaking
Driving on Fabric

- Geotextile traffics well
- Avoid sudden changes in acceleration
- Avoid sharp or sudden turns
- Wrinkles should be cut out and fixed before paving over
Driving on Fabric

- Ensure breaking is off and truck in neutral before dumping
- Allows concrete dumper to move truck without damaging geotextile
Cost Advantage Example

Asphalt Interlayer vs. Reflectex™

- Material Cost and Installation
  - ≥75% cost savings using Reflectex™
- Example Project - Design/Build Estimates (Rough Estimate)
  - Based off 3” Asphalt Interlayer
  - Estimated only concrete interlayer material-installation cost

<table>
<thead>
<tr>
<th>Interlayer</th>
<th>Unit Cost</th>
<th>Interlayer Volume</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot Mix Asphalt</td>
<td>$75/ton</td>
<td>1148 tons/mi</td>
<td>$86,100/ln-mi</td>
</tr>
<tr>
<td>Geotextile Interlayer</td>
<td>$3.00/yd.²</td>
<td>7,322 yd.²/mi</td>
<td>$21,966/ln-mi</td>
</tr>
</tbody>
</table>

Estimated Project Savings Per Lane Mile

- $64,134/ln-mi

Total Estimated Project Savings (64 Lane Miles)

- $4,104,580
Research

Geotextile Interlayer Research Projects

- Transtec Group – 2010 to 2012
  - North Dakota Friction Study – 1.6 psi compared to 16 psi
  - CTB/Geotextile to New PCC Pavement
- Transtec Group – 2011 to 2012
  - Tested and Reported Reflective White Concrete Interlayer Results
  - Continue to work closely together to improve concrete pavements
- University of Minnesota – Lev Khazanovich – 2012 to 2013
  - Drainage & Reflective Cracking Study – 15 MM ESALS
  - Concrete Deflection Various Loading – Lab Study
- MnRoad Facility – Tom Burnham, PE - 2013
  - Large Scale Case Study
  - Drainage (Transmissivity)
  - Concrete Deflection
SDDOT US12 Case Study -2012
SDDOT US12 Results

• Increased Cracking over black geotextile and asphalt interlayers
• Tensile Strength – 72 hours (insignificant between all sections)
• Ultimate Compressive Strength – 1000 psi increase over asphalt
  • No surface cooling water was applied
  • Dry fabric did not affect hydration during curing
• Decreased Stress-Strength Ratios
  • South Dakota = 5% due to much cooler ambient temperatures
  • Texas = 10% based on same modeling from SDDOT case study
• Ambient Temperature – 70°
  • Asphalt and Black Geotextile surface temp. = 116°
  • Reflectex™ surface temp. = 72°
Lateral Drainage Case Study

- University of Minnesota – Lev Khazanovich
  - Scope of Work
    - Simulated 15,381,330 ESAL (Equivalent Single Axle Load)
    - 5” Overlay with 1% slope
    - Static (2.9 psi) & Dynamic (29 psi) Loading
  - Results
    - Loading produced no significant wear of the geotextile
    - No reflective cracking after 15 million ESAL’s with 3” and 5” Overlays
    - Geotextile exceeded transmissivity requirements for static and dynamic loading.
LVR Cell 40

- Thin unbonded overlay – 2013
  - 3” Overlay with different
  - Thickness of geotextile
  - 4” Overlay with different
    Thickness of geotextile
- Structural fibers in concrete
- 6’ x 6’ x 3” panels
- Fabric interlayer
- Industry support
- Follow-up to University of Minnesota Minne-ALF
ML Cells 60-63

• 6” whitetopping - 2004
• ~ 900 ft total,
• Split into two ~450 ft cells
• Structural fibers in concrete
• 6’ x 6’ and 12’ x 12’ panels
• Hypothesis: fibers + aggregate interlock take the place of dowels for load transfer
Project Spotlights/Case Studies
Project: OK/DOT Project
Project Size: 60,000
Year: 2007
Owner: OK/DOT
Contractor:
ADT: 15,000
Overlay Thickness: 8”
Joint Spacing: 15’
Cost Savings: $45,000/Lane Mile
EPC: Poor
PPC: Excellent

• Over Cement Treated Base
• 15 oz. Material
• Reconstruction
• Good Drainage = Decreased Base Erosion
Project: MIDOT Little Mack Ave.
Project Size: 30,000 yd.²
Year: 2010
Owner: MIDOT
Contractor: AEW
ADT: 12,000
Overlay Thickness: 4”
Joint Spacing: 6’ x 6’
Cost Savings: $90,000
EPC: Poor
PPC: 1 longitudinal crack/cracking where driveways meet roadway, Panel Grinding 1st 2 weeks.
MI/DOT US 10 Study

Project: MI/DOT US 10 Study
Project Size: 5,000 yd.²
Year: 2013
Owner: MIDOT
Contractor: AJAX
ADT: 15,000
Overlay Thickness: 6”
Joint Spacing: 15’
Cost Savings: $30,000/Lane Mile
EPC: Poor
PPC: Excellent

- Deflection Testing
- Drainage Study
- Temperature Gradient
- Side by Side Study to 1” Asphalt Interlayer
- 3/16” Faulting, Excessive Spalling
SD/DOT US12 UBOL

Project: SDDOT US12
Project Size: 275,000 yd.² - 18 Lane Miles
Year: 2012
Owner: SDDOT
Contractor: Upper Plains
ADT: 5,000
Overlay Thickness: 8”
Joint Spacing: 15’
Cost Savings: $90,000/Lane Mile
EPC: Poor
PPC: Excellent

• ¼” to ¾” Faulting
• Excessive Spalling and Corner Cracking
• Skewed Joints
• 45 year old existing pavement
MO/DOT Route 79 UBOL

Project: MODOT Route 79
Project Size: 180,000
Year: 2013
Owner: MODOT
Contractor:
ADT: 10,000
Overlay Thickness: 5"
Joint Spacing: 15’
Cost Savings: $45,000/Lane Mile
EPC: Poor
PPC: Excellent

Lessons Learned: Leave intersection fabric out until ready to pave for through traffic.
SD/DOT US 14 Project

Project: SD/DOT US 14
Project Size: 200,000
Year: 2012
Owner: SD/DOT
Contractor: Upper Plains
ADT: 7,500
Overlay Thickness: 5”
Joint Spacing: 12’
Cost Savings: $80,000/Lane Mile
EPC: Poor
PPC: Excellent

• Flagged Traffic
• One Diagonal Crack at the beginning of project
• Single Lane Construction
MN/DOT I-94 Project

Project: MN/DOT I-94 Project
Project Size: 275,000
Year: 2013
Owner: MN/DOT
Contractor: PCI
ADT: 35,000
Overlay Thickness: 6”
Joint Spacing: 15’
Cost Savings: $50,000/Lane Mile
EPC: Poor
PPC: Excellent

• Installing Fabric at Radius – Produces Wrinkle, Cut wrinkle, fold fabric over in direction of pavement and fasten.
Project History

- 2013 – 2018 – MnRoad Facility - Reflectex™/Concrete Fibers
- 2013 – MODOT Route 79 UBOL - Reflectex™ (136,333 yd.²)
- 2013 – SDDOT US12 Waubay UBOL (Knife River) - Reflectex™ (301,600 yd.²)
- 2013 – MNDOT I-94 UBOL (PCI) - Reflectex™ (248,625 yd.²)
- 2012 - SDDOT US12 Groton to Aberdeen UBOL (UPCI) – (275,000 yd.²)
- 2012 – SDDOT US14 Huron UBOL (UPCI) - Reflectex™ (200,000 yd.²)
- 2011 – Reflectex™ Pilot Study – Austin, TX (Decreased stress-strain by 10%)
- 2010 – MNDOT I-35 UBOL – 1341NH Concrete Interlayer
- 2010 – I-35W Moose Lake to Mahtowa – 1341 NH Concrete Interlayer
- 2009 – I-35N Scott County – 1341 NH Concrete Interlayer
- 2008 – Oklahoma Case Study – 1341NH Concrete Interlayer
- 2006 – Missouri Case Study – 1341NH Concrete Interlayer
Geotextile Interlayer Summary

- Several projects with geotextile interlayers since 2006 – Good to Excellent Condition – Little Mack Ave. 4” UBOL still under investigation
- Reflective modifiers decrease substrate temperatures reducing early age cracking risks up to 10%
- Provides stress absorption and dissipates crack inducing stresses associated with movement within the substrate, to keep the overlying new PCC pavement from cracking
- Can be placed at any time of day without the need for multiple contractors
- Cheaper construction cost saving project cost from $6 to $18/yd.$^{2}$ or $42,000 to $126,720/lane mile
- Minimizes/Eliminates the need for water to cool surface temperatures greater than 110°F
- Deflection of thinner unbonded overlays with different thicknesses of geotextile interlayers need to be evaluated further – MnRoad and MI/DOT
Questions?
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