Concrete Overlay Design (Thickness and more ...)
The Principal Factors of Concrete (Overlay) Pavement Design

- Geometrics
- Thickness
- Joint Systems
- Materials
The Principal Factors of Concrete (Overlay) Pavement Design

- Geometrics
- Thickness
- Joint Systems
- Materials

Most Often Influence Cost & Selection of Projects
The Principal Factors of Concrete (Overlay) Pavement Design

- Geometrics
- Thickness
- Joint Systems
- Materials

Most Often Influence
Real-world Performance
# MnROAD Whitetopping Distress (Mainline – 5 yrs service)

<table>
<thead>
<tr>
<th>Cell</th>
<th>Panels Cracked (%)</th>
<th>Corner Cracks</th>
</tr>
</thead>
<tbody>
<tr>
<td>4”-4’x4’ (93)</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>3”-4’x4’ (94)</td>
<td>40</td>
<td>165</td>
</tr>
<tr>
<td>3”-5’x6” (95)</td>
<td>8</td>
<td>17</td>
</tr>
<tr>
<td>6”-5’x6’ (96)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6”-10’x12’ (97U)</td>
<td>13</td>
<td>0</td>
</tr>
<tr>
<td>6”-10’x12’ (92D)</td>
<td>3</td>
<td>0</td>
</tr>
</tbody>
</table>

4’x4’ Panels - Corner Breaks due to Wheel Loadings
Longitudinal Joint Layout

- 2 ft x 2 ft
- 3 ft x 3 ft
- 4 ft x 4 ft
- 6 ft x 6 ft

Traffic

Outer Shoulder

12 ft
How Are Pavements (and Overlays) Designed

- Today, we have data-driven methods to design major elements of concrete pavements
  - Thickness
  - Joint Spacing
  - Edge Support
  - Load Transfer
  - Flexural Strength
  - Subgrade Support
  - Subbase
  - And more
Important Considerations in Overlay Design

- Required Future Design Life of the Overlay
- Traffic Loading (ESALs)
- Pre-overlay Repair
- Reflective Crack Control
- Subdrainage
- Structural vs Functional Overlays
- Recycling Existing Pavement (PCC & AC)
- Durability of aggregate for new concrete
Important Considerations in Overlay Design (cont.)

- Shoulders
- Existing PCC Slab Durability
- PCC Overlay Joints
- PCC Overlay Reinforcement
- PCC Overlays Bonding / Separation Layers
- Overlay Design Reliability Level & Overall Standard Deviation
- Pavement Widening
- Traffic Disruptions and User Delay Costs
Design Balances Several Factors

- Desired service life, load-carrying capacity
- Costs
- Existing pavement condition, preoverlay repairs
- Design (thickness, etc.)
Thickness Design Procedures

• Empirical Design Procedures
  – Based on observed performance
    ▪ ‘72, ‘86/’93 AASHTO Design Procedures

• Mechanistic-Empirical Design Procedures
  – Based on mathematically calculated pavement responses
    ▪ Pavement-ME (MEPDG)
    ▪ PCA Design Procedure (PCAPAV)
    ▪ ACPA Ultrathin Whitetopping Design Procedure
    ▪ StreetPave (ACPA Design Method)
    ▪ BCOA-ME (Univ. of Pittsburgh, 2013)

AASHO Road Test at Ottawa, Illinois (approximately 80 miles southwest of Chicago) between 1956 and 1960
1993 AASHTO Guide

• Based on mathematical models derived from empirical data collected during the AASHO Road Test in the late 1950’s.

• Procedure provides suitable bonded and unbonded concrete overlay designs.

• The AASHTO computer software for implementation of the 1993 AASHTO Guide is called DARWin. In addition, a number of agencies and State Departments of Transportation have developed custom software and spreadsheets to apply this procedure.
Structural Deficiency Approach to Overlay Design (1993 AASHTO Guide)

- **Original Capacity**
- **Capacity after Rehabilitation**
- **Effective Capacity of Existing Pavement**
- **Capacity of Overlay**

**Axes:**
- **Structural Capacity**
- **Loads**
Overlay Design - Basic Steps
1993 AASHTO

1. Determine Existing Pavement Information
2. Determine Required Future Structural Capacity
   ➢ Predict Future Traffic / ESALs
3. Determine Existing Structural Capacity
   ➢ Perform Condition Survey
   ➢ Perform Deflection Testing
   ➢ Perform Coring / Materials Testing
4. Determine Overlay Structural Capacity and Thicknesses

Overlay Designs Must Address the Causes of Functional & Structural Problems and Prevent Recurrence

Limitations?
Mechanistic-Empirical Design

• The Mechanistic Part:
  ➢ Structural models predict responses of pavement (stresses, strains, deflections) to loads and environment

• The Empirical Part:
  ➢ Data-based models predict pavement performance (IRI, cracking, faulting, etc.) for given pavement stress/strain/deflection

Allows consideration of new designs and design features – INNOVATION!

Examples:
  smaller panels or widened lanes (w/reduced slab thickness)
M-E PDG (and PavementME)

- M-E PDG combines a mechanistic-based analysis approach with field performance data in order to enable the engineer to confidently predict the performance of pavement systems.

- MEPDG provides models and design tools for JPCP & CRCP overlays of existing HMA, JPCP & CRCP.

- Method adopts an integrated pavement design approach which allows:
  - Designer to determine the overlay thickness based on the interaction between the pavement geometry (slab size, shoulder type, load transfer, steel reinforcement).
  - Consideration of support conditions, local climatic factors, and concrete material and support layer properties.
Family of Concrete Overlays

Concrete Overlays

Bonded Family
- Bonded Concrete Overlay of Concrete Pavements
- Bonded Concrete Overlay of Asphalt Pavements
- Bonded Concrete Overlay of Composite Pavements

Unbonded Family
- Unbonded Concrete Overlay of Concrete Pavements
- Unbonded Concrete Overlay of Asphalt Pavements
- Unbonded Concrete Overlay of Composite Pavements

Bond is integral to design
Old pavement is base
**Bonded** versus **Unbonded (intent)**

- **Bonded**: Use to eliminate surface defects; increase structural capacity; and improve surface friction, noise, and rideability.

- **Unbonded**: Use to restore structural capacity and increase pavement life equivalent to full-depth pavement. Also results in improved surface friction, noise, and rideability.
Jointing Patterns Vary

- Joint spacing depends on bond, stiffness of support, etc.

Match Existing Joint Spacing/Location

- Bonded Concrete Overlay of Concrete Pavements
- Bonded Concrete Overlay of Asphalt Pavements
- Bonded Concrete Overlay of Composite Pavements

Joint Spacing based on Thickness; Shorter Panels = Less Curl/Warp

- Bonded Concrete Overlay of Composite Pavements
- Unbonded Concrete Overlay of Concrete Pavements
- Unbonded Concrete Overlay of Asphalt Pavements
- Unbonded Concrete Overlay of Composite Pavements

Joint Spacing is Similar to New Concrete Pavement; Shorter Might be Used, Especially for Unbonded over Concrete
Typical PCC Overlay Service Lives

<table>
<thead>
<tr>
<th>Concrete Overlay Type</th>
<th>Typical Life</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bonded on Concrete</td>
<td>15-25 years</td>
</tr>
<tr>
<td>Unbonded on Concrete</td>
<td>20-30 years</td>
</tr>
<tr>
<td>Bonded on Asphalt/Composite</td>
<td>5-15 years</td>
</tr>
<tr>
<td>Unbonded on Asphalt/Composite</td>
<td>20-30 years</td>
</tr>
</tbody>
</table>

Based on FHWA's “Portland Cement Concrete Overlays – State of the Technology Synthesis” (FHWA-IF-02-045)
Bonded Concrete Overlays

Bonded Concrete Overlays of Concrete Pavements
—previously called bonded overlays—

Bonded Concrete Overlays of Asphalt Pavements
—previously called ultra-thin whitetopping—

Bonded Concrete Overlays of Composite Pavements
Bonded Overlays of ACP

- Thickness – 4 to 6 in. (*moderately loaded*)
  - State/county highways
  - Secondary routes
  - Collectors

- Thickness – 2 to 4 in. (*lightly loaded*)
  - City streets
  - Urban intersections
  - Parking lots
How Do Bonded Overlays over Asphalt Work?

- Concrete bonds to the asphalt
  - Lowers the neutral axis
  - Decreases stresses in the concrete
- Short joint spacing
  - Controls cracking
  - Slabs act as paver-blocks
- Fibers improve concrete toughness
Bonding Effects on Edge Stress

Unbonded

Bonded
Effects of AC Thickness

Concrete

Tension

Comp.

Asphalt

NA

Concrete

Tension

Comp.

Asphalt

2x

x
Need for Joints

• Designed crack
• Why crack control
  – Shrinkage cracks
  – Thermal cracks
• Minimize impact of cracks
Effects of Joint Spacing – Load Stress

Short Slabs Deflect
Very little flexural stress

Standard Slabs Bend
Higher flexural stress
Effects of Panel Length: Shrinkage and Curl/Warp Stresses

Effect of Slab Length on Shrinkage Force

- Curling & warping is produced by the shrinkage force at the slab surface.
  - Due to drying and thermal differential shrinkage on the surface of the concrete.
- The magnitude of this force is dependent on the length of the surface.
  - Shorter slabs have less length, which means that shorter slabs have reduced curling

Effect of Slab Length on Curling/Warping

- All concrete slabs curl / warp so that approximately 1/4 of the slab length is lifted of the subgrade / subbase support
- By reducing slab length, the amount lifted, and the height of the lift is greatly reduced

Cantilever = 1/4 L

Length 12 to 15 ft., cantilever = 3 to 3.75 ft

Length 6 ft., cantilever = 1.5 ft
Summary of Best Overlay Jointing Practices

• Joint spacing (max = 18-to-24 x thickness)
  - For <3 in. overlay, use 3 by 3 ft
  - For 3 to 6 in. overlay, use 6 by 6 ft
  - For > 6 in. use full width and conventional spacing

• Adjust depth of saw cut for actual slab thickness
  - Full depth plus ½” for bonded over concrete
  - T/3 for unbonded

• Dowel & tie bar use
  - Dowels not necessary for overlay thickness < 8 in.
  - For unbonded overlays > 4 in., may use tie bars at longitudinal joints
Longitudinal Joint Layout

- 2 ft x 2 ft
- 3 ft x 3 ft
- 4 ft x 4 ft
- 6 ft x 6 ft

12 ft

Traffic

Outer Shoulder

Outer Shoulder
Source: Burnham (MnDOT)
The bonded concrete overlays of asphalt mechanistic-empirical design procedure (BCOA-ME) was developed at the University of Pittsburgh under the FHWA Pooled Fund Study TPF 5-165. This pavement structure has been referred to as thin and ultrathin whitetopping. This site is a repository for all information relating to the BCOA-ME. The information has been sorted based on its intended use and can be retrieved by clicking on the appropriate tab below. The BCOA-ME can be run directly from this site by clicking on the “Design Guide” tab below.

http://www.engineering.pitt.edu/Vandenbossche/BCOA-ME/
# BCOA-ME Design

**Instruction:**
Select from drop-down list; Enter data; Enter data or use calculation.

(Please enable the Macros and the Internet Explorer (not mandatory) to run the spreadsheet.)

## General Information

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Latitude (degree):</td>
<td>44.5</td>
</tr>
<tr>
<td>Longitude (degree):</td>
<td>93.1</td>
</tr>
<tr>
<td>Elevation (ft):</td>
<td>874</td>
</tr>
<tr>
<td>Estimated Design Lane ESALs:</td>
<td>200,000</td>
</tr>
<tr>
<td>Maximum Allowable Percent Slabs Cracked (%):</td>
<td>25%</td>
</tr>
<tr>
<td>Desired Reliability against Slab Cracking (%):</td>
<td>85%</td>
</tr>
</tbody>
</table>

## Climate

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>AMDAT Region ID</td>
<td>5</td>
</tr>
<tr>
<td>Sunshine Zone</td>
<td>2</td>
</tr>
</tbody>
</table>

## Existing Structure

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Post-milling HMA Thickness (in):</td>
<td>6</td>
</tr>
<tr>
<td>HMA Condition:</td>
<td>Adequate</td>
</tr>
<tr>
<td>Composite Modulus of Subgrade Reaction, k-value (psi/in):</td>
<td>250</td>
</tr>
<tr>
<td>Does the existing HMA pavement have temperature cracks?</td>
<td>Yes</td>
</tr>
</tbody>
</table>

## PCC Overlay

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Average 28-day Flexural Strength (psi):</td>
<td>650</td>
</tr>
<tr>
<td>Estimated PCC Elastic Modulus (psi):</td>
<td>3,930,000</td>
</tr>
<tr>
<td>Coefficient of Thermal Expansion ($10^{-6}$ in/°F/in):</td>
<td>5.5</td>
</tr>
<tr>
<td>Fiber Type:</td>
<td>No Fibers</td>
</tr>
<tr>
<td>Fiber Content (lb/cu yd) (Only used when a fiber type is selected):</td>
<td>0</td>
</tr>
</tbody>
</table>

## Joint Design

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Joint Spacing (ft):</td>
<td>6</td>
</tr>
</tbody>
</table>

## Performance Analysis

- Calculated PCC Overlay Thickness (in): 3.26
- Design PCC Overlay Thickness (in): 3.5
- Is there potential for reflective cracking? | Yes

[Solved.]
Structural Fibers Considerations

- Does not increase the concrete’s strength
- Increases toughness
- Increases post-crack integrity
  - Helps control plastic shrinkage cracking
  - Steel fibers not recommended where deicing salts may be used.
Structural Fibers

- Straight synthetic: Strux 90/40
- Crimped synthetic: Enduro 600

Residual strength ratio = 24%
Concrete Overlay Design: Comparing BCOA-ME and SJPCP Module in Pavement-ME

Authors:
Dr. Julie Vandenbossche, University of Pittsburgh
Kevin Alland, University of Pittsburgh
Dr. Mark Snyder, University of Pittsburgh - PRESENTER

Prepared for:
ACPA Colorado/Wyoming Chapter Annual Workshop
Denver, CO
March 16, 2017
Comparing BCOA-ME and SJPCP Pavement ME
Limitations and Capabilities

<table>
<thead>
<tr>
<th>Panel Thickness</th>
<th>Panel size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. BCOA-ME</td>
<td>4.5 to 8 ft</td>
</tr>
<tr>
<td>3 to 6.5 in</td>
<td></td>
</tr>
<tr>
<td>2. Pavement ME</td>
<td>4.5 to 8 ft</td>
</tr>
<tr>
<td>4 to 8 in</td>
<td></td>
</tr>
</tbody>
</table>

Note: BCOA-ME also handles smaller panels (to 2 x 2, 2” thick) and larger panels (up to 12 ft). Pavement ME Design SJPCP does not.

Source: Vandenbossche et al, 2017
Structural Design Consideration of HMA

HMA thickness > 8 in is considered to be 8 in for both BCOA-ME and Pavement ME

(Additional HMA thickness *is* considered in BCOA-ME for prediction of reflective cracking; Pavement ME does not have capability to predict reflective cracking.)

Source: Vandenbossche et al, 2017
Joint Faulting

• Neither Pavement ME or BCOA ME currently predict faulting, but …

• Faulting model currently being developed for BCOA-ME at U-Pitt

Source: Vandenbossche et al, 2017
Primary Analytical Differences Between BCOA-ME and Pavement ME

Source: Vandenbossche et al, 2017
Concrete/Asphalt Interaction

Real World

BCOA-ME Model

Concrete Layer
Partial Debonding
HMA Layer
k-value

Pavement ME Model

Concrete Layer
Fully Bonded
HMA Layer
k-value

Source: Vandenbossche et al, 2017
# HMA stiffness-fatigue reduction

<table>
<thead>
<tr>
<th>HMA condition</th>
<th>Fatigue cracking (%)</th>
<th>Damage factor</th>
<th>$E_{\text{HMA}}$ reduction (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BCOA-ME</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adequate</td>
<td>0 – 8%</td>
<td>0.4</td>
<td>10</td>
</tr>
<tr>
<td>Marginal</td>
<td>8 – 15%</td>
<td>0.6</td>
<td>20</td>
</tr>
<tr>
<td><strong>Pavement-ME</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All</td>
<td>65%</td>
<td>1.1</td>
<td>48</td>
</tr>
</tbody>
</table>

**Pavement ME**
- Does not account for different levels of distress in HMA
- Unrealistic level of HMA fatigue cracking (65%) required because HMA and overlay are modeled as fully bonded

Source: Vandenbossche et al, 2017
Joint Behavior

BCOA-ME

HMA layer is continuous

Pavement ME

Joint extends through entire equivalent layer

Source: Vandenbossche et al, 2017
# HMA stiffness

<table>
<thead>
<tr>
<th>BCOA-ME</th>
<th>Pavement ME</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1. Estimate $E_{HMA}$ for new mix</strong></td>
<td></td>
</tr>
<tr>
<td>• Binder selected from LTPP bind</td>
<td>• Select binder grade</td>
</tr>
<tr>
<td>• Typical gradation, voids, effective binder</td>
<td>• Select gradation, voids, effective binder (standard values used for calibration)</td>
</tr>
<tr>
<td><strong>Step 2. Adjust $E_{HMA}$</strong></td>
<td></td>
</tr>
<tr>
<td>• Aging</td>
<td>• Aging</td>
</tr>
<tr>
<td>• Damage factor based on observed distress</td>
<td>• Constant damage factor</td>
</tr>
<tr>
<td></td>
<td>• Includes the effect of debonding</td>
</tr>
</tbody>
</table>

Source: Vandenbossche et al, 2017
Bonded Concrete Overlays

Bonded Concrete Overlays of Concrete Pavements
—previously called bonded overlays—

Bonded Concrete Overlays of Asphalt Pavements
—previously called ultra-thin whitetopping—

Bonded Concrete Overlays of Composite Pavements
Bonded Concrete over Concrete – Advantages

- Increase structural capacity.
  - More efficient than AC.
    - 1 in. of PCC ~ 2 in. of AC
  - Critical edge stresses are about 35% lower than an equivalent asphalt overlay.
- Long service life
  - High PSI.
- Lower user & engineering costs.
- Rut free
Bonded Concrete on Concrete
1993 AASHTO

- Slab Thickness Design
  Bonded overlay design equation:

\[
D_{ol} = D_f - D_{eff}
\]

where:

- \( D_{ol} \) = Required concrete overlay thickness
- \( D_f \) = Thickness of new concrete pavement for design conditions
- \( D_{eff} \) = Effective thickness of existing concrete

Note: Effects of panel size on bonding are not considered!
Determination Of Effective Slab Thickness \( (D_{\text{eff}}) \)

\[
D_{\text{eff}} = F_{j\text{c}} \times F_{\text{dur}} \times F_{\text{fat}} \times D
\]

Where:

- \( F_{j\text{c}} \) = Joints and Cracks Adjustment Factor
- \( F_{\text{dur}} \) = Durability Adjustment Factor
- \( F_{\text{fat}} \) = Fatigue Adjustment Factor
- \( D \) = Effective Thickness of Existing Slab, in.
# Design-relevant Assumptions for Bonded Concrete Methodologies

<table>
<thead>
<tr>
<th>Design Method</th>
<th>Design Assumptions, Deficiencies / Strengths and/or Items to Note</th>
</tr>
</thead>
</table>
| 1993 AASHTO Guide   | • Assumes complete bond for entire life of the overlay.  
                      • Effective structural capacity of the existing pavement is based on the condition survey or the remaining life methods. These two methods have different limitations and may yield inconsistent or unreasonable results.  
                      • Pavement designers are familiar with this design process and variables for almost 20 years.                                                                                                  |
| M-E PDG             | • Integrates slab geometry, climatic factors, concrete material and layer properties into thickness design compared to the 1993 AASHTO Guide.                                                                 |
                      | • Assumes complete bond for entire life of the overlay.                                                                                                                                                        |
                      | • This method is still under evaluation, calibration, and implementation by State Highway Agencies.                                                                                                          |
Unbonded Concrete Overlays

Unbonded Concrete Overlays of Concrete Pavements
—previously called unbonded overlays—

Unbonded Concrete Overlays of Asphalt Pavements
—previously called conventional whitetopping—

Unbonded Concrete Overlays of Composite Pavements
Unbonded on Concrete / Composite
1993 AASHTO

- Slab Thickness Design

Unbonded overlay design equation:

\[ D_{ol} = \sqrt{D_f^2 - D_{eff}^2} \]

where:

- \( D_{ol} \) = Required PCC overlay thickness
- \( D_f \) = Thickness of new PCC pavement for design conditions
- \( D_{eff} \) = Effective thickness of existing PCC
Unbonded on Concrete / Composite
1993 AASHTO

Determination Of Effective Slab Thickness ($D_{eff}$)

$$D_{eff} = F_{jcu} \times D$$

Where

$F_{jcu} =$ Joints and Cracks Adjustment Factor
$D =$ Thickness of Existing Slab, in.
Unbonded Concrete Overlay
Joints & Cracks Adjustment Factor, \( F_{jcu} \)

Adjusts for PSI loss due to unrepaired joints, cracks, and other discontinuities
- Number of deteriorated transverse joints per mile
- Number of deteriorated transverse cracks per mile
- Number of existing expansion joints, exceptionally wide joints (>1 in.), or AC full-depth patches

Very little reflective cracking has been observed in unbonded overlays

Can use thicker interlayer instead of repairs
Unbonded Concrete Overlay
Joints & Cracks Adjustment Factor, \( F_{jcu} \)

Figure 5.13. \( F_{jcu} \) Adjustment Factor for Unbonded JPCP, JRCP, and CRCP Overlays
Unbonded on Concrete: 1993 AASHTO

- Separator layer (interlayer)
  - Can significantly affect performance
  - Functions
    - Isolate overlay from underlying pavement
    - Allow differential horizontal movement
    - Provide a level surface for the overlay construction
  - Types
    - Dense- or open-graded HMA, typ. 1-2 in.
    - Nonwoven Geotextile
    - Other materials have been used with varying success
Nonwoven Geotextile Interlayer are being used as the Separator Interlayer

“Non-woven fabrics are defined as a web or sheet of fibers bonded together by entangling fiber or filaments mechanically, thermally or chemically. They are flat, porous sheets that are made directly from separate fibers.

Missouri DOT
• Completed about 25 projects utilizing the fabric to include interstate highways, state routes, lower volume roads, and airports
• All fabrics have been placed between existing old concrete and the new unbonded overlay
• The existing concrete was bare or was milled to remove asphalt overlays
• To date, no issues have arisen with performance, and the first project (2007) is performing well
• Missouri DOT currently has three approved fabrics (see Missouri DOT website for specifications)

Core from Germany showing non-woven geotextile interlayer between surface concrete and cement-treated base. Fabric bonds to PCC but not CTB or LCB.
## Typical Fabric Specs

<table>
<thead>
<tr>
<th>Property</th>
<th>Requirement (95% PWL)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fabric Type</strong></td>
<td></td>
</tr>
<tr>
<td>• Non-woven Geotextile</td>
<td></td>
</tr>
<tr>
<td>• Uniform color</td>
<td></td>
</tr>
<tr>
<td><strong>Mass per unit area</strong></td>
<td>≥ 13.3 oz/sq.yd ≤ 16.2 oz/sq.yd</td>
</tr>
<tr>
<td><strong>Thickness under pressure</strong></td>
<td>0.29 psi: ≥ 0.12 in. 2.9 psi: ≥ 0.10 in. 29 psi: ≥ 0.04 in.</td>
</tr>
<tr>
<td><strong>Tensile strength</strong></td>
<td>≥ 685 lb/ft</td>
</tr>
<tr>
<td><strong>Maximum elongation</strong></td>
<td>≤ 130% (≤ 60% recommended as best practice)</td>
</tr>
<tr>
<td><strong>Water permeability in normal direction under pressure</strong></td>
<td>≥ 3.3×10^-4 ft/s) [under pressure of 2.9 psi]</td>
</tr>
<tr>
<td><strong>Alkali resistance</strong></td>
<td>≥ 96% Polypropylene/Polyethylene</td>
</tr>
</tbody>
</table>
It is recommended that the design thickness calculated using the 1993 AASHTO Guide be increased by 0.5 in. when a nonwoven geotextile interlayer is used in lieu of HMA.
Pavement-ME Unbonded Concrete Overlays
(Uses the same process as new pavements...)

• Determine basic design parameters (traffic, soil conditions, etc.)

• Develop preliminary designs (thickness, base designs, joint spacing, and other design features)

• Evaluate the predicted performance from Pavement-ME over the analysis period (e.g., 50 years) to determine the life-cycle activity profiles describing “when” and “what” rehabilitation activates will be performed.

• Calculate the Initial and Life Cycle Costs for each pavement design over the analysis period.

• Evaluate designs and modify as needed to develop a pavement section that meets or exceed the required initial performance period and has the lowest life cycle cost.
Guide for the Design of Concrete Overlays using Existing Methodologies

• Background of recommended overlay design techniques
  - 1992 AASHTO Overlay procedure
  - Pavement-ME/MEPDG
  - ACPA Bonded Concrete Overlay of Asphalt pavements
  - (BCOA-ME background on host website)

• Detailed examples of how to use the existing design methodology

Learn by example – then apply for your situation!

Available online:
http://www.cptechcenter.org/
### Which Overlay Design Method(s)?

<table>
<thead>
<tr>
<th>Concrete Overlay Type</th>
<th>Design Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Unbonded</strong> on Asphalt, Composite, or Concrete</td>
<td>AASHTO ME, ACPA StreetPave 12, AASHTO 93, OptiPave 2.0</td>
</tr>
<tr>
<td><strong>Bonded</strong> on Asphalt or Composite</td>
<td>ACPA BCOA, ACPA StreetPave 12, BCOA ME, CO 6x6x6</td>
</tr>
<tr>
<td><strong>Bonded</strong> on Concrete</td>
<td>AASHTO ME, ACPA StreetPave 12, AASHTO 93</td>
</tr>
</tbody>
</table>

[apps.acpa.org](http://apps.acpa.org)
 Lots of Guidance Available...
Thank You For Your Attention!