Concrete Overlays of Existing Asphalt Pavements (Whitetopping)

Louisiana Transportation Conference
February 10, 2009

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Director of Education and Training
States with Concrete Overlay Experience

- With concrete overlay experience (mainly overlays on asphalt)
- With little known concrete overlay experience
Concrete Overlays

- Interest in concrete overlays has grown tremendously in the last decade (NOW!!).

- Significant recent research:
  - FHWA (ISTEA Section 6005).
  - NCHRP and ACPA Studies.
  - State studies.
  - LTPP.
Advantages of Concrete Overlays

- Concrete overlays generally do not require extensive repairs of existing pavement.
- Quick to construct.
- Potentially long performance lives.
- Low maintenance requirements.
- Can be designed to carry heavy truck traffic.
- Effective life-cycle costs.
- Recyclable.
Overlay Solutions for Rehabilitation and Maintenance

Over 200 miles in Iowa
Classes of Concrete Overlays

- **Thin**
  - Bonded Resurfacing Group
    - Bonded Concrete Resurfacing of Concrete Pavements
    - Bonded Concrete Resurfacing of Asphalt Pavements
    - Bonded Concrete Resurfacing of Composite Pavements
  - Unbonded Resurfacing Group
    - Unbonded Concrete Resurfacing of Concrete Pavements
    - Unbonded Concrete Resurfacing of Asphalt Pavements
    - Unbonded Concrete Resurfacing of Composite Pavements

- **Thick**

Bond is integral to design

Old pavement is base
Evaluation of Existing Pavements for Overlays

- A detailed evaluation is required to establish the best overlay strategy.
- The ultimate goal is to assess the stability and structural capacity of the existing pavement.
- The survey information is also used to determine if pre-overlay repairs are required and to what extent. (rarely necessary except in isolated locations.)
## Pavement Evaluation

### Evaluating Pavement Condition for Concrete Overlays

#### 1 Pavement History
- Pavement material (including aggregate coefficient of thermal expansion, design age, thickness, layers)
- Existing traffic and performance level
- Design life

#### 2 Visual Examination
- Concrete
- Asphalt / Composite

#### 3 Core Analysis
- Depth of distress
- Type of distress
- VE: Verification of thickness for transverse
- Etc.

#### 4 Options
(Least extent of problems)

<table>
<thead>
<tr>
<th>4-a. Materials-Related Tests</th>
<th>Concrete</th>
<th>Asphalt / Composite</th>
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<tr>
<td>Conduct if</td>
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<td>Petrography analysis</td>
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<td>Poor air void system</td>
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<td>Coefficient of thermal expansion</td>
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<th>4-b. Subsurface tests</th>
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<td>Falling weight deflectometer tests</td>
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<td>Subgrade support</td>
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<td>Pavement properties</td>
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<td>Load transfer efficiency</td>
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<td>Presence of voids</td>
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<td>Asphalt stiffness</td>
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<td>Subgrade tests</td>
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<td>Shrink-swell characteristics</td>
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<td>Seal strength (dynamic cone penetration or standard penetration test)</td>
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<tr>
<th>4-c. Surface Texture Tests</th>
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<td>Friction (skid resistance)</td>
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#### 5 Condition Assessment Profile

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<tr>
<th>Condition</th>
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<tbody>
<tr>
<td>Structural Deficiencies</td>
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<td>Corner breaks</td>
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<td>Joint deterioration</td>
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<tr>
<td>Treated panels</td>
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<td>Longitudinal cracking</td>
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<td>Popping/popping</td>
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<td>Punchout</td>
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<td>Materials-related distress</td>
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<td>Transverse cracking</td>
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<td>Subgrade/Subbase Conditions</td>
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<tr>
<td>Map cracking (low to medium)</td>
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<td>Popping (low ASR)</td>
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<td>Popouts</td>
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<td>Noise</td>
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<td>Corrosion</td>
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<td>Joint reflective cracking</td>
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<td>Roughness (not distress related)</td>
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<td>Plastic shrinkage cracks</td>
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### Condition Evaluation Report and Pavement Condition Rankings

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3 Core Analysis

- Depth of distress
- Type of distress
- Verification of thickness for base/subbase
- Etc.

4 Options (recommended as part of problem)

5 Condition Assessment Profile

Concrete
- Surface Deficiencies
- Fracture loss
- Joint deterioration (lack of re-attachment)
- Map cracking (non-ASR)
- Pores
- Noise
- Scaling
- Roughness (not distress related)
- Plastic shrinkage cracks
- Thermal shrinkage cracks

Asphalt / Composite
- Surface Deficiencies
- Bleeding/washing
- Block cracking
- Fracture loss
- Noise
- Corrosion
- Joint reflective cracking
- Roughness (not distress related)
- Rutting
- Washout/erosion

Deconcentrated

Aguas

AA

Condition Evaluation Report and Pavement Condition Rankings

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# Evaluating Pavement Condition for Concrete

## 1 Pavement History
- Pavement material (including appropriate coefficient of thermal expansion), design, age, thickness, layers.
- Remaining life
- Defined traffic and performance level
- Defined design life
- Elevations and grade restrictions
- Etc.

## 2 Visual Examination

<table>
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<tr>
<th>Condition Assessment Profile</th>
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<tr>
<td>Surface Deficiencies</td>
<td>Bleeding/flaking</td>
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<td>Roughness</td>
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<td>Friction loss</td>
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<td>Shrinkage (not distress related)</td>
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<td>Structural Deficiencies</td>
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<td>Fatigue (traffic cracking)</td>
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<td>Depressions</td>
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<td>Heaves</td>
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<td>Potholes</td>
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## 4 Options
(Indicated by core analysis)

### 4-a. Materials-Related Tests
- Conduct if
  - Materials or durability issues are indicated and/or
  - Roadway provides high level of service, especially if a bonded overlay is being considered.
  - Petrography analysis
    - Concrete material related distress
    - Poor air void system
  - Asphalt stripping
  - Coefficient of thermal expansion

### 4-b. Subsurface Tests
- Conduct if
  - Pavement or subgrade support issues are indicated and/or
  - Roadway provides high level of service, especially if a bonded overlay is being considered.
  - Falling weight deflectometer tests
    - Subgrade support (K value)
    - Subgrade variability
    - Pavement properties
    - Load transfer efficiency
    - Presence of voids
    - Asphalt stiffness
    - Concrete flexural
  - Subgrade tests
    - Freeze-thaw characteristics
    - Shrink-swell characteristics
    - Soil strength (dynamic cone penetration or standard penetration test)

### 4-c. Surface Texture Tests
- Conduct if
  - Materials or durability issues are indicated and/or
  - Roadway provides high level of service, especially if a bonded overlay is being considered.
  - International roughness index
  - Friction (skid resistance) tests

## 4-P Condition Evaluation Report and Pavement Condition Rankings

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Pavement Evaluation

- On high-volume roads, falling weight defectometer (FWD) testing can provide subgrade k-values and variability, concrete modulus, load transfer efficiency, and the presence of voids.
### Condition Assessment Profile

#### Concrete

**Surface Deficiencies**
- Friction loss
- Joint deterioration (low to medium)
- Map cracking (non-ASR)
- Popouts
- Noise
- Scaling
- Roughness (not distress related)
- Plastic shrinkage cracks
- Thermal shrinkage cracks
- Etc.

**Structural Deficiencies**
- Corner breaks
- Joint deterioration (severe)
- Tented panels
- Longitudinal cracking
- Pumping/faulting
- Punchout
- Materials-related distress (medium to severe)
- Transverse cracking
- Subgrade/Subbase Condition
- Etc.

#### Asphalt / Composite

**Surface Deficiencies**
- Bleeding/flushing
- Block cracking
- Friction loss
- Noise
- Corrugation
- Joint reflective cracking
- Roughness (not distress related)
- Rutting
- Weathering/raveling
- Shoving
- Slippage
- Etc.

**Structural Deficiencies**
- Fatigue (alligator) cracking
- Depressions
- Heaves
- Longitudinal cracking
- Potholes
- Transverse thermal cracking
- Rutting/shoving
- Subgrade/Subbase Condition
- Etc.
Overlay Decision Flow Chart

Pavement Condition Rankings
(based on existing pavement conditions)

Concrete Pavement Condition

Good (Concrete)
Structurally and materially sound but in need of increased structural capacity, improved rideability or skid resistance, or removal of surface defects

Asphalt/Composite Pavements Condition

Good (Asphalt/Composite)
Structurally and materially sound but in need of increased structural capacity, improved rideability or skid resistance, or removal of surface defects

Fair (Concrete)
Structurally and materially sound but in need of surface repairs or enhancement

Fair (Asphalt/Composite)
Structurally and materially sound but has surface distresses such as rutting, shoving, slippage, or thermal cracking

Poor (Concrete)
Has measurable surface distresses and exhibits some structural, material, and/or other durability-related deterioration

Poor (Asphalt/Composite)
Has measurable surface distresses such as severe rutting, shoving, slippage, thermal cracking, and exhibits some structural deterioration

Deteriorated (Concrete)
Exhibits significant deterioration, including structural, material, and/or other durability-related distresses

Deteriorated (Asphalt/Composite)
Exhibits significant surface deterioration and some structural distresses

Can spot surface repairs and/or spot structural repairs cost-effectively correct existing or prevent potential distresses? And/or Can milling the surface remove surface deficiencies cost-effectively, bringing the pavement to “Good Condition” before overlay is constructed?

Can an unbonded overlay design with minor repairs and/or thin milling cost-effectively meet future traffic loads and design life requirements?

Can a 2.5-in. (63.5-mm) bonded overlay design cost-effectively meet future traffic loads and design life requirements? Or Can a 4-in. (102-mm) or greater unbonded overlay design cost-effectively meet future traffic loads and design life requirements?

Any indications of potential future durability problems, such as early-age materials-related distress (MDM) or unstable conditions?

Can spot repairs with an unbonded overlay cost-effectively correct existing or prevent potential distresses (e.g., potholes, rutting, or thermal cracks) or major deficiencies (e.g., materials-related distress, cracking, asphalt stripping, etc.)?

On-site recycling and reconstruction options:
- Mill or crush pavement as granular material, recycle as base or shoulder material. (Although not a mainstream approach, concrete pavements may be rehabilitated as long as they are uniform and the subgrade is stable enough to support the stabilization process. See page 2.)
- Place full depth concrete.
- Full-depth pavement replacement
Uses and Advantages - Thin Bonded Overlay of Asphalt Pavements

2”–5” thickness

- Use when existing pavement is in fair or better structural condition with surface distress.
- Use to eliminate any surface defects; increase structural capacity; and improve surface friction, noise, and ride.

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Important Elements of Thin Bonded Concrete over Asphalt Pavements

Bonded concrete overlays of asphalt pavements
–previously called ultra-thin whitetopping, UTW–

- Small square panels reduce curling, warping, & shear stresses.
- Mill if necessary to correct crown, remove surface distresses, improve bonding. Insure to leave 3” min. HMA after milling.
- HMA surface temperature below 120 F before paving.
Isolated spots of heavy distress can be determined through evaluation such as the stiffness of the asphalt pavement and subgrade support conditions. Localized areas of weakness can be strengthened through patching. Milling can remove a number of asphalt surface distresses.
Known Design Issues (Over Asphalt)

- Materials.
- Bond.
- Slab size (jointing) is critical.
- Underlying asphalt thickness and stiffness is important.
Materials

- Concrete mix is selected based on requirements for traffic opening
- Fibers are an integral part of mix design
- Smaller top-size of coarse aggregate
- Fast track paving jobs use mixes with compressive strengths > 3000 psi in 24 hours
Construction Steps

- Core Existing Asphalt
- Mill and Clean
- Place finish and cure
- Early Saw
- Open to Traffic
Traffic Control
Milled Surface
Clean Surface
Concrete Placement

Placement using Slipform Pavers
Finishing

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Curing
Early Sawing
Opening to Traffic
International Conference on Best Practices for ULTRATHIN AND THIN Whitetoppings

April 13 to 14, 2005

Hotel Denver Tech Center
Denver, Colorado

FINAL PROGRAM
Colorado Experience

- Findings incorporated in the Colorado design and specifications.
  - Minimum HMA thickness = 5 inches.
  - Minimum k = 150 pci.
  - Mill and clean HMA prior to overlay placement.
  - Avoid placement on new HMA
  - Preferred thickness = 6 inches with 6 ft by 6 ft panels
  - Deformed steel bars at longitudinal joints, no steel at transverse joints.
Iowa Experience

- Minimum thickness for ultrathin is 2 inches if placed on a stable base with good drainage.
- 4 inch ultrathin performs well with 2x2, 4x4 or 6 ft by 6 ft panels.
- Fibers hold cracks together but are effective only for thinner panels.
- Narrow saw cuts with no joint sealant is acceptable.
- Performance is good for 10 plus years.
Illinois Experience

- High volume bus pads were replaced in Chicago as a test project.
- Highly variable base of differing properties.
- The standard was to perform full depth repairs on the HMA (frequent).
- High strength PCC with structural steel fibers was used after milling out HMA.
- Highly cost effective with excellent performance.
Both bonded and unbonded concrete overlays have shown excellent performance if designed and constructed correctly.

The choice of overlay type is based on the condition of the existing roadway and the desired objectives.

Pre-overlay repairs are generally not required for most projects.

Fast-track techniques are frequently employed to promote early opening to traffic.
Concrete Overlays

Payment

Materials-
Cubic Yard

Placement-
Square Yard

NOTE: Divided payment is the most equitable and economic.
Additional Information

The following information may be useful in selecting, designing and constructing concrete overlays:

- American Concrete Pavement Association – numerous publications ([www.pavement.com](http://www.pavement.com))
- Guide to Concrete Overlay Solutions (available through ACPA, publication #TB021P)
- Many additional references (Google)