Pavement Rehabilitation Using Hot Mix Asphalt

- National Perspective -

NAPA
NATIONAL ASPHALT PAVEMENT ASSOCIATION
Rehabilitation Process

• Evaluate Existing Pavement and Conditions
• Evaluate Options
• Construct Project
• Monitor Performance
Evaluate Existing Pavement and Conditions

- Distress Survey.
- Drainage Survey.
- Traffic Count.
- Friction Evaluation.
- Structural Evaluation, if needed.
Distress Survey

- Routine Pavement Management Activity
- Project-by-Project Basis
- Identify Major Distress Types
  - Most Prevalent
  - Most Harmful
- Use Data to Evaluate Options or Trigger Further Investigation
Distress Survey

- Determine the Extent and Severity
  - Extent
    - Area
    - Length
    - Percent of Slabs
  - Severity
    - Width of Cracks
    - Depth of Ruts
    - Degree of Faulting
Distress Survey

• Load Related Distress
  – Examples
    • Mid-Panel Cracking
    • Fatigue Cracking
    • Rutting
  – Need Structural Evaluation

• Non-Load Related Distress
  – Examples
    • Raveling
    • Scaling
  – Consider Reactive Maintenance
Flexible Pavement Distress
Severe Bleeding
Severe Bleeding
Fatigue and Transverse Cracking
Severe and Extensive Fatigue Cracking
The Ultimate Fatigue Cracking
Severe Thermal Cracking
Thermal Cracking - Sealed
Thermal Cracking with Chip Seal and Snow Plow Damage
Thermal Cracking
Severe Thermal Cracking with Sealing?
Longitudinal Joint - Wrong Place
Joint Reflective Cracking
Stripping

Pavement Distress - Types
Raveling
Rutting
Drainage Survey

• Surface Drainage
  – Ponding
  – Drainage Inlet Locations
  – Medians and Ditches
  – Existing Edge Drains

• Subsurface
  – Infiltration
  – Weakened Areas
Traffic Count

• Total Traffic
  – AADT
  – Directional Distribution
  – Lane Distribution

• Loading
  – % Commercial Trucks
  – ESALs
Roughness

• Ranges of International Roughness Index (IRI)
  – All types of roads
  – Interstate highways
  – Comparison of states and the US
  – Vehicle operating costs versus IRI
Roughness

Figure 9.2: IRI Roughness Scale (replotted from Sayers et al., 1986)
<table>
<thead>
<tr>
<th>Description</th>
<th>PSR Rating</th>
<th>IRI</th>
<th>NHS Ride Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Good</td>
<td>≥4.0</td>
<td>&lt;1.0 m/km (&lt;60 in/mi)</td>
<td></td>
</tr>
<tr>
<td>Good</td>
<td>3.5-3.9</td>
<td>1.0-1.5 m/km (60-94 in/mi)</td>
<td>Acceptable (0-2.7 m/km)</td>
</tr>
<tr>
<td>Fair</td>
<td>3.1-3.4</td>
<td>1.5-1.9 m/km (95-119 in/mi)</td>
<td></td>
</tr>
<tr>
<td>Mediocre</td>
<td>2.6-3.0</td>
<td>1.9-2.7 m/km (120-170 in/mi)</td>
<td></td>
</tr>
<tr>
<td>Poor</td>
<td>≤2.5</td>
<td>&gt;2.7 m/km (&gt;170 in/mi)</td>
<td>Less than Acceptable (&gt;2.7 m/km)</td>
</tr>
</tbody>
</table>
IRI for Rural Interstates—2001

Source: FHWA, Highway Statistics, 2001
VOC versus IRI for HMA

Vehicle Operation Cost ($/veh.-km) vs. Roughness (m/km)

- Train
- Double-Unit
- Single-Unit
- Car

2.7
Friction or Skid Resistance

Friction factor (like a coefficient of friction): \( f = \frac{F}{L} \)

Skid number: \( SN = 100(f) \)

where: \( F \) = frictional resistance to motion in plane of interface

\( L \) = load perpendicular to interface
# Friction or Skid Resistance

## Table 9.3: Typical Skid Numbers (from Jayawickrama et al., 1996)

<table>
<thead>
<tr>
<th>Skid Number</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 30</td>
<td>Take measures to correct</td>
</tr>
<tr>
<td>≥ 30</td>
<td>Acceptable for low volume roads</td>
</tr>
<tr>
<td>31 - 34</td>
<td>Monitor pavement frequently</td>
</tr>
<tr>
<td>≥ 35</td>
<td>Acceptable for heavily traveled roads</td>
</tr>
</tbody>
</table>
Friction or Skid Resistance

Figure 9.13: Lock Wheeled Skid Tester
Structural Evaluation

- Material Samples
  - Cores
  - Base
  - Subgrade

- Deflection Testing
  - Maximum Deflection - Overall Strength
  - Deflection 5’ From Load - Subgrade
A tolerable level of deflection is a function of traffic and the pavement structural section.
Overlaying a pavement with HMA will reduce its deflection. The thickness needed to reduce the deflection to a tolerable level can be estimated.
The deflections experienced by a pavement varies throughout the year due to temperature and moisture changes.
Primary Types of Deflection Measure Devices Used in the US

- Static (Benkelman Beam)
- Impulse (Falling Weight Deflectometer)
Benkelman Beam

Figure 9.16: Benkelman Beam Schematic

Figure 9.17: Benkelman Beam in Use
Falling Weight Deflectometer (FWD)

Figure 9.22: FWD Impulse Loading Mechanism (foreground) and Sensors (background)

Figure 9.23: FWD

Figure 9.24: Dynatest 8000 FWD

Figure 9.25: KUAB FWD

Figure 9.26: JILS FWD
Structural Evaluation with Deflections

- Maximum deflection ($D_0$)
- Area Parameter ($A$)
- Subgrade Modulus ($M_R$)
Area Parameter

The sensors measure pavement deflection underneath them. To calculate the FWD AREA parameter, data from the sensors at the loading plate ($D_0$), and 12 inches ($D_1$), 24 inches ($D_2$), and 36 inches ($D_3$) from the loading plate are used.

\[
\text{AREA} = \frac{6(D_0 + 2D_1 + 2D_2 + D_3)}{D_0}
\]

where: 
\( \text{AREA} \) = the FWD AREA Parameter. Expressed in units of length (usually inches or mm).

\( D_0 \) = surface deflection at the test load center
\( D_1 \) = surface deflection at 12 inches from the test load center
\( D_2 \) = surface deflection at 24 inches from the test load center
\( D_3 \) = surface deflection at 36 inches from the test load center
### Table 9.4: Some Typical AREA Values

<table>
<thead>
<tr>
<th>Pavement</th>
<th>AREA Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>inches</td>
</tr>
<tr>
<td><strong>Rigid pavement</strong></td>
<td>24 - 33</td>
</tr>
<tr>
<td>Thick flexible pavement &gt;= 100 mm (4 inches)</td>
<td>21 - 30</td>
</tr>
<tr>
<td>Thin flexible pavement &lt; 100 mm (4 inches)</td>
<td>16 - 21</td>
</tr>
<tr>
<td><strong>BST</strong></td>
<td>15 - 17</td>
</tr>
<tr>
<td>Weak BST</td>
<td>12 - 15</td>
</tr>
</tbody>
</table>
Subgrade Modulus (quick estimate)
(from AASHTO 93 Guide)

\[
M_R = \frac{P(1 - \mu^2)}{(\pi)(D_r)(r)} \quad \text{(Eq. 7.16)}
\]

where \( M_R \) = backcalculated subgrade resilient modulus (psi),

\( P \) = applied load (lbs),

\( D_r \) = pavement surface deflection a distance \( r \) from the center of the load plate (inches), and

\( r \) = distance from center of load plate to \( D_r \) (inches).
## Typical Values of Subgrade Moduli

<table>
<thead>
<tr>
<th>Material</th>
<th>Climate Condition</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dry</td>
<td>Wet — No Freeze</td>
<td>Wet - Freeze</td>
<td>Unfrozen</td>
<td>Frozen</td>
</tr>
<tr>
<td></td>
<td>psi (MPa)</td>
<td>psi (MPa)</td>
<td>psi (MPa)</td>
<td>psi (MPa)</td>
<td>psi (MPa)</td>
</tr>
<tr>
<td>Clay</td>
<td>15,000 (103)</td>
<td>6,000 (41)</td>
<td>6,000 (41)</td>
<td>50,000 (345)</td>
<td></td>
</tr>
<tr>
<td>Silt</td>
<td>15,000 (103)</td>
<td>10,000 (69)</td>
<td>5,000 (34)</td>
<td>50,000 (345)</td>
<td></td>
</tr>
<tr>
<td>Silty or Clayey Sand</td>
<td>20,000 (138)</td>
<td>10,000 (69)</td>
<td>5,000 (34)</td>
<td>50,000 (345)</td>
<td></td>
</tr>
<tr>
<td>Sand</td>
<td>25,000 (172)</td>
<td>25,000 (172)</td>
<td>25,000 (172)</td>
<td>50,000 (345)</td>
<td></td>
</tr>
<tr>
<td>Silty or Clayey Gravel</td>
<td>40,000 (276)</td>
<td>30,000 (207)</td>
<td>20,000 (138)</td>
<td>50,000 (345)</td>
<td></td>
</tr>
<tr>
<td>Gravel</td>
<td>50,000 (345)</td>
<td>50,000 (345)</td>
<td>40,000 (276)</td>
<td>50,000 (345)</td>
<td></td>
</tr>
</tbody>
</table>
Example of Pavement Evaluation
Data in the WSDOT PMS
Specific WSDOT structural design policy is contained in the *WSDOT Pavement Guide*, Volume 1. In general, WSDOT uses the following structural design procedures:

- New pavements (including reconstructed pavements).
  - *Flexible*. The AASHTO Guide for Design of Pavement Structures (1986 or 1993 version). This is an [empirical procedure](#).
  - *Rigid*. The AASHTO Guide for Design of Pavement Structures (1986 or 1993 version). This is an [empirical procedure](#).
- Rehabilitation.
  - *HMA overlays*. Either the [mechanistic-empirical procedure](#) used in the EVERPAVE computer program (for use with flexible pavements) or the [empirical procedure](#) described in the AASHTO Guide for Design of Pavement Structures.
  - *PCC overlays*. The AASHTO Guide for Design of Pavement Structures for unbonded PCC overlays. This is an [empirical procedure](#). Generally, only [unbonded PCC overlays](#) will be used if a PCC surfacing is selected. [Bonded PCC overlays](#) are not considered as a structural solution and have a higher than acceptable risk of premature failure.
Pavement Rehabilitation
Types of HMA overlay design procedures

- Engineering judgment

- Component analysis: Widely used in a number of applications/design procedures

- Nondestructive testing with limiting deflection: Still used with measurement instruments such as the Benkelman Beam.

- Mechanistic-empirical: This is the primary HMA overlay design method used by WSDOT. This approach is gaining acceptance in other states and countries.
Pavement Rehabilitation Component Analysis

- The Asphalt Institute (AI)
  - Determine “effective thickness” of the existing pavement structure.
  - Design a “new” pavement structure
  - Difference in the two structures (new – effective) amounts to the overlay thickness.
  - To use the AI approach, need:
    - Subgrade analysis
    - Traffic analysis
    - Pavement structure thickness analysis (determine effective thickness of existing and all new design for the given subgrade and traffic).
## Component Analysis

**Table 1. Example of Asphalt Institute Conversion Factors for Estimating Thickness of Existing Pavement Components to Effective Thickness [after Ref. 2]**

<table>
<thead>
<tr>
<th>Description of Layer Material</th>
<th>Conversion Factor*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Native subgrade</td>
<td>0.0</td>
</tr>
<tr>
<td>2. a. Improved subgrade — predominantly granular materials</td>
<td>0.0</td>
</tr>
<tr>
<td>b. Lime modified subgrade of high PI soils</td>
<td>0.0</td>
</tr>
<tr>
<td>3. a. Granular subbase or base — CBR not less than 20</td>
<td>0.1 - 0.3</td>
</tr>
<tr>
<td>b. Cement modified subbases and bases constructed from low PI soils</td>
<td></td>
</tr>
<tr>
<td>4. a. Cement or lime-fly ash bases with pattern cracking</td>
<td>0.3 - 0.5</td>
</tr>
<tr>
<td>b. Emulsified or cutback asphalt surfaces and bases with extensive cracking, rutting, etc.</td>
<td></td>
</tr>
<tr>
<td>c. PCC pavement broken into small pieces</td>
<td></td>
</tr>
<tr>
<td>5. a. Asphalt concrete surface and base that exhibit extensive cracking</td>
<td>0.5 - 0.7</td>
</tr>
<tr>
<td>6. a. Asphalt concrete — generally uncracked</td>
<td>0.9 - 1.0</td>
</tr>
<tr>
<td>b. PCC pavement — stable, undersealed and generally uncracked pavement</td>
<td></td>
</tr>
<tr>
<td>7. Other categories of pavement layers listed in Ref. 2</td>
<td></td>
</tr>
</tbody>
</table>

*Equivalent thickness of new asphalt concrete
### Component Analysis

**Table 2. Asphalt Institute Traffic Classifications [after Ref. 2]**

<table>
<thead>
<tr>
<th>Type of Street or Highway</th>
<th>Estimated 18,000 lb (80 kN) ESALs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Parking lots</td>
<td>5,000</td>
</tr>
<tr>
<td>2. Light traffic residential streets and farm roads</td>
<td></td>
</tr>
<tr>
<td>1. Residential streets</td>
<td>10,000</td>
</tr>
<tr>
<td>2. Rural farm and residential roads</td>
<td></td>
</tr>
<tr>
<td>1. Urban and rural minor collectors</td>
<td>100,000</td>
</tr>
<tr>
<td>2. Urban minor arterial and light industrial streets</td>
<td>1,000,000</td>
</tr>
<tr>
<td>2. Rural major collector and minor arterial highways</td>
<td></td>
</tr>
<tr>
<td>1. Urban freeways and other principal arterial highways</td>
<td>3,000,000</td>
</tr>
<tr>
<td>2. Rural interstate and other principal arterial highways</td>
<td></td>
</tr>
<tr>
<td>1. Some interstate highways</td>
<td>10,000,000</td>
</tr>
<tr>
<td>2. Some industrial roads</td>
<td></td>
</tr>
</tbody>
</table>
Component Analysis (“Figure 1”)

Note: Each plotted diagonal line represents a constant AC thickness.
Asphalt Institute Full-Depth ($T_N$) (actual figure from AI)

If $M_r = 15,000$ psi and design ESALs = 1,000,000, then HMA full-depth thickness = 7.7 inches
### Component Analysis

- **Effective pavement thickness**

<table>
<thead>
<tr>
<th>Layer Thickness (in.)</th>
<th>Conversion Factor (Table 1)</th>
<th>Effective Thickness (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 x</td>
<td>0.5</td>
<td>1.5</td>
</tr>
<tr>
<td>8 x</td>
<td>0.2</td>
<td>1.6</td>
</tr>
<tr>
<td></td>
<td>Total $T_e$</td>
<td>3.1</td>
</tr>
</tbody>
</table>

- Required new "full-depth" asphalt concrete pavement thickness ($T_n$) = 7.7 in. (refer to Figure 1).

- Thickness of asphalt concrete overlay = $T_n - T_e = 7.7 - 3.1$ in. = 4.6 in.
Pavement Rehabilitation
Limiting Pavement Surface Deflections

Limiting pavement surface

– Surface deflections can be taken with a variety of deflection devices. Typically, this is either the Benkelman Beam (BB) or the Falling Weight Deflectometer (FWD).

– Compute the Representative Rebound Deflection (RRD). You must consider the time of the year during which the deflections are taken.

– The overlay thickness is a function of ESALs and RRD
Representative Rebound Deflection (RRD)

\[ \text{RRD} = \left( \bar{x} + 2s \right) f(c) \]

- Mean of deflection measurements
- Standard deviation of deflection measurements
- Critical period adjustment factor (\( c = 1 \) if measurements made during the most critical period)
- Temperature adjustment factor
Limiting pavement surface deflections—Asphalt Institute

Figure 2. Sketch of Asphalt Institute Temperature Adjustment Factors for Benkelmen Beam Deflections [after Ref. 7.2]
Limiting pavement surface deflections—Asphalt Institute

Figure 3. Sketch of Asphalt Concrete Overlay Thickness Required to Reduce Pavement Deflection from a Measured to a Design Deflection Value [after Ref. 7.2]
Pavement Rehabilitation

AASHTO Overlay Design Procedure (1993)

- Introduction: WSDOT Pavement Guide, PG, Paragraph 1.8.1: Note types of overlays that are possible. WSDOT primarily uses the AASHTO procedure as a design check for HMA overlays placed on flexible pavement.

- Overlay design considerations
  - Pre-overlay repair including level-up or milling
  - Reflection crack control
  - Traffic (ESALs mostly)
  - Subdrainage
  - Rutting—understand cause(s)
\[ D_{ol} = \frac{SN_{ol}}{\alpha_{ol}} = \frac{(SN_f - SN_{eff})}{\alpha_{ol}} \]

To come up with \( D_{ob} \), need:

- \( SN_f \)
- \( SN_{eff} \)
- \( \alpha_{ol} \)
AASHTO 93

• The effective structural number $SN_{eff}$:
  – Use NDT
  \[ SN_{eff} = 0.00453 \sqrt{E_p} \]
  – Use Condition
  – Use Remaining Life

• The future structural number $SN_f$:
  – Traffic
  – Soil
  – Pavement Condition at End of Analysis
AASHTO 93

Use Nomograph as for New Pavement

Example:

\[ W_0 = 5 \times 10^6 \]
\[ R = 95 \% \]
\[ S_0 = 0.35 \]
\[ W_e = 5000 \text{ psi} \]
\[ \Delta PSI = 1.5 \]

Solution: \( SN = 3.0 \)

Figure 3.1. Design Chart for Flexible Pavements Based on Using Mean Values for Each Input
AASHTO 93

\[ a_{ol} = 0.42 \text{ to } 0.44 \]

\[
D_{ol} = \frac{S_{N_{ol}}}{a_{ol}} = \left( \frac{S_{N_f} - S_{N_{eff}}}{a_{ol}} \right)
\]
Perpetual Pavements

- 40-75 mm SMA, OGFC or Superpave
- 100 mm to 150 mm Zone Of High Compression
- High Modulus Rut Resistant Material (Varies As Needed)
- Max Tensile Strain
- Flexible Fatigue Resistant Material 75 - 100 mm

Pavement Foundation
Rehabilitation of Flexible Pavement to Perpetual Pavement

- Conduct investigation as typical rehab project
  - Distress Survey
  - Traffic
  - Friction
  - Drainage
  - Structural

- If damage confined to surface, consider Perpetual Pavement design
  - Determine depth of surface distress through cores
Perpetual Pavement Design

- Determine Mechanistic Design Inputs
  - Pavement Structure
    - Seasonal Material Properties – Modulus values
    - Layer Thicknesses – Use milled depth of pavement for start of 2\textsuperscript{nd} layer
  - Traffic
    - Use AADT and truck classifications
- Perform structural analysis to find overlay to limit strains in pavement
Perpetual Pavement

Under ~85\% of Loads

Limit Bending to < 100 \( \mu\varepsilon \) (NCHRP 9-38)

Limit Vertical Compression to < 200\( \mu\varepsilon \) (Monismith, Nunn)

Find Required Overlay Thickness

Base (as required)

Subgrade
New Jersey I-287
Surface Cracking
Perpetual Pavement

Available at www.asphaltalliance.com
Perpetual Pavements

• Save asphalt and aggregate over the long term. It’s sustainable.
• Lower Life Cycle Cost
• Lower User Cost
### Comparison of Structures

<table>
<thead>
<tr>
<th>Year</th>
<th>Activity</th>
<th>Year</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>6” HMA/10” Base</td>
<td>0</td>
<td>11” HMA/6” Base</td>
</tr>
<tr>
<td>15</td>
<td>Mill 2”/Overlay 3”</td>
<td>18</td>
<td>Mill 2”/Overlay 2”</td>
</tr>
<tr>
<td>25</td>
<td>10% Patching + Mill 2”/Overlay 3”</td>
<td>33</td>
<td>Mill 2”/Overlay 2”</td>
</tr>
<tr>
<td>35</td>
<td>Reconstruct with 8” HMA</td>
<td>48</td>
<td>Mill 2”/Overlay 2”</td>
</tr>
<tr>
<td>50</td>
<td>Mill 2”/Overlay 3”</td>
<td>50</td>
<td>-----</td>
</tr>
<tr>
<td>Year</td>
<td>Conventional (tons/lane-mile)</td>
<td>Perpetual Pavement (tons/lane-mile)</td>
<td></td>
</tr>
<tr>
<td>------</td>
<td>-----------------------------</td>
<td>-----------------------------------</td>
<td></td>
</tr>
<tr>
<td></td>
<td>HMA*</td>
<td>Gravel Base*</td>
<td>HMA*</td>
</tr>
<tr>
<td>0</td>
<td>2,376</td>
<td>3,168</td>
<td>4,356</td>
</tr>
<tr>
<td>15</td>
<td>1,188</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>1,426</td>
<td></td>
<td></td>
</tr>
<tr>
<td>33</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>3,168</td>
<td></td>
<td></td>
</tr>
<tr>
<td>48</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>1,188</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>9,346</td>
<td>3,168</td>
<td>6,732</td>
</tr>
<tr>
<td>RAP</td>
<td>2,337</td>
<td></td>
<td>1,683</td>
</tr>
<tr>
<td>Aggregate</td>
<td>6,659</td>
<td>3,168</td>
<td>4,797</td>
</tr>
<tr>
<td>Asphalt Binder**</td>
<td>350</td>
<td></td>
<td>252</td>
</tr>
</tbody>
</table>
Material Usage

HMA, tons

Save 31%

0 5000 10000
Conv. Perp. Pavmt.

RAP, tons

Save 28%

0 1000 2000 3000
Conv. Perp. Pavmt.

Aggregate, tons

Save 32%

0 5000 10000
Conv. Perp. Pavmt.

Binder, tons

Save 28%

0 100 200 300 400
Conv. Perp. Pavmt.
Costs

Save 44%
Evaluate Options

• Select Alternatives
  – Effectiveness
  – Available Funding
  – Competing Projects

• Weigh Costs Against Effectiveness (Life Cycle Costs)

• Prioritize Projects to Optimize Available Funds

• Consider User Costs
Select Alternatives

- Rehabilitation Without Overlay
  - Reactive Maintenance
  - Crack Sealing
  - Surface Treatments

- Rehabilitation With HMA Overlay
  - HMA Overlay of Asphalt Pavement
  - HMA Overlay of PCC Pavement
Pavement Rehabilitation Design Factors

• Pavement type
• Condition of existing pavement
  – Drainage
  – Distress
  – Response to load
• Foundation strength/stiffness
  – Subbase
  – Subgrade
• Future traffic loading
• Additional corrections (safety, capacity, etc)
Rehabilitation With HMA Overlay

• Address Functional Problems
  – Skid Resistance
  – Raveling
  – Surface Distresses

• Address Structural Problems
  – Pavement Strengthening
HMA Overlay of Asphalt Pavement

• Correction of Problems
  – Cut & Patch
  – Crack Sealing
  – Mill Surface Defects

• Apply Tack Coat

• HMA Overlay
  – Thickness
  – Mix Type
Surface Milling
Asphalt Concrete Overlay—US 2
Paving Over Pizza
FHWA - Data from Long-Term Pavement Performance Study

- Data from GPS-6 (FHWA-RD-00-165)
- Conclusions
  - Thicker overlays mean less:
    - Fatigue Cracking
    - Transverse Cracking
    - Longitudinal Cracking
  - Most AC Overlays ≥ 15 years before Rehab
  - Many AC Overlays > 20 years before Significant Distress
Asphalt Pavement Association Of Michigan
Ultra-Thin Overlay

Presentation

Charles E. Mills, P.E., Dir. Of Engineering

2937 Atrium Drive, Suite 202
Okemos, MI 48864
517-323-7800  517-323-6505 (Fax)
Asphalt Pavement Association Of Michigan
Ultra-Thin Overlay

Presentation Overview

Purpose
Specification Development
Applications
Limitations
Price
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Description:

• A dense graded bituminous mixture with an application rate between 65 - 90 lbs./sq.yd.
• .60 inch to .80 inch thickness
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Surface Texture
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Close-up .75 in
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Ultra-Thin Overlay

Purpose:

• Protect the pavement structure
• Slow rate of deterioration
• Correct surface deficiencies
• Improve skid - resistance
• Improve ride quality (restores crown)
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Original Performance Targets:

• Low to moderate volume roads
• Alternate to Chip Seal
• Ability to improve ride quality
• Life expectancy 6 - 8 years
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Specification Development:

- Survey of membership
- Field review of projects constructed between 1993 – 1996
- Gathered information on mixture properties
- Use local materials
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Ultra-Thin Overlay

Original Mixture Specification 1993

<table>
<thead>
<tr>
<th>Aggregate Gradation:</th>
<th>Total Passing (% by weight)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sieve Size</td>
<td></td>
</tr>
<tr>
<td>12.5 mm (1/2”)</td>
<td>100</td>
</tr>
<tr>
<td>9.5 mm (3/8”)</td>
<td>99-100</td>
</tr>
<tr>
<td>4.75 mm (#4)</td>
<td>75-95</td>
</tr>
<tr>
<td>2.36 mm (#8)</td>
<td>55-75</td>
</tr>
<tr>
<td>600 µm (#30)</td>
<td>25-45</td>
</tr>
<tr>
<td>75 µm (#200)</td>
<td>3-8</td>
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</tbody>
</table>
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Ultra-Thin Overlay

Original Mixture Specification 1993
(Low to Moderate Traffic)

Physical Properties:

• Percent crush (min) 50%
• Angularity Index (MTM 118) (min) 2.5
• L.A. Abrasion (max) 40
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Original Mixture Specification 1993
(Low to Moderate Traffic)

Mixture Criteria:

• Air Voids % 4.5
• VMA (min) % 17.5
• Fines/Binder % max 1.2
• Flow (mm) 2 - 4
• Stability min 4.0 kN
Current MDOT Ultra-Thin HMA Mixture Specification
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Current Practice:

• Low and medium volume moved to pavement sealant category. Emerging technology for high volume roads
• Alternate to Micro-Surfacing & Chip Seal
• Specification developed by Industry/MDOT Mixtures Task Force
• Mixture properties/materials engineered for specific traffic levels
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Ultra-Thin Overlay

**Traffic Classifications**

<table>
<thead>
<tr>
<th></th>
<th>Low Volume</th>
<th>Medium Volume</th>
<th>High Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comm. ADT*</td>
<td>&lt;380</td>
<td>380 - 3400</td>
<td>&gt;3400</td>
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<tr>
<td></td>
<td>Comm. ADT*</td>
<td>Comm. ADT*</td>
<td>Comm. ADT*</td>
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<td></td>
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</table>

* Two-Way Truck Traffic
# Physical Properties of Combined Aggregates

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Low Volume</th>
<th>Medium Volume</th>
<th>High Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent Crush (min)</td>
<td>50%</td>
<td>75%</td>
<td>95%</td>
</tr>
<tr>
<td>Angularity Index (MTM 118) (min)</td>
<td>2.5</td>
<td>3.0</td>
<td>4.0</td>
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<tr>
<td>L.A. Abrasion Loss (max)</td>
<td>40</td>
<td>35</td>
<td>35</td>
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<tr>
<td>Aggregate Wear Index</td>
<td>260</td>
<td>260</td>
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</table>
# Ultra Thin H.M.A. Mixture Criteria

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Low Volume</th>
<th>Medium Volume</th>
<th>High Volume</th>
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</thead>
<tbody>
<tr>
<td>Marshall Air Voids %</td>
<td>4.5</td>
<td>4.5</td>
<td>5.0</td>
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<tr>
<td>VMA % (min)</td>
<td>15.5</td>
<td>15.5</td>
<td>15.5</td>
</tr>
<tr>
<td>Fines/Binder % (max)</td>
<td>1.2</td>
<td>1.4</td>
<td>1.4</td>
</tr>
<tr>
<td>Flow (mm)</td>
<td>2-4</td>
<td>2-4</td>
<td>2-4</td>
</tr>
<tr>
<td>Stability (min)</td>
<td>4.0 kN</td>
<td>4.0 kN</td>
<td>4.0 kN</td>
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</tbody>
</table>
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Ultra-Thin Overlay

Asphalt Binder Selection

<table>
<thead>
<tr>
<th>Low Volume Comm. ADT &lt;380</th>
<th>Medium Volume Comm. ADT 380 - 3400</th>
<th>High Volume Comm. ADT &gt;3400</th>
</tr>
</thead>
<tbody>
<tr>
<td>PG 64-22</td>
<td>PG 64-28P</td>
<td>PG 70-22 P</td>
</tr>
</tbody>
</table>
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Ultra-Thin Overlay Use

Existing Pavement Conditions:

• Good cross section
• Good base, structurally sound
• Visible surface distress may include:
  • Moderate cracking, ≤ 3/8” wide
  • Raveling and surface wear
  • Slight to moderate flushing or polishing
  • Occasional patch in good condition
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Fancher Street, Mt. Pleasant - 2000
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Ultra-Thin Overlay

M-60 - 2004
Asphalt Pavement Association Of Michigan
Ultra-Thin Overlay

US-127 - 2004
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Ultra-Thin Overlay Use

Existing Pavement Preparation:

• Repair of minor base failures and depressions
• Filling of voids in pavement surface
• Removal/replacement of patches with high asphalt content
Ultra-Thin Overlay Use

Limitations:

Do Not Place On...

- Severely distressed concrete
- Rutted pavements require pre-treatment (3/8 in. deep or more)
- Pavements with a weak base
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As Bid Cost: 2007

Wtg. Avg. Cost per syd

- Ultra-Thin – low $ 2.27
- Ultra-Thin – medium $ 2.39
- Ultra-Thin – high $ 2.82
- Microsurfacing – warranty $ 2.35
# Asphalt Pavement Association Of Michigan

## Ultra-Thin Overlay

### Prevention Maintenance Treatments Cost Comparison

<table>
<thead>
<tr>
<th>Treatment</th>
<th>$/syd</th>
<th>Cost/mile (24’ wide)</th>
<th>MDOT Life extension range (years)</th>
<th>MDOT Life extension range average (years)</th>
<th>Cost/mile* per year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Double chip seal</td>
<td>$2.35</td>
<td>$33,088</td>
<td>3-6</td>
<td>4.5</td>
<td>$7,353</td>
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<tr>
<td>Micro-surface</td>
<td>$2.35</td>
<td>$33,088</td>
<td>3-5</td>
<td>4</td>
<td>$8,272</td>
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<tr>
<td>Ultra-thin low</td>
<td>$2.27</td>
<td>$31,962</td>
<td>5-9</td>
<td>7</td>
<td>$4,566</td>
</tr>
<tr>
<td>Ultra-thin med</td>
<td>$2.39</td>
<td>$33,651</td>
<td>5-9</td>
<td>7</td>
<td>$4,807</td>
</tr>
<tr>
<td>Ultra-thin high</td>
<td>$2.82</td>
<td>$39,706</td>
<td>5-9</td>
<td>7</td>
<td>$5,672</td>
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</tbody>
</table>

Average Life Extension estimated by APAM

Unit Prices based on MDOT Information
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Genesee County - Ultra-Thin - 1997
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Davison Highway
Micro-Surfacing transitioning to Ultra-Thin overlay
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US-127 – 3 yrs old – Medium Volume
Ultra-Thin
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Ultra-Thin Overlay

Fancher Street, Mt. Pleasant – 6 years old
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Advantages:

• Ease of construction, use standard paver
• Minimal construction time
• Don’t have to adjust structures
• Don’t have to wait to place permanent pavement markings
Advantages:

• Very smooth riding surface
• Quiet
• Improved ride quality
• No excess stone buildup
• No broken windshields from loose aggregate