Highway Engineering-II

Chapter 6

Pavement Rehabilitation

Contents

- Types of Major Distresses in Pavements and their Remedies
- International roughness index
- Design of pavement overlays
- Types of overlays and construction techniques
Learning Outcome

- Understand highway management system, various types of distresses and rehabilitation techniques

Introduction to Rehabilitation

- Pavement rehabilitation refers to the broad range of treatments for Repair, Rehabilitation, Restoration and Replacement of pavements, colloquially referred as the 4-Rs.
- Historically, these 4-R treatments excluded routine maintenance activities (e.g., pothole filling).
- Restoration refers to a variety of surface treatments such as crack filling and coating, while resurfacing includes chip sealing and overlaying with either asphalt concrete or Portland cement concrete (specifically called as surface treatments).
- Recycling consists mainly of incorporating reclaimed asphalt pavement (RAP) into new asphalt concrete.
- Reconstruction is, in essence, new construction.
Various Rating Manuals

- Pavement Rehabilitation: A Guide for Minnesota Cities and Counties
  MN LRRB

- Distress Identification for the Long Term Pavement Performance Program
  SHRP

Identifying the Distress is the 1st Step in the Process
Identifying Distresses Includes:

- Name
- Severity
- Amount

"Rate what you see and not what you think."

Flexible Pavement Distresses

Check pavement interactive website for details of rigid and flexible pavement distresses
Distress Modes

- **Surfacing Distress**
  - Cracking
  - Raveling
  - Potholing
  - Edge-Break

- **Deformation Distress**
  - Rutting
  - Roughness

- **Pavement Surface Texture Distress**
  - Texture Depth
  - Skid Resistance

- **Drainage Distress**
  - Drainage

Already discussed in the laboratory

Chapter 5
Cracking

- **Types**
  - Fatigue
  - Thermal/Transverse
  - Block
  - Edge
  - Longitudinal
  - Reflection
  - Slippage (U-shaped cracks in areas of braking, turning, accelerating)

<table>
<thead>
<tr>
<th>Types of cracking</th>
<th>Causes</th>
<th>Remedies/cures</th>
</tr>
</thead>
</table>
| Fatigue Cracks    | • Insufficient strength  
                   • End of pavement life  
                   • Too heavy of loads | • Remove and replace  
                   • Mill and overlay |
| Thermal Cracks    | • Contraction and Expansion of Pavement with temperature change | • Crack Filling  
                   • Full-Depth Reclamation  
                   • Thick Overlay |
| Block Cracks      | • High Void Content  
                   • Oxidative Hardening of the AC  
                   • Thermal Cracking | • Crack Filling/Sealing  
                   • Seal Coat  
                   • Full-Depth Reclamation  
                   • Thick Overlay |
| Edge Cracks       | • Soil Movement Beneath Pavement | • Crack Filling/Sealing  
                   • Full-Depth Reclamation |
| Longitudinal Cracks | • Low Temperatures | • Crack Sealing  
                     • Thick Overlay |
| Reflective Cracks | • Existing cracks or joints in the underlying structure  
                   • Concrete slab movements | • Crack Filling  
                   • Extensive Pre-Overlay  
                   • Saw & Seal |
| Slippage Cracking | • Poor bond between asphalt surface and underlying layer | • Crack Filling/Sealing  
                   • Full-Depth Reclamation |
# Surface Defects

- **Rutting**
  - • Low Air Voids
  - • Smooth, Rounded Aggregate
  - • Excess Dust
  - • Remove/Replace 100 mm
  - • Micro-surfacing

- **Shoving**
  - • Unstable Mix
  - • Braking, stopping, accelerating
  - • Slipage between layers
  - • Remove and Replace
  - • Mill and Overlay
  - • Thick Overlay

- **Bleeding**
  - • Too high asphalt content
  - • improperly seal coat or too heavy prime or tack coat
  - • Sand blot
  - • Micro-surfacing

- **Polished Aggregates**
  - • Soft aggregate
  - • Heavy traffic
  - • Seal coat
  - • Micro-surfacing
  - • Thin Overlay

- **Raveling**
  - • Asphalt binder unable to hold dusty aggregates
  - • segregation & stripping
  - • low in-place density
  - • aged asphalt binder
  - • Seal Coat
  - • Micro-surfacing
  - • Thin Overlay

- **Potholes**
  - • Raveling of crack & Insufficient strength
  - • Moisture damage & Freeze-thaw
  - • Patch

- **Patching deterioration**
  - • Poor bonding to existing layer
  - • Improper compaction & Poor materials
  - • Propagation of original distress
  - • Remove and replace
  - • Re-patch
  - • Assess original distress

<table>
<thead>
<tr>
<th>Types of Defects</th>
<th>Causes</th>
<th>Remedies/cures</th>
</tr>
</thead>
</table>
| Rutting          | • Low Air Voids
  • Smooth, Rounded Aggregate
  • Excess Dust |
|                  | • Remove/Replace 100 mm
  • Micro-surfacing |
| Shoving          | • Unstable Mix
  • Braking, stopping, accelerating
  • Slipage between layers |
|                  | • Remove and Replace
  • Mill and Overlay
  • Thick Overlay |
| Bleeding         | • Too high asphalt content
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| Raveling         | • Asphalt binder unable to hold dusty aggregates
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| Patch deterioration | • Poor bonding to existing layer
  • Improper compaction & Poor materials
  • Propagation of original distress |
|                  | • Remove and replace
  • Re-patch
  • Assess original distress |
Distress Types in Rigid Pavements

Main Distresses in Rigid Pavement

- Spalling
- Faulting and pumping (already discussed in chapter 2)
- Polished Aggregate
- Shrinkage Cracking
- Punch-out (already discussed in chapter 4)
- Linear Cracking
- Joint Load Transfer System Deterioration
- Durability Cracking
- Corner Break
- Alkali-Aggregate Reaction
- Reactive Aggregate Distress
- Pop-outs
- Blowup
Transverse Cracking

- **Causes:**
  - Slab longer than 15’ ft
    - Slab Curl
    - Curing
- **Cures:**
  - Crack Sealing
  - Full-depth rigid repair
  - Dowel bar retrofit

Longitudinal Cracking

- **Causes:**
  - Waiting too long to cut center joint
  - Subsoil settlement
    - Meander cracks
- **Cures**
  - Joint Sealing
  - Full depth replacement
  - Subsurface stabilization
Pumping

- Causes:
  - Water
  - Fines
  - Lack of load transfer
  - Loading

- Cures
  - Under sealing
  - Dowel bar retrofit
  - Full depth rigid repair
  - Concrete pavement grinding

Faulting

- Causes:
  - End-result of pumping
  - Eroded subsoil

- Cures:
  - Full-depth rigid repair
  - Under-sealing
  - Dowel bar retrofit
  - Grinding
Transverse Joint Spalling

- **Causes:**
  - Improper dowel alignment
  - Lack of joint seal

- **Cures:**
  - Crack & Joint Seal
  - Bonded Patching
  - Full-depth patching

Wear & Polishing

- **Causes:**
  - Traffic wears off surface aggregate

- **Cures:**
  - Grinding
  - Asphalt Overlay
Scaling

- Causes:
  - Non-air-entrained concrete
  - De-icing chemicals
  - Improper finishing technique

- Cures:
  - Grinding
  - Asphalt overlay
  - Bonded resurfacing
  - Partial depth patch

Shallow Reinforcing

- Cause:
  - Reinforcing Steel too close to surface

- Cure:
  - Asphalt overlay or patch
  - Replacing steel & partial or full depth repair
**Corner Cracking**

- **Causes:**
  - Insufficient soil support
  - Temperature related slab

- **Cures:**
  - Partial or full-depth patch
  - Replace slab
  - Stabilize subsurface

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**Blowups**

- **Causes:**
  - Expansion of concrete
  - Poorly sealed joints
  - Hot weather

- **Cures:**
  - Pressure relief joints to prevent
  - Patch or reconstruction after occurrence
Joint Load Transfer System Deterioration

Possible Causes

- Load transfer dowel bars can fail for two principal reasons:
  - **Corrosion.** If inadequately protected, dowel bars can corrode over time. The corrosion products occupy volume, which creates tensile stresses around the dowel bars, and a severely corroded dowel bar is weaker and may fail after repeated loading.
  - **Misalignment.** Dowel bars inserted crooked or too close to the slab edge may create localized stresses high enough to break the slab. Misalignment can occur during original construction or during dowel bar retrofits.

Repair

- Removal and replacement of the affected joint load transfer system followed by a full-depth patch for affected area.

Durability or D-Cracking

- Series of closely spaced, crescent-shaped cracks near a joint, corner or crack. It is caused by freeze-thaw expansion of the large aggregate within the PCC slab.

Causes:

- Poor quality aggregate
- Freeze/thaw cycle

Cures:

- Temporary:
  - Partial depth asphalt patch
- Permanent:
  - Full-depth repair

Photo courtesy of C.S. Hemsworth.
Pavement Rehabilitation
(Design of Pavement Overlays)

Introduction

- Typically, rehabilitation is triggered using pavement distress criteria (e.g., reaching threshold values in particular distresses).
- In addition, there are circumstances where pavement rehabilitation is triggered by safety rather than distress/roughness considerations (e.g., the need to increase pavement texture in order to improve skid resistance).
- The range of feasible 4-R treatments depends on pavement condition, as defined by the type of distresses present and their extent/severity, as well as the degree of structural strengthening necessary. Ideally, the best among the feasible 4-R treatments should be selected on the basis of life-cycle cost analysis (LCCA).
### Table 13.1
Guidelines for Flexible Pavement Rehabilitation Treatments and Estimated Service Lives

<table>
<thead>
<tr>
<th>Fatigue Cracking</th>
<th>Extent (% Length)</th>
<th>Asphalt Layer Thickness</th>
<th>Typical Treatments</th>
<th>Estimated Service Life</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>1–10%</td>
<td>&lt;200 mm</td>
<td>Patch or chip sealing</td>
<td>5</td>
</tr>
<tr>
<td>Medium</td>
<td>11–25%</td>
<td>&gt;200 mm</td>
<td>50 mm overlay</td>
<td>12</td>
</tr>
<tr>
<td>Medium</td>
<td>11–25%</td>
<td>&gt;200 mm</td>
<td>75 mm overlay</td>
<td>12</td>
</tr>
<tr>
<td>Medium</td>
<td>25–50%</td>
<td>&gt;200 mm</td>
<td>75 mm overlay</td>
<td>12</td>
</tr>
<tr>
<td>Medium</td>
<td>25–50%</td>
<td>&gt;200 mm</td>
<td>150 mm overlay</td>
<td>12</td>
</tr>
<tr>
<td>High</td>
<td>&gt;50%</td>
<td>&gt;200 mm</td>
<td>100 mm overlay</td>
<td>12</td>
</tr>
<tr>
<td>High</td>
<td>&gt;50%</td>
<td>&gt;200 mm</td>
<td>Reconstruction</td>
<td>15</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Transverse Cracking</th>
<th>Extent (Spacing)</th>
<th>Typical Treatments</th>
<th>Estimated Service Life</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>&gt;15 m</td>
<td>Rout and Seal</td>
<td>8</td>
</tr>
<tr>
<td>Medium</td>
<td>10–15 m</td>
<td>Clean and Seal</td>
<td>5</td>
</tr>
<tr>
<td>High</td>
<td>&lt;10 m</td>
<td>Clear/seal, and 50 mm overlay</td>
<td>10</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rutting</th>
<th>Extent (% Length)</th>
<th>Typical Treatments</th>
<th>Service Life</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;6 mm</td>
<td>&gt;25%</td>
<td>Do nothing</td>
<td>—</td>
</tr>
<tr>
<td>6–12 mm</td>
<td>&gt;25%</td>
<td>Grinding</td>
<td>7</td>
</tr>
<tr>
<td>12–25 mm</td>
<td>&gt;25%</td>
<td>Grinding</td>
<td>4</td>
</tr>
<tr>
<td>&gt;25 mm</td>
<td>&gt;50%</td>
<td>Mill and inlay 50 mm overlay</td>
<td>10</td>
</tr>
</tbody>
</table>

### Table 13.2
Guidelines for Jointed Rigid Pavement Rehabilitation Treatments and Estimated Service Lives

<table>
<thead>
<tr>
<th>Faulting Severity</th>
<th>Extent (% Length)</th>
<th>LTE*</th>
<th>Typical Treatments</th>
<th>Service Life</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>&gt;25%</td>
<td>&gt;70%</td>
<td>Do nothing</td>
<td>—</td>
</tr>
<tr>
<td>Medium</td>
<td>&gt;25%</td>
<td>&gt;70%</td>
<td>Grinding</td>
<td>5</td>
</tr>
<tr>
<td>Medium</td>
<td>&gt;25%</td>
<td>&lt;70%</td>
<td>Load transfer restoration and grinding</td>
<td>15</td>
</tr>
<tr>
<td>Medium</td>
<td>&gt;25%</td>
<td>&gt;70%</td>
<td>Grinding</td>
<td>6</td>
</tr>
<tr>
<td>Medium</td>
<td>&gt;25%</td>
<td>&lt;70%</td>
<td>Load transfer restoration and grinding</td>
<td>10</td>
</tr>
<tr>
<td>High</td>
<td>&gt;50%</td>
<td>&lt;70%</td>
<td>Crack/seal or rubblize and 125 mm overlay</td>
<td>12</td>
</tr>
<tr>
<td>High</td>
<td>&gt;50%</td>
<td>&lt;70%</td>
<td>Reconstruction</td>
<td>35</td>
</tr>
</tbody>
</table>

*Load Transfer Efficiency

### Panel and Corner Cracking

<table>
<thead>
<tr>
<th>Severity</th>
<th>Extent (% Length)</th>
<th>Typical Treatments</th>
<th>Service Life</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>1–10%</td>
<td>Panel replacement</td>
<td>7</td>
</tr>
<tr>
<td>Medium</td>
<td>11–25%</td>
<td>AC overlay</td>
<td>12</td>
</tr>
<tr>
<td>Medium</td>
<td>11–25%</td>
<td>Unbonded PC overlay</td>
<td>35</td>
</tr>
<tr>
<td>High</td>
<td>&gt;25%</td>
<td>Reconstruction</td>
<td>35</td>
</tr>
</tbody>
</table>
AASHTO (1993) Flexible Pavement Overlay Design Method

- AASHTO\textsuperscript{1} recommends an empirical flexible pavement overlay thickness design method that relies on the effective structural number (SN) of an existing pavement, denoted by $SN_{EFF}$.
- The remaining ESAL-life of an existing flexible pavement section is defined as the percent difference between the number of ESALs estimated to reach a terminal serviceability of 1.5 and the number of ESALs accumulated up to the present, expressed as (next slide):

$$RL = 100 \left( 1 - \frac{N_p}{N_{1.5}} \right)$$

where $RL$ is the remaining life, and $N_p$ and $N_{1.5}$ are the accumulated ESALs to the present and to terminal serviceability, respectively. The nomograph shown in Figure 13.1 is used to compute the condition factor ($CF$), which allows computing the effective structural number $SN_{EFF}$ of this section as:

$$SN_{EFF} = CF \times SN_0$$

where $SN_0$ is the original structural number of the pavement section.
AASHTO (1993) Flexible Pavement Overlay Design Method

The required overlay thickness $D_{OL}$ is computed using:

$$D_{OL} = \frac{SN_f - SN_{EFF}}{a_1}$$

where $SN_f$ is the structural number of a new pavement at this site designed to sustain the future-life ESALs anticipated as computed using the procedure described in Chapter 11. Typically, an $a_1$ value of 0.44 is used for new asphalt concrete layers.
Example

- Determine the thickness of the asphalt concrete overlay required for an existing pavement with asphalt concrete, unbound base and Sub-base layer thicknesses of 18 cm, 15 cm and 20 cm (7, 5.9, and 7.9 in.) respectively.
- The section has experienced 3.5 million ESALs to date; its serviceability is 2.5 in the PSI scale; and it is estimated that if left untreated, it could sustain another 1.5 million ESALs before its PSI reduces to a terminal value of 1.5. It is estimated that the overlaid pavement needs to have a structural number of 4.8 to sustain future traffic. The pavement layers drain within one day if they become saturated, which happens 10% of the time.

Solution to Example

- Draining within one day characterizes the drainage as “good” which, combined with 10% of time saturation, allows estimating drainage coefficients for the base and the sub-base layers of 1.1.

\[ S_{N_0} = 0.44 \times 7 + 0.14 \times 1.1 \times 5.9 + 0.11 \times 1.1 \times 7.9 = 4.94 \]

The remaining life factor is computed from Equation 13.1 as:

\[ RL = 100 \left( 1 - \frac{3.5}{5.0} \right) = 30\% \]

Using a 30% remaining life, Figure 13.1 gives a condition factor (CF) of 0.82, which allows computing the effective structural number \( SN_{EFF} \) from Equation 13.2 as:

\[ SN_{EFF} = CF \times S_{N_0} = 0.82 \times 4.94 = 4.05 \]

Given a required future structural number of 4.8, the overlay thickness can be computed from Equation 13.3 as:

\[ D_{OL} = \frac{SN_F - SN_{EFF}}{\alpha_1} = \frac{4.8 - 4.05}{0.44} = 1.7 \text{ in to be rounded up to 2 in (5 cm)} \]
AASHTO (1993) Rigid Pavement Overlay Design Method

- Study by yourself
- Chapter 13 of Pavement Design and Materials

Family of Concrete Overlays

Concrete Overlays

- Existing Pavement Concrete
  - Bonded Concrete Overlay
  - Unbonded Concrete Overlay
- Existing Pavement Asphalt
  - Conventional Whitetopping Overlay
  - Ultra-Thin Whitetopping Overlay
Bonded Concrete Overlay

- Consists of a thin concrete layer (100 mm or less) on top of an existing concrete surface (existing pavement is in good condition & requires little pre-overlay repair)
- Good candidates for bonded overlays are pavements that have little deterioration, but are too thin due to increased traffic volumes.
- Specific steps are taken to bond the new concrete overlay to the existing concrete.
- The bonded overlays created a much thicker monolithic slab

- Do NOT apply to appreciably distressed pavements. pavements with high-severity "D" cracking or reactive aggregate problems.

Bond = Strength

Advantages

- Increase structural capacity.
  - More efficient than AC.
    - One in. of PCC ~ two 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
Pre-Overlay Repair

Transverse Cracks

- Not all transverse cracks require repair.
- Address working cracks (faulting, pumping corner breaks)
  - Full-depth repair.
  - Random crack control.

NOTE: Untreated cracks will eventually reflect through. Saw & seal the cracks

Placement of Crack Control Cages

Recessing Bars

2 inches Cover

Milled
Pre-Overlay Repair

Joint Deterioration

➢ Spalling, blow-ups, corner breaks.
  ▪ Repair Full or Partial Depth

➢ Lightly spalled joints may be milled to sound concrete.
  ▪ Depressions less than 2 in. deep, fill with concrete during the overlay operation.
  ▪ Depressions more than 2 in. deep, fill with concrete prior to the overlay.

Bonding

➢ Bonding between the two layers is principally a mechanical process
  ▪ Depends primarily on the soundness and cleanliness of the underlying pavement.

➢ Full Bond
  ▪ Bond shear strength = 200 psi (min.)

➢ Is grout required to enhance bonding?
Bonded Concrete Overlay (Surface Preparation)

- Cleanliness is key to long-term performance.
- Surface preparation procedures:
  - **Cold-milling** (Scarifying) and **Shotblasting** are effective surface removal techniques, which provide a coarse texture that will benefit bond strength.
  - Milling the existing surface will remove all contaminants and loose material. Depths of 1/4 to 1/2 inch have proven to be adequate for bonded overlay projects.
  - **Shotblasting** is the second technique and it is by far the most common, and most proven procedure.

Bonded Overlays

**Curing**

- Critical because high ratio of surface area to volume of concrete.
- Apply ASAP
  - 1 gallon/100 sq.ft.
- Coat all exposed edges.
- Avoid extreme weather.
- Avoid contact with prepared surfaces.

**Performance**

- Good when:
  - Placed correctly and at the right time.
- Poor when:
  - Placed on deteriorated pavements.
  - Loss of bond does not necessarily constitute failure.
Unbonded Concrete Overlay

- Consists of thick concrete layer (125 mm or greater) on top of an existing concrete.
- Uses a “separation interlayer of asphalt” to separate new overlay and existing concrete.
- This separation interlayer also acts as a cushioning layer and prevents distresses from the underlying pavement reflecting into the overlay.

When to Use Unbonded Overlays

- Little or no remaining structural life
- Extensive and severe durability distress
- Medium to very heavy truck traffic
- Very weak or wet subgrade
- Other obstacles to reconstruction
Un-bonded Overlay (Benefits)

- Little pre-overlay repair needed
- Improved Structural Capacity.
  - Very Strong Base that can maintain traffic
  - Reduced Faulting, Pumping, & Loss of Support
- Can place on pavement in bad condition.
  - i.e. "D" cracked pavements, ASR, etc.
  - No future reflective cracking.
- Avoids reconstruction problems
  - Less construction time

Un-bonded Overlay- Pre-overlay Repair

Unbonded Overlays are less sensitive to underlying pavement condition than any other Overlay type

May be needed:
- Repair/replace shattered or rocking slabs
- Repair punch-out's in CRCP

Probably not needed:
- Repair of other slab cracking
- Repair of joint spalling
- Load transfer restoration
Un-bonded Concrete Overlay

**Separation Interlayer:**
- Allows layers to act independently.
- Prevents distresses from reflecting into overlay.
- Materials that work:
  - Asphalt concrete
  - Some surface treatments
- Materials that do not:
  - Polyethylene
  - Roofing paper
  - Curing compound

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**Unbonded Concrete Overlay**

**Separation Interlayer:**
- “Key”
- Overlay
- Old Pavement
- Smooth Slip Plane
- Overlay
- Old Pavement
- Thick Interlayer (> 50 mm)
# Unbonded Overlays

<table>
<thead>
<tr>
<th>Jointing</th>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>➢ Mismatch joints.</td>
<td>➢ Very Good</td>
</tr>
<tr>
<td>➢ Saw joints d/3.</td>
<td>➢ Can be expected to perform for 20+ years.</td>
</tr>
<tr>
<td></td>
<td>▪ Most failures are due to the use of inadequate separation layers.</td>
</tr>
</tbody>
</table>

Overlay joints should be mismatched from working cracks too.

---

## Concrete Overlays of Asphalt Pavements (White-topping)

- Consists of a thick concrete layer (100 mm or greater) placed directly on top of an asphalt concrete pavement.
- Behaves as a new pavement on a strong base.

- Whitetopping:
  - Well-established, proven pavement rehabilitation technique

- Ultrathin Whitetopping:
  - Newer technology
  - Still under evaluation by some

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Whitetopping - Advantages

**Construction**
- Can place on pavement in bad condition.
  - Little or no pre-overlay repair needed.
- Avoid reconstruction problems.
  - Minimal rain delays.
  - Maintain traffic on existing surface.

**Structural**
- Improved structural capacity.
  - Reacts structurally as if on strong base course.
- Maintains high level of serviceability.
- Concrete slabs bridge problems asphalt cannot.
- Reduced potential for pumping, faulting and loss of support.

Whitetopping - Advantages

**Safer**
- Visibility
- Decreased stopping distances
- Non-rutting
- Less work zone reconstruction
  - *less accidents*
Whitetopping Construction

- Critical issue is uniform support
  - Subgrade / base failures need repair
  - Need to evaluate drainage
- Address surface distortions
  - Direct application
  - Profile milling
  - Leveling course

Whitetopping Construction

- Direct Application
  - Sweep surface and place
  - Use when rutting ≤ 50 mm
  - On crowned roadways makes thickened edges
  - Economical, practical.
- Surface cross-section survey.
  - Determine cross-sectional area & overlay volume.
  - Concrete overlay fills ruts.
Whitetopping Construction

Transverse Cracks

“Key”

Overlay

Smooth Slip Plane

Overlay

---

Whitetopping Construction

- **Profile Milling**
  - Use when rutting > 50 mm
  - Removes between 25 and 75 mm
  - Can shave off top of ruts

- **Leveling Course**
  - Consider only where extreme rutting or distortion exists
    - Use when rutting > 50 mm
    - Places between 25 and 50 mm of AC
      - Can just fill ruts
    - Requires more equipment, materials, time
  - Usually most expensive option
Ultra-Thin Whitetopping

- A concrete overlay, 2 to 4 inches thick with close joint spacing, bonded to the existing asphalt pavement.
  - May or may not contain fibers
- Can carry traffic loadings typical of
  - low-volume roads
  - city streets
  - parking areas
  - intersections
  - bus pads
  - etc.

UTW Design Issues

- Bond is critical.
- Slab size (jointing) is important.
- Underlying asphalt thickness is important.
UTW Construction Steps

- Milling for Surface Preparation
- Clean Surface
- Placing Concrete
- Cutting Joints 2’ x 2’ panels