Asphalt Pavement Maintenance and Rehabilitation Techniques

Introduction and Housekeeping

- Restrooms & Emergency Exit(s)
- Cell phones, texting, side conversations
- Instructor
  - Mike Robinson, PE
  - 30+ years’ experience as contractor, consultant, and agency representative

Self Introductions

- Name
- Employer / organization
- Experience
- Why are you here / what do you want to cover?
Course Outline

- Cracks
- Patching
- Thin Overlays
- In-place and central plant recycling

The objective is to optimize maintenance, repair, and rehabilitation for asphalt pavements.

This course includes images and videos obtained from various vendors, equipment manufacturers, and contractors. This does not constitute endorsement of any products, equipment, or companies.

Pavement Preservation – No Structural Benefit

- Fog Seals
- Rejuvenators
- Slurry Seals
- Micro Surfacing
- High Density Mineral Bond
- Chip Seals
- Double Chip Seals
- Cape Seals
- Otta Seal
Low Volume Pavements

• Tend to suffer more from environmental stresses than from load-related stresses
• Rate and manner of deterioration tends to differ from high-volume pavements

Pavement Distresses / Failure Modes

Load-related

Environmental

Crack Sealing

• Reduce moisture infiltration into subgrade
• Reduce potential for incompressibles
• Improve ride quality (in some cases)
Not a Structural Repair

Crack Sealing - General

Timing is important
Season
Subsequent treatment(s)
Preparation is important
Clean
Dry
Sound pavement on both sides

Narrow Cracks

Overband?
Rout and seal
Wide Cracks

Lots of crack seal?
Patch
Remove and patch
Cold mill and patch

Mastics

Overlays and Surface Treatments
Crack Sealing
- Equipment in good working order
- If hot air blasting, do not overheat
- Follow manufacturer's recommendations
- Use care when opening to traffic

Patching
Can be very effective for limited areas
Make sure you identify and address the root cause.

Select Appropriate Limits

Consider pavement condition
Consider means and methods

Appropriate removal limits?
Place the Mix

Allow for Compaction

Mastics
Cold Milling

Smooth, uniform substrate for paving:
Uniform mat thickness
Uniform mat texture
Uniform mat density
Easier to control yield
Valuable millings produced
Often better than a leveling course.

Thin (1.5” or less) Overlays

Thin Overlays
Thickness vs NMAS

NMAS – nominal maximum aggregate size
One sieve size larger than the first sieve to retain more than 10%.

$t/NMAS$:
- at least 3 for fine-graded mixes
- at least 4 for coarse-graded mixes

Nominal Maximum Aggregate Size

Generally, as the NMAS decreases:
- Binder content increases
- Crushing costs may increase
- Permeability decreases

Mixes with 4.75-mm (#4) NMAS have been developed and used successfully.

Higher paver speed

300 tph * 2,000 lb/ton / 60 min/hr / 145 pcf /
12’ wide / 1” deep = 70 feet per minute

Optimum paver speed for ride quality – 45 fpm?
In addition to paver speed, thin lifts reduce the amount of smoothness improvement you can expect – existing roughness is a larger percentage of lift thickness.

- 1” overlay, 70 degrees, 15 mph wind, 300° mix temp – less than 9 minutes to compact

- 10 – 12 impacts per foot

70 fpm * 5 passes * 12 impacts/ft / 90% efficiency = 4,700 vibrations per minute
Pneumatic-tired roller recommended. Vibratory effort may need to be reduced.

Hot Mix Overlays for Rutting

Roller
Not enough densification here

Too thin and too cold here
And remember…

ALL of the rolling has to be completed in less than 9 minutes

Greater influence of underlying layers for nuclear density gauges

Thin cores can be difficult
Why Worry?

NCAT Report 16-02
• Decreasing in-place air voids improves performance
• 1% decrease in air voids:
  - 8 - 44% improvement in fatigue
  - 7 - 66% improvement in rutting

Why Worry?

NCAT Report 16-02
• 1% decrease in air voids can extend service life by 10% (conservatively)
• Increasing the required minimum density can save nearly 10% in net present value

Intelligent Compaction

Image courtesy of Sakai
But the mapping is very helpful

Image courtesy of Topcon

Thin Overlays

Use less mix, but often more expensive mix.

Paver speed increases, production rate decreases, or both.

Ride quality may be more difficult to obtain.

Less thickness = less structural contribution.

Thin Overlays

May need high frequency rollers, more rollers, or both.

Time available to compact limited.

Density more difficult to measure.

Higher (93% of Rice minimum) density recommended.
Two- and Three-Layer Systems

- Slurry over Chip (Cape Seal)
- Pre-level with Microsurfacing, then Chip and Slurry

Treatments for Cracking

Fabric?

Advantages
- Relatively low cost IF cracking is retarded or prevented
- Can be used under chip seals

Limitations
- Potentially inhibits/eliminates future recycling
- Placement challenges
tack, folds, corners, etc.
Fabrics can be difficult to pave over

Treatments for Cracking

Fabric?

Proper tack material and application is key
Minimum 2” thick overlay recommended

Wind and Fabric
Treatments for Cracking
Grids
Advantages
Relatively low cost IF cracking is retarded or prevented
Limitations
Potentially inhibits / eliminates future recycling
Placement challenges
tack, folds, corners, etc.
Can be difficult to pave over

Treatments for Cracking
Grids?

Proper tack material and application is key
Minimum 2” thick overlay recommended

Treatments for Cracking
Grids?
Treatments for Cracking

Stress Absorbing Membrane Interlayers (SAMI)
- Rubberized or fabric
Saw and seal (for HMA over PCCP)
High strain asphalt crack relief interlayer

Asphalt-Rubber Chip Seal

Gap-Graded Asphalt-Rubber Hot Mix
Asphalt-Rubber

Viscosity is what defines Asphalt-Rubber Binder:
- Asphalt-Rubber: 1,500 to 2,500 Centipoises at 375°
- Extremely Viscous

Rubberized Asphalt Terminal Blend
- 300 to 600 Centipoises at 325°
- Significantly less viscous than AR

PelletPave
Treatments for Cracking

- Fibers?

Hot-In-Place Recycling

Surface Defects
- Raveling
- Flushing
- Shallow Rutting
- Shallow top-down cracking
Hot-In-Place Recycling

Advantages
- Reuse of existing materials
- Minimal materials purchased

Limitations
- Limited effective depth
- Appropriate recycling / rejuvenating agent
- Specialized equipment
- Potential for excessive aging
- Air quality

FHWA report – 3 to 8 years

HIPR Construction
- Equipment concerns
  - Preheaters
  - Millers / Scarifiers
  - Additive metering / mixing system
  - Spreader / paver / rollers
- Weather
- Mix design
- Temperature control
- Mat quality
- Compaction

Deep Cracks
In-Situ Recycling

- Little or no material haul
- Little damage to surrounding roadways
- Limited construction traffic impacts
- Limited material costs
- Protect or even improve subgrade
- Adjust profile and cross slope
- Relatively fast
- Can run traffic on the material
- Variety of wearing course options

Full-Depth Reclamation
Vertical Mixing

Lateral Mixing

Can Improve Subgrade
Additives

- Cement
- Lime – quick or hydrated
- Fly ash
- Emulsion
- Foamed Asphalt

Injection of foamed bitumen and water into the aggregate via separate injection systems

Check Spread Rate
Compaction

Test for Moisture and Density

Prime Coat?

- Keep moisture in for cement / lime hydration
- Protect surface if not covered immediately
- Cutback, lignin, or similar – emulsion not recommended.
Micro-cracking CTB?
Roll with vibratory roller 2 days after construction.
- Reduce number and severity of reflective cracks (but may not eliminate them)
- Produces hundreds of tiny cracks rather than fewer, larger shrinkage cracks

Cold In-Place Recycling – Partial Depth

Candidate Projects
Distress can be severe, but must be limited to the pavement layer.
Additives

- Emulsion
- Foamed Asphalt
- Portland Cement
- Lime

Images courtesy of Graniterock
Mix Design – Marshall Method

Images courtesy of Graniterock
Typical Mix Designs
1% to 3% emulsion or foamed asphalt
1% to 2% Portland cement or lime
Moisture for compaction
Indirect (split) tensile criteria is typical
– 35 psi +/-
For foamed asphalt:
  Expansion ratio
  Half-life

Lower Utilities

Cold Milling / Key Cuts
Note cement being spread ahead of the operation.
Double Chip Seal

Cape Seal
Slurry or microsurfacing over a single or double chip seal

Plantmix Overlay
## Structural contribution of additives

<table>
<thead>
<tr>
<th>Additive</th>
<th>AASHTO '93 Structural Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>0.10 – 0.12</td>
</tr>
<tr>
<td>Portland Cement</td>
<td>0.14 (UCS = 300 psi)</td>
</tr>
<tr>
<td>Asphalt Emulsion</td>
<td>0.25 - 0.28</td>
</tr>
<tr>
<td>Foamed Asphalt</td>
<td>0.30-0.35 (40-50 psi IDT)</td>
</tr>
</tbody>
</table>

## Section Comparison

- **FDR – 15”**
- **Cement – 11”**
- **Emulsion – 6”**
- **Foamed asphalt – 5”**

## Additive Pros Cons

<table>
<thead>
<tr>
<th>Additive</th>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>Low cost, low complexity, no cure time, no prime coat</td>
<td>Limited strength</td>
</tr>
<tr>
<td>Portland Cement / lime / fly ash</td>
<td>Moderate to high strength, suitable for soils and aggregate, low cost, drying</td>
<td>Reflective cracking risk, cure time, prime coat</td>
</tr>
<tr>
<td>Asphalt Emulsion</td>
<td>Moderate to high strength, can be used in thin sections, some suitable for granular material</td>
<td>May require complex equipment, cure time, more expensive</td>
</tr>
<tr>
<td>Foamed Asphalt</td>
<td>High strength, can be used in thin sections, no cure time, suitable for granular material</td>
<td>May require complex equipment, more expensive</td>
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Selection and Design Walkthrough

- Failure analysis
- Subsurface Investigation
  - Types of materials and thicknesses
  - Soils and moisture contents
  - Shallow utilities
- Geometry and drainage
- Traffic
- Desired surfacing
- Section design
- Specifications and bid package
- Quality management

Failure Analysis

- Load-related or environmental?
  - Subgrade failure?
  - Drainage / moisture?
  - Localized as well as general
Subsurface Investigation

Types of materials and thicknesses
Subsurface Investigation

Cold mill prior?
• Maintain vertical clearance / curb reveal.
• Reduce section to accommodate desired process.
• Recover high-value RAP for hotmix or other uses.

Subsurface Investigation

Soils and moisture contents

Subsurface Investigation

Shallow utilities
Geometry and Drainage

- Seasonal issues
- Desired changes to profile and cross slope

Traffic

- Heavy traffic is the concern
- May have seasonal issues (spring thaw)
- Expansive soils?
- Any anticipated changes in traffic?
- Construction traffic

Desired Surface

<table>
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<tr>
<th>Structural contribution &amp; surface quality</th>
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</thead>
<tbody>
<tr>
<td><strong>Wearing Course</strong></td>
</tr>
<tr>
<td>Chip Seal</td>
</tr>
<tr>
<td>Double Chip Seal</td>
</tr>
<tr>
<td>Cape Seal</td>
</tr>
<tr>
<td>Plantmix</td>
</tr>
</tbody>
</table>
Section Design

- AASHTO ‘93 recommended
  - Relatively simple, allows comparison of equivalent sections, data for various treatments available
- Need to select a strength value
  - Used for design
  - Inserted into specifications
  - Achieved in the field

CIR / FDR Mix Designs
Requires sampling & testing prior to start
Testing during construction takes time
Whose problem is it if requirements aren’t met during production?
CIR / FDR Mix Designs

Recommendations:
- Use conservative values for structural design
- Develop mix design to easily exceed those values
- Monitor construction

Specifications & Bid Package

- Existing specifications available
- Make sure they suit your needs
  - Design assumptions including strength
  - How you plan to administer the project
- Avoid specific equipment requirements
  - Focus on end result
- Advertise early
- Allow scheduling flexibility

Submittals

The suppliers of aggregates to [Company Name] Inc. are as follows:

- 3/4” max aggregate supplied by [Supplier Name], located in [Location].
- 3/8” max aggregate supplied by [Supplier Name], located in [Location].

Please let me know if you have any further questions or concerns. Thank you.
Quality Management

- At a minimum, you need to control
  - Depth of treatment
  - Consistency of material vs design assumptions
  - Moisture conditioning
  - Additive types and rates
  - Uniform mixing
  - Compaction
  - Curing if required
- Contractor QC with owner verification recommended

Additive Metering

- Unit weight
- Dry additives
  - Length, width, and depth
- Liquid additives
  - Single-unit machines
  - Trains with weighbridge
Cold Central Plant Recycling

Advantages
Greater control over materials
Opportunity to reduce variability
Can use materials from one location at a different location
Can combine with in-place recycling

Limitations
Increased cost relative to in-situ methods
Load, haul, treat, haul again

Central Plant Recycling

Versatility

• Pulverize
  • Asphalt Zipper to equipment trains
• Profiling and cross slope options
• Additives and mixing
  • Cement, fly ash, lime, asphalt emulsion, foamed asphalt, or none
• In place or central plant
• Structural contribution
  • Aggregate base to almost plantmix
MNDOT 2016-14 – CIR & FDR w/ Chip

- 12% to 42% lower life-cycle costs compared to 4” overlay
- Estimated life expectancies of 17 to 19 years
- May not meet user expectations

Summary

- Cracks
- Overlays
- In-Place Recycling
  - Hot or cold
  - Full or partial-depth
  - Variety of additives
    - Portland cement, lime, fly ash, asphalt emulsion, foamed asphalt
- Cold Central-Plant Recycling
- Project Evaluation