What’s New in Paving?
14th Annual Public Works Continuing Education Conference

Andrew Hipolit, PE, PP, CME

- Municipal Engineer for 30 years
- Regional Manager of Maser Consulting’s Mt. Arlington office
- Municipal Representative for 20 towns
- ahipolit@maserconsulting.com
OVERVIEW

- Pavement Preservation
  - New Technologies
  - Traditional Techniques
- Pavement Failures
- Preservation Options
  - Resurfacing
  - Maintenance

PAVEMENT PRESERVATION
NEW TECHNOLOGIES
MICRO SURFACING

- Micro surfacing halts oxidation and raveling and can be used to increase surface friction, address profile leveling and to fill ruts.

COLD IN-PLACE RECYCLING

- Recycle old roads into new ones.
- Existing pavement is pulverized into aggregate & mixed with a rejuvenating asphalt emulsion & reused to resurface the road.
WARM MIX ASPHALT

- Decreased production temperature to ~225°F
- Reduced emissions from burning fuels, fumes, & odors generated at the plant & the paving site

CAPE SEAL

- A chip seal covered with a slurry or microsurface
- Benefits include a very smooth surface with an increased durability by sealing the subbase
HIMA – HIGHLY POLYMER MODIFIED ASPHALT

- Reduces pavement thickness by 40%
- >2x the loading capacity of ordinary asphalt

INFRARED REPAIR

- Patch potholes, repair utility cuts, adjust asphalt around manholes & valve boxes, repair paver seams, create “welded joints” in patches or new paving
PAVEMENT PRESERVATION
TRADITIONAL TECHNIQUES

MILL & PAVE

- Grind top 2-3” & apply 2-3” of surface course
- Typically uses Hot Mix Asphalt
CRACK SEAL

- Polymer modified rubber blend
- Keeps water out of sub base to protect underlying pavement
- Reduce freeze/thaw cycles

CHIP SEAL

- Combines asphalt emulsion with fine aggregates
- Impermeable & skid resistant wearing course
FOG SEAL / REJUVENATION

- Application of diluted, slow-setting asphalt emulsion
- Restore flexibility to existing HMA pavement

FULL DEPTH RECLAMATION

- Pulverize entire asphalt surface & underlying base
- Reuses existing onsite materials
TACK COAT

- Light application of emulsion between HMA layer to create strong adhesive bond without slippage
- Reduce slippage, rutting & shovage

BALANCING MAINTENANCE & PRESERVATION

- Understand the need to continue mill & pave program for failing roads
- Also need to maintain newer roads
- Set aside budget for maintenance before failure stage
PAVEMENT FAILURES

TYPES OF PAVEMENT FAILURE

- Cracking
- Distortion
- Disintegration
- Skidding Hazards

PHOTO SOURCE: GRAND BLANC (MICHIGAN) PD FACEBOOK, 2/23/18
PAVEMENT FAILURE: CRACKING

**ALLIGATOR (FATIGUE)**
- Subgrade and asphalt base compress from vehicle weight
- Initial cracks form and spread through water intrusion and further asphalt base compression

**REFLECTION**
- Caused by breaks or cracks in underlying layers due to movement at the original crack
- Stresses concentrate and cracks reflect to new surface over time

**EDGE**
- Cracks within one to two feet of edge of pavement
- Causes include: water damage, insufficient base, vegetation and heavy traffic

**TRANSVERSE**
- Perpendicular to pavement centerline
- Caused by: shrinkage/thermal changes or reflection from existing crack

**BLOCK**
- Series of large (over 1’) rectangular cracks
- Expansion / shrinkage due to temperature changes

**LONGITUDINAL**
- Parallel to pavement centerline
- Caused by: poorly constructed joint, shrinkage, cracks reflecting up or longitudinal segregation due to improper paver operation
### PAVEMENT FAILURE: DISTORTION

#### SLIPPAGE CRACKING
- Crescent-shaped cracks
- Low-strength asphalt mix or poor bond between pavement layers
- Caused by forces applied by turning or braking

#### RUTTING
- Linear surface depression in wheel path
- Deformation of pavement layers or subgrade
- Can be caused by insufficient pavement thickness, lack of compaction and weak asphalt mixes

#### SHOVING (WASH-BOARDING)
- Ripples across pavement surface
- Areas with severe horizontal loading, such as intersections
- Caused by: excess asphalt, too much fine aggregate, rounded aggregate, too soft asphalt mix or weak granular base

#### DEPRESSIONS (BIRD-BATH)
- Localized low spot
- Caused by settlement or other failure in the lower pavement layers or by poor construction

#### UPHEAVEL
- Localized upward movement in pavement due to swelling of subgrade
- Example: frost heave

#### PATCH FAILURE
- Distress occurring at previous patch
- Rate at which patch deteriorates influenced by compaction, material selection and quality of surrounding pavement
**PAVEMENT FAILURE: DISINTEGRATION**

| **RAVELLING** | Aggregate particles wearing away from asphalt due to traffic  
| | Indicates asphalt has hardened or poor quality mixture was used |

| **POTHoles** | Localized upward movement in pavement due to swelling of subgrade  
| | Example: frost heave |

| **POLISHED AGGREGATE** | Some aggregate can wear to smooth finish under traffic  
| | Surface roughness must be restored |

---

**BLEEDING**

- Pavement surface can become flush with asphalt & lose skid resistance  
- Caused by too much asphalt in mix, excess tack or bond coat, or poor construction of seal-coat  
- Traffic can also over-compact an unstable mix & force asphalt to surface
TIMING OF TREATMENT IS CRITICAL

Asphalt Deterioration Curve

$1 of preventive maintenance here...
Eliminates or delays spending $8 - $10 on rehabilitation here.

75% of Life

12% of Life

Years

ASPHALT DETERIORATION CURVE

Applying the Right Treatment, to the Right Road, at the Right Time...

Excellent
Good
Fair
Poor
Very Poor
Failed

1. Crack Seal/Fog Seal Rejuvenation
2. Chip Seal
3. Polymer modified Chip Seal
4. Cape Seal; AR-SAM/SAMI; FiberMat
5. HMA Overlay; Bonded Pavements
6. Mill & HMA Overlay
7. In-Place Recycling & Overlay
8. Full Depth Reconstruction
9. Crack Filling (as needed)
RESURFACING OPTIONS

- Full Depth Reclamation
- Partial Depth Mill & Pave
- Cold In-Place Recycling
- Warm Mix Asphalt
- HiMA
- Fog Seal/Rejuvenator
- Pavement Fabric
FULL DEPTH RECLAMATION

- Recycles existing materials from base to surface course
- Apply to areas with base failure
- Service Life: 35 years
- Cost: $16/SY

PARTIAL DEPTH MILL & PAVE

- Grind top 2-3” and apply 2-3” of surface course, typically HMA. Apply with tack coat
- Apply when & where patching is not sufficient
- Service Life: 30 years
- Cost: ~$10/SF
COLD IN-PLACE RECYCLING

- Grind surface course and add recycling agents (e.g., emulsified asphalt and chemical additives)
  - Apply at ~110°F
  - Apply to pavement with cracking and sound base
  - Followup with fog seal
- Service Life: 12 years
- Cost: $6.50/SY

WARM MIX ASPHALT

- Surface course laid at ~225°F
- Benefits:
  - Reduce greenhouse gases
  - Better compaction on the road
  - Haul paving mix for longer distances
  - Extending paving season by being able to pave at lower temperatures
- Service Life: 15 years
- Price: $13/SY
  - ~20% less than HMA
HiMA - HIGHLY POLYMER MODIFIED ASPHALT

- Polymers reduce pavement rutting, stripping, thermal cracking and stress cracking
- More than 2x loading capacity of ordinary asphalt
  - 1.5” HiMA vs. 2.5” HMA overlay
  - Resistant to fatigue & deformation
- Service Life: 20 years
- Cost: $12/SY
  - 30% cheaper than HMA due to thinner overlay

FOG SEAL/REJUVENATOR

- Diluted asphalt emulsions
- Apply on top of newly resurfaced road
- Prevents oxidation and improves appearance
- Service Life: 1-2 years
- Cost: $0.40/SY
PAVEMENT FABRIC

- Moisture barrier and a stress absorbing interlayer
  - Retards crack reflection for 3x longer than without fabric
  - Millable and recyclable
- Exhibits best results when covered with a 2” asphalt overlay
- Good for areas without ability to apply thick asphalt surface course
- Cost: $2.50/SY

RESURFACING COSTS

<table>
<thead>
<tr>
<th>METHOD</th>
<th>COST</th>
<th>EXTENDS ROAD LIFESPAN BY:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Depth Reclamation</td>
<td>$16.00 / SY</td>
<td>35 years</td>
</tr>
<tr>
<td>Partial Depth Mill &amp; Pave</td>
<td>$10.00 / SF</td>
<td>30 years</td>
</tr>
<tr>
<td>Cold In-Place Recycling</td>
<td>$6.50 / SY</td>
<td>10-15 years</td>
</tr>
<tr>
<td>Warm Mix Asphalt</td>
<td>$13.00 / SY</td>
<td>10-15 years</td>
</tr>
<tr>
<td>HiMA</td>
<td>$12.00 / SY</td>
<td>10-15 years</td>
</tr>
<tr>
<td>Fog Seal/Rejuvenator</td>
<td>$0.40 / SY</td>
<td>1-2 years</td>
</tr>
<tr>
<td>Paving Fabric</td>
<td>$2.50 / SY</td>
<td>10-15 years</td>
</tr>
</tbody>
</table>
MAINTENANCE OPTIONS

- Microsurfacing
- Slurry Seal
- Crack Sealing
- Chip Seal/Polymer Modified Chip Seal
- Cape Seal
- Thin HMA Overlay
- Infrared Repair
MICROSURFACING

- Polymer modified cold-mix paving system
- Applied to existing asphalt or concrete pavement in 3/8" layer or less
- Repair:
  - halts oxidation and raveling
  - increases surface friction
  - levels profile
  - fills ruts up to 1-1/2" deep
- Maintenance:
  - prevents UV deterioration & water penetration
  - seals cracks up to 1/4" thick
  - restores surface/contrast and aesthetics

MICROSURFACING

- Environmentally friendly
  - Study performed by BASF Corporation found microsurfacing significantly less harmful to environment compared to other road reconstruction methods
  - 50% less materials than mill & pave
  - 40% less energy required (cooler production and application)
- Cost Effective
  - ambient temperature application = ~40% less energy required
  - less material = less transport cost
MICROSURFACING

- Efficient
  - Can lay 500 tons per day, with no long traffic delays (equates to an 6.6 lane miles)
  - Similar to slurry seal, but chemical additives allow quicker hardening
  - Can be applied in wider range of weather conditions, lengthening paving season
  - Roads can re-open in as little as one hour
- Service Life: 6-9 years
- Cost: $2.75 / SY

MICROSURFACING

Microsurfacing vs. Slurry Seal

- Similar to slurry, but microsurfacing differs by:
  - higher polymer content in its emulsion
  - higher asphalt residual content
  - fast-setting chemicals allow a faster break
  - contains higher quality aggregate
  - requires higher quality control
CRACK SEALING

- Polymer modified rubber blend
- Keeps water out of sub base to protect underlying pavement
- Reduce freeze/thaw cycles
- Service Life: 1-3 years
- Cost: $1.00 / LF

CHIP SEALING

- Protective wearing surface; can also upgrade a gravel road to paved
- Asphalt binder applied to existing surface, followed by layer of aggregate chips rolled into the binder
- Treats or prevents areas of oxidation, top down fatigue cracks, raveling and loss of friction
- Aggregate larger and looser than microsurfacing slurry; can cause vehicle damage
- Service Life: 5-7 years
- Cost: $2.25 / SY
CAPE SEAL

- Chip seal covered with a slurry or micro-surface
- Very smooth surface with an increased durability by sealing the subbase
- Repairs moderately to severely cracked pavement, loss of friction and water penetration
- Not recommended for use on unsealed cracks >1/4" (unless a scrub seal is used) or for ruts > 3/8” deep
- Service Life: 6-8 years
- Cost: $4.00 / SY

THIN HMA OVERLAY

- Surface mixes of 1.5” or less compacted applied to structurally sound road
- Can be simple overlay or part of mill & pave
- Addresses functional problems as a form of preservation, as opposed to increasing the overall strength of a pavement structure
- Can be recycled, restores skid resistance, quickly placed, provides a quiet, smooth roadway that can handle heavy traffic
- Service Life: 8-9 years
- Cost: $4.00 / SY
INFRARED REPAIR

- Infrared rays heat asphalt from inside out to plant temperature around 325°F without burning.
- Patch potholes, fix bird baths / high spots, repair utility cuts, adjust asphalt around utilities, repair paver seams, create “welded joints” in patches or new paving.
- For small areas only; not for failed pavement.
- Service Life: 3-5 years.
- Cost: $5,000/day.

MAINTENANCE COSTS

<table>
<thead>
<tr>
<th>METHOD</th>
<th>COST</th>
<th>EXTENDS ROAD LIFESPAN BY:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microsurfacing</td>
<td>$2.75 / SY</td>
<td>6-9 years</td>
</tr>
<tr>
<td>Crack Seal</td>
<td>$1.00 / LF</td>
<td>1-3 years</td>
</tr>
<tr>
<td>Chip Seal</td>
<td>$2.25 / SY</td>
<td>5-7 years</td>
</tr>
<tr>
<td>Cape Seal</td>
<td>$4.00 / SY</td>
<td>6-8 years</td>
</tr>
<tr>
<td>Thin HMA Overlay</td>
<td>$4.00 / SY</td>
<td>8-9 years</td>
</tr>
<tr>
<td>Infrared Repair</td>
<td>$5,000 / day</td>
<td>3-5 years</td>
</tr>
</tbody>
</table>
**MAINTENANCE SCHEDULE**

When to Perform Maintenance

<table>
<thead>
<tr>
<th>Year</th>
<th>New Pavement</th>
<th>Crack Treatment</th>
<th>Crack Treatment &amp; Microsurfacing</th>
<th>Crack Treatment &amp; Microsurfacing</th>
<th>Crack Treatment &amp; Microsurfacing</th>
<th>2 in Mill &amp; Pave</th>
<th>Crack Treatment</th>
<th>Crack Treatment &amp; Microsurfacing</th>
<th>Crack Treatment &amp; Microsurfacing</th>
<th>Crack Treatment &amp; Microsurfacing</th>
<th>Reconstruction</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**ASPHALT DETERIORATION CURVE**

Applying the Right Treatment, to the Right Road, at the Right Time...

- Excellent
- Good
- Fair
- Poor
- Very Poor
- Failed

1. Crack Seal/Fog Seal Rejuvenation
2. Chip Seal
3. Polymer modified Chip Seal
4. Cape Seal; AR-SAM/SAMI; FiberMat
5. HMA Overlay; Bonded Pavements
6. Mill & HMA Overlay
7. In-Place Recycling & Overlay
8. Full Depth Reconstruction
9. Crack Filling (as needed)
A BALANCED APPROACH

- Before: worst first, individual roads
- Current approach: Maximize Four Objectives
  1. **Miles treated**: increase average Pavement Condition Index of total network
  2. **Condition**: apply right treatment to the right road at the right time
  3. **Budget**: maximize with strategic plan for network over time
  4. **Time**: accommodate immediate needs while predicting future demands

CONCLUSION

- Keep good roads in good condition while addressing immediate needs
- Preventative maintenance rather than replacement
- Maximize budgets over time and increase miles treated
# Overall Cost & Service Life Breakdown

## Costs & Service Life Breakdown

<table>
<thead>
<tr>
<th>Type</th>
<th>Method</th>
<th>Cost</th>
<th>Extends Road Lifespan By:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Resurfacing</strong></td>
<td>Full Depth Reclamation</td>
<td>$ 16.00 / SY</td>
<td>35 years</td>
</tr>
<tr>
<td></td>
<td>Partial Depth Mill &amp; Pave</td>
<td>$ 10.00 / SF</td>
<td>30 years</td>
</tr>
<tr>
<td></td>
<td>Cold In-Place Recycling</td>
<td>$ 6.50 / SY</td>
<td>10-15 years</td>
</tr>
<tr>
<td></td>
<td>Warm Mix Asphalt</td>
<td>$ 13.00 / SY</td>
<td>10-15 years</td>
</tr>
<tr>
<td></td>
<td>HIMA</td>
<td>$ 12.00 / SY</td>
<td>10-15 years</td>
</tr>
<tr>
<td></td>
<td>Fog Seal/Rejuvenator</td>
<td>$ 0.40 / SY</td>
<td>1-2 years</td>
</tr>
<tr>
<td></td>
<td>Paving Fabric</td>
<td>$ 2.50 / SY</td>
<td>10-15 years</td>
</tr>
<tr>
<td><strong>Maintenance</strong></td>
<td>Microsurfacing</td>
<td>$ 2.75 / SY</td>
<td>6-8 years</td>
</tr>
<tr>
<td></td>
<td>Crack Seal</td>
<td>$ 1.00 / LF</td>
<td>varies</td>
</tr>
<tr>
<td></td>
<td>Chip Seal</td>
<td>$ 2.25 / SY</td>
<td>5-7 years</td>
</tr>
<tr>
<td></td>
<td>Cape Seal</td>
<td>$ 4.00 / SY</td>
<td>6-8 years</td>
</tr>
<tr>
<td></td>
<td>Thin HMA Overlay</td>
<td>$ 4.00 / SY</td>
<td>8-9 years</td>
</tr>
<tr>
<td></td>
<td>Infrared Repair</td>
<td>$ 5,000 / day</td>
<td>3-5 years</td>
</tr>
</tbody>
</table>

## Resources

- [https://www.clrp.com/edu/g-a/075-cape_seal.html](https://www.clrp.com/edu/g-a/075-cape_seal.html)
- [http://url.csuchico.edu/cp2c/documents/Library/interlayers-paving_fabrics_to_reduce_reflective_cracking.pdf](http://url.csuchico.edu/cp2c/documents/Library/interlayers-paving_fabrics_to_reduce_reflective_cracking.pdf)
- [http://www.uatwp.org/?wpfb_dl=606](http://www.uatwp.org/?wpfb_dl=606)
- [http://www.sustainablecitynetwork.com/topic_channels/transportation/article_1bd10322-e719-11e1-9242-001a4bcf6878.html](http://www.sustainablecitynetwork.com/topic_channels/transportation/article_1bd10322-e719-11e1-9242-001a4bcf6878.html)
- [https://www.clrp.com/edu/g-a/075-cape_seal.html](https://www.clrp.com/edu/g-a/075-cape_seal.html)