2016 Local Roads Workshop

Perpetual Pavement
Perpetual Pavements

Perpetual Pavements
Perpetual Pavements

Topics

• Introduction
• Design Considerations
• HMA Layers
• Michigan’s Projects
• Summary
• Resources
Introduction

• Not a new concept
  – Full-Depth
  – Deep Strength
  – Mill & Fill
  – Not just for Freeways
**Perpetual Pavements**

<table>
<thead>
<tr>
<th>Pavement Foundation</th>
<th>Max Tensile Strain</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5 - 3” SMA, OGFC or Superpave</td>
<td>Flexible Fatigue Resistant Material 3 - 4”</td>
</tr>
<tr>
<td>4” to 6” Zone Of High Compression</td>
<td>High Modulus Rut Resistant Material (Varies As Needed)</td>
</tr>
</tbody>
</table>

*Pavement Foundation*
Perpetual Pavements

Performance Goals - Avoid These

- Repeated Bending Leads to Fatigue Cracking
- Repeated Deformation Leads to Rutting
Perpetual Pavements

› Bottom-up Design and Construction

› Foundation
  » **Stable Paving Platform**
  » **Minimize Seasonal Variability and Volume Change in Service**
  » **Adequate Drainage / Drainage Maintenance**

› Fatigue Resistant Lower Asphalt Layer

› Rut Resistant Upper Asphalt Layers
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Mechanistic Performance Criteria

Under ESAL

Limit Bending to < 65µε (Monismith, Von Quintus, Nunn, Thompson)

Thick HMA (> 8”)

Base (as required)

Subgrade

Limit Vertical Compression to < 200µε (Monismith, Nunn)
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HMA Considerations

• HMA Base Layer

• Intermediate Layer

• Wearing Surface
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- Fatigue Resistant Asphalt Base
  - Minimize Tensile Strain with Pavement Thickness
  - Thin Asphalt Pavement = **Higher Strain**
  - Higher Strain = **Shorter Fatigue Life**
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- **Fatigue Resistant Asphalt Base**
  - Minimize Tensile Strain with Pavement Thickness
  - Thicker Asphalt Pavement = **Lower Strain**
  - Strain Below Fatigue Limit = **Indefinite Life**
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- Fatigue Resistant Asphalt Base
  - High Effective Asphalt Content Mixes = Greater Strain Capability
  - Modified Binders = Greater Strain Capability

![Graph showing strain vs. fatigue life for high and low asphalt content](Image)
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- Rut Resistant Upper Layers
  - **Aggregate Interlock**
    - Crushed Particles
    - Stone-on-Stone Contact
  - **Binder**
    - High Temperature PG
    - Polymers
    - Fibers
  - **Air Voids**
    - Avg. 4% to 6% In-Place
  - **Surface**
    - Renewable
    - Tailored for Specific Use
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How do we know it works??
### Performance of Washington Interstate Flexible Pavements (based on 176 mi.)

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Time Since Original Construction (years)</th>
<th>Thickness of Original AC (in.)</th>
<th>Time from Original Construction to First Resurfacing (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>31.6</td>
<td>9.2</td>
<td>12.4</td>
</tr>
<tr>
<td>Range</td>
<td>23 to 39</td>
<td>4 to 13.6</td>
<td>2 to 25</td>
</tr>
</tbody>
</table>
## Performance of Washington Interstate Flexible Pavements (based on 176 mi.)

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Age of Current Wearing Course (years)</th>
<th>Current IRI (in/mi)</th>
<th>Current Rut Depth (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range</td>
<td>0 to 27</td>
<td>25.4 to 82.6</td>
<td>0.04 to 0.28</td>
</tr>
</tbody>
</table>
Ohio Study of Flexible Pavements

- Examined Performance on 4 Interstate Routes
  - HMA Pavements - Up to 34 Years without Rehabilitation or Reconstruction
  - “No significant quantity of work . . . for structural repair or to maintain drainage of the flexible pavements.”
  - Only small incremental increases in Present Cost for HMA pavements.
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SURFACE CRACKING

WHEEL LOAD

Crack (surface initiated)
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New Jersey I-287
Surface Cracking
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Washington State - Top-Down in Asphalt Pavements > 150 mm
Rehabilitation

Possible Distresses

- Top-Down Fatigue
- Thermal Cracking
- Raveling

Solutions

- Mill & Fill
- Thin Overlay

2 - 4"

High Quality SMA, OGFC or Superpave

20+ Years Later

Structure Remains Intact
Perpetual Pavements

FHWA - Data from Long-Term Pavement Performance Study

- Data from GPS-6 (FHWA-RD-00-165)
- Conclusions
  - Most AC Overlays ≥ 15 years before Rehab
  - Many AC Overlays > 20 years before Significant Distress
  - Thicker overlays mean less:
    - Fatigue Cracking
    - Transverse Cracking
    - Longitudinal Cracking
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MDOT Perpetual Pavement Project: US-24

• US 24 (Telegraph Rd) – M-5, south 1.25 miles, northbound lanes only
• Industry / MDOT Partnership
• State of the Art Pavement design concepts
• Constructed in 2002
• Intensive Material Sampling & Testing
• Performance Monitoring
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MDOT Perpetual Pavement Project: US-24

- Perpetual Pavement
  - 2.5” ,4E10 ,PG 70-28P
  - 3.0” ,3E10 ,PG 70-22P
  - 4.5” , 2E10,PG 58-28
  - 10”
  - 12.” 21AA Agg. Base
  - 14” Sand Subbase
  - 36” Total Section

- Regular Mdot design
  - 2.0” ,5E10,PG 70-22P
  - 2.5” ,4E10,PG 70-22P
  - 4.0” ,3E10,PG 58-28
  - 8.5”
  - 6.4” ,21AA Agg.Base
  - 18.4” Sand Subbase
  - 33.3” Total Section
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MDOT Perpetual Pavement Project: US-24

- Other Design Changes:
  - Increased mat density requirement
    + 1% for Surface & Leveling Courses
    + 2% for Base course
  - Base course mixture properties
    3% design air voids
  - + 1% increase in minimum VMA
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I-96 Perpetual Pavement Demonstration Project

- I-96, M39 to Schaeffer Road approximately 2.7 miles
- West Bound Express Lanes
- 3 Lanes
- Construction – Fall 2005
I-96 Perpetual Pavement Demonstration Project

• Very High Traffic Loads
• Average Daily Truck Traffic – 9,600
• 20 yr. ESALS, One way - 22,694,400
• 40 yr. ESALS, One way – 56,400,000
Perpetual Pavements

I-96 Perpetual Pavement Demonstration Project

- 1.5” Surface
- 2.5” Leveling
- 10” Base
- 14”
- 16” OGDC Aggregate Base (21AA-Mod)
  (Geo Textile Fabric)
- 8” Sand Subbase Class IIA
- 38” Total Pavement Section

Lime Stabilized Subgrade
The APA (Asphalt Pavement Alliance) is a partnership between NAPA, the State Asphalt Pavement Associations (SAPA) and the Asphalt Institute.

Since 2001, the APA’s Perpetual Pavement Award program has recognized 100 long-life pavements in 30 U.S. states and one Canadian province.

These Roads were all at least 35 years old when honored, and have never experienced a structural failure.
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APA Perpetual Pavement Award

Award Criteria:

• Greater than 35 years

• No more than 4 inches of HMA structure added over life.

• Average interval of resurfacing of greater than 13 years.
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SOME THINGS ACTUALLY GET BETTER WITH AGE — INCLUDING ASPHALT PERPETUAL PAVEMENTS.

The pavement structure lasts indefinitely. Every 10 to 20 years, the surface is milled up and recycled; an overlay is placed during off-peak hours; and road users get a good-as-new highway. There’s no need for the entire highway to be removed and replaced from the ground up. Perpetual pavement is a pavement that remains a permanent asset: a pavement that our grandchildren’s grandchildren will be able to use; a pavement that’s infinitely reclaimable, reusable and renewable.

Think smart.
Decide diligently.
Perpetual pavements make sense.

2007 Award Winner:
M-24, Tuscola Co.

ASPHALT. AGE 60

The Michigan Department of Transportation (MDOT) won its first APA Perpetual Pavement Award in 2007 for a section of M-24 in Tuscola County. This section of M-24 was originally built in 1956, and after 55 years of service, is still going strong—with only resurfacing in 1975, 1999, and 2007. Congratulations to MDOT on a pavement that has truly stood the test of time.

www.apa-mi.org
Perpetual Pavements

2009 Award Winner: US-31, Ottawa and Muskegon Co.

Asphalt. Age 58

The Michigan Department of Transportation (MDOT) won its second APA Perpetual Pavement Award in 2009 for a section of US-31 in Ottawa and Muskegon Counties. This section of US-31 was originally built in 1958, and after 53 years of service is still going strong — with only resurfacing in 1978, 1999, and 2005. Congratulations to MDOT on a pavement that has truly stood the test of time.
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2015 Award Winner: M-20, Isabella Co.

Just announced in March!
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Summary

› Structure Lasts 50+ years.
  » Bottom-Up Design and Construction
  » Indefinite Fatigue Life

› Renewable Pavement Surface.
  » High Rutting Resistance
  » Tailored for Specific Application

› Consistent, Smooth and Safe Driving Surface.

› Environmentally Friendly.

› Avoids Costly Reconstruction and Disruption.
Rehabilitation

Possible Distresses
- Top-Down Fatigue
- Thermal Cracking
- Raveling

Solutions
- Mill & Fill
- Thin Overlay

Structure Remains Intact

2 - 4"

High Quality SMA, OGFC or Superpave

20+ Years Later
Perpetual Pavements

The Perpetual Pavement concept was first articulated in 2000 and the concept has rapidly gained acceptance.

The APA's newest technical document on the subject is Perpetual Asphalt Pavements: A Synthesis. This comprehensive publication captures the activities that have taken place over the last decade, synthesizes the information in a way that is useful to providing guidance for Perpetual Pavement design and construction, and provides a vision for further research and development to refine Perpetual Pavements.

Perpetual Pavement Design Software
The APA offers two versions of its software for the design and analysis of Perpetual Pavements. Both versions of the software are available as free downloads.

PerRoad 3.5
PerRoad is based on the mechanistic-empirical design philosophy. The program couples layered elastic analysis with a statistical analysis procedure (Monte Carlo simulation) to estimate stresses and strains within a pavement. In order to predict the strains which would prove detrimental for fatigue cracking or structural rutting, PerRoad requires the following inputs:

- Seasonal pavement moduli and annual coefficient of variation (COV)
- Seasonal resilient moduli of unbound materials and annual COV
- Thickness of bound materials and COV
- Thickness of unbound materials
- Load spectrum for traffic
- Location for pavement response analysis
- Magnitude of limiting pavement responses
- Transfer functions for pavement responses exceeding the user-specified level for accumulating damage

Download PerRoad 3.5 now

PerRoadXpress 1.0
PerRoadXpress is an easy-to-use, all-on-one-screen program for designing Perpetual Pavements for low- and medium-volume roads and parking lots. The designer chooses a type of asphalt cement. PerRoadXpress then allows the designer to use defaults for traffic and soil, or to input the actual values if they are known. Granular base thicknesses from 0 to 10 inches are included. The software quickly provides the user with a recommendation for the total thickness of asphalt pavement needed for a particular situation. PerRoadXpress was developed in response to requests by public works officials and owners of commercial property.

Download PerRoadXpress 1.0 now

http://www.asphaltroads.org/perpetual-pavement/about-perpetual-pavements/
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Resources

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Questions?