

# Perpetual Pavements



# Perpetual Pavements

2011 Local Roads Workshop

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# Perpetual Pavements



## Topics

- Introduction
- Mechanistic-Based Design
- Foundation
- HMA Considerations
- Performance Goals
- Current Perpetual Pavement Efforts
- Summary
- References

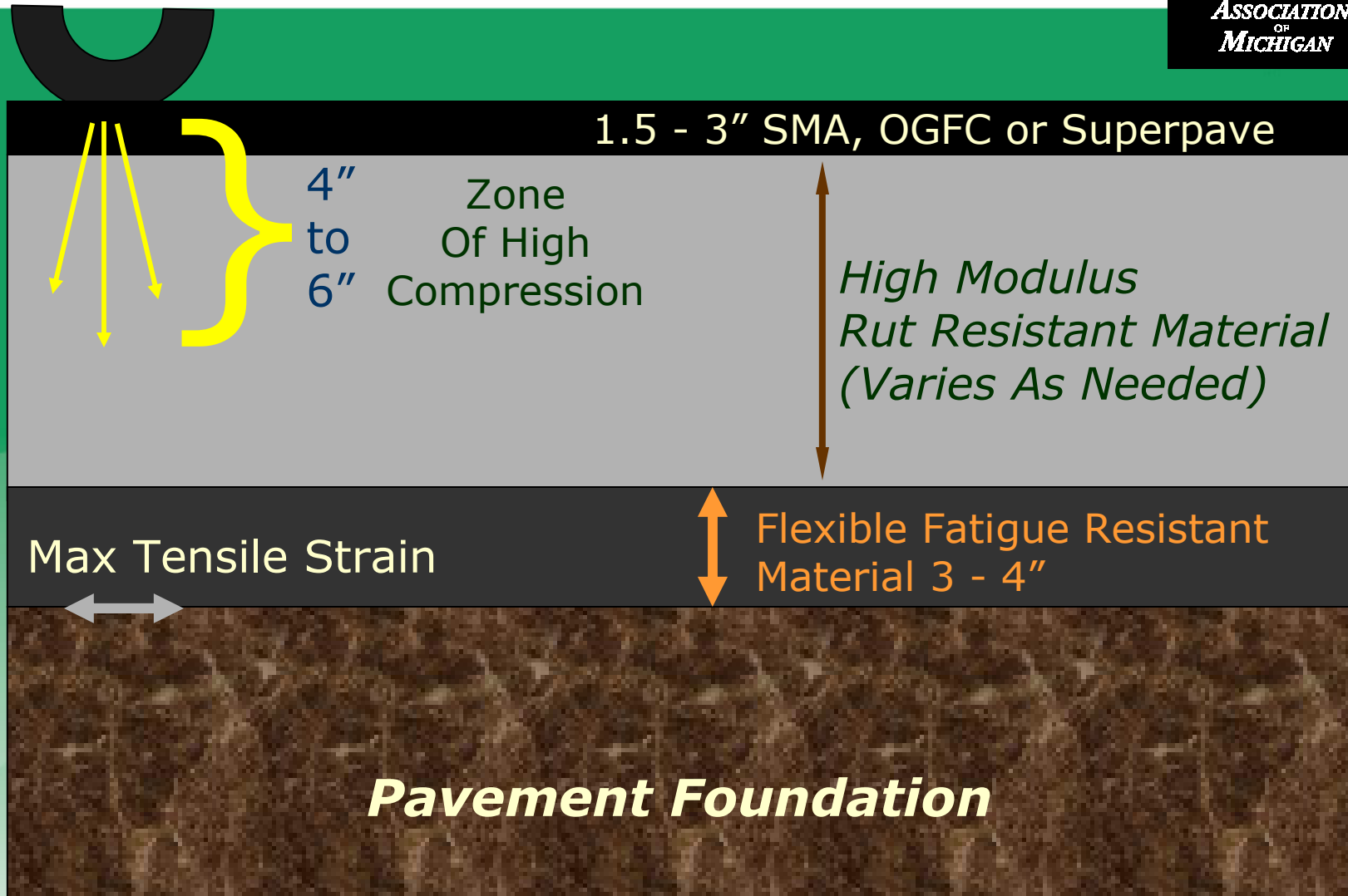
# Perpetual Pavements



## Introduction

- Not a new concept
  - Full-Depth
  - Deep Strength
  - Mill & Fill
  - Not just for Freeways

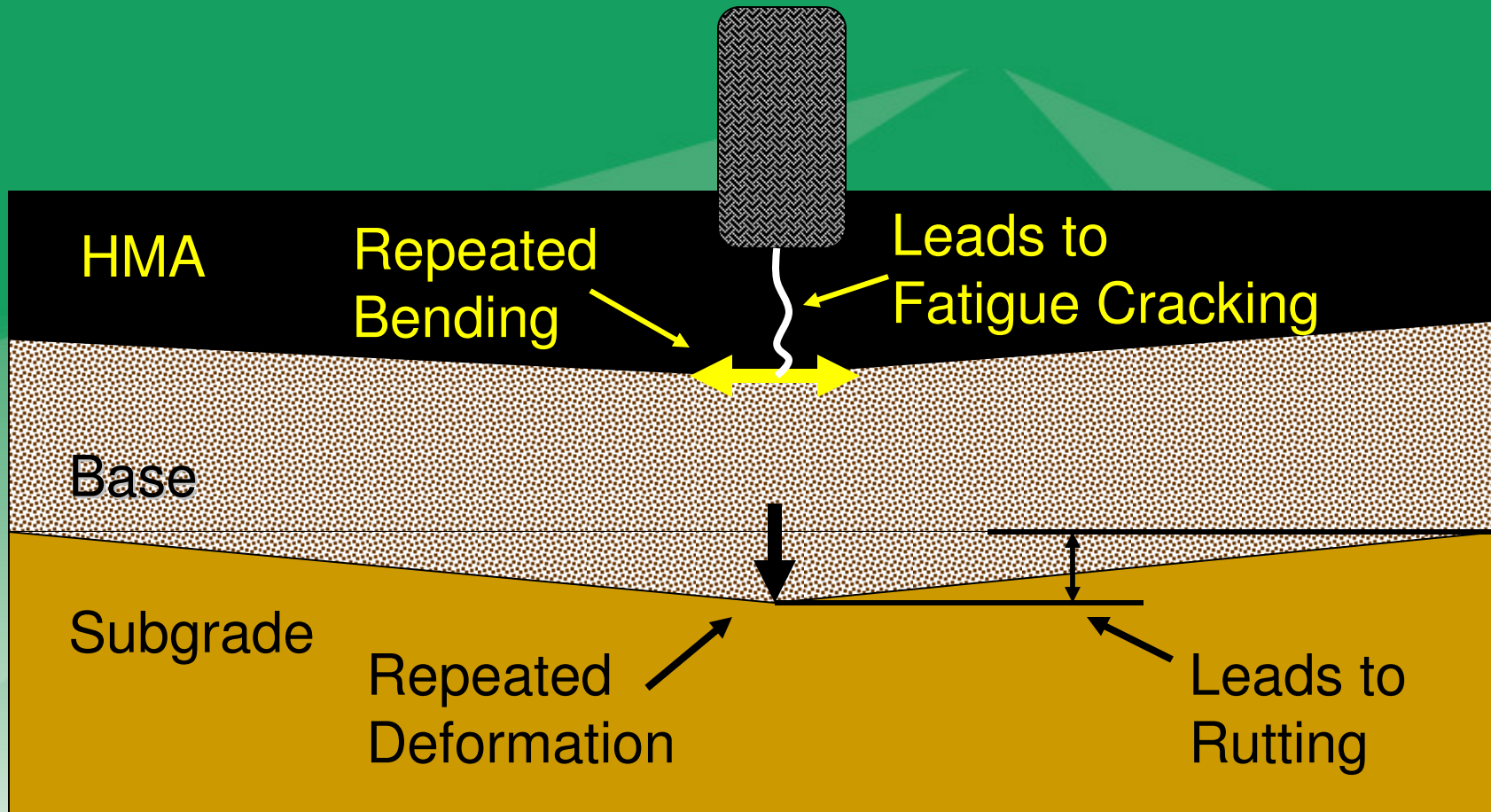
# Perpetual Pavements



# Perpetual Pavements



## Performance Goals - Avoid These



# Perpetual Pavements

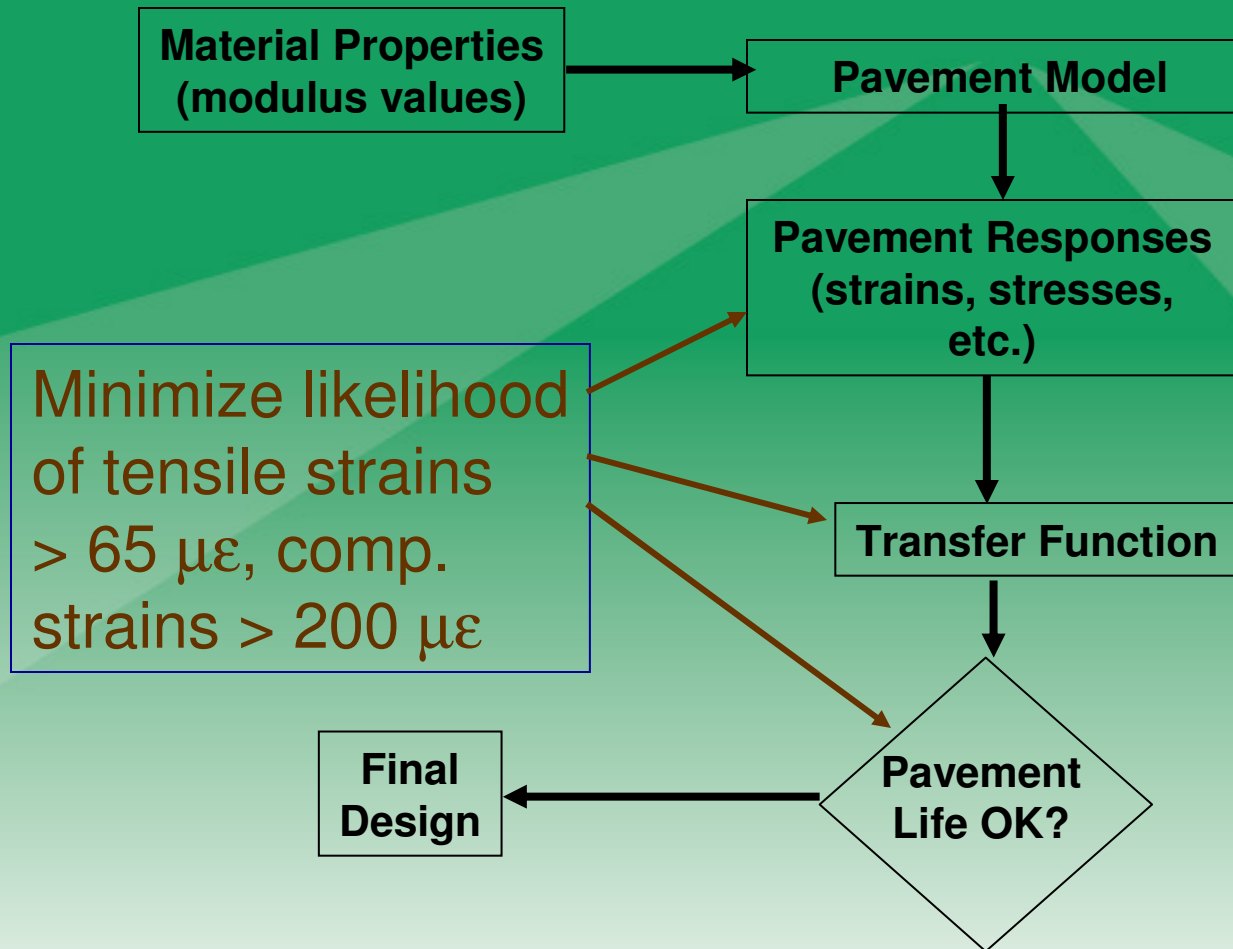


- > Bottom-up Design and Construction
- > Foundation
  - » **Stable Paving Platform**
  - » **Minimize Seasonal Variability and Volume Change in Service**
- > Fatigue Resistant Lower Asphalt Layer
- > Rut Resistant Upper Asphalt Layers

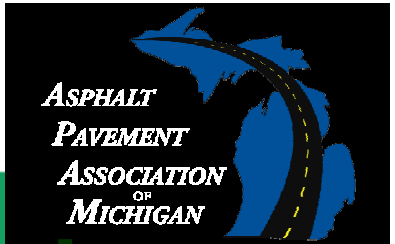
# Perpetual Pavements



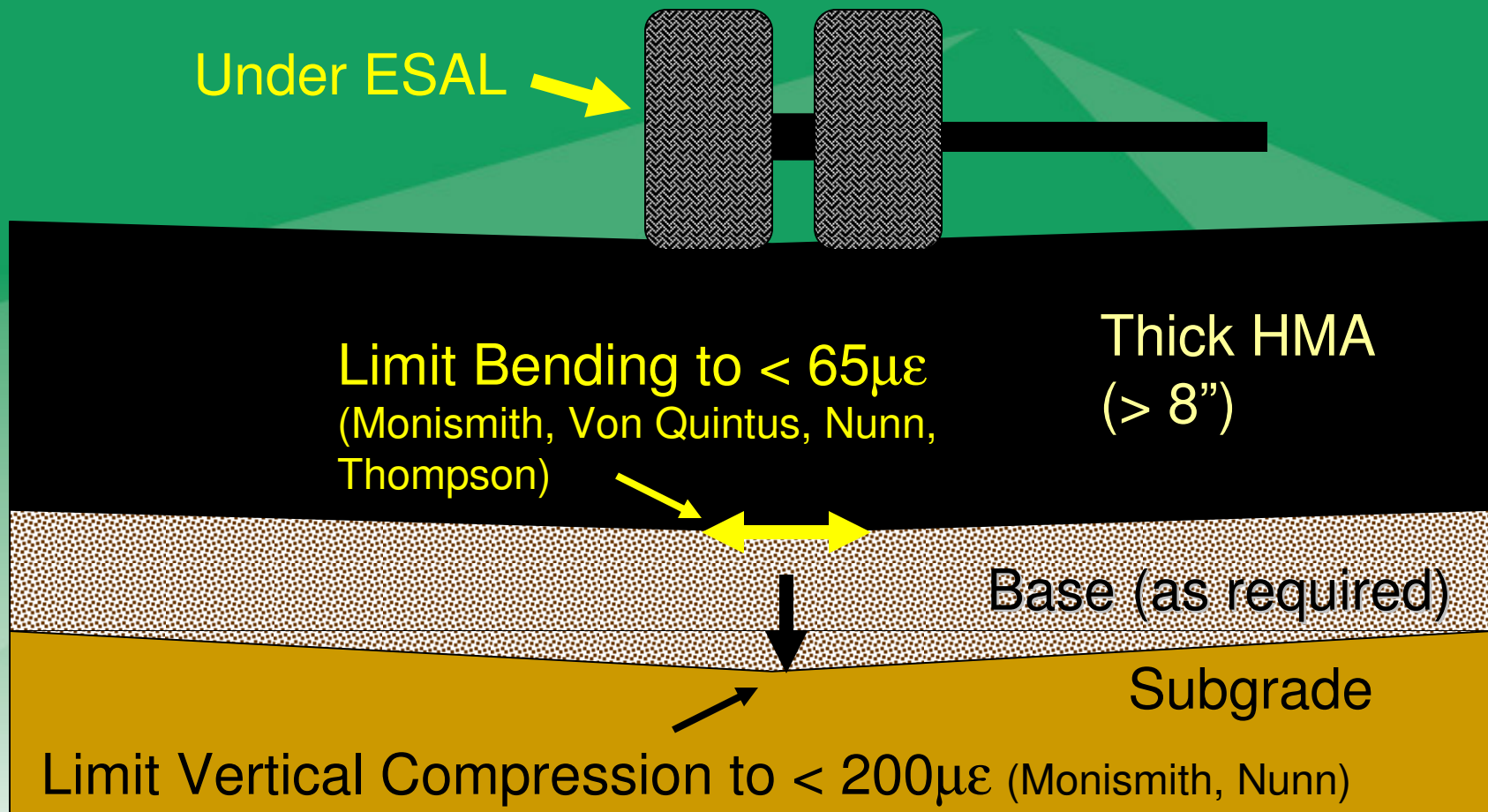
## Mechanistic-Based Design



# Perpetual Pavements



## Mechanistic Performance Criteria



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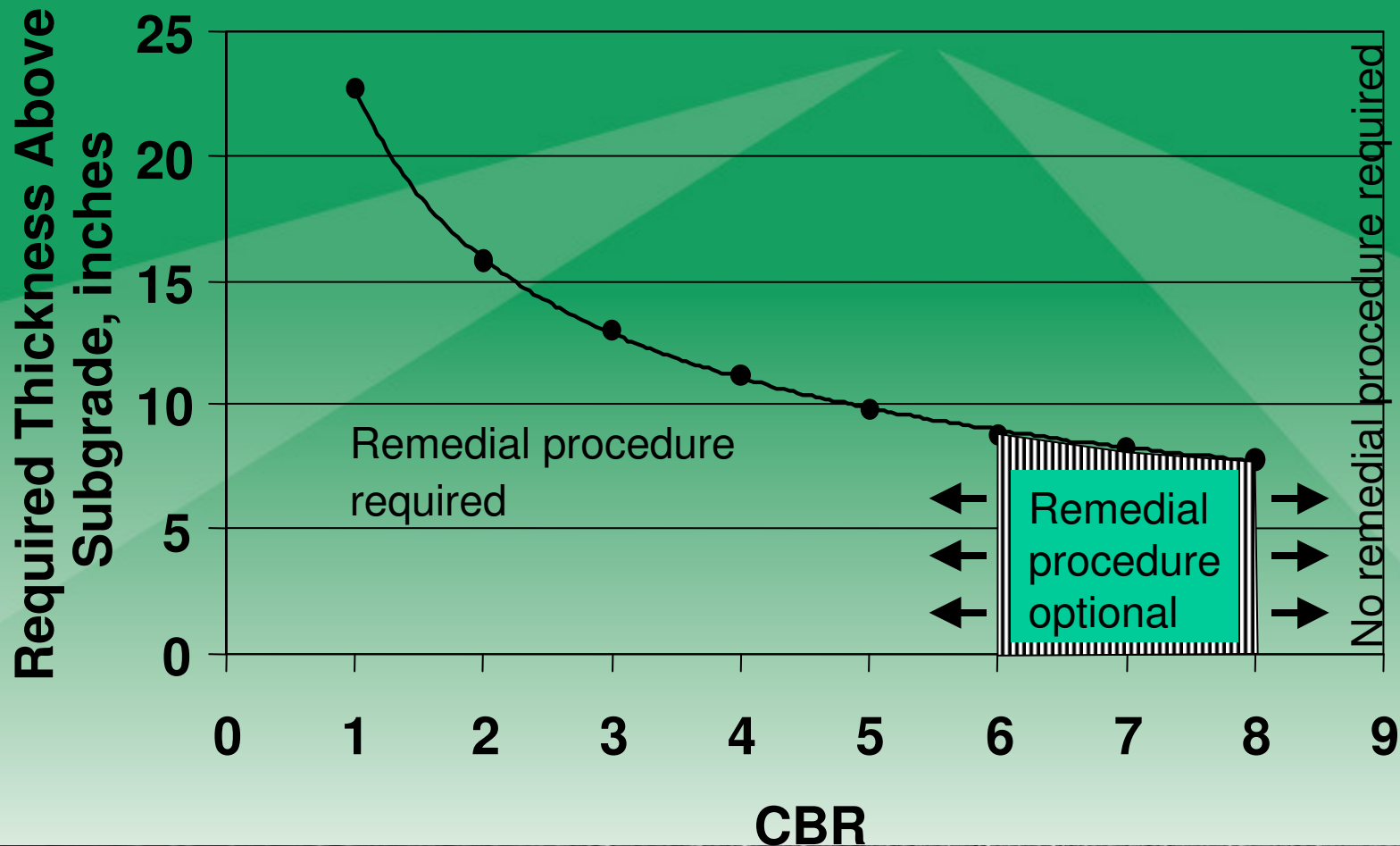
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## Foundation - Illinois



# Perpetual Pavements



## Foundation Requirements

- Drainage
  - As Needed
  - Consider Maintenance Requirements
- Seasonal Changes
- Special Conditions
  - Frost Heave/Thaw Weakening
  - Expansive Soils

# Perpetual Pavements



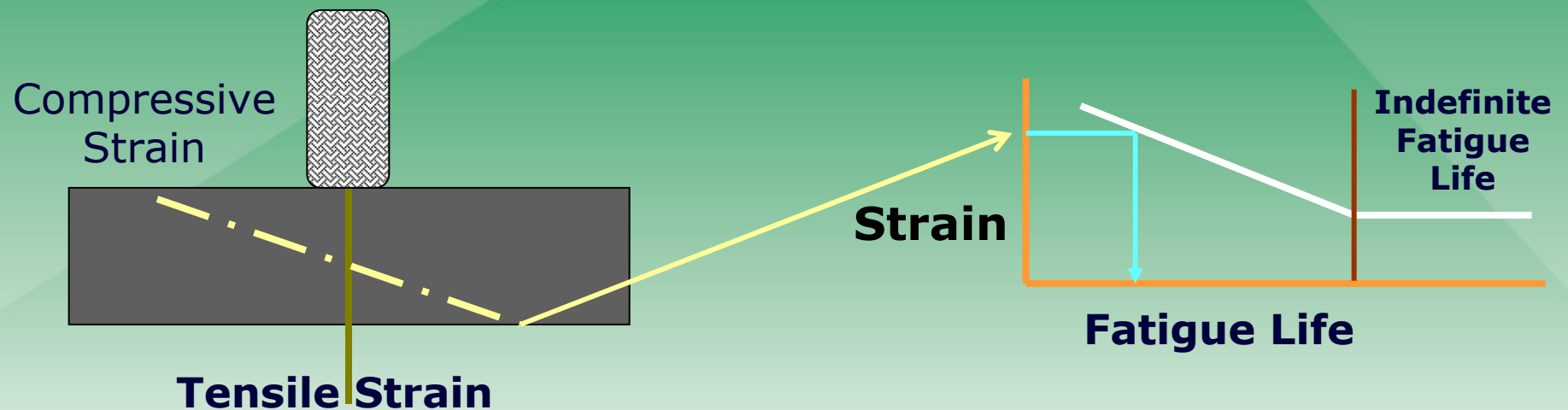
## HMA Considerations

- HMA Base Layer
- Intermediate Layer
- Wearing Surface

# Perpetual Pavements



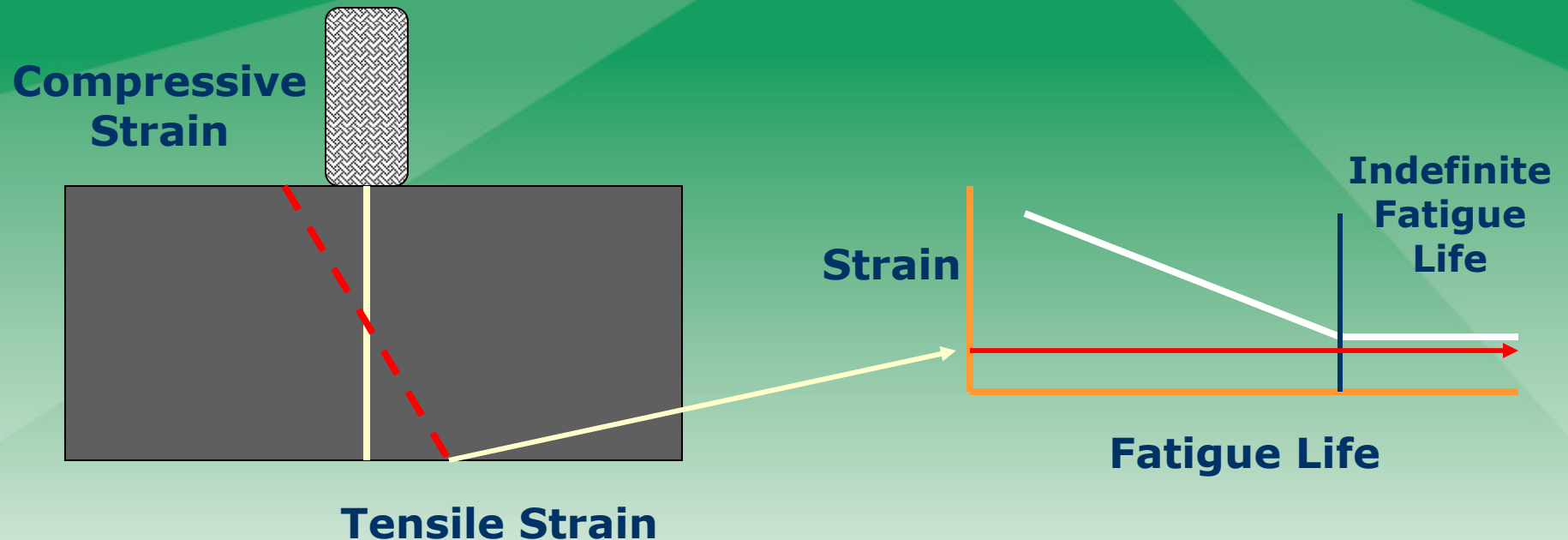
- > Fatigue Resistant Asphalt Base
  - » Minimize Tensile Strain with Pavement Thickness
  - » Thin Asphalt Pavement = **Higher Strain**
  - » Higher Strain = **Shorter Fatigue Life**



# Perpetual Pavements



- > Fatigue Resistant Asphalt Base
  - » Minimize Tensile Strain with Pavement Thickness
  - » Thicker Asphalt Pavement = **Lower Strain**
  - » Strain Below Fatigue Limit = **Indefinite Life**

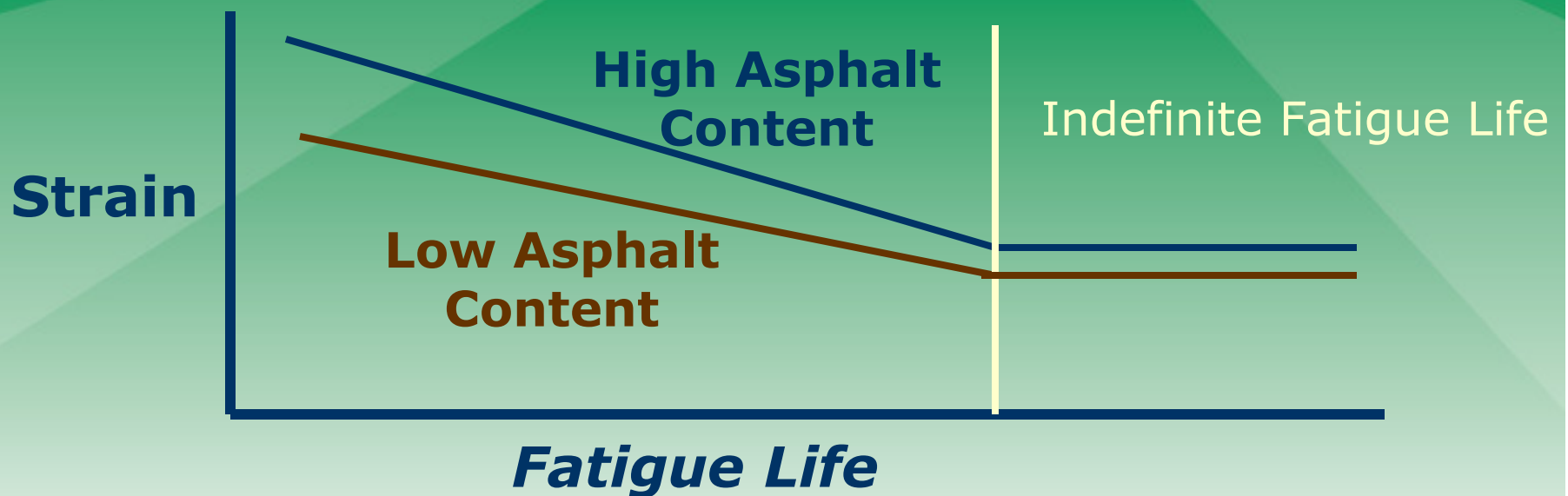


# Perpetual Pavements



## > Fatigue Resistant Asphalt Base

- » High Effective Asphalt Content Mixes = **Greater Strain Capability**
- » Modified Binders = **Greater Strain Capability**



# Perpetual Pavements



## > 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*



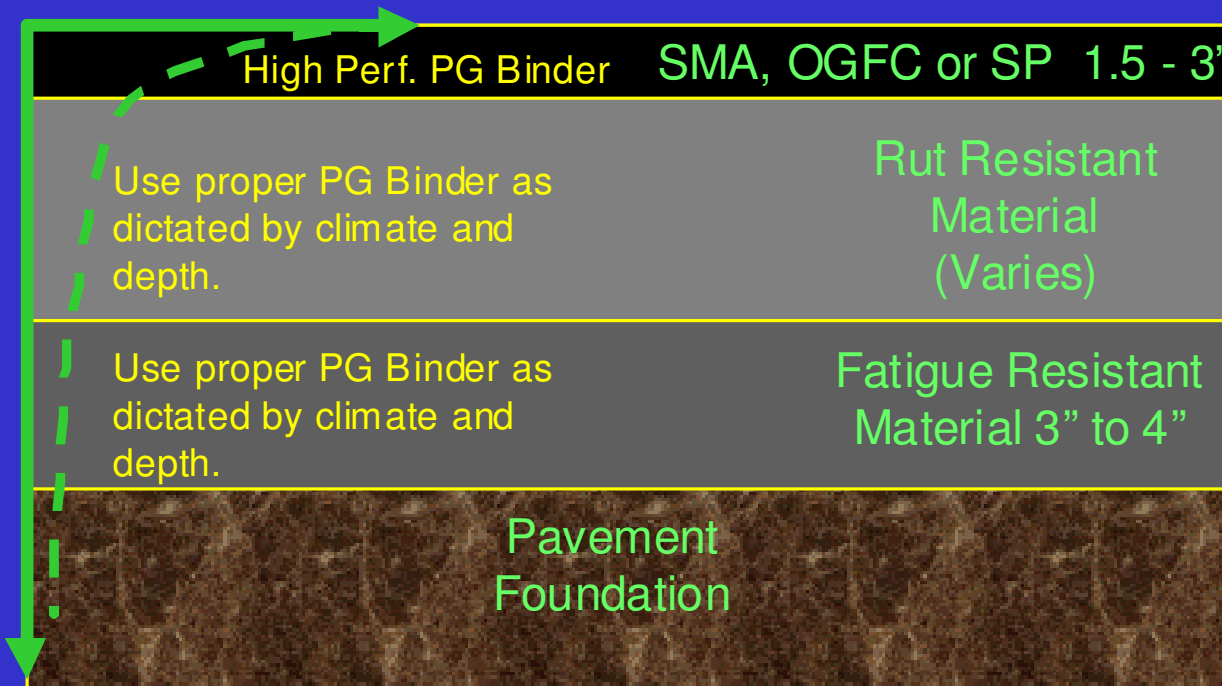
# Perpetual Pavements



LTTP Bind software:

[www.fhwa.dot.gov/pavement/ltp/bind/download.cfm](http://www.fhwa.dot.gov/pavement/ltp/bind/download.cfm)

Temperature



Impact of Temperature Gradient on Asphalt Grade.

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# Perpetual Pavements



**How do we know it works??**

# Perpetual Pavements



## Performance of Washington Interstate Flexible Pavements (based on 176 mi.)

Statistic	Time Since Original Construction (years)	Thickness of Original AC (in.)	Time from Original Construction to First Resurfacing (years)
Average	31.6	9.2	12.4
Range	23 to 39	4 to 13.6	2 to 25

# Perpetual Pavements



## Performance of Washington Interstate Flexible Pavements (based on 176 mi.)

Statistic	Age of Current Wearing Course (years)	Current IRI (in/mi)	Current Rut Depth (in)
Range	0 to 27	25.4 to 82.6	0.04 to 0.28

# Perpetual Pavements



## Ohio Study of Flexible Pavements

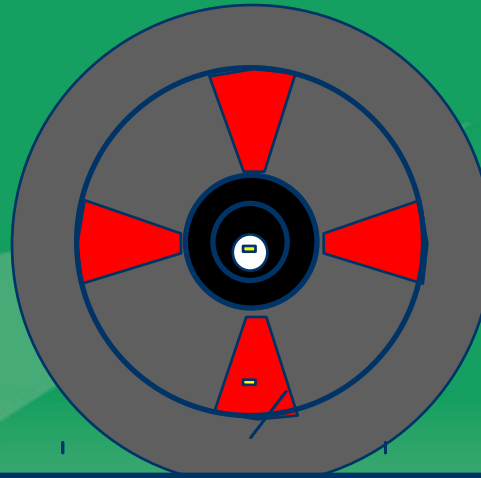
- Examined Performance on 4 Interstate Routes
  - HMA Pavements - Up to 34 Years without Rehabilitation or Reconstruction
  - “No significant quantity of work . . . for structural repair or to maintain drainage of the flexible pavements.”
  - Only small incremental increases in Present Cost for HMA pavements.

# Perpetual Pavements



## SURFACE CRACKING

WHEEL LOAD



Crack  
(surface initiated)

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# Perpetual Pavements



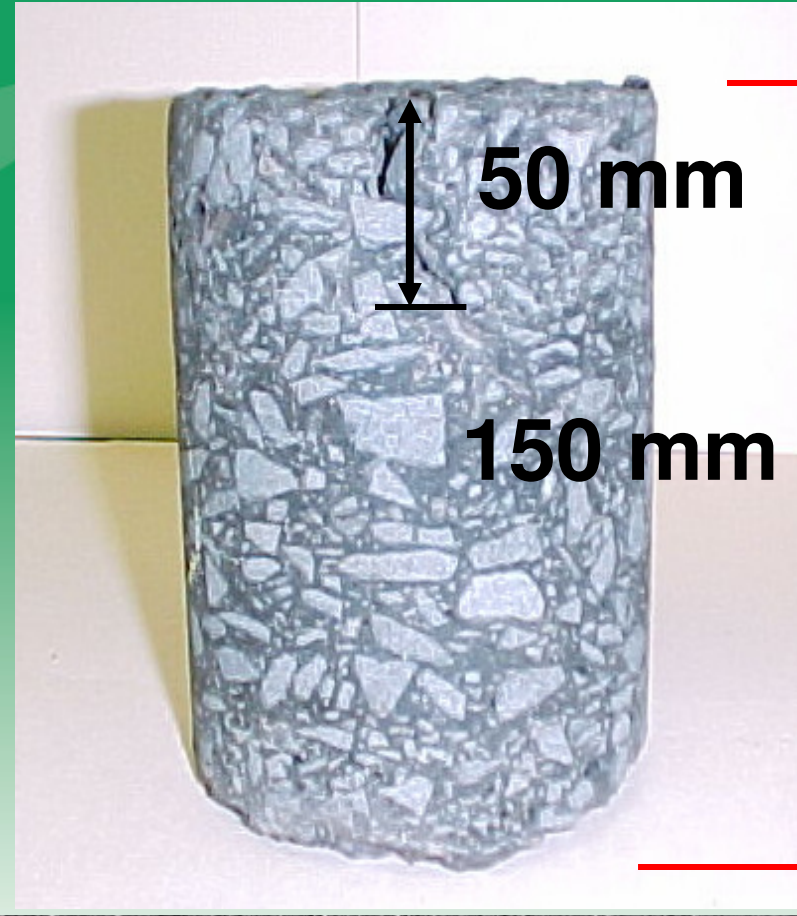
## New Jersey I-287 Surface Cracking



# Perpetual Pavements



Washington State - Top-Down in  
Asphalt Pavements > 150 mm



# Rehabilitation



## Possible Distresses

- > *Top-Down Fatigue*
- > *Thermal Cracking*
- > *Raveling*

## Solutions

- > *Mill & Fill*
- > *Thin Overlay*

Structure Remains Intact



High Quality SMA, OGFC or Superpave

20+ Years  
Later

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# Perpetual Pavements



## FHWA - Data from Long-Term Pavement Performance Study

- Data from GPS-6 (FHWA-RD-00-165)
- Conclusions
  - *Most AC Overlays  $\geq 15$  years before Rehab*
  - *Many AC Overlays  $> 20$  years before Significant Distress*
  - Thicker overlays mean less:
    - Fatigue Cracking
    - Transverse Cracking
    - Longitudinal Cracking

# Perpetual Pavements



- > Rut Resistant Upper Layers
  - Rutting Occurs in Upper Asphalt Layers
    - **Full-Scale Tracks**
      - » *Mn/ROAD*
      - » *WesTrack*
      - » *NCAT*
    - **Accelerated Pavement Testing**
      - » *CalAPT*
      - » *FHWA*

# Perpetual Pavements



## NON-STRUCTURAL RUTTING



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# Perpetual Pavements



## 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

# Perpetual Pavements



## 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

# Perpetual Pavements



## 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

# Perpetual Pavements



## US 24 – Standard Design Life Cycle Cost

Year	Activity	Cost (per lane/km)
0	Construction	114,729
10	Maint (historical).	21,000
13	Mill/Overlay	27,800
26	Reconstruct	114,729
36	Maint.(historical)	21,000
39	Mill /overlay	27,800
52	Reconstruct	0
	Present Value	199,938
	discount rate (3.9%)	

# Perpetual Pavements



## US 24 – Perpetual Pavement Life Cycle Cost

Year	Activity	Cost (per lane/km)
0	Construction	150,228
15	Mill/ 1.5 Overlay	18,881
30	Mill /3.5” Overlay	38,083
52	Reconstruct	0
	Present Value discount rate (3.9%)	172,950



# Perpetual Pavements



## 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

# Perpetual Pavements



## 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

# Perpetual Pavements



## Others in Michigan

- Leonard Street, Grand Rapids
- I-75, Rubblize and Perpetual Pavement Overlay

# Perpetual Pavements



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SOME THINGS ACTUALLY GET BETTER WITH AGE  
– INCLUDING ASPHALT PERPETUAL PAVEMENTS.

The pavement structure lasts indefinitely. Every 18 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.

**ASPHALT. AGE 55**

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.

**APA** ASPHALT PAVEMENT ASSOCIATION OF MICHIGAN  
AsphaltRoads.org

ASPHALT PAVEMENT ASSOCIATION OF MICHIGAN  
www.apa-mi.org

## 2007 Award Winner: M-24, Tuscola Co.

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# Perpetual Pavements



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Think smart.  
Decide diligently.  
Perpetual pavements make sense.

**ASPHALT. AGE 53**

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, 1997, and 2003. Congratulations to MDOT on a pavement that has truly stood the test of time.

  
AsphaltRoads.org

  
www.apa-mi.org

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

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# Perpetual Pavements



- > 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



High Quality SMA, OGFC or Superpave

20+ Years  
Later

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# Perpetual Pavements



## PerRoadXPress Software

PerRoadXPress

Press F1 to access full help file. Press Shift+F1 to access context-sensitive pop-up help.

Functional Classification:

Two-Way AADT:  (500 to 5000)

%Trucks:  (1 to 20)

%Growth:  (0 to 3)

Design Trucks:  (Total Trucks in 30 Years)

Design ESALs:  (Total ESALs in 30 Years)

AASHTO Soil Classification:

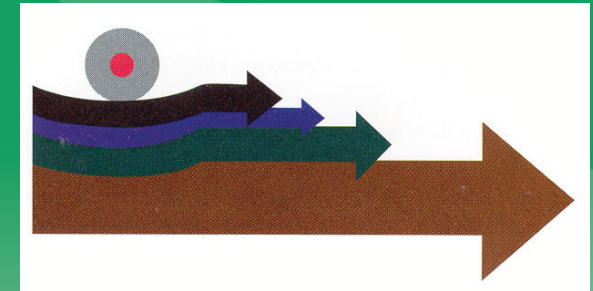
Soil Modulus:  (10,000 to 30,000 psi)

Aggregate Base Thickness:  (0 to 10 in.)

HMA Modulus:  (400,000 to 1,000,000 psi)

Calculated HMA  in.

Design HMA  in. Calculated thickness rounded up to nearest 0.25".

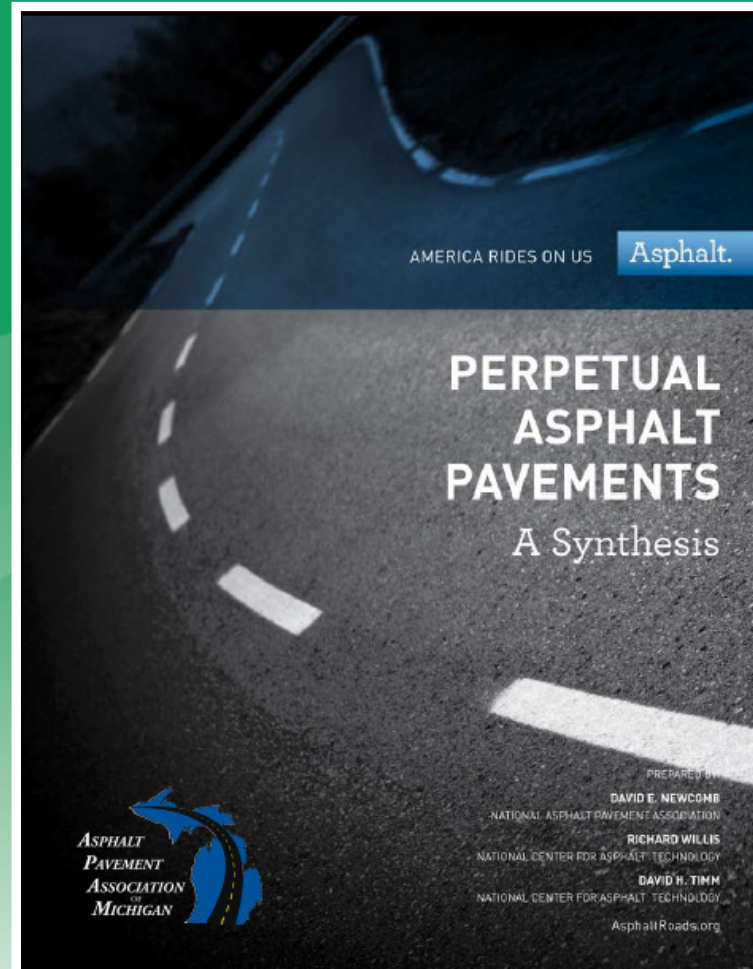


[www.apa-mi.org](http://www.apa-mi.org)

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