Perpetual Pavements

2011 Local Roads Workshop

Perpetual Pavements

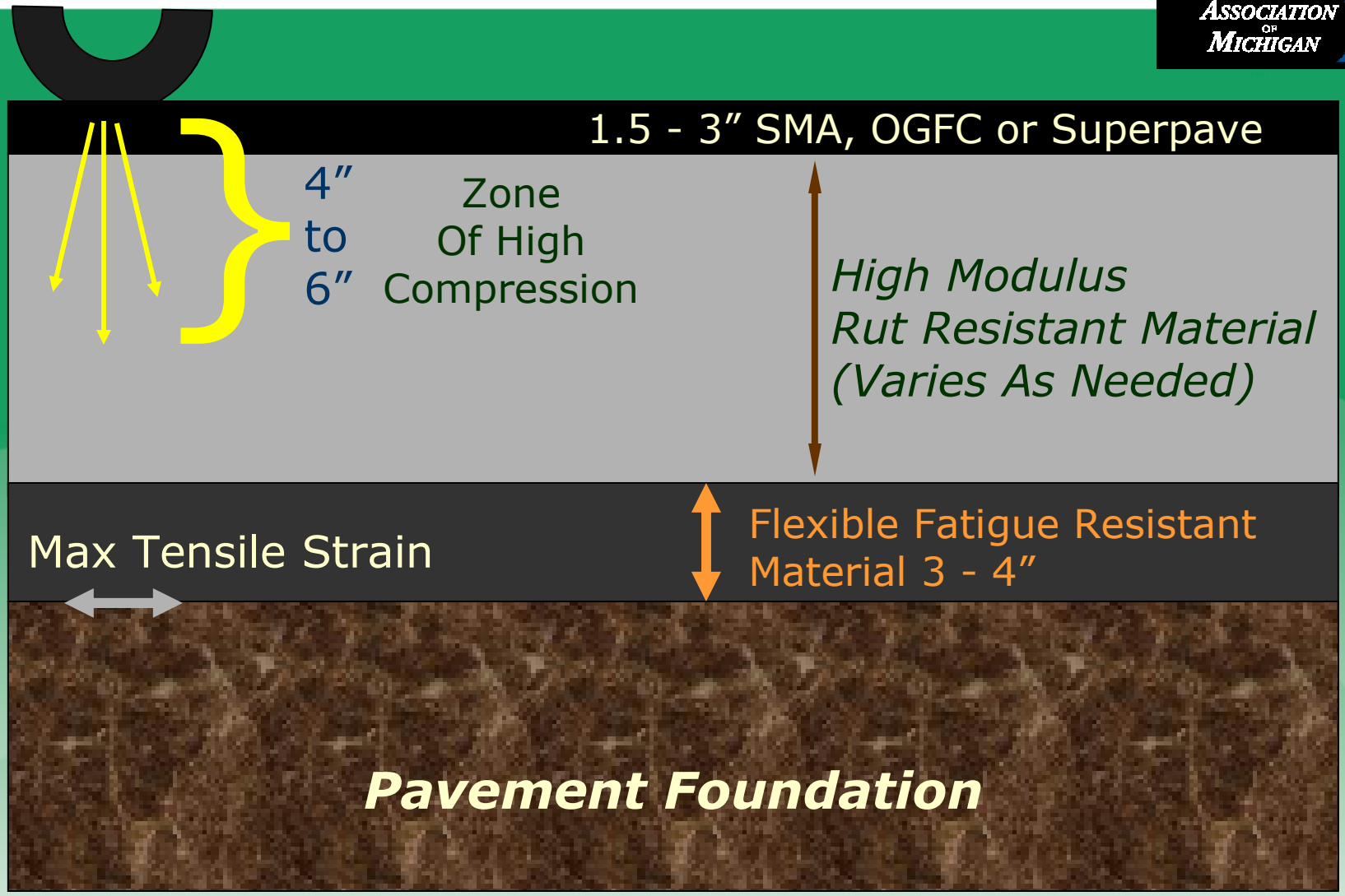
Topics

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

Introduction

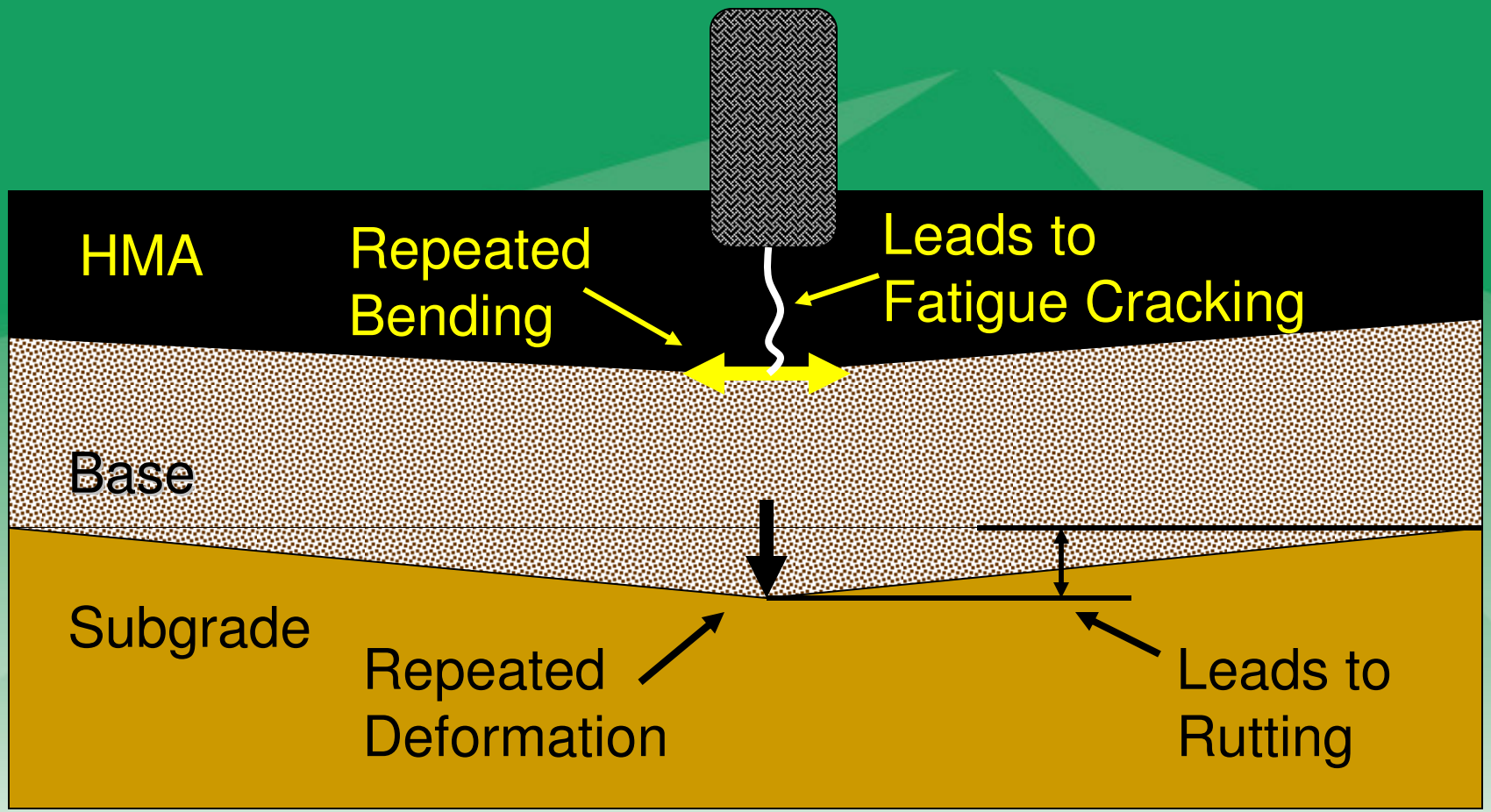
- Not a new concept
  - Full-Depth
  - Deep Strength
  - Mill & Fill
  - Not just for Freeways

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

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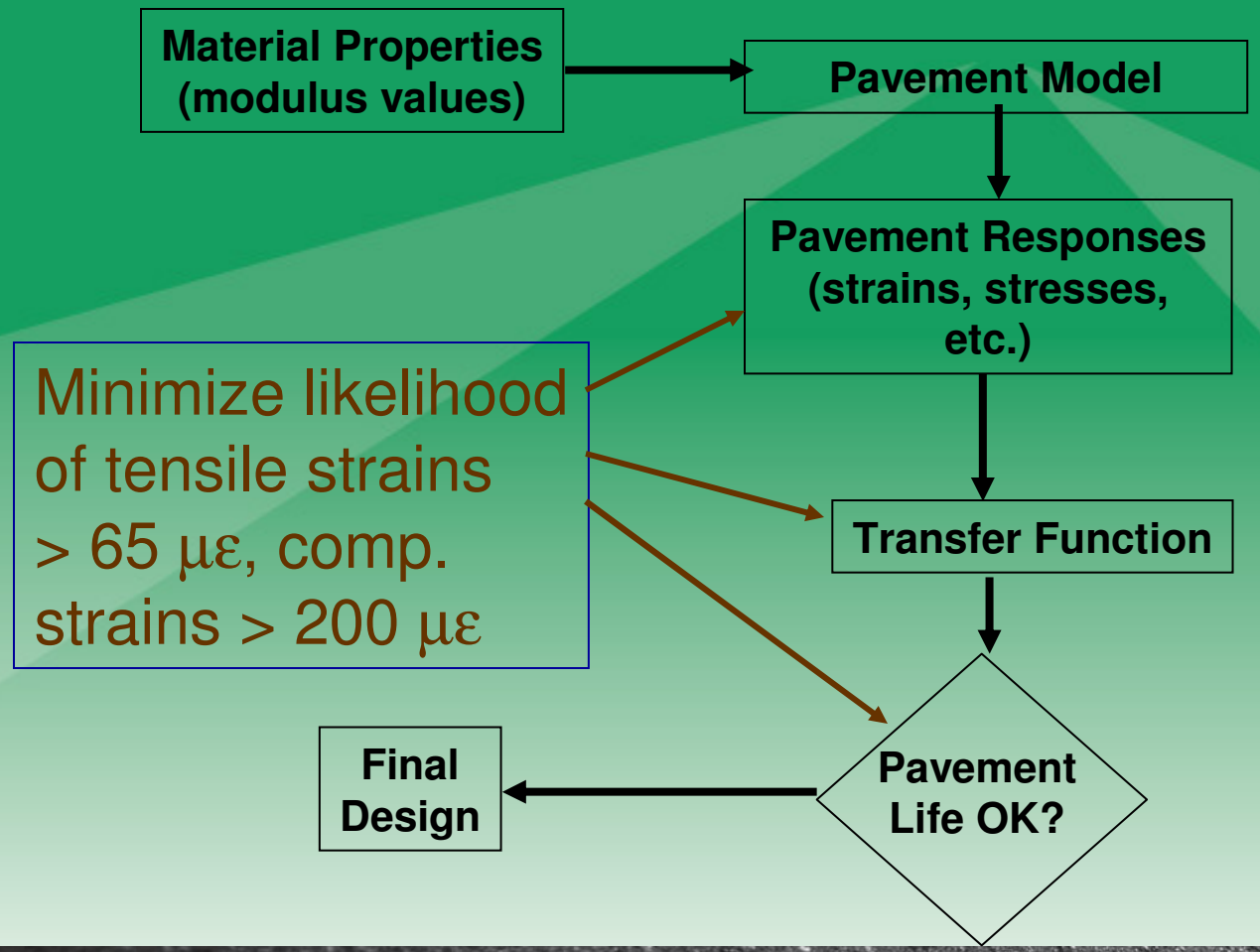
Mechanistic-Based Design



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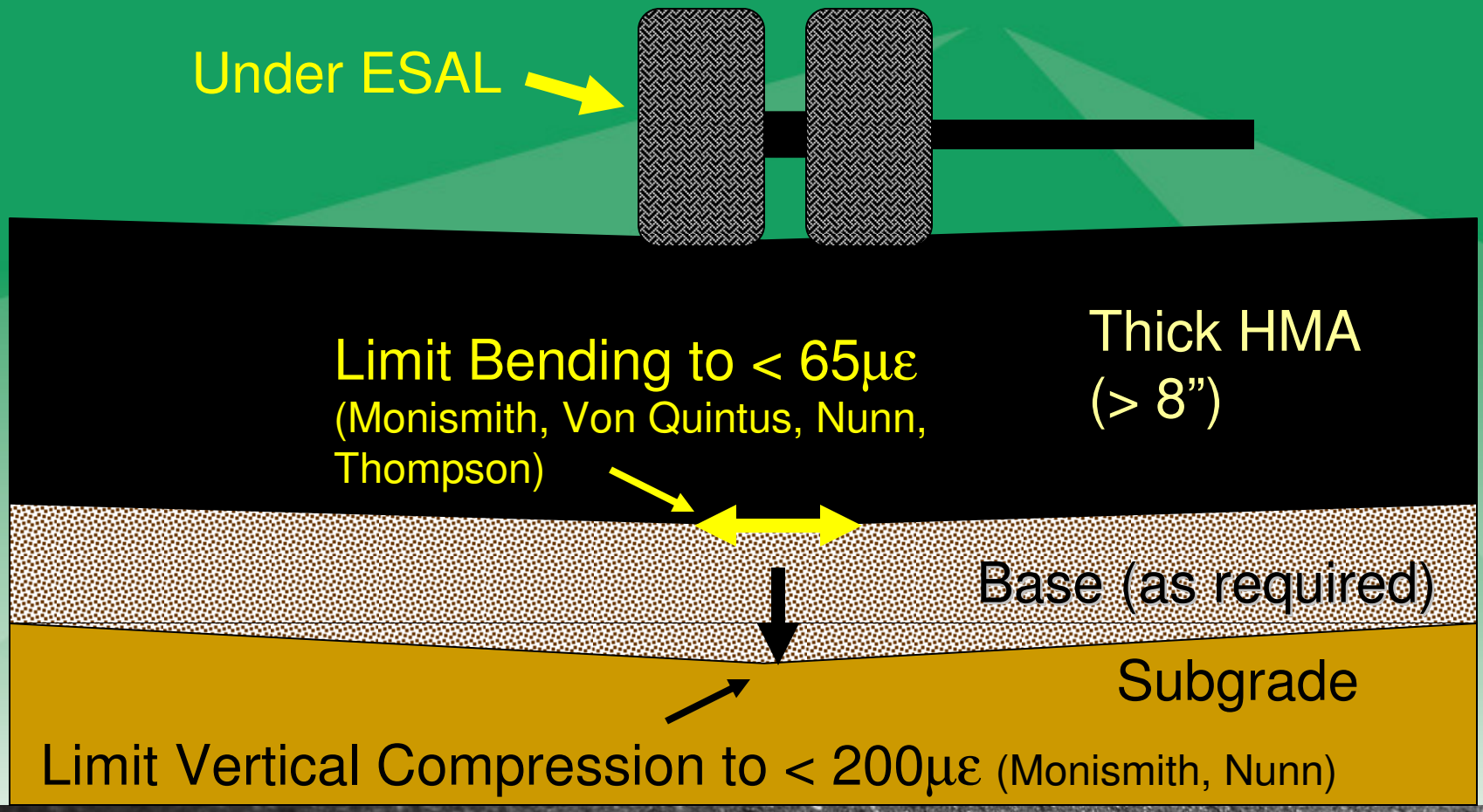
Mechanistic Performance Criteria



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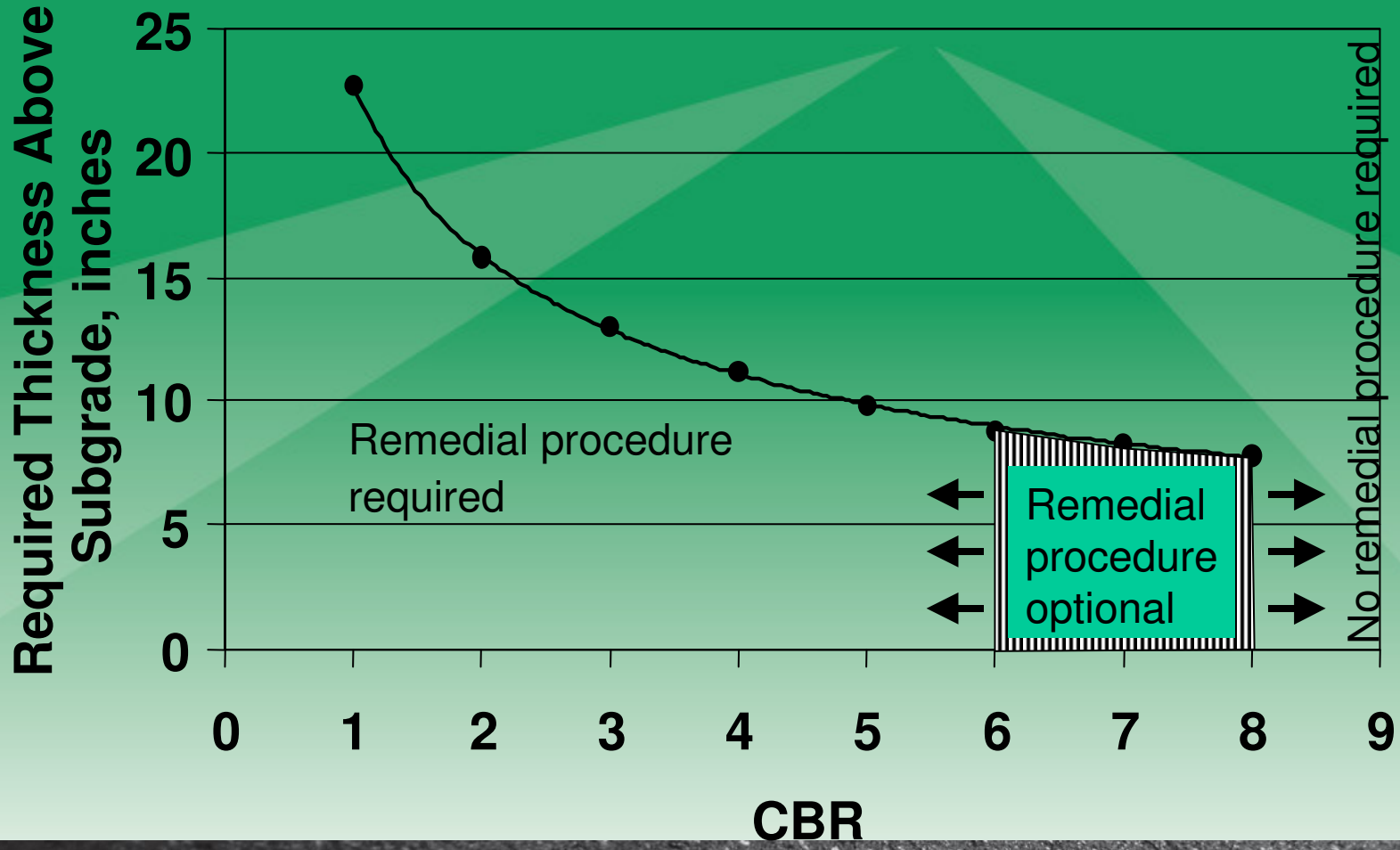
Foundation - Illinois



Perpetual Pavements

Foundation Requirements

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

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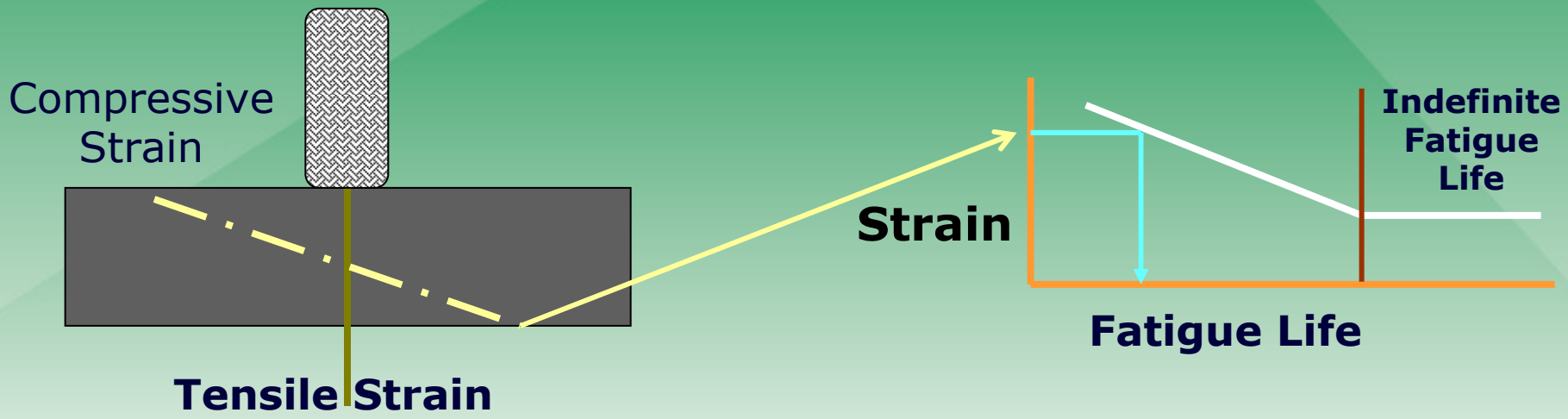
HMA Considerations

- HMA Base Layer
- Intermediate Layer
- Wearing Surface

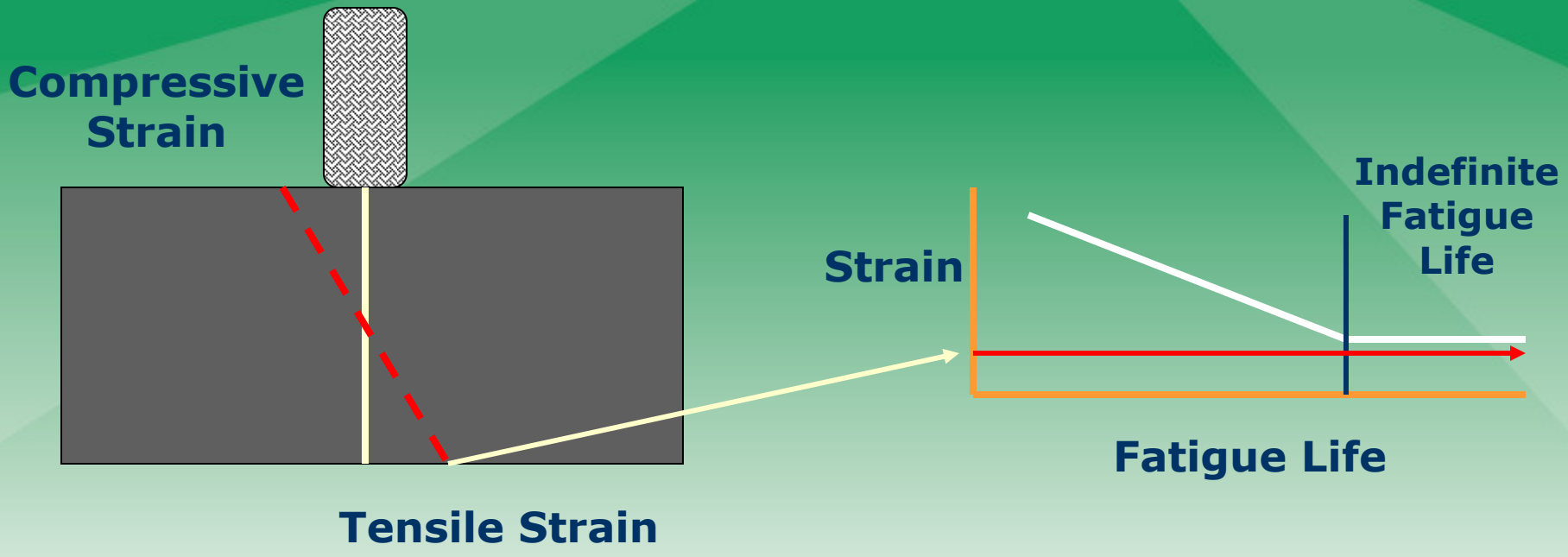
Perpetual Pavements

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



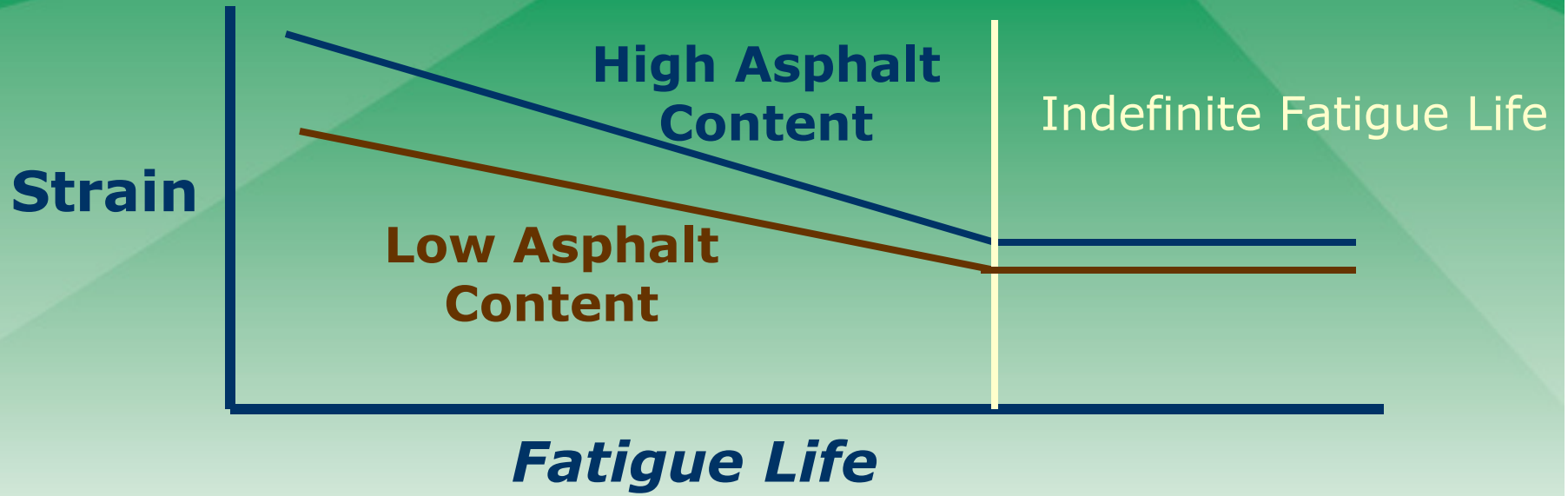
Perpetual Pavements

- 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**

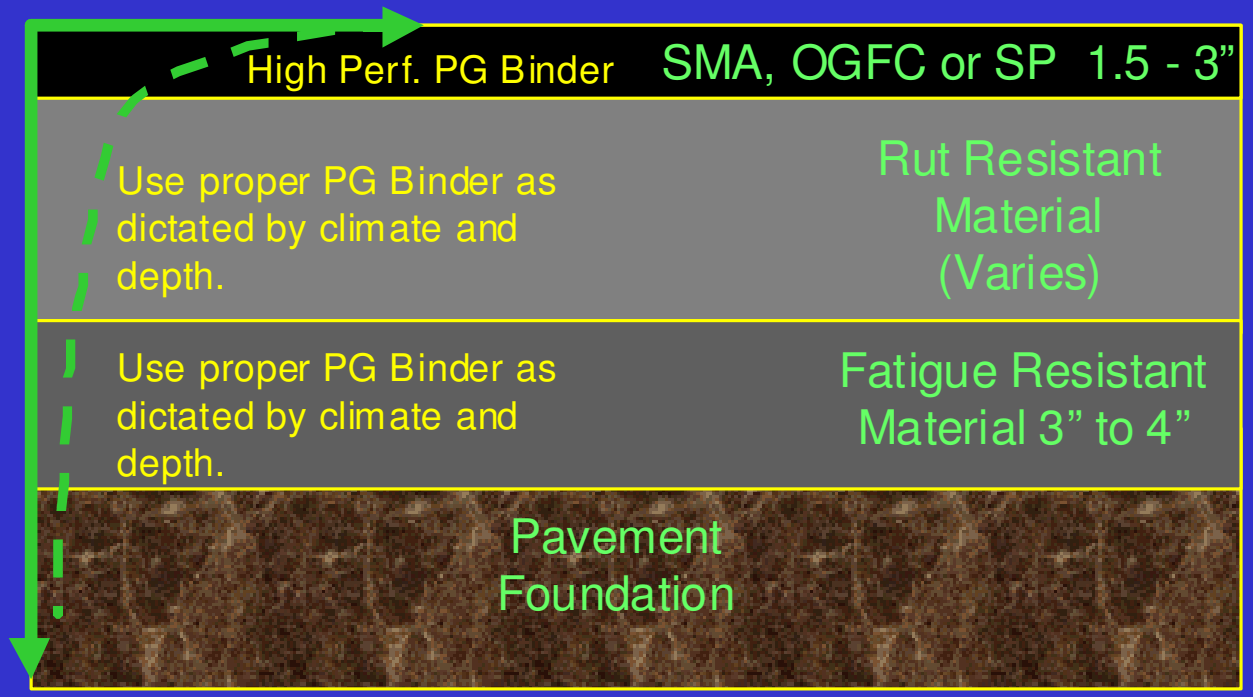


Perpetual Pavements

- 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/ltpp/bind/dwnload.cfm



Impact of Temperature Gradient on Asphalt Grade.

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

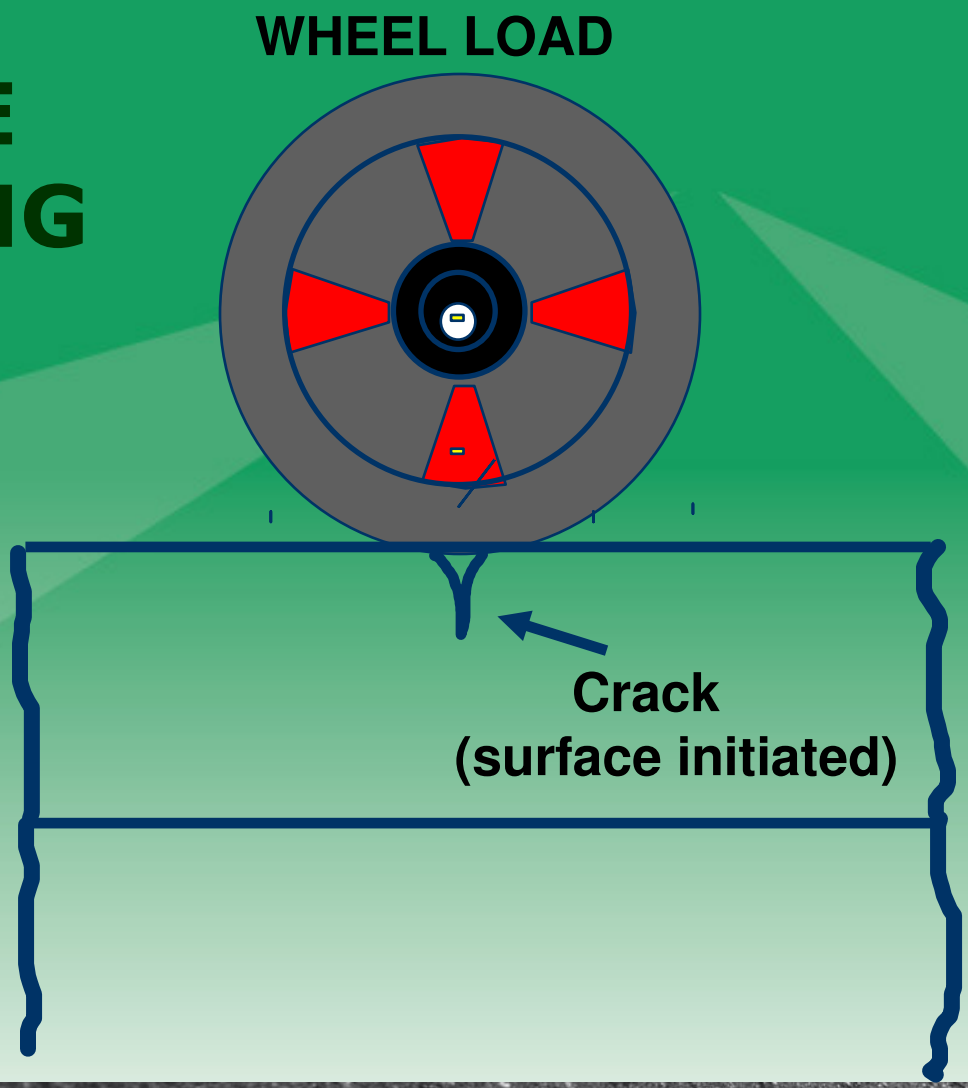
Ohio Study of Flexible Pavements

- 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

ASPHALT PAVEMENT ASSOCIATION OF MICHIGAN

SURFACE CRACKING



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

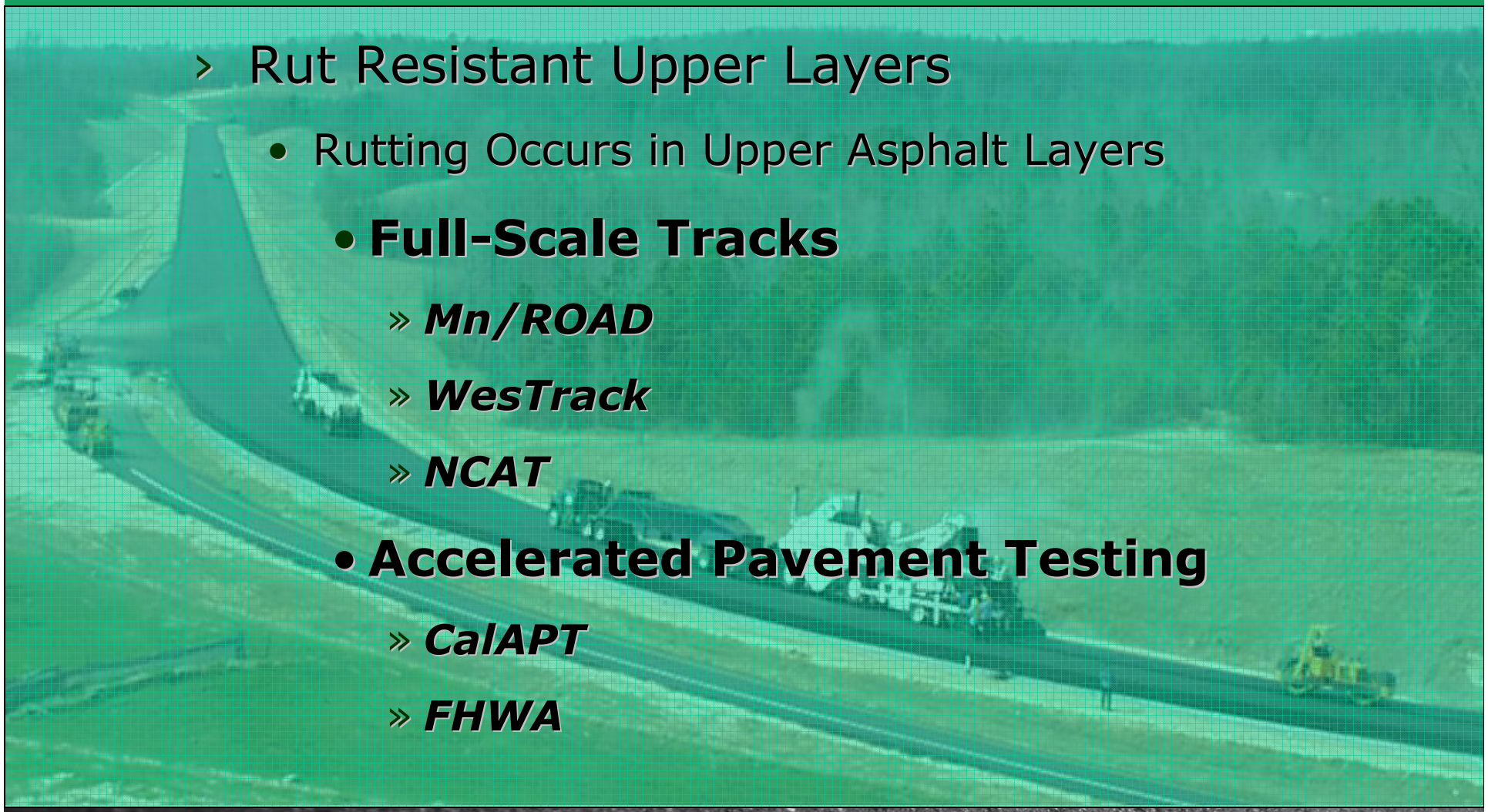
2 - 4″

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

Perpetual Pavements

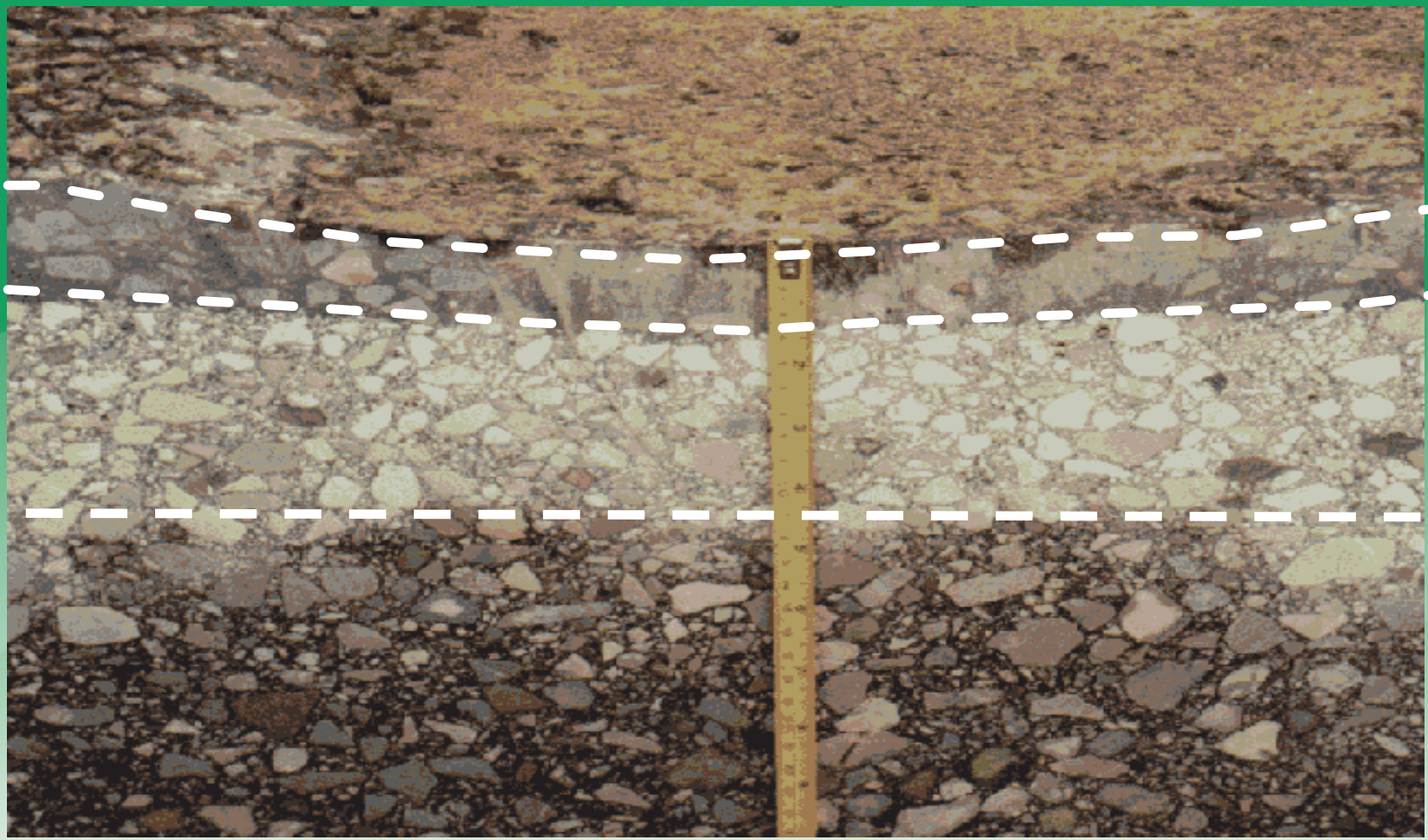


- Rut Resistant Upper Layers
  - Rutting Occurs in Upper Asphalt Layers
    - **Full-Scale Tracks**
      - ***Mn/ROAD***
      - ***WesTrack***
      - ***NCAT***
    - **Accelerated Pavement Testing**
      - ***CalAPT***
      - ***FHWA***

Perpetual Pavements

Asphalt Pavement Association of Michigan

NON-STRUCTURAL RUTTING



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	**Regular Mdot design**
2.5” ,4E10 ,PG 70-28P	2.0” ,5E10,PG 70-22P
3.0” ,3E10 ,PG 70-22P	2.5” ,4E10,PG 70-22P
4.5” , 2E10,PG 58-28	4.0” ,3E10,PG 58-28
10”	8.5”
12.” 21AA Agg. Base	6.4” ,21AA Agg.Base
14” Sand Subbase	18.4” Sand Subbase
36” Total Section	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 discount rate (3.9%)	199,938

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

2007 Award Winner: M-24, Tuscola Co.

Perpetual Pavements

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

MICHIGAN RIDES ON US Asphalt.

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

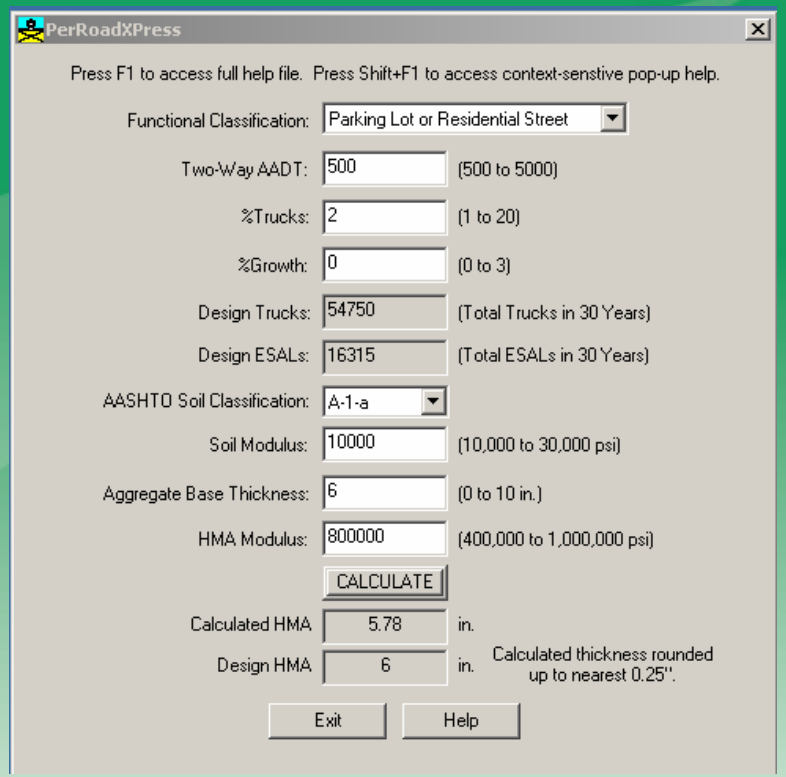
- *Mill & Fill*
- *Thin Overlay*

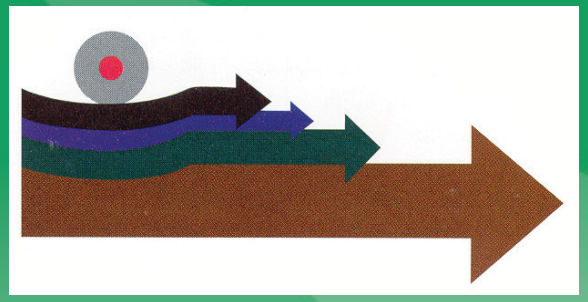
Structure Remains Intact

2 - 4″

Perpetual Pavements

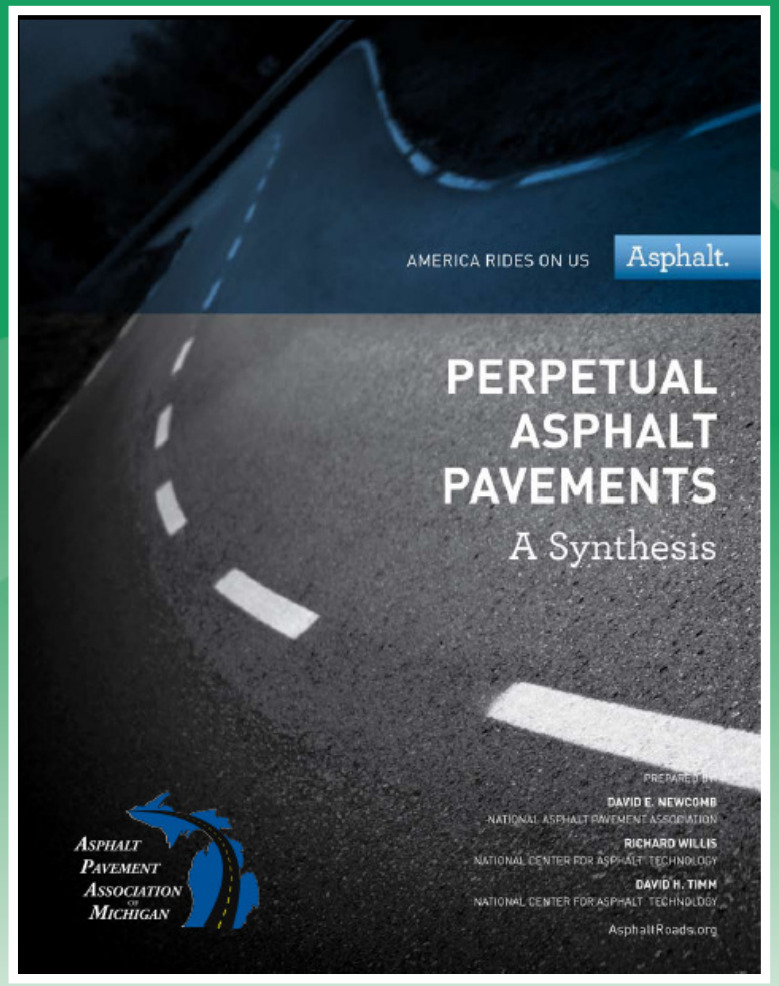
PerRoadXPress Software





www.apa-mi.org

Perpetual Pavements



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