Empirical Design

- AASHO road test procedure (1958)
- Updated in 1993 AASHTO Pavement Guide
- Pavement designed to fail after a certain number of load repetitions
- Increased number and size of loads require thicker pavements
Mechanistic Design

Moving toward design tools based on:

- Strengths of materials
- Stress-strain relationships
Endurance Limit Theory

• Research by Monismith and McLean at Cal-Berkeley (2) indicates that HMA exhibits an “endurance Limit” (strain level) below which fatigue damage does not accumulate.
Endurance Limit Theory

Thompson and Carpenter, University of Illinois, (1) conclude:

- Data supporting the concept of an endurance limit” for HMA have been presented for a wide variety of mixtures,
- Each mixture may have an individual endurance limit, but in no case has it been shown that a value lower than 70 micro-strain is required
- Data indicating that overloads do not significantly alter the existence of an endurance limit have been presented
Actual pavement performance

• The Transportation Research Laboratory (UK), Michael Nunn (3) reported that heavy duty HMA pavements in the UK did not show fatigue damage, even after carrying loads far in excess of their original design.

• Similar experience in Washington, Ohio and other US states.
Washington State Performance Data

• Study of Asphalt Pavements

• I-90 Spokane to Seattle

• No Reconstruction of Any Pavement for Structural Reasons
Ohio Performance

- Flexible pavements on Ohio’s Interstate highways conservatively designed for 20 year life, after nearly 40 years of service, have never required replacement or major rehabilitation.
- In fact the Ohio DOT has never even done a LCCA for major rehabilitation of a flexible section.
Conclusion

• It should be possible to design and build HMA pavements that will never fail in fatigue and will have indefinite structural life

• The Perpetual Pavement Concept
Pavement Design Concepts

- Fatigue Resistant Asphalt Base
  - Minimize Tensile Strain with Pavement Thickness and/or higher strength
  - Thicker/stronger Pavement = Lower Strain
  - Strain Below Fatigue Limit = Indefinite Life
Pavement Design Concepts

- Fatigue Resistant Asphalt Base
  - High Asphalt Content Mixes = Greater Strain Capability
  - Modified Binders = Greater Strain Capability
Pavement Design Concepts

- Bottom-up Design and Construction
- Foundation
  - Stable Paving Platform – prepared, drained
  - Minimize Seasonal Variability and Volume Change in Service
- Fatigue Resistant Lower Asphalt Layer
- Rut Resistant Upper Asphalt Layers
Pavement Design Concepts

Max Tensile Strain

4” to 6” Zone of High Compression

1.5 - 3” SMA, OGFC or Superpave

High Modulus Rut Resistant Material 4.5 - 6”

Flexible Fatigue Resistant Material 3 - 4”

Pavement Foundation
Design Concepts

Existing

- Designed to fail after load repetitions
- Empirical design principles employed
- 2-layer design

Perpetual Pavement

- Designed to withstand ultimate load
- Mechanistic design principles employed
- 3-layer design system

Absolutely Asphalt ... For Cost, For Convenience, For Comfort!!
Perpetual Pavement

- 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.

- Avoids Costly Reconstruction.
Perpetual Pavement

Summary

build a Perpetual Pavement

By designing for the fatigue limit of the material rather than traffic repetitions.

By employing mechanistic design principles.

By using a 3-layer design

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The Ohio Demonstration Project

- Relocated US 30 at Wooster
- Open to traffic December, 2005
- 16 ½ inch thick HMA, 3-layer design
- Fully instrumented, for environmental factors, loads, deflection
- Materials and design assumptions to be evaluated through research.
The Ohio Demonstration Project

US 30 Perpetual Pavement Demonstration Project
The Ohio Demonstration Project

Instrumentation:

- Weigh-in-motion scales
- Deflection measurement
- Load cells
- Strain gages at every level of the pavement
- Temperature and moisture measurement throughout
The Ohio Demonstration Project

Self contained weather station
PerRoad Express

• PerRoadXpress is an easy-to-use, all-on-one-screen program for designing Perpetual Pavements for low- and medium-volume roads and parking lots.

• http://www.eng.auburn.edu/users/timmdav/PerRoadXPress.msi
For more Information

• www.flexiblepavements.org

• Ohio Asphalt magazine
References

1. Fatigue Design Principles for Long Lasting HMA Pavements, Thompson and Carpenter
Questions?

• About Perpetual Pavement?
• Anything else?