Mechanistic-Empirical Pavement Design
Evolution of pavement design

Overview

- Brief History
- AASHTO 93
- ME Pavement Design
- DARWin ME Design Example
1950’s AASHO Road Test Data
Refinements in 1986 and 1993 to materials inputs, reliability and rehab design
Heavy truck traffic has increased 10-20 times since the 1960’s
Road test pavements sustained 1 million axle load applications
equates to less than what some modern pavements carry in the first few years
Application of this procedure to modern traffic means that we have to extrapolate the data
Rehabilitation design procedures were not included in the AASHO test
Climate not considered
One type of subgrade was used
One PCC and one HMA mixture were used
Truck characteristics have changed
   suspension, axle configurationss, tire type and pressure
Other deficiencies...
Empirical: Based on, concerned with, or verifiable by observation or experience rather than theory or pure logic.
Mechanistic: Determined by physical processes alone
AASHTO ‘93 – Empirical Design

• “Design” Structural Number:

\[ SN = a_1 D_1 + \sum_{i=2}^{n} a_i D_i m_i \]

- \( SN \) = structural number = \( f \) (structural capacity)
- \( a_i \) = \( i^{th} \) layer structural coefficient
- \( D_i \) = \( i^{th} \) layer thickness (inches)
- \( m_i \) = \( i^{th} \) layer drainage coefficient
- \( n \) = number of layers (3, typically)

Layer Coefficients:
- HMA Surface: 0.34
- HMA Intermediate: 0.36
- HMA Base: 0.34
- Rubblized Concrete: 0.20
- Compacted Aggregate: 0.14
With the SN some key factors were unaccounted for

Joint Task Force on Pavements got together in the 90’s and decided that a new design guide was needed
Came out with Guide for Mechanistic-Empirical Design
OF NEW AND REHABILITATED PAVEMENT
STRUCTURES in 2002
Mechanistic Design = Purely Scientific Approach relying on mechanics of structural behavior loading. Requires knowledge of fundamental material properties and precise geometric properties of the structure.

Empirical Design = design based on experimental results or experience. Requires many observations to establish links between design variables and performance. Does not require scientific basis for observed relationships.

Empirical Data from thousands of test sites across US and Canada (LTPPP) since 1987.

ME = determines pavement responses through mathematical models and relates them to observed performance.
ME Design Procedure

Predicted IRI
Initial IRI: 63.0 in/mi

Traffic

Materials

Structure

Climate
Reliability – probability that pavement will not exceed the performance criteria
See Chapter 52 of the Indiana Design for more examples
Pavement Distresses - HMA

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Pavement Distress - PCCP
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DARWin 93  Required Data

Design Life  Traffic
Foundation  Performance
Stiffness    Criterion

Reliability
<table>
<thead>
<tr>
<th>Direction of Traffic</th>
<th>Water Cement Ratio</th>
<th>Layer Thickness</th>
<th>Cement Type</th>
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<tbody>
<tr>
<td>Aggregate Type</td>
<td></td>
<td>Resilient Modulus</td>
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<tr>
<td>Percent Trucks</td>
<td>Average Tensile Strength</td>
<td>Design Life</td>
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<td>Sieve Analysis</td>
<td>Water Table Depth</td>
<td>Joint Sealant</td>
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<td>Flexural Strength</td>
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<tr>
<td>Dowel Bar Size</td>
<td>Construction Month</td>
<td>Dowel Bar Location</td>
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<tr>
<td>Construction Month</td>
<td></td>
<td>Project Length</td>
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<tr>
<td>Pavement Cores</td>
<td>Asphalt Dynamic Modulus</td>
<td>Asphalt Properties</td>
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<tr>
<td>Hourly Truck Distribution</td>
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<td>Performance Criteria</td>
<td>Slab Width</td>
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<td>Curing Method</td>
<td>PCC-Base Interface</td>
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<td>Axle Type and Location</td>
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<tr>
<td>Traffic Open Month</td>
<td>Asphalt Creep Compliance</td>
<td>Operational Speed</td>
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<td>Concrete Unit Weight</td>
<td>Liquid Limit</td>
<td>AASHTO Soil Classification</td>
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</table>
Darwin ME Design Example
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