2002 Design Guide
Preparing for Implementation

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Excerpts from the 2002 Guide
Implementation Package
2002 Design Guide Presentation Overview

- Need for Design Guide
- NCHRP 1-37A - Status
- Guide Basics
- Asphalt
- Implementation Steps
Change Is Needed!

- If we keep doing things the way we have been doing them, we will continue to get the same results we have been getting.

  - “No one I know is satisfied with the performance and costs of our pavements”.
Changes in our approach!

- The 2002 Design Guide represents a major change in the way we do design. It brings the designer closer to reality and considers traffic, structural features, materials, construction, and climate far more than ever before.
- This means the designer now will be more involved in the design and expected performance of their pavements.
The 2002 Design Guide provides a framework for continuous improvement over the years to come to keep up with changes in trucking, materials, computers, construction, design concepts, and so on.
1. Structural response models
2. Materials characterization
3. Traffic characterization
4. Climate effects
5. Mechanistic distress models
6. Smoothness models
7. Calibration of models
8. Rehabilitation design
9. Design reliability
10. Design Guide text
11. Software
12. Training-Implementation
So What’s Left?

Finalizing 2002 Guide
Finalizing Training Materials & Implementation
Debugging Software
Completion of Calibration
Finalizing Reliability

Apr 03
Jan. 03
Guide Basics: Development Requirements

- Apply/enhance of existing state-of-the-art technology.
- Common design parameters across pavement types:
  - Materials & soils characterization
  - Climate parameters
  - Traffic characterization
  - Design reliability
Products You Will See:

- Manuals
- Software
- Guidelines
- Recommended tests
- Implementation Materials
- Training Materials
2002 DESIGN GUIDE
SOFTWARE
Layout Convenient for Providing Inputs

- General Information
- Status and Summary
- Inputs
- View Results and Outputs
- Run Analysis
Guide Basics:
Develop the 2002 Guide for design of new and rehabilitated pavement structures based on M-E principles.
Design/Analysis Process

- Foundation Analysis
- Climate EICM
- Materials Testing
- Traffic Analysis

- Trial Design Strategy
- Pavement Response Model
- Distress/Smoothness Prediction Models
- Damage Accumulation
- Field Data Calibration

- Constructability Issues
- Viable Alternatives

- Select Strategy
- Life Cycle Cost Analysis

- Modify Strategy

- Meet Performance Criteria?
  - Yes
  - No
Flexible Pavement Performance

- Fatigue Cracking
- Longitudinal Cracking
- Thermal Cracking
- Rut Depth
- IRI
**Design Inputs:**

The 2002 Guide will use a hierarchical approach to determine design inputs.

<table>
<thead>
<tr>
<th>Input Level</th>
<th>Determination of Input Values</th>
<th>Knowledge of Input Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Project/Segment Specific Measurements</td>
<td>Excellent</td>
</tr>
<tr>
<td>2</td>
<td>Correlations/Regression equations, Regional values</td>
<td>Good</td>
</tr>
<tr>
<td>3</td>
<td>Defaults, Educated Guess</td>
<td>Fair - Poor</td>
</tr>
</tbody>
</table>
Input Parameter Categories:

1. Traffic
2. Materials
3. Climate
4. Design reliability
5. Structure/trial design
6. Performance
Materials Characterization

HMAC

• Modulus of Elasticity

Asphalt Mixtures
Dynamic Modulus
ASTM D3497

Unbound Materials
Resilient Modulus
NCHRP 1-28A
AASHTO T307
HMA Mixture: Dynamic (Complex) Modulus

\[ |E^*| = \frac{\sigma_0}{\varepsilon_0} \]

Adjusted for temperature & time of loading.

- \( |E^*| \) = Dynamic modulus
- \( \sigma_0 \) = Maximum (peak) dynamic stress
- \( \varepsilon_0 \) = Peak recoverable axial strain

\[ \phi = \frac{t_i}{t_p} \times (360) \]
## HMA Materials Data:

<table>
<thead>
<tr>
<th>Material</th>
<th>Parameter</th>
<th>Level 1</th>
<th>Level 2</th>
<th>Level 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mix</td>
<td>Master Curve</td>
<td>Mix Specific</td>
<td>Not Required</td>
<td>Not Required</td>
</tr>
<tr>
<td></td>
<td>IDT-Creep/Strength</td>
<td>Mix Specific</td>
<td>Reduced Testing</td>
<td>Reduced Testing</td>
</tr>
<tr>
<td></td>
<td>Air Voids</td>
<td>Not Required</td>
<td>Mix Design</td>
<td>Specification</td>
</tr>
<tr>
<td>Asphalt</td>
<td>G*/Phase Angle</td>
<td>AASHTO MP1 Binder Test</td>
<td>AASHTO MP1 Binder Test</td>
<td>Not Required</td>
</tr>
<tr>
<td></td>
<td>Pen./Vis./SG.</td>
<td>Not Required</td>
<td>Mix Design</td>
<td>Not Required</td>
</tr>
<tr>
<td></td>
<td>Type (PG, Vis.)</td>
<td>Not Required</td>
<td>Not Required</td>
<td>Specification</td>
</tr>
<tr>
<td>Aggr.</td>
<td>Effective SG.</td>
<td>Not Required</td>
<td>Mix Design</td>
<td>Quarry Specific</td>
</tr>
<tr>
<td></td>
<td>Gradation</td>
<td>Not Required</td>
<td>Mix Design</td>
<td>Specification</td>
</tr>
</tbody>
</table>

- Poisson’s Ratio
- Moisture Susceptibility
Predictive Equation for Dynamic Modulus

\[
\log E^* = -1.249937 + 0.02932 \rho_{200} - 0.001767 (\rho_{200})^2 - 0.002841 \rho_4 - 0.058097 V_a \\
- 0.802208 \left( \frac{V_{\text{beff}}}{V_{\text{beff}} + V_a} \right) + \frac{3.871977 - 0.0021 \rho_4 + 0.003958 \rho_{38} - 0.000017 (\rho_{38})^2 + 0.005470 \rho_{34}}{1 + e^{(-0.603313 - 0.313351 \log(f) - 0.393532 \log(\eta))}}
\]

where:

- \( E^* \) = dynamic modulus, 10^5 psi.
- \( \eta \) = bitumen viscosity, 10^6 Poise.
- \( f \) = loading frequency, Hz.
- \( V_a \) = air void content, %.
- \( V_{\text{beff}} \) = effective bitumen content, % by volume.
- \( \rho_{34} \) = cumulative % retained on the \( \frac{3}{4} \) in sieve.
- \( \rho_{38} \) = cumulative % retained on the 3/8 in sieve.
- \( \rho_4 \) = cumulative % retained on the No. 4 sieve.
- \( \rho_{200} \) = % passing the No. 200 sieve.
## Material Testing Required - AC Binder Characterization

<table>
<thead>
<tr>
<th>Test</th>
<th>Level</th>
<th>Specification</th>
</tr>
</thead>
</table>
| Penetration         | 1, 2  | ASTM D 5  
AASHTO T 49                      |
| Viscosity at 60°C   | 1, 2  | ASTM D 2171  
AASHTO T 202                     |
| Viscosity at 135°C  | 1, 2  | ASTM D 2170  
AASHTO T 201                     |
| Brookfield Viscosity| 1, 2  | AASHTO T P48                         |
| Softening Point     | 1, 2  | AASHTO T 3  
ASTM D 36                       |
| Shear Modulus       | 1, 2  | AASHTO T P5                         |
Material Testing Required - Asphalt Mix Characterization

<table>
<thead>
<tr>
<th>Test</th>
<th>Level</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complex Modulus</td>
<td>1</td>
<td>(On gyratory compacted specimens)</td>
</tr>
<tr>
<td>Indirect Creep</td>
<td>1</td>
<td>Needed for thermal cracking analysis (on gyratory compacted specimens)</td>
</tr>
<tr>
<td>Permanent Deformation</td>
<td>Special</td>
<td>Needed for regional calibration (on gyratory compacted specimens)</td>
</tr>
<tr>
<td>Fatigue Cracking</td>
<td>Special</td>
<td>Needed for regional calibration (on flexural beam samples)</td>
</tr>
</tbody>
</table>
Flexible Pavement Structures

- Asphalt Concrete
- Unbound Base
- Unbound Sub-Base
- Compacted Subgrade
- Natural Subgrade

- Asphalt Concrete
- Unbound Base
- Compacted Subgrade
- Natural Subgrade

- Asphalt Concrete
- Unbound Base
- Unbound Sub-Base
- Compacted Subgrade
- Natural Subgrade

- Asphalt Concrete
- Compacted Subgrade
- Natural Subgrade

- Asphalt Concrete
- Asphalt Treated Base
- Unbound Sub-Base
- Compacted Subgrade
- Natural Subgrade

- Asphalt Concrete
- Unbound Base
- Unbound Sub-Base
- Compacted Subgrade
- Natural Subgrade

- Asphalt Concrete
- Cement Treated Base
- Unbound Sub-Base
- Compacted Subgrade
- Natural Subgrade

- Asphalt Concrete
- Unbound Base
- Asphalt Treated or Cement Treated Layer
- Compacted Subgrade
- Natural Subgrade
Predicted Performance

Flexible Pavements

- Fatigue cracking
  Bottom-up and Top-down
- Permanent Deformation (rutting)
  Bound and unbound layers
- Thermal Fracture
- Smoothness, IRI

[Graph showing the relationship between Distress Or Damage Value and Response]
Implementation Steps

1. Agency acceptance/adoption
2. Training on design procedure
3. Establish design input procedures
4. Obtain needed equipment
5. State validation & calibration
LTPP Sections Used to Calibrate New Asphalt Concrete Pavement Design
Website: www.2002designguide.com

For more information see the Design Guide Website and NCHRP 1-37A project reports