2002 Design Guide

General Overview

2002 Southeastern Pavement Management & Design Conference

June 24, 2002
AASHTO GUIDE FOR
Design of Pavement Structures

PUBLISHED BY THE AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS

1993 Version
AASHO Road Test (late 1950s)

(AASHO, 1961)
One Rainfall Zone...

Figure 9. Average annual precipitation, in inches. (AASHTO, 1961)
One Temperature Zone...

Average Maximum and Minimum Daily Temperature by Months

From HIGHWAY RESEARCH BOARD
Special Report No.1
"Frost Action In Roads And Airfields"

Figure 10. Average annual frost penetration, in inches.

(AASHO, 1961)
One Subgrade...

Figure 16. Embankment construction, loop 1, using rotary speed mixers to process and adjust moisture content of soil (AASHO, 1961)

A-6 / A-7-6 (Clay)
Poor Drainage

NCHRP 1-37A
Limited Set of Materials...

- One asphalt concrete
  - 3/4” surface course
  - 1” binder course
- One portland cement concrete (3500 psi @ 14 days)
- Four base materials
  - Well-graded crushed limestone (main experiment)
  - Well-graded uncrushed gravel (special studies)
  - Bituminous-treated base (special studies)
  - Cement-treated base (special studies)
- One uniform sand/gravel subbase
1950s Construction Methods...

Figure 57. Compacting subbase.

Figure 29. Bituminous concrete construction.

1950s Vehicle Loads...

Figure 23. Test vehicles, showing typical axle arrangements and loadings.
Traffic Input - ESALs

What is an ESAL?
(Based on serviceability)

Which criterion?
(They don’t all give the same result!)
Limited Traffic Applications

AXLE LOAD REPETITIONS

PAVEMENT THICKNESS

Data Limits (AASHO Road Test)

Projection B

Projection A

0 1 Million > 100 Million
1950s
Data Analysis...
(Empirical)

Figure 26. Chart reader used with longitudinal profilometer to transcribe information to punched paper tape.

Figure 27. IBM tape-to-card printing punch.

Figure 28. Bendix G 15-D computer at project.

(AASHO, 1961)
Field Performance - The LTPP Study

AASHO Road Test Site
2002 Design Guide
1-37A Presentation Overview

- Status
- Flexible Pavements
- Rigid Pavements
- Rehabilitation
- Software Overview
The technical presentations on model details and software are on Tuesday.
NCHRP Project 1-37A

Development of the 2002 Guide for the Design of New and Rehabilitated Pavements

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Resource Pool:
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Objective:

Develop the 2002 Guide for design of new and rehabilitated pavement structures based on M-E techniques.
Study Requirements

- Application/enhancement of existing state-of-the-art technology.
- Common design parameters across pavement types:
  - Materials & soils characterization
  - Climate parameters
  - Traffic characterization
  - Reliability

Asphalt & PCC Pavements Treated Alike As Far As Possible!
1. Structural response models
2. Materials characterization
3. Traffic characterization
4. Climate modeling
5. Mechanistic distress models
6. Smoothness models
7. Calibration of models
8. Rehabilitation
9. Design reliability
10. 2002 Design Guide text
11. 2002 Software
12. Training-Implementation
Inputs important! Many obstacles overcome to reduce number & complexity.

Asphalt & PCC Pavements Treated Alike As Far As Possible!

2002 Design Guide
NCHRP 1-37A
Design Inputs to aid implementation:

Hierarchical approach for determining design inputs to help implementation.

<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>Good</td>
</tr>
<tr>
<td>2</td>
<td>Correlations/Regression equations, Regional values</td>
<td>Fair</td>
</tr>
<tr>
<td>3</td>
<td>Defaults, Educated Guess</td>
<td>Poor</td>
</tr>
</tbody>
</table>
Products You Will See:

- Manuals
- Software
- Guidelines
- Test Procedures
- User’s Manual
- Training Materials
Products You Will See:

✓ Procedures for pavement, LCCA, traffic analysis
✓ Procedures for evaluating existing pavements
✓ Recommendations on rehabilitation treatments, subdrainage, and foundation improvements for problem soils
Products can be found on the 2002 Website:

www.2002designguide.com
2002 DESIGN GUIDE
SOFTWARE
2002 Design Software Program

- Handles both U.S. Customary and SI units.
- User-friendly software with online/on-screen help in two levels
  - Context sensitive help for all design inputs
  - Detail HTML help accessible from each screen
- Runs on Windows 98, 2000, NT, XP
- Hardcopy and electronic copy outputs (HTML and/or Excel Workbooks)
Program Layout

General Information

Inputs

Status and Summary

View Results and Outputs
Color Coded Status Icons

Green to indicate completed inputs.

Yellow to indicate that default values will be used for the design.

Red to indicate that these inputs are still needed for the design process.
Design/Analysis Process

Foundation Analysis → Climate EICM → Materials Testing → Traffic Analysis

- Inputs
- Analysis

- Modify Strategy
  - No
  - Meet Performance Criteria?
    - Yes
      - Constructability Issues → Viable Alternatives
      - Life Cycle Cost Analysis
    - No
      - Trial Design Strategy
        - Pavement Response Model
          - Damage Accumulation
            - Field Data Calibration
            - Distress Prediction Models
  - Yes
    - Select Strategy

Strategy Selection

Design Guide
NCHRP 1-37A
2002 Design Guide Approach – Axle Load Spectra

• Axle load repetitions by
  - Vehicle class
    • Single axle
    • Tandem
    • Tridem
    • Quad
    • Special vehicles
  - Axle load group (load level)
  - Time
    • Monthly proportion
    • Hourly (PCC pavements) proportion
    • Annual growth
HMA Pavement Structures:

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

2. Asphalt Concrete  
   Unbound Base  
   Compacted Subgrade  
   Natural Subgrade

3. Asphalt Surface  
   Asphalt Binder  
   Asphalt Base  
   Compacted Subgrade  
   Natural Subgrade

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

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

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

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

8. Asphalt Concrete  
   Asphalt Treated or Cement Treated Layer  
   Compacted Subgrade  
   Natural Subgrade
Predicted Distresses:

- Fatigue Cracking
- Longitudinal Cracking
- Thermal Cracking
- Rut Depths
- IRI
Concrete Pavement Structures

Concrete Slab (JPCP, CRCP)

Base Course (unbound, asphalt, cement)

Sub Base (unbound, stabilized)

Compacted Subgrade

Natural Subgrade

Bedrock

E_c

E_base

E’s of layers
CRCP Punchout – Major Structural Distress
IRI = f(Distress)
Part II—Chapter 5
Evaluation existing pavements for rehabilitation

Part III—Chapter 5
Identification of feasible rehabilitation strategies

Part III—Chapter 6, HMAC
rehabilitation of existing pavements
Part III—Chapter 7, PCC
rehabilitation of existing pavements
HMAC Overlay Analysis

EXISTING PAVEMENT

PRE-OVERLAY TREATMENTS

OVERLAY ANALYSIS

PCC

COMPOSITE

MILL

FULL DEPTH REPAIR SLAB REPLACEMENT

CRACK & SEAT BREAK & SEAT RUBBILIZE

AC OVERLAY OVER PCC

AC OVERLAY OVER FRACTURED SLAB

FLEXIBLE OR SEMI RIGID

MILL

PARTIAL OR FULL DEPTH REPAIR

AC OVERLAY OVER AC
**PCC Restoration/Overlay Analysis**

**Existing Flexible/Composite**
- Milling
- Patching
- Shoulder replacement
- Subdrainage

**Existing Rigid**
- Load Transfer Restoration
- Full-depth repair
- Partial depth repair
- Slab replacement
- Shoulder replacement
- Retrofit tied PCC shoulder
- Subdrainage

**Retrofit tied PCC shoulder**
- Full-depth repair
- Partial depth repair
- Slab replacement
- Shoulder replacement
- Retrofit tied PCC shoulder
- Subdrainage
- Diamond grinding

**PCC Overlay**
- Cracking
- Faulting
- Punchouts
- Smoothness

**Existing PCC**
- Cracking
- Faulting
- Punchouts
- Smoothness

**2002 Design Guide**
NCHRP 1-37A
Implementation Issues

- Training on design procedure
- Establish database for design inputs
- Local validation and calibration of distress models
  - Establish database of sections in state
  - Input guidelines for local conditions and materials
  - Adjust performance models as needed
Communication and training are essential!

- Mechanistic principles
- Design-Analysis Process
- Traffic
- Climate
- Materials Characterization
- Prediction Models
- Pavement Evaluation

✓ Power Point Slides
✓ Video, CD
✓ Examples & Demos
✓ Manuals

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NCHRP 1-37A
JPCP Calibration States
(LTPP Data from 23 States)
Local Calibration and Confirmation of Default Values

**Inputs**
- Review all inputs, procedures, defaults, ranges.
- Establish agency procedures for inputs.

**Calibration**
- Materials database
- Traffic database
- Performance database
- Rehabilitation database
So What’s Left?

Finalizing 2002 Guide

Finalizing Training Materials & Implementation

Integration & Debugging Software

Completion of Calibration

Reliability Implementation

Nov 02

Jan. 02
Benefits from the 2002 Guide.

- Adequate Structural Design
- Adequate Materials
- Proper Mixture Design
- Construction Factors

Fully Considered

Long-Life, Cost-Effective & Reliable Pavements