Using PMS Data to Calibrate MEPDG Pavement Distress Prediction Models: A Case Study

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MDOT’s Two – Phase Implementation Approach

• Phase I - SS No. 163
• Applied Research Associates (ARA)
• Become familiar with Mississippi’s materials, pavements, rehabs etc.
• Educate MDOT staff on info requirements for local calibration
• Develop a detailed plan for Phase II, local calibration
Data Sources

- Pavement management sections
- Mississippi’s LTPP sites
- Warranty job data
- Other research project data
Decision to use PMS Data for Initial Calibration

• Budget considerations
• Volume and type of PMS data
• Depth and level of detail
• Longevity of PMS Data
MDOT’s PMS Data Analysis Sections

- Homogeneous construction history and geometrics
- Identified by county/route/logmile/direction
- Use only typical section from plans
- Projects entered by Districts
- Approximately 5,400 sections in data
MDOT’s PMS Data Condition/Distress

• Data collected every two years on entire network
• Rightmost through lane of undivided highways, north- and eastbound only
• Rightmost through lane of both directions for divided highways
• Laser data collected on 100% of through lanes
• Calibration done daily, QA sites collected
MDOT’s PMS Data
Condition/Distress continued

- Manual video distress analysis done on two 500-ft samples per mile
- QA done on randomly picked sections and based on queries for data problems
- Distresses quantified according to SHRP Manual
- Overall Pavement Condition Rating (PCR) calculated using deduct curves
MDOT’s PMS Data Information Retrieval

- Data kept in TMIS (Transportation Management Information System)
- Report average fault, rut, IRI for entire section
- Report percentages of rut, IRI that fall into certain ranges
- Report distress quantities and/or densities
- Limited mapping, query & reporting
PMS Meets MEPDG

- Climate
- Rut Depth
- Fatigue Cracking
- Thermal Cracking
- Ride Quality

Pavement Management Sections

- Traffic
- Materials
- Soils
What Our PMS Data Has

- Layer types for all courses
- Layer thicknesses
- Project numbers
- Mix design numbers of surface course
- GIS-enabled/GPS coordinates
- Some material properties
- Several condition surveys’ worth of data
What Our PMS Data Doesn’t Have

• Distress data between samples
• Station numbers (yes and no), equations
• Material properties other than %AC, max aggregate size, gyratory.Marshall, PG, etc.
• Layer thicknesses other than typical plan section
• Skid/Deflection data on much of the system
Implementation
Identification of Typical Pavements Used in Mississippi

- Product of SS # 163 - development of Factorial Experiment Design for Calibration and Validation of Distress Prediction Models
- Table that captures various combinations of pavement structural sections and materials used in Mississippi; i.e. for a given pavement
- Starting with original construction AC
# Factorial Experiment Design

<table>
<thead>
<tr>
<th>Subgrade Type</th>
<th>Binder Type</th>
<th>Mix Type</th>
<th>Pavement Type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Conventional</td>
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<td></td>
<td>L</td>
</tr>
<tr>
<td>Non Stabilized</td>
<td>Modified D</td>
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<tr>
<td>Non Stabilized</td>
<td>Modified S</td>
<td>D</td>
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<td>S</td>
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<td>Modified D</td>
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<tr>
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<td>Modified S</td>
<td>D</td>
<td></td>
</tr>
</tbody>
</table>
Factorial Experiment Design

- 44 potential different combinations just for HMA
- Terms and definitions are not the same between MDOT PMS and MEPDG
- Some pavements could fit more than one category
Data Needs from PMS

- Polymer-modified vs. nonmodified binder
- Mix type (dense-graded, Superpave)
- Stabilized or unstabilized subgrade
- Classification by base layers
- Pavement thickness
## Summary – Factorial Options

<table>
<thead>
<tr>
<th>Factors</th>
<th>Options</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate</td>
<td>1</td>
<td>One climatic zone</td>
</tr>
<tr>
<td>AC thickness</td>
<td>3</td>
<td>Low, medium, high</td>
</tr>
<tr>
<td>Base / subbase</td>
<td>2</td>
<td>Stabilized, granular</td>
</tr>
<tr>
<td>Subgrade soil</td>
<td>2</td>
<td>Stabilized, nonstabilized</td>
</tr>
<tr>
<td>Pavement type</td>
<td>5</td>
<td>Conventional, deep strength, semi rigid, AC overlay of AC and PCC</td>
</tr>
<tr>
<td>Binder type</td>
<td>2</td>
<td>Conventional, modified</td>
</tr>
<tr>
<td>Mix type</td>
<td>2</td>
<td>Dense, Superpave</td>
</tr>
</tbody>
</table>
Asphalt Pavement Types for MEPDG

- Conventional
  - AC over granular base/subbase
- Semi-rigid
  - AC over bound base/subbase with cementitious materials
- Deep strength
  - AC over bound base/subbase with asphalt
- Full Depth
Flexible Pavement Design Strategies

- Full Depth
  - Deep Strength
    - HMA Wearing Surface
      - HMA Binder & Base Layers
        - ATB or Black Base
        - Aggregate Base
      - Aggregate Subbase
    - Improved or Stabilized Embankment
      - Subgrade Soil
Distress Types for HMA Pavements

- Fatigue Cracking
- Longitudinal
- Smoothness/ride quality
- Rutting
- Thermal Cracking
Flexible Pavement Distresses

- Fatigue Cracking
- Thermal Cracking
- Longitudinal Cracking
- Rutting
- IRI
Issues with PMS Construction History Data

- Some samples fit more than one MEPDG pavement type (semi-rigid and deep-strength)
- Difficult to search some PMS data fields
- Some attributes not in PMS data
- Only have typical sections
- Limited material properties
- Project vs. network level
Issues with Distress Data

- Different weather conditions & operators
- Rater subjectivity
- Different classifications of distresses
- Can affect PCR calculations and trends
- Location referencing (logmile vs. stations)
- Only used 1997 and later
Distress Data Issues—cont’d

- No way to compare video year-to-year
- No way to easily query data for some desired attributes
Design Guide Challenges

- Software—v 1.0 to AASHTOware
- Analysis vs. design tool
- Iterative process
- Models not all finished yet
People Factors

- Personnel changes on both sides
- Business processes within MDOT
- Greatest Generation/Early Baby Boomer retirements
- Shift from field to computer
- Efforts to get data corrected
Decisions Made by MDOT & ARA

- Use only distress data since 1997
- Only sections ½-mile long or longer
- Only original construction asphalt at first
- Only sections constructed since 1985
- Find 500-ft samples that were in the same place year to year
PMS Data Process

• Query for desired pavement type, mix, thickness etc. to fit factorial experiment design
• Query samples to check location from year to year
• Check to see if the analysis section has been modified and when
• Check to see if as-built plans exist
PMS Data Process—cont’d

- Run through distress data extraction program
- ARA analyzes to see if sample(s) can be used
How Does Our Data Stack Up?

• New construction analysis sections
  • 66 analysis sections (379 500-ft sample units with data)
• Analysis conducted
  • Percent of good data (at sample unit level)
  • Check for distress progression with time
  • Each sample unit with time progression is valid data point
# Rating Scheme and Percentages

<table>
<thead>
<tr>
<th>Rating</th>
<th>Percent Good Data</th>
<th>Analysis Sections *</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>$\geq 90%$</td>
<td>52%</td>
</tr>
<tr>
<td>Good</td>
<td>75% - 89%</td>
<td>29%</td>
</tr>
<tr>
<td>Satisfactory</td>
<td>50% - 75%</td>
<td>17%</td>
</tr>
<tr>
<td>Poor</td>
<td>$\leq 49%$</td>
<td>2%</td>
</tr>
</tbody>
</table>

* New construction only
Rating Scheme and Percentages

<table>
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<tr>
<td>Poor</td>
<td>( \leq 49% )</td>
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</table>

- Excellent (52)
- Good (29)
- Satisfactory (17)
- Poor (2)
Advantages of PMS Data

• Volume of data available
• Many years of condition data
• Construction history mostly accurate
• MDOT has database-savvy PM personnel
• GIS-enabled, GPS coordinates
• Detail level of our distress data
Disadvantages

- Time-consuming
- Difficult to communicate
- Not easy to query for some attributes
- Iterative process
- Useable format
- Some samples don’t show trends
Beyond PMS Data

• Much MEDPG desired data still manual
• Microfiche, construction project diaries
• Materials Division testing data
• Integration of traffic data still ongoing
• Construction & materials data not GIS-referenced
The Future

- Asphalt with overlays, then concrete
- Continue to work with ARA on local calibration with historical data
- New PMS software and optimization
- Future calibration to be done at project level on new construction projects
- MDOT will collect and process condition/distress data on new projects
Implementation - Phase II

- SS No. 170 “Implement the 2002 Design Guide for MDOT (Phase II)
- Review inputs required by the MEPDG
- Complete design guide software sensitivity analysis
- Assemble data for calibration and validation of performance models
Lessons Learned So Far

- Communication is key
- Must have people who know data inside and out
- Must be able to get data into meaningful format
- PMS data best for initial calibration
- Each state must decide if and to what extent they can use their PMS data for MEPDG
Pavement Management and MEPDG

- Design
- Feedback
- Performance
QUESTIONS?