Implementation Activities of New MEPDG in Louisiana

Zhongjie “Doc” Zhang, PhD, PE

May 12, 2009
Task Force Committee

- Chaired by the representative of Chief Engineer of LA DOTD
- Members are from research, material, design, traffic, maintenance, preservation, PMS, construction, etc.
Function of Task Force Committee

- Develop a feasible work plan for implementing new pavement design guide
- Guide the implementation process
- Coordinate the implementation effort of the department
- It will be a long term effort with no deadline for implementation

- Research section takes the lead

- Louisiana Transportation Research Center (LTRC) has been conducting research projects in various areas that can serve both the current and new M-E pavement design procedures
LTRC Research Projects

- **Traffic Input Study, finished:**
  - Reviewed current practice of traffic data collection by LA DOTD
  - Developed a strategic plan for permanent WIM data collection needed by MEPDG
  - Recommended axle load spectra and vehicle class distributions based on currently available short term WIM data
  - Updated LEF table for 1993 pavement design guide
Steering axle weight (Class 9 vehicle) versus frequency for Site #38

Steering axle weight (Class 9 vehicle) versus frequency for Site #53
Gross vehicle weight (Class 9 vehicle) versus frequency for site #107

Gross vehicle weight (Class 9 vehicle) versus frequency for site #20
Development of a Strategic Plan

- Factors considered
  - Current practices of the traffic data collection process by LA DOTD and other states.
  - Official truck route zones of Louisiana
  - Location of weight enforcement sites
  - Other traffic data input required by M-EPDG
  - Site selection and traffic data collection guidelines by TMG
Strategic Plans

- Alternative Plan #1
  - 29 permanent WIM stations
    - 17 for interstates
    - 12 for principal arterials
  - 15 additional portable sites on the principal arterials as the supplement to the permanent WIM for traffic data collection
Strategic plans

• Alternative Plan #2
  o 7 are allocated to interstates
  o 10 are allocated to principal arterials
  o 12 weight enforcement stations
  o This plan has a lower implement cost than plan 1 does
LTRC Research Projects cont.

- Traffic Input Study, future effort:
  - Establish the mechanism within the department to use the WIM data from existing weight enforcement stations (13) for pavement design purpose
  - Conduct a traffic pattern study using 7-day WIM data to further reduce the number of permanent WIM stations required in Louisiana
  - Work with traffic data collection, design, and construction sections to build more permanent WIMs
Material Properties:

- Louisiana Asphalt Mixtures and MEPDG “E*”, on going
  - Catalog Elastic Moduli measured for Louisiana mixtures
  - Compare E* of asphalt mixtures predicted by the MEPDG models to the measured E*
  - Investigate the MEPDG rut prediction as it relates to variation in E*
  - Develop correlation of E* to other laboratory test for asphalt mixtures
  - Prepare design recommendations for DOTD asphalt pavement design
Dynamic Modulus $|E^*|$ Test

- IPC UTM-25
- AASHTO TP-62
- Sinusoidal axial compressive stress is applied to a specimen – temperature and frequency

<table>
<thead>
<tr>
<th>Frequency (HZ)</th>
<th>25, 10, 5, 1, 0.5, 0.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temp. (°C)</td>
<td>-10, 4.4, 25, 38, 54.4</td>
</tr>
</tbody>
</table>

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

\[ \phi = \omega t \]
Interim Findings

- Asphalt mixture models available in MEPDG correlate well with tested values of Louisiana AC mixes
Material Properties:

- Warm AC Mix, on going
  - Compare Warm mix to standard hot mix in both lab and field, designed & constructed using standard hot mix asphalt design protocol & construction specs.
  - Compare $E^*$ and other lab parameters of Warm Mix to ones of standard hot mix
  - Compare production and compaction of Warm Mix to standard hot mix using in-situ strength measurement devices
Material Properties:

- Characteristics of Asphalt Treated Base, on going
  - Measure $E^*$ for low cost asphalt base mixture containing 75% 610 base stone, 25% concrete sand, and 3% asphalt
  - Evaluate constructability of ATB and verify compaction limits
  - Compare $E^*$ to modulus of unbound 610 stone base.
Material Properties:

- Characteristics of Unbound Stone Base, finished
  - Determined the typical values of resilient modulus of 610 stone base used in Louisiana
  - Determined the typical values of permanent deformation potential of 610 stone base used in Louisiana.
Material Properties:

- Coefficient of Thermal Expansion Effects on Louisiana’s PCC, finished
Determined the variance of CTE for concrete mixes used in Louisiana

Provided recommendations of CTE for input to new MEPDG in PCC pavement design

Evaluated the current specification for maximum spacing of transverse joints in jointed plain concrete pavement (JPCP) given CTE
Preliminary Findings

- PC Concrete using siliceous river gravel exhibits higher coefficient of thermal expansion than limestone.
- Concrete in saturated condition exhibits higher coefficient of thermal expansion than unsaturated.
- More research is recommended for saturated or partially saturated slab condition.
- Coefficient of thermal expansion plays a large role in recommended joint spacing.
Material Properties:

- Cementitiously Stabilized Bases
  - Provided resilient moduli of soils stabilized by cement, lime, and other cementitious materials, finished
  - Work on FE model to simulate the rutting performance of the cementitiously stabilized base/subbase materials under accelerated loading
LTRC Research Projects cont.

- **Material Properties:**
  - Subgrade modulus
    - Established correlations among results of lab test and in-situ tests such as DCP, FWD, DYNAFLECT, etc. finished
    - Work on LA DOTD testing specs, training manual, and workshop on DCP testing
    - Will require DCP testing data in subgrade soil survey for pavement design purpose
Correlation: DCP- Direct Model

Direct Model
$R^2=0.91$

$$M_r = \frac{151.8}{(DCPI)^{1.096}}$$
## Summary of Different Models

<table>
<thead>
<tr>
<th>Device</th>
<th>Method</th>
<th>$R^2$</th>
<th>RMSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>DCP</td>
<td>DCP-Soil Property Model</td>
<td>0.92</td>
<td>0.98</td>
</tr>
<tr>
<td></td>
<td>DCP-Direct Model</td>
<td>0.91</td>
<td>1.23</td>
</tr>
<tr>
<td>CIMCPT</td>
<td>CIMCPT- Soil Property Model</td>
<td>0.86</td>
<td>1.18</td>
</tr>
<tr>
<td></td>
<td>CIMCPT- Direct Model</td>
<td>0.77</td>
<td>1.26</td>
</tr>
<tr>
<td>Dynaflect</td>
<td>Dynaflect</td>
<td>0.73</td>
<td>1.46</td>
</tr>
<tr>
<td>FWD</td>
<td>ELMOD 5</td>
<td>0.71</td>
<td>1.32</td>
</tr>
<tr>
<td></td>
<td>MODULUS 6</td>
<td>0.52</td>
<td>1.60</td>
</tr>
<tr>
<td></td>
<td>EVERCALC 5.0</td>
<td>0.51</td>
<td>1.64</td>
</tr>
<tr>
<td></td>
<td>Florida Equation</td>
<td>0.49</td>
<td>1.65</td>
</tr>
</tbody>
</table>
LTRC Research Projects cont.

- Pavement Structure
  - Update pavement performance index models for various pavement types and structures using PMS database, finished
LTRC Research Projects cont.

- **Pavement Type**
  - Asphalt
  - Jointed Concrete
  - Composite
  - Continuously Reinforced Concrete

- **Distress Type**
  - IRI
  - Fatigue
  - Patching
  - Rutting
  - Longitudinal Cracking
  - Transverse Cracking
Generalized Model

(Family Deterioration Curves)

- Generalized models were developed
  - Based on Distress Index and Age
  - Highway Classification
  - Pavement Type
  - Distress Type
  - Example: *IHS-ASP-Fatigue Model, etc.*
Roughness Index Generalized Model (NHS)

\[ tfdt = y = 0.27x^{0.35} \]

\[ R^2 = 0.92 \]
Pavement Structure:

Measurement of Seasonal Changes and Spatial Variations in Pavement Unbound Base and Subgrade Properties, on going
Main Objective

To investigate field moisture variation over time in highway unbound bases and subgrade soils and its impact on their engineering properties

To develop a reliable design methodology to consider such impact
Research Approach

- Develop correlations between climatic factors such as rainfall and the variations in soil moisture for different climatic zones in Louisiana.
- Use estimated range in variation of moisture to predict the changes in soil properties using laboratory and field monitoring data.
This is a map of annual precipitation averaged over the period 1961-1990. Station observations were collected from the NOAA Cooperative and USDA-NRCS SnoTel networks, plus other state and local networks. The PRISM modeling system was used to create the gridded estimates from which this map was made. The size of each grid pixel is approximately 4x4 km. Support was provided by the NRCS Water and Climate Center.

Copyright 2000 by Spatial Climate Analysis Service, Oregon State University

Legend (in inches)
- Under 52
- 52 to 56
- 56 to 60
- 60 to 64
- Above 68

For information on the PRISM modeling system, visit the SCAS web site at http://www.ocs.orst.edu/prism

The latest PRISM digital data sets created by the SCAS can be obtained from the Climate Source at http://www.climatesource.com
Divided Climatic Zone
Selected Sites for Instrumentation and Sample Collection
Field Instrumentation
Pavement Structure:

- Evaluate Pavement Structures Using New M-E Pavement Design Guide, just started

The objective of this study is to evaluate the performance of typical flexible pavement type, materials, and structures currently used in Louisiana and identify the areas for future local calibration of the new M-EPDG.
LTRC Research Projects cont.

- Identify lab and field data available within DOTD and LTRC to determine the input for the new M-EPDG
- Predict the performance of typical pavement types with materials and structures currently used in Louisiana and compare the results with PMS data
- Identify the areas for future local calibration of the new M-EPDG
Thanks!