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Past Chair Canadian User Group
AASHTOWEAR Pavement ME Design

February 7, 2017
What you will hear today

• An Introduction On AASHTOWARE Pavement ME Design
• AASHTOWARE ME Design Task Force;
• Canadian User Group for AASHTOWARE Pavement ME Design and Their Activities;
• AASHTOWARE Pavement ME Design Canadian Calibration Efforts;
• AASHTOWARE Pavement ME Design Canadian User Guide;
## Pavement Design Procedures in Canada

<table>
<thead>
<tr>
<th>Agency</th>
<th>General Design Method(s)</th>
<th>Design Life (years) / New/Rehabilitation</th>
<th>Economic Analysis</th>
<th>Analysis Method</th>
<th>Period</th>
<th>Discount Rate (%)</th>
<th>Include Salvage Value?</th>
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<tbody>
<tr>
<td>British Columbia</td>
<td>AASHTO '93</td>
<td>20 / -</td>
<td>Present Worth</td>
<td>20</td>
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<td>Alberta</td>
<td>AASHTO '93 (New &amp; Rehab)</td>
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<td>Saskatchewan</td>
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<td>Present Worth</td>
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<td>Manitoba</td>
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<td>Ontario</td>
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<td>Quebec</td>
<td>AASHTO '93, CHAUSSEE 2.2</td>
<td>Major Highways: 20 / 20 Other Projects: 15 / 15</td>
<td>Present Worth</td>
<td>40</td>
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<td>New Brunswick</td>
<td>AASHTO '93 (now being considered for implementation), Rebound Values</td>
<td>20 / 15</td>
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<td>Prince Edward Island</td>
<td>Asphalt Institute, Thickness Design</td>
<td>20 / 12</td>
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<td>Nova Scotia</td>
<td>AASHTO '93, Correlation Charts using AADT &amp; Grain Size of Subgrade</td>
<td>20 / -</td>
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<td>Newfoundland</td>
<td>Standard Sections</td>
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<td>PWGSC</td>
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<td>Present Worth</td>
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</tbody>
</table>
AASHTOWare Pavement ME Design

Climate → Materials → Response → Damage → Time → Damage Accumulation → Distress

Traffic → Structure
### Major differences AASHTO '93 vs AASHTOWare Pavement ME Design

<table>
<thead>
<tr>
<th>Parameter</th>
<th>AASHTO '93</th>
<th>AASHTOWare Pavement ME Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hierarchical Levels</td>
<td>One level</td>
<td>Level 1, Level 2 and Level 3</td>
</tr>
<tr>
<td>Inputs</td>
<td>5 for Flexible 10 for Rigid</td>
<td>100</td>
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<tr>
<td>Weather Stations</td>
<td>N/A</td>
<td>223 Across Canada</td>
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<td>Traffic</td>
<td>ESAL’s</td>
<td>Axle Load Spectra, AADTT</td>
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<tr>
<td>Performance Criteria</td>
<td>N/A</td>
<td>Terminal IRI, AC Rutting, Total Rutting, Thermal Cracking, Fatigue Cracking both top-down and bottom-up</td>
</tr>
</tbody>
</table>
How Can ASSHTOWARE Pavement ME Design Help Me?

- Evaluate design features;
- Evaluate strategies for optimizing design;
- Agency-established performance criteria;
- New Construction materials;
- Considers all the major pavement interactions;
How Can ASSHTOWARE Pavement ME Design Help Me?

- Quantify additional damage caused by:
  - Unique truck loading configurations or
  - Increased truck weights;
- As-constructed construction data;
- Cost effectiveness of construction strategies;
- Established performance criteria;
- Output can be used for:
  - Life-cycle cost analysis,
  - Performance related specifications,
  - Establishing warranties.
AASHTOWARE Me Design Task Force

Pavement ME Design Task Force

1. Manage the Software
2. Review the Contractor Progress
3. Evaluate the Contract Deliverables
4. Determine the Schedule for Releases
5. Update the Strategic Plan
6. Oversee the Support, Maintenance and Enhancement
7. Communicate with Licenses
8. Monitor and Propose Development Projects
AASHTOWARE Me Design Task Force

Task Force Members

1. John Donahue, Missouri DOT, Chairperson
2. Vicki Schofield, AASHTO Project Manager
3. William Barstis, Mississippi DOT
4. Jay Goldbaum, Colorado DOT
5. Marta Juhasz, Alberta Transportation
6. Mehdi Parvini, California DOT
7. Tom Yu, FHWA Liaison
8. Felix Doucet, TAC Liaison
9. Shane Marshall, SCOJD Liaison
10. Jack Dartman, T&AA Liaison
AASHTOWEAR Pavement ME Design Licenses

Licensing Update

1. 105 Workstation Licenses
2. 38 Site Licenses
3. 36 Educational Licenses
4. 31 International Licenses
   - 17 Canada
   - 14 Other Countries
AASHTOWEAR Pavement ME Design Canadian User Group

- TAC Pool fund Study Pavement and soils and Materials Committees
- September 2004 MEPDG Project Steering Committee
- October 2004 - RFP Issued
- November 2004 - RFP Closed
- December 2004 - Awarded
- January 2005 - April 2005
- April 2005
Meeting since September 2008

- 2 face to face meetings and 2-3 telephone meetings per year
- Around 20 members present at each meeting
- Around 50 members on the mailing list
- Provinces: BC, Alberta, Manitoba, Ontario, Quebec
- Municipalities: Edmonton, Winnipeg
- Associations: Cement Canada, Ontario Hot Mix Producers
- Many consultants
Canadian User Group Benefits

• Working Together
  – Running the Software
  – Developing your Practical Knowledge
  – Discussions on Specific Topics
  – Publishing Applied Technical Information
  – Increasing your Technical Contacts
  – Gaining Confidence and Recognition
Technical Papers

- TAC Conference 2013
  - TAC Pavement ME User Group – Canadian Climate Trials
- CTAA Conference 2013
  - Sensitivity of Pavement ME Design to Climate and Other factors
- TAC Conference 2014
  - Reliability Sensitivity of Pavement ME Design
• Step 1. Select hierarchical input level
• Step 2. Develop experimental plan and sampling template
• Step 3. Estimate sample size.
• Step 4. Select roadway segments
• Step 5. Evaluate project and distress data
• Step 6. Conduct field testing and forensic investigation
• Step 7. Assess local bias
• Step 8. Eliminate local bias
• Step 9. Assess standard error of the estimate
• Step 10. Reduce standard error of the estimate
• Step 11. Interpretation of the results
AASHTOWEAR Pavement ME Design Canadian Calibration Efforts

- Ontario
- Manitoba
- Quebec
- Alberta
AASHTOWEAR Pavement ME Design Ontario Calibration Efforts

Default parameters for AASHTOWare Pavement ME Design for Ontario
MTO's Asset Management System (AMS)

- Pavement Management System (PMS) integrated to AMS in 2015
- Consists of approx. 1900 road segments covering all provincial highways
- Reports pavement performance indexes such as PCI, DMI, IRI and rut depth
- Contains performance data since 1970s
- Contains limited information on construction history and pavement structures
Traditional Approach – Split Sample

- A portion of the data (typically half or more) is used for calibrating the coefficients while the remainder is used to validate accuracy.

- Minimum roadway segments suggested in the Guide:
  - Distortion (Total Rutting) – 20 (*64)
  - Load-Related Cracking – 30 (*46)
  - Non-Load-Related Cracking – 26 (*59)
  - IRI (*48)

* Number used in this calibration
Traffic (Axle Load Spectra)
Layer Contribution to Rutting;
Rutting Calibration;
Alligator Cracking;
Longitudinal Cracking;
Thermal Cracking;
IRI
Manitoba has been evaluating the MEPDG since 2007

- Compared designs, Pavement ME vs AASHTO '93 vs deflection based;
- Compared predicted and observed performance and surface distresses;
- Provided designs based on Pavement ME Design software
• 13 Weather Stations
• Developed level 1 & 2 Traffic Data
• Developed level 1 and 2 mechanical properties data for local materials
• Gathered Pavement performance and surface distress data
Focus on flexible pavements only

- Calibrate the rutting model
- Calibrate the thermal cracking model
- Evaluate the bottom up fatigue cracking at later stage as the predicted values are very low and do not control the designs
- Evaluate the top down fatigue cracking at later stage as it is difficult to identify (may require coring)
- Assess whether the globally calibrated fatigue cracking predictions can be used for calibrating the roughness (IRI) model by adjusting the coefficients only
AASHTOWEAR Pavement ME Design Quebec Calibration Efforts

• Focused around the following models:
  – Rutting
  – Fatigue
  – Cracking
ARA 2013 Document - Define a work Plan

Establish levels of Accuracy

Establish default values;

Confirm/establish calibration factors;

Develop a practical design manual

Train Staff/consultants in the use of the new design procedure.
Analysis of Existing Weight in motion Data

Development of Asphalt data
- Binder G*
- Mixture E*
- Creep Compliance
- Tensile Strength

Development of Concrete input data

Climate Data (27 Weather Stations in Alberta)
# AASHTOWEAR Pavement ME Design Alberta Calibration Efforts

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Background - Location</td>
<td>Terminal IRI</td>
</tr>
<tr>
<td>Existing Structure &amp; Year of Construction</td>
<td>Total Rutting</td>
</tr>
<tr>
<td>AADTT</td>
<td>Total Fatigue Cracking (Bottom-up &amp; Top-down)</td>
</tr>
<tr>
<td>Climate Station (s) used</td>
<td>Total Transverse Cracking (Thermal &amp; Reflective)</td>
</tr>
<tr>
<td>Rut Depth</td>
<td>Asphalt only Rutting</td>
</tr>
<tr>
<td>Historical Asphalt binder Type(s) in existing pavement</td>
<td>Achieved Reliability from Results</td>
</tr>
<tr>
<td>Back calculated Subgrade Resilient Modulus</td>
<td></td>
</tr>
<tr>
<td>Target Performance Criteria</td>
<td></td>
</tr>
<tr>
<td>Target Reliability</td>
<td></td>
</tr>
</tbody>
</table>
Default parameters for AASHTOWare Pavement ME Design

- Based on Ontario Guide
- Participants: Alberta, Manitoba, Ontario, Quebec, Edmonton
- In constant progress
Development of a Material Properties Database for Pavement ME

Materials Properties Database for Darwin-ME

Agency Contact

Unbound Materials

Asphalt Binder

Asphalt Mix

PCC Mix

Created by William KS Tang P.Eng - Manitoba Infrastructure and Transportation (MIT)
Materials Properties Database Program

for Darwin-ME

USER GUIDE

Prepared by:
Manitoba Infrastructure and Transportation
Materials Engineering
Pavement Section
August, 2011
What if Scenarios

• What if the subgrade did not meet density or was substantially different than what was in the design?

• What if the granular layer(s) did not meet density or thickness?

• What if the granular materials were substantially out of specification?

• What is the effect of Too much Asphalt Cement in the mix? Too Little?

• What is the effect of not enough Compaction during placement?

• What really is the effect of using the wrong grade of binder in the mix?

• What if the mix is placed too thin?
Conclusions

• Software is a tool;
• Calibration is Required;
• Calibration is expensive and takes time and effort;
• Can be used to evaluate effect of:
  - Low and high in-situ air voids;
  - High or low asphalt cement content;
  - Wrong binder usage;
  - Increased traffic volumes;
  - Loss of Subgrade support;
  - Sub-base and base gravel issues;
Questions?