Cracking: Future Directions (?)

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Our Discussion Today...

• Recap Current Status of Pavement-ME Design (MEPDG)

• The Future: Curious Philosophies, Key Questions and Possible Directions

CAUTION: This presentation is designed to be provocative

pro·voc·a·tive  adjective

1. causing annoyance, anger, or another strong reaction, especially deliberately

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Cracking Models & Transfer Functions

**Bottom-up cracking**

**Top-down cracking**

**Transverse cracking**

**Reflection cracking**
# Mixture Properties for Cracking Models

**Pavement-ME Build 2.3**

<table>
<thead>
<tr>
<th>Types of Cracks</th>
<th>Mixture Properties</th>
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</thead>
<tbody>
<tr>
<td>Bottom-Up</td>
<td>• Fatigue strength from flexural beam fatigue test</td>
</tr>
<tr>
<td>Top-Down</td>
<td></td>
</tr>
<tr>
<td>Transverse (Thermal)</td>
<td>• Indirect tensile strength</td>
</tr>
<tr>
<td>Reflection</td>
<td>• Indirect tensile creep compliance</td>
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</table>
# MEPDG Cracking: Summary

<table>
<thead>
<tr>
<th>Cracking Designation</th>
<th>Status</th>
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<tbody>
<tr>
<td>Bottom-Up</td>
<td>• No changes or enhancements; none planned for the short-term</td>
</tr>
<tr>
<td>Top-Down</td>
<td>• No changes to date; changes anticipated (NCHRP 1-52)</td>
</tr>
<tr>
<td>Transverse (Low Temp)</td>
<td>• No changes to date; need for changes identified (long-term)</td>
</tr>
<tr>
<td>Reflection</td>
<td>• Major enhancements in Version 2.2 <em>(replaced regression with M-E)</em></td>
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CONTEXT

• Cracking models in the MEPDG / Pavement-ME Design

• Bottom-up fatigue cracking (mostly)
Curious Philosophy #1

The ‘design’ approach in the MEPDG focuses on *managing* the failure of the pavement – rather than seeking to *avoid* failure...

Key Questions: #1

In the context of bottom-up fatigue cracking, is it desired to continue to *predict* the extent of fatigue cracking – or – attempt to *prevent* fatigue cracking?
Recommendations: “Preventing” Fatigue Cracking

• Improve ‘perpetual pavement design’ within Pavement-ME Design®
  o Endurance limit predictive equation - NCHRP 9-44
  o Incorporate the endurance limit for all analyses

• Improve guidance in the MEPDG Manual… regarding perpetual pavement
  o Mix type selection for layers within a perpetual pavement cross-section
  o Material properties for layers within the cross-section
Key Questions: #2

Is it important and/or desirable to model all forms of load-related cracking using the same general approach and/or mechanistic basis?

• Reflection: fracture
• Top-Down: regression—but, moving to (?) fracture
• Bottom-up: bending/flexure
Recommendations: Common Basis for Cracking Models

• Develop and implement a fracture-based bottom-up fatigue cracking model
  o Pursue a fracture-based model form similar to that used for reflection cracking and is anticipated for top-down cracking.
  o Ensure that any new fatigue cracking model is compatible with the concepts of perpetual pavement design.

• Seek, insofar as possible, to link the model forms for *structural* design to the cracking-related material performance measures generated for asphalt *mixture* design.
Curious Philosophy #2:

When pursuing new technologies for pavements and mixtures, we strongly encourage researchers to ‘simplify’ the implementation product...in many cases, we seek to engineer our design processes to the point where it does not require an engineer to perform the design.
Key Questions: #3

Is it important and/or desirable to integrate, more fully, asphalt mixture characterization between the processes for asphalt mixture design and flexible pavement structural design?

For example, should performance-related tests used for asphalt mixture design yield material properties which are also used in structural design models?
Recommendations: Integrating Structural and Mixture Design

• Develop/refine VECD design procedures
  o Streamline laboratory testing and data analysis procedures for S-VECD in the context of asphalt mixture design;
  o Produce user-friendly software which would allow a typical mixture design laboratory to complete an S-VECD based design.
    ▪ Investigate methodologies to ‘estimate’ S-VECD mixture performance-related metrics with less extensive testing and analysis requirements;
    ▪ Firmly establish the potential error associated with any estimation processes.
Recommendations:
Integrating Structural and Mixture Design

• Refine and expand structural pavement design procedures contained in the LVECD program.
  o Publish global calibration metrics for the LVECD design system;
  o Provide procedures for executing local calibration studies.
  o Produce a comprehensive pavement design guide based on the LVCED system.

• Support FHWA PRS Efforts
  o FlexMAT™, FlexPAVE™, PASSFlex™
Recap: Key Questions...

In the context of **bottom-up fatigue cracking**, is it desired to continue to *predict* the extent of fatigue cracking – or – attempt to *prevent* fatigue cracking?

Is it important and/or desirable to model all forms of load-related cracking using the same general approach and/or mechanistic basis?

Is it important and/or desirable to integrate, more fully, asphalt mixture characterization between the processes for asphalt mixture design and flexible pavement structural design?

For example, should performance-related tests used for asphalt mixture design yield material properties which are also used in *structural* design models?
Okay...discuss!

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