

Cracking: Future Directions (?)



Kevin Hall

University of Arkansas

Nam Tran

NCAT



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

Powered by [Oxford Dictionaries](#)

Cracking Models & Transfer Functions



Bottom-up cracking



Top-down cracking



Transverse cracking



Reflection cracking

Mixture Properties for Cracking Models

Pavement-ME Build 2.3

Types of Cracks	Mixture Properties
Bottom-Up	<ul style="list-style-type: none">• Fatigue strength from flexural beam fatigue test
Top-Down	
Transverse (Thermal)	<ul style="list-style-type: none">• Indirect tensile strength• Indirect tensile creep compliance
Reflection	

MEPDG Cracking: Summary

Cracking Designation	Status
Bottom-Up	<ul style="list-style-type: none">• No changes or enhancements; none planned for the short-term
Top-Down	<ul style="list-style-type: none">• No changes to date; changes anticipated (NCHRP 1-52)
Transverse (Low Temp)	<ul style="list-style-type: none">• No changes to date; need for changes identified (long-term)
Reflection	<ul style="list-style-type: none">• Major enhancements in Version 2.2 (<i>replaced regression with M-E</i>)

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®
 - Endurance limit predictive equation - NCHRP 9-44
 - Incorporate the endurance limit for all analyses
- Improve guidance in the *MEPDG Manual...* regarding perpetual pavement
 - Mix type selection for layers within a perpetual pavement cross-section
 - 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
 - Pursue a fracture-based model form similar to that used for reflection cracking and is anticipated for top-down cracking.
 - 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
 - Streamline laboratory testing and data analysis procedures for S-VECD in the context of asphalt mixture design;
 - 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.
 - Publish global calibration metrics for the LVECD design system;
 - Provide procedures for executing local calibration studies.
 - Produce a comprehensive pavement design guide based on the LVCED system.
- Support FHWA PRS Efforts
 - 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!

Kevin Hall

(kdhall@uark.edu)

Nam Tran

(nht0002@auburn.edu)