

WELCOME TO THE

AASHTOWare™



PAVEMENT

ME DESIGN

WEBINAR SERIES

- The webinar will start at 11:00 AM Central/12:00 AM Eastern



FY 2024 Webinar #3

Semi-Rigid Pavement Design

February 20, 2024

FY 2024 Webinar #3, Semi-Rigid Pavement Design

Moderator:

- ▶ Hari Nair, PE, Virginia
Department of
Transportation; Chairperson

Presenters:

- ▶ John Donahue, PE, ARA

Presentation will be available for viewing on the
ME-Design Resource website:

<http://www.me-design.com>

Pavement ME Task Force Members

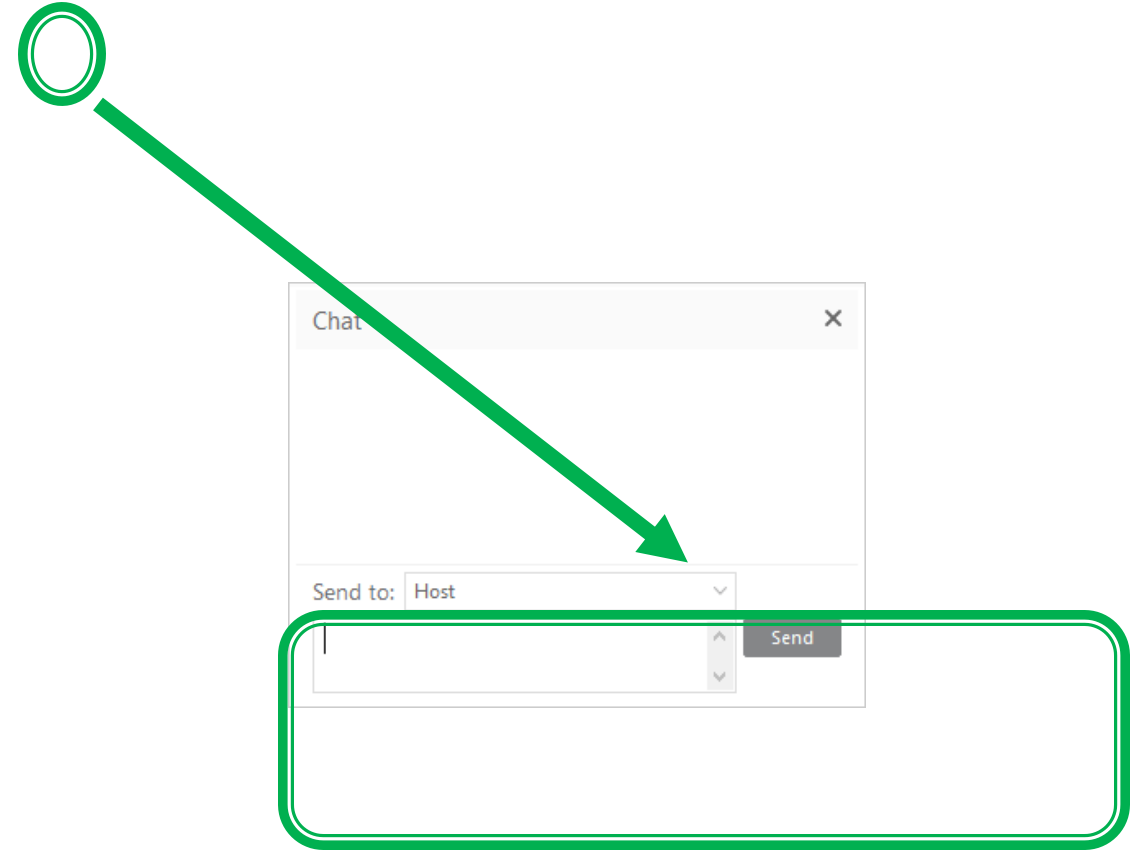
1. Ryan Fragapane, **AASHTO**, Product Director
2. Ben Sade, **AASHTO**, Associate Product Manager
3. Hari Nair, PE, Virginia DOT, **Chair**
4. Ian Rish, PE, Georgia DOT, **Vice-Chair**
5. Patrick Bierl, PE, Ohio DOT
6. Nusrat Morshed, PE, New Jersey DOT
7. Kumar Dave, PE, Indiana DOT
8. Dulce Feldman, PE, California DOT
9. Jason Simmons, PE, Utah DOT
10. Susanne Chan, Ontario MOT, TAC Liaison
11. Tom Yu, PE, FHWA Liaison

FY 2024 Webinar #3, Semi-Rigid Pavement Design

- ▶ Phones are being muted.
- ▶ Please post your questions in the Q&A box. This can be accessed by clicking on the WebEx Q&A button.
- ▶ The presenters will answer all questions at the end of the webinar/demonstration as time permits.
- ▶ Questions not answered, because of time, will be responded to separately.

Housekeeping Items

If you have an issue during the webinar



If you have an issue with the sound and are using your computer audio, please dial in using a phone.

Housekeeping Items

To see
presentation
in full screen

The screenshot shows the top toolbar of the Pavement ME Design software. The 'View' menu is open, and 'Fit in Viewer' is selected. The main content area displays the software title and webinar information. A green circle highlights the 'View' menu, and a green line connects it to the text on the left.

RETURN Audio Mute Me Participants Chat Annotate

PAVEMENT
ME DESIGN

FY 2024 Webinar #1
Multiple Asphalt Overlays Enha

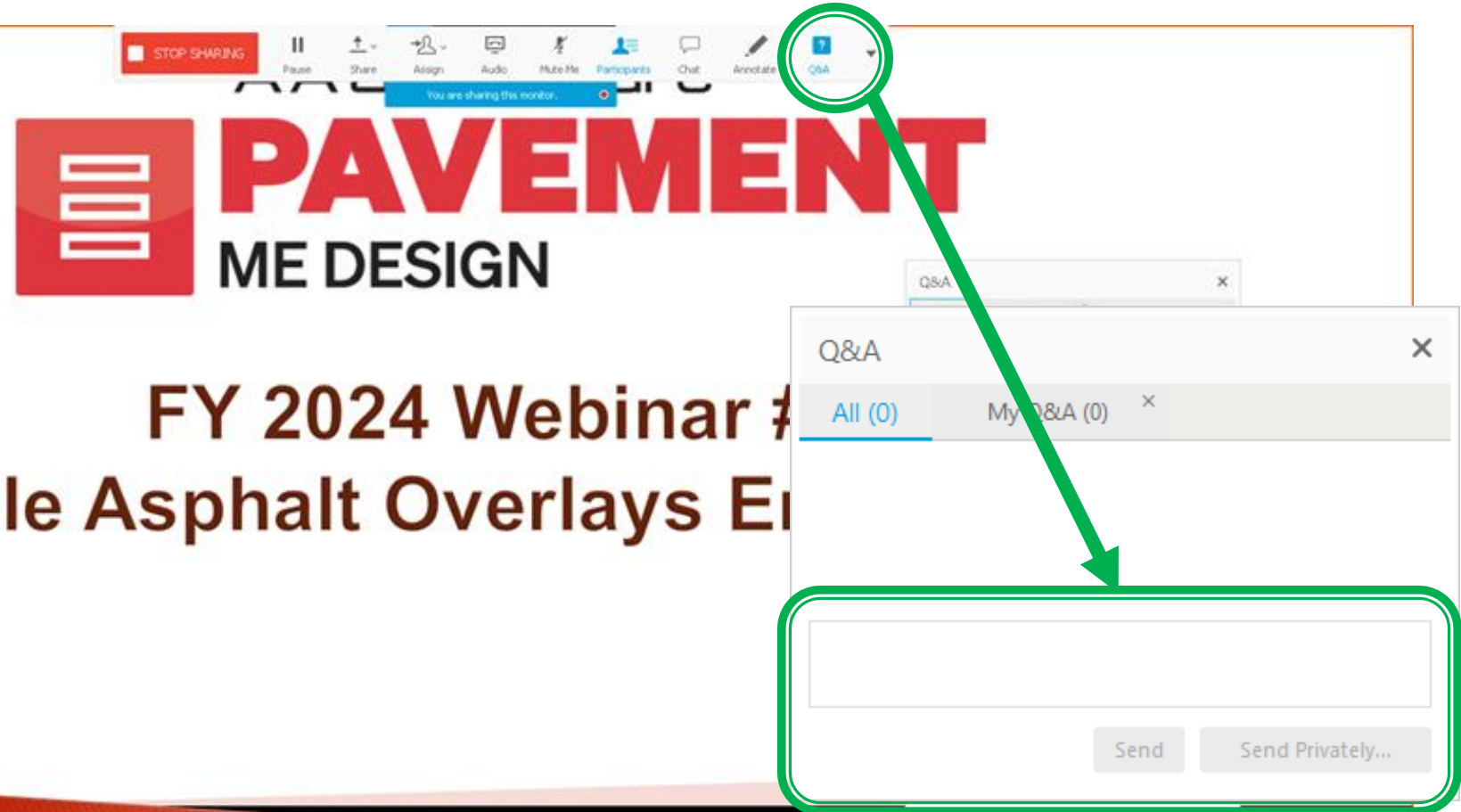
Manage Panels...
Ask to Control
Audio Conference...
Speaker/Microphone Audio Test...
View
Session Info...
Audio & Video Statistics...
Return to Session Window

Restore View
Fit in Viewer
Fit to Width
25%
50%
75%
100%
200%
400%

AASHTO Ware™
PAVEMENT
ME DESIGN

Housekeeping Items

To ask the presenters a question.



The screenshot shows a webinar interface with a top toolbar containing icons for 'STOP SHARING', 'Pause', 'Share', 'Assign', 'Audio', 'Mute Me', 'Participants', 'Chat', and 'Annotate'. A green circle highlights the 'Q&A' icon in the toolbar, with a green arrow pointing to a 'Q&A' window. The window has a title bar 'Q&A' and a close button 'x'. Below the title bar are two tabs: 'All (0)' and 'My Q&A (0)'. The main area of the window is empty, and at the bottom are two buttons: 'Send' and 'Send Privately...'. The background of the webinar shows the 'PAVEMENT ME DESIGN' logo and the text 'FY 2024 Webinar # Multiple Asphalt Overlays E'.

FY 2024 Webinar #3 Semi-Rigid Pavement Design

Poll 1: Questions 1, 2, and 3



1. How many individuals are viewing this webinar at your location?

1

2

3 to 5

More than 5

2. What is your affiliation?

State Government

Federal Government

Contractor/Association

Consultant

Academia

3. What version of the PMED software are you or your organization using?

- None, do not have a license
- Earlier Desktop before version 2.5
- Desktop version 2.5 or 2.6
- Web App Version 3
- Multiple versions – dependent on client.

FY 2024, Webinar #3: Semi-Rigid Pavement Design

Webinar Outline:

1. Introduction
2. Defining Semi-Rigid
3. PMED Analysis
4. Sensitivity
5. Calibration Coefficients
6. Summary and Takeaways
7. Question and Answer Session

Introduction

- ▶ AASHTOWare Pavement M-E Design (PMED) users have the option to create and analyze semi-rigid pavement designs.
- ▶ The semi-rigid design model was last globally calibrated for the PMED 2.5 version, thus the model in the 2.6 desktop and 3.0 web applications are also *globally* current.
- ▶ Global calibration of semi-rigid models in PMED used performance data from LTPP test sections.

Introduction

- ▶ Semi-rigid pavements can be designed with a second overlay in PMED.
- ▶ PMED semi-rigid designs can be locally calibrated in the Calibration Assistance Tool (CAT).

Introduction

- ▶ This presentation will only cover cement and/or fly ash stabilized bases, that behave as bound layers with flexural strength, *directly* under an asphalt pavement.
- ▶ It will *not* cover
 - Stabilized bases under JPCP and CRCP
 - AC pavements with an unbound layer between the AC and stabilized base.

Webinar Assumptions

Attendee has prior experience with:

- ▶ PMED desktop or web application versions
- ▶ AASHTO MEPDG Manual of Practice (MOP)
- ▶ Characterizing layers in a pavement structure
- ▶ Agency performance thresholds for distress/IRI.

Learning Outcomes

1. Define the meaning of a semi-rigid pavement within the context of the PMED software.
2. Select inputs for semi-rigid design in PMED.
3. Understand key input sensitivity for PMED semi-rigid design predictions.
4. Comprehend the influence of transfer function calibration coefficients on predicted performance.

FY 2024, Webinar #3: Semi-Rigid Pavement Design

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Defining Semi-Rigid Design

A semi-rigid pavement design consists of an asphalt layer(s) directly on a cementitious treated base layer having flexural strength.

Defining Semi-Rigid Design

Types of semi-rigid layers include –

- Cement treated base (CTB)
- Roller compacted concrete (RCC)
- Lean concrete base (LCB)

Cementitious materials in the semi-rigid layer may also include lime, lime-fly ash, and other SCMs.

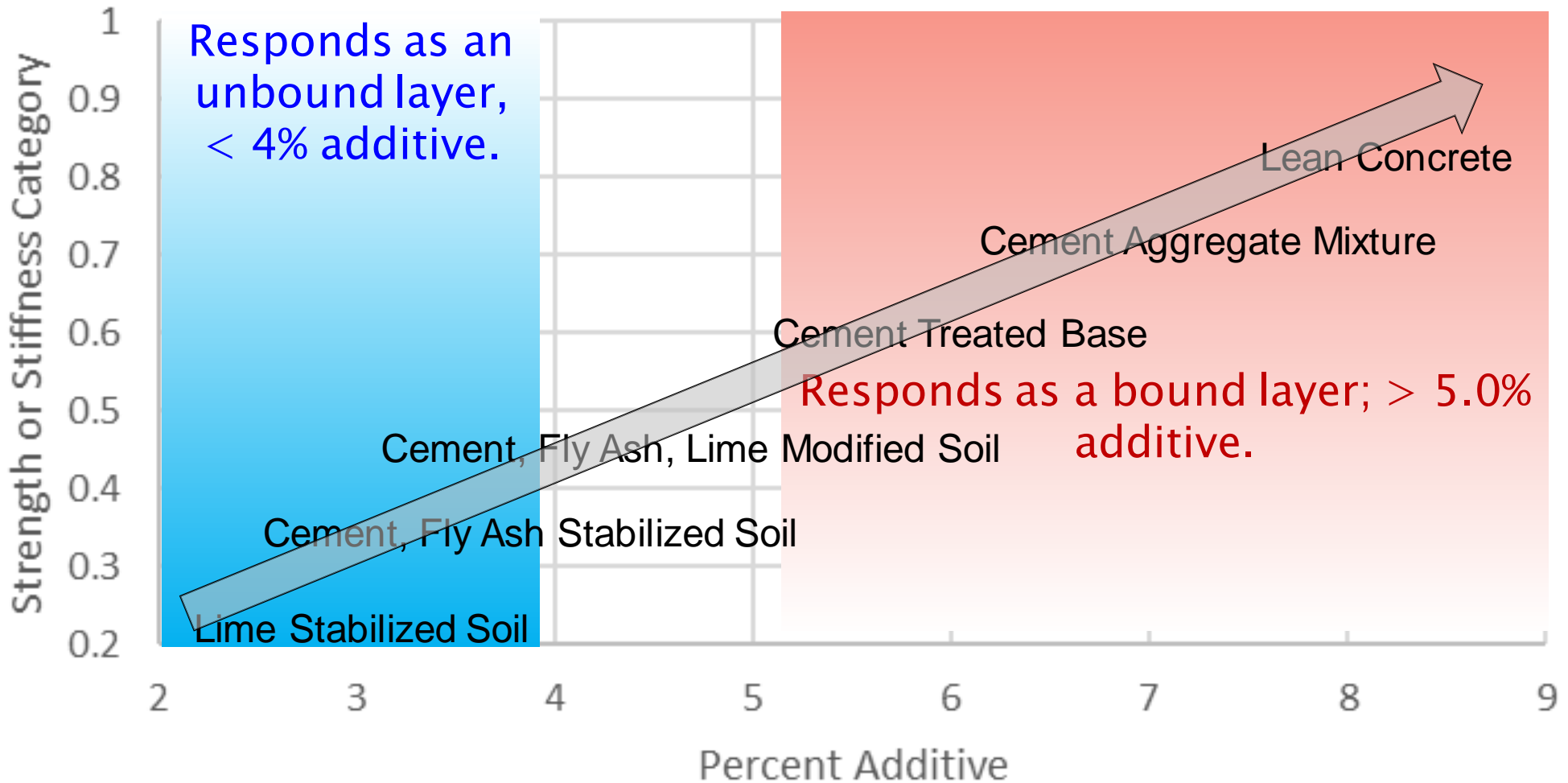


Defining Semi-Rigid Design

A CTB layer is chemically stabilized, but not all chemical stabilization yields a semi-rigid or bound layer.

- Higher amounts of Portland cement and/or other cementitious materials produce a bound layer capable of resisting tensile stress and fatigue cracks; responds as a bound layer.
- Lower amounts of Portland cement and/or other cementitious materials produce a layer that does not resist tensile stresses; responds as an unbound layer.

Types of Chemically Stabilized Layers



A composite pavement consisting of AC placed over PCC is technically a semi-rigid pavement, however, it is less likely to be constructed as a practical application of the semi-rigid design concept, because of cost.

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PMED Semi-Rigid Analysis

Design Workspace Running Designs Completed Designs

Create New Design Upload Design(s)

Search

▼ Designs

Create New Design

Name: Semi-Rigid Example

Description:

Unit System: US SI

Use Template:

Create Cancel

Design Workspace

Running Designs

Completed Designs

Create New Design

Upload Design(s)

Search



▼ Designs



Semi-Rigid Example



General Information

Performance Criteria

Traffic

Climate

Structure

Maintenance Strategy

Calibration

Design Properties

Sensitivity Combination

Thickness Optimization

Go to validation error

Design name

Semi-Rigid Example

Design Type

New Pavement

Pavement Type

Semi-Rigid Pavement

Design life (years)

20

Base construction date

May 2025

Pavement construction date

June 2026

Traffic opening date

September 2026

Use special traffic

Unit system

US SI

Semi-Rigid Performance Criteria

Design Name: Semi-Rigid Example | Design Type: New Pavement | Pavement Type: Semi-Rigid Pavement

Performance Criteria	Limit	Reliability	Report Visibility
Initial IRI (in/mi)	63 ✓		<input checked="" type="checkbox"/>
AC thermal cracking (ft/mi)	1000 ✓	50	<input checked="" type="checkbox"/>
AC bottom up fatigue cracking (% of lane area)	25 ✓	50	<input checked="" type="checkbox"/>
AC top down fatigue cracking (% of lane area)	25 ✓	90 ✓	<input checked="" type="checkbox"/>
Permanent deformation (AC only) (in)	0.25 ✓	90 ✓	<input checked="" type="checkbox"/>
Permanent deformation (total pavement) (in)	0.75 ✓	90 ✓	<input checked="" type="checkbox"/>
Terminal IRI (in/mi)	172 ✓	90 ✓	<input checked="" type="checkbox"/>
Chemically stabilized layer - fatigue fracture (% lane area)	25 ✓	50	<input checked="" type="checkbox"/>
AC total fatigue cracking: bottom-up + reflective (% lane area)	25 ✓	90 ✓	<input checked="" type="checkbox"/>
AC total transverse cracking: thermal + reflective (ft/mi)	2500 ✓	90 ✓	<input checked="" type="checkbox"/>

Semi-Rigid Prediction Models

- ▶ Total rut depth and individual AC, unbound aggregate base, and subgrade layer rutting (only recommend total rut depth model for implementation unless individual layer rutting measured)
- ▶ Bottom-up fatigue cracking - AC
- ▶ Top-down fatigue cracking - AC
- ▶ Fatigue cracking - CTB (not recommended for design)
- ▶ Transverse cracking - AC
- ▶ Reflection cracking of CTB fatigue cracks - AC
- ▶ Reflection cracking of CTB transverse cracks - AC
- ▶ IRI

**Recommend using total
fatigue cracking for design**

Semi-Rigid Prediction Models

- ▶ Total rut depth and individual AC, unbound aggregate base, and subgrade layer rutting (only recommend total rut depth model for implementation unless individual layer rutting measured)
- ▶ Bottom-up fatigue cracking - AC
- ▶ Top-down fatigue cracking - AC
- ▶ Fatigue cracking - CTB
- ▶ Transverse cracking - AC
- ▶ Reflection cracking of CTB fatigue cracks - AC
- ▶ Reflection cracking of CTB transverse cracks - AC
- ▶ IRI

Recommend using total transverse cracking for design

General Information

Performance Criteria

Traffic

Climate

Structure !

Maintenance Strategy

Calibration

Design Properties

Sensitivity Combination

Thickness Optimization

Edit Structure

Done Editing

Overwrite

Default asphalt concrete



Soil cement



A-7-5



A-2-4

A-2-5

A-2-6

A-2-7

A-3

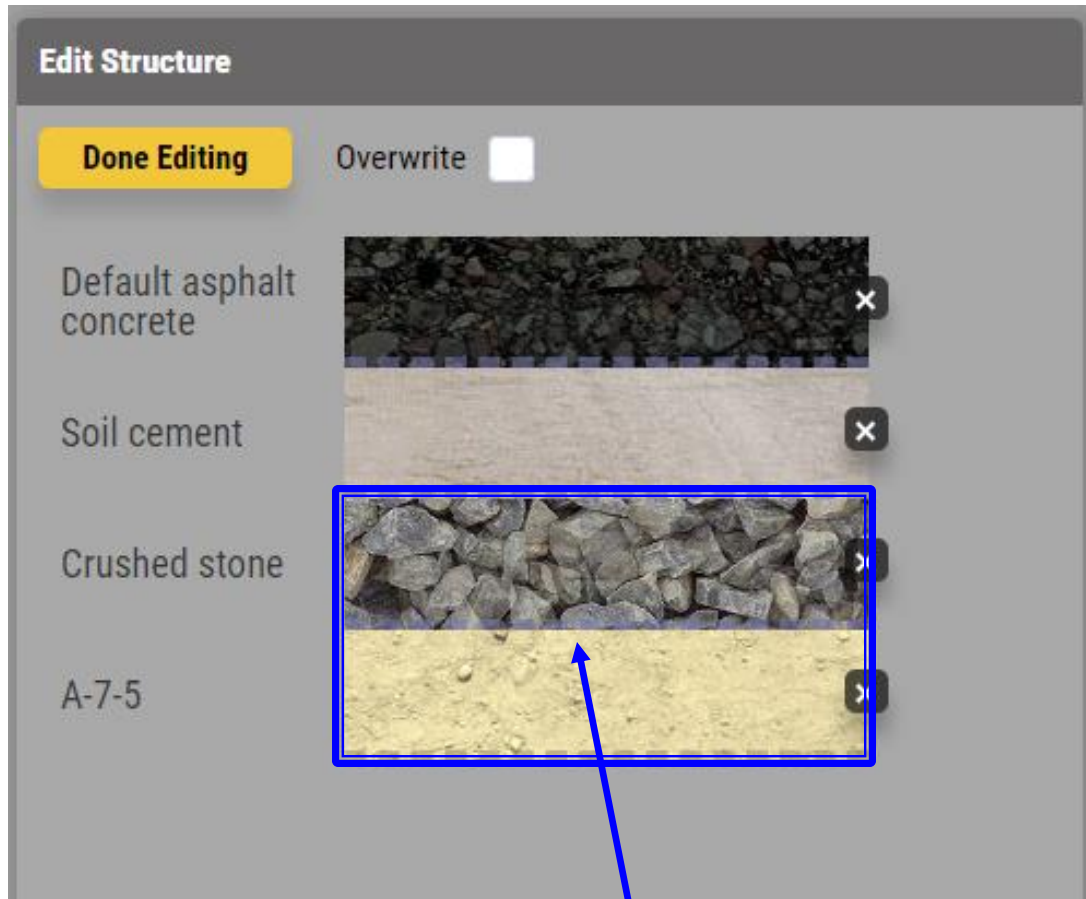
A-4

A-5

A-6

Design Errors/Warnings - Design Status: Error(1) Warning(0) Info;

Design Name	Component	Group Name	Property	Message	Navigation
Semi-Rigid Example	Structure	Structure	Structure	A minimum of two unbound layers (base or subgrade) are required to correctly model base and subgrade moisture conditions. If the asphalt or concrete layers are placed directly on the subgrade, add an additional subgrade layer with identical properties.	



Unbound base layer / subgrade



Unbound base layer / subgrade

Two Layer Options

Design Name: Semi-Rigid Example | Design Type: New Pavement | Pavement Type: Semi-Rigid Pavement

General Information
 Performance Criteria
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 Climate
 Structure
 Maintenance Strategy
 Calibration
 Design Properties
 Sensitivity Combination
 Thickness Optimization
 Run analysis

Cement Base Cracking
 Cement Base General
 Cement Base Strength
 Cement Base Thermal

Chemically stabilized base crack fatigue LTE (%) ✓

Chemically stabilized base crack transverse LTE (%) ✓

Chemically stabilized base crack spacing (ft) ✓

Layer Selection

Layer 1 : Flexible : Default asphalt concrete ✓

Layer 2 : Chemically Stabilized : Soil cement ✓

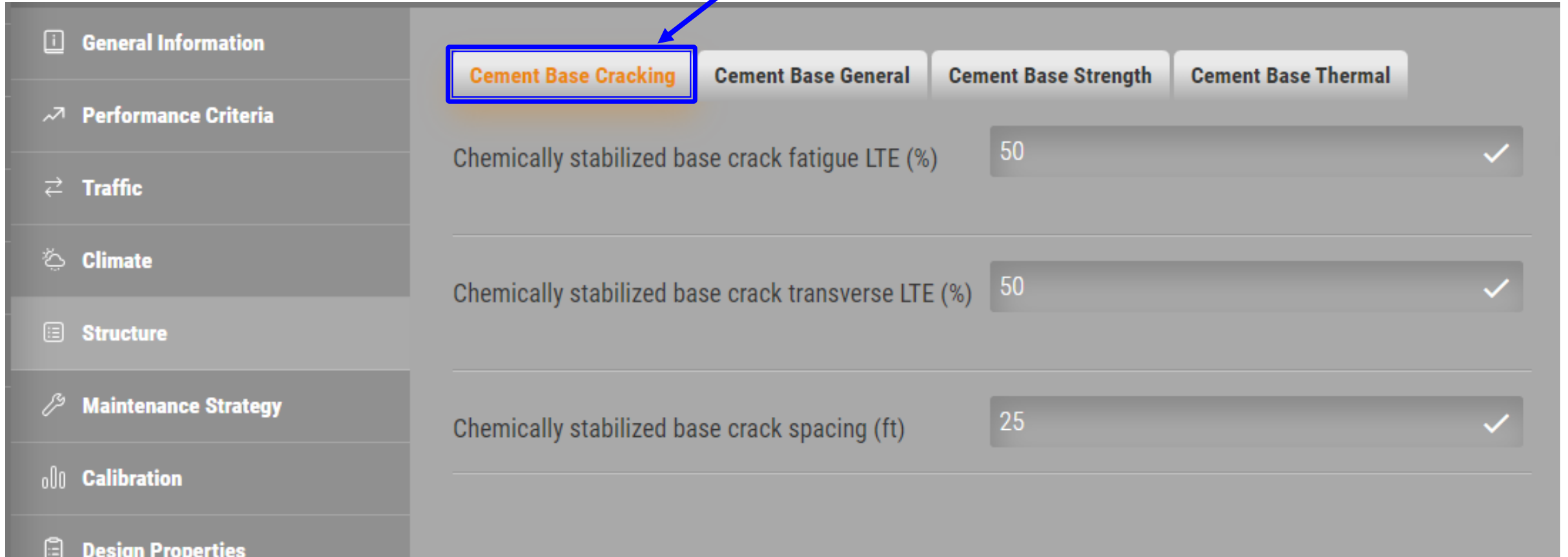
Layer 3 : Non-stabilized Base : Crushed stone (A-1-a) ✓

Layer 4 : Subgrade : A-7-5 (A-7-5)

Semi-Rigid Layer Structural Inputs

(Material inputs listed in MOP Table 10-6)

Physical Layer Characteristics



The screenshot displays the 'Physical Layer Characteristics' settings in the AASHTO Ware software. The left sidebar contains navigation options: General Information, Performance Criteria, Traffic, Climate, Structure, Maintenance Strategy, Calibration, and Design Properties. The main content area is divided into three tabs: 'Cement Base Cracking' (highlighted with a blue box and a blue arrow), 'Cement Base General', and 'Cement Base Thermal'. Under the 'Cement Base Cracking' tab, three parameters are listed, each with a value and a checkmark:

Parameter	Value	Status
Chemically stabilized base crack fatigue LTE (%)	50	✓
Chemically stabilized base crack transverse LTE (%)	50	✓
Chemically stabilized base crack spacing (ft)	25	✓

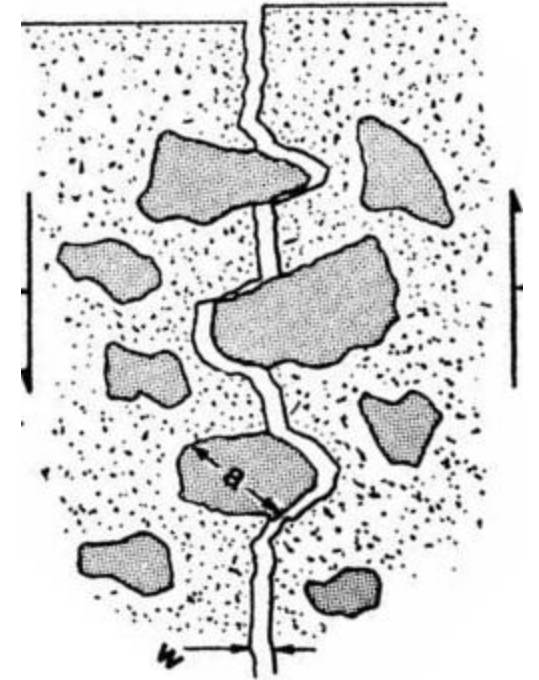
CTB Layer Crack Spacing

- ▶ User must input CTB crack spacing from shrinkage cracking (10' – 40' typical range)
- ▶ Crack spacing is fixed will *not* decrease for duration of analysis period
- ▶ Crack spacing can be defined by cement content
- ▶ Crack spacing determines maximum transverse reflective cracking (ft/mile)
Ex. For 25' spacing – $(5280/25)*12'$ width $\approx 2500'$



CTB Crack Load Transfer Efficiency (LTE)

- ▶ User must input CTB LTE for both fatigue and transverse cracks
- ▶ LTE is fixed and will *not* change for duration of PMED analysis
- ▶ LTE influences stress intensity factor (SIF) in fracture mechanic model simulation and, therefore, determines rate of reflective crack formation.



CTB LTE

- Fatigue crack LTE is a calibration parameter that cannot be measured directly.
- Transverse crack LTE is a calibration parameter that can be measured directly.

Engineering Properties and Volumetric Characteristics

Design Name: Semi-Rigid Example | Design Type: New Pavement | Pavement Type: Semi-Rigid Pavement

General Information

Performance Criteria

Traffic

Climate

Structure

Maintenance Strategy

Calibration

Design Properties

Cement Base Cracking

Cement Base General

Cement Base Strength

Cement Base Thermal

Poisson's ratio ... 0.2 ✓

Unit weight (lb/ft³) 150 ✓

Engineering Properties and Volumetric Characteristics

Design Name: Semi-Rigid Example | Design Type: New Pavement | Pavement Type: Semi-Rigid Pavement

General Information

Performance Criteria

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Maintenance Strategy

Calibration

Design Properties

Cement Base Cracking | Cement Base General | **Cement Base Strength** | Cement Base Thermal

Modulus of rupture (psi)	400	✓
Minimum elastic/resilient modulus (psi)	150000	✓
Elastic/resilient modulus (psi)	2000000	✓

Engineering Properties and Volumetric Characteristics

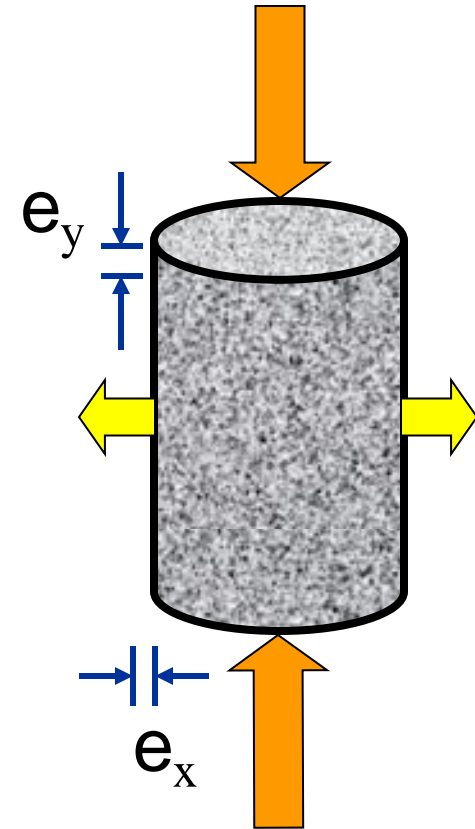
Semi-Rigid Material Inputs	Test Standard
Unit Weight	AASHTO T 121
Flexural Strength; 28-day	AASHTO T 97
Poisson's Ratio	ASTM C469
Elastic Modulus; 28-day	ASTM C469
Minimum Elastic/Resilient Modulus	*****



Poisson's Ratio

Default – 0.20

$$\mu = \frac{\epsilon_x}{\epsilon_y}$$



Modulus of Rupture

- ▶ 28-day strength flexural strength (modulus of rupture) for CTB ~ 300 – 500 psi
 - Default value: 400 psi
- ▶ Can correlate compressive strength (AASHTO T 22) to flexural strength
- ▶ The flexural strength does not change over time in the PMED software.

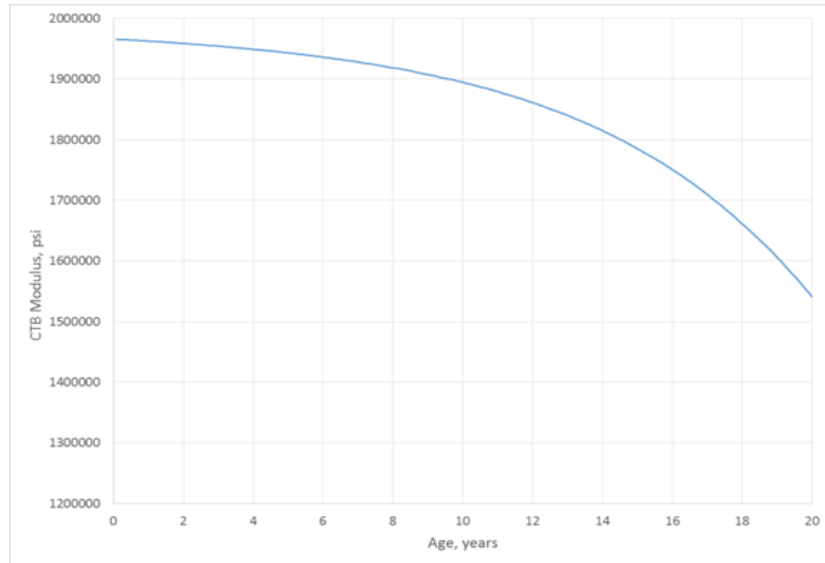


Elastic Modulus (28-Day)

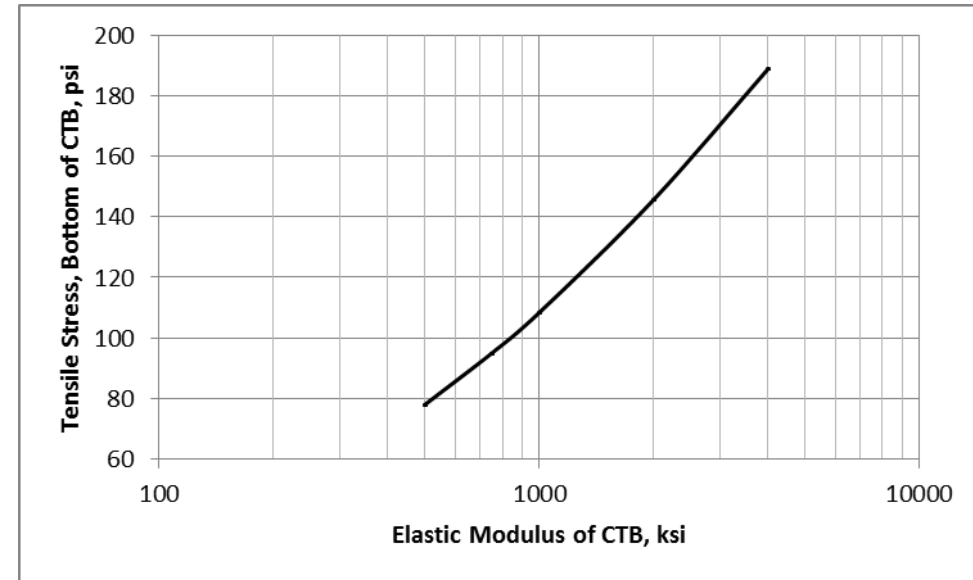
- ▶ 28-day elastic modulus of rupture) for CTB ~ 1,000,000 – 4,000,000 psi
 - Default value: 2,000,000 psi



Elastic Modulus (Minimum)



**Age increase → Modulus decrease
because of fatigue damage**



**Modulus decrease → Tensile stress decrease, so
damage per wheel load decreases**

Fixed flexural strength and decreasing tensile stress means fatigue damage would decrease to zero unless a minimum elastic modulus value was set in PMED.

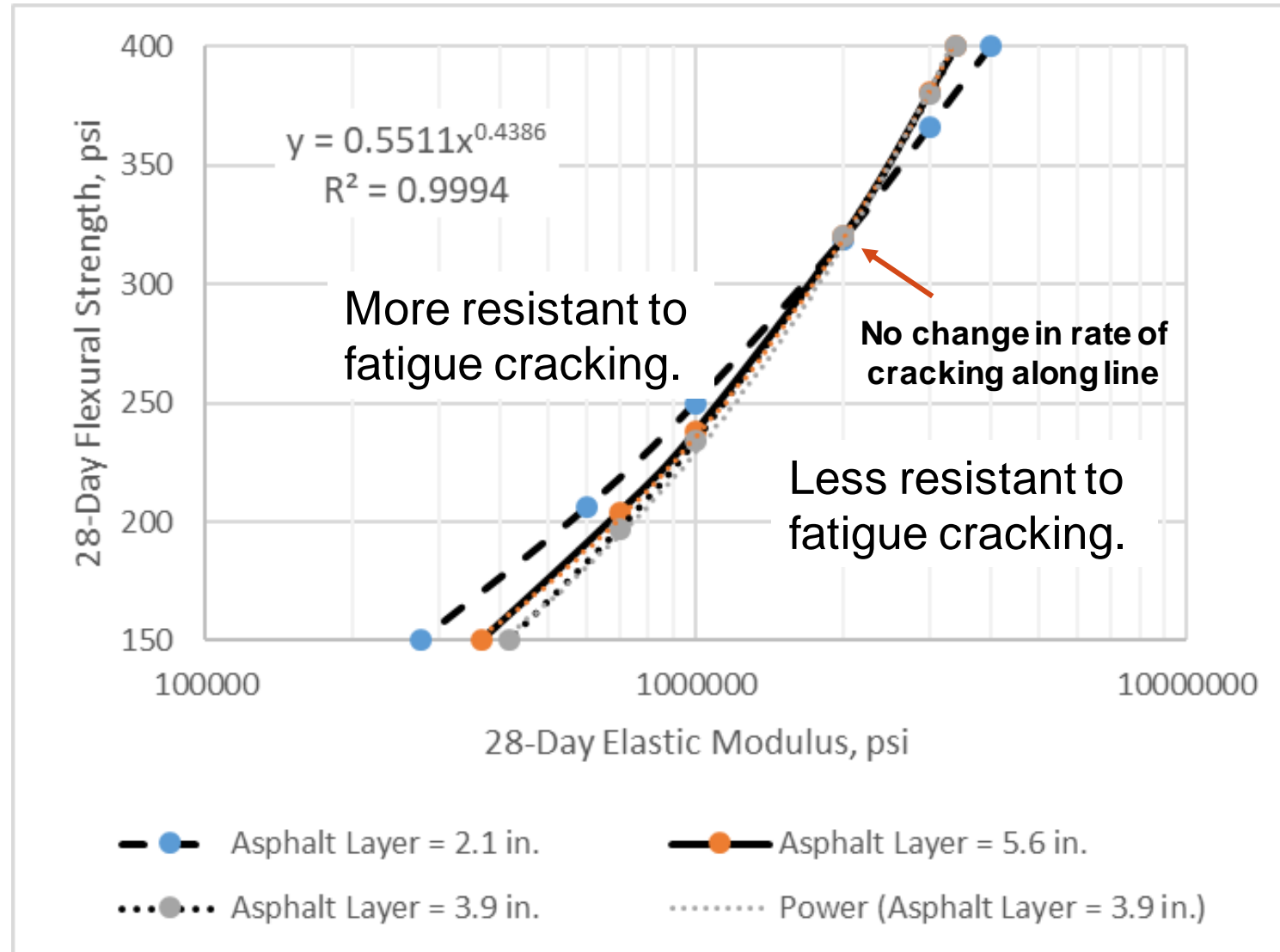
PMED default value is 150,000 psi, however, suggested value for the minimum elastic modulus is the 28-day elastic modulus to ensure fatigue damage accumulation continues.

Strength and Modulus Design Considerations

1. Relationship between the elastic modulus and flexural strength will vary depending on degree of semi-rigid layer stabilization.
2. Minimum layer thicknesses for the asphalt and cement stabilized layers are input for consistent strength-modulus relationship in fatigue crack modeling.
3. Full bond should be retained between the asphalt and cement stabilized layers over the design period.

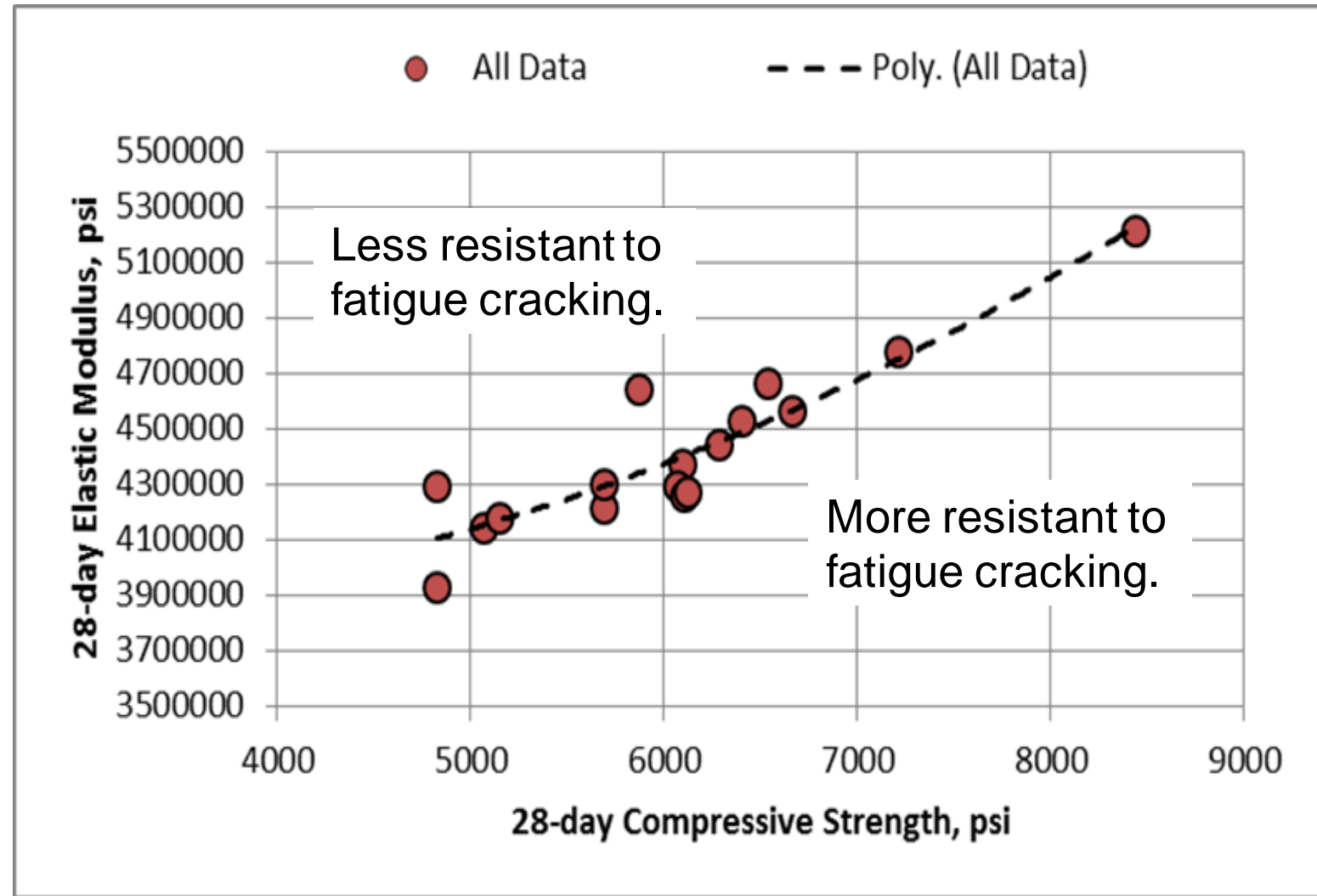
Relationship between Strength and Modulus

CTB



Relationship between Strength and Modulus

LCB



Thermal Property Characteristics

Design Name: Semi-Rigid Example | Design Type: New Pavement | Pavement Type: Semi-Rigid Pavement

Cement Base Cracking | **Cement Base General** | **Cement Base Strength** | **Cement Base Thermal**

Heat capacity (BTU/(lb·°F)) 0.28 ✓

Thermal conductivity (BTU/(h·ft·°F)) 1.25 ✓

General Information

Performance Criteria

Traffic

Climate

Structure

Maintenance Strategy

Calibration

Design Properties

Thermal Property Tests

Semi-Rigid Material Inputs	Test Standard
Heat Capacity	ASTM D2766
Thermal Conductivity	ASTM E1952

Heat capacity range ~ 0.10 – 0.50 Btu/(lb)(°F)

Default – 0.28

Thermal conductivity range ~ 0.2 – 2.0 Btu/(ft)(hr)(°F)

Default – 1.25

Semi-Rigid Thickness Optimization

Design Name: Semi-Rigid Example | Design Type: New Pavement | Pavement Type: Semi-Rigid Pavement

- General Information
- Performance Criteria
- Traffic
- Climate
- Structure
- Maintenance Strategy
- Calibration
- Design Properties
- Sensitivity Combination
- Thickness Optimization
- Run analysis

Design Layers

	Layer	Current Thickness (in)	Minimum	Maximum
<input type="checkbox"/>	Layer 1 : Flexible : Default asphalt concrete	12	0 ✓	0 ✓
<input checked="" type="checkbox"/>	Layer 2 : Chemically Stabilized : Soil cement	10	8 ✓	12 ✓
<input type="checkbox"/>	Layer 3 : Subgrade : A-7-5 (A-7-5)	8	0 ✓	0 ✓
<input type="checkbox"/>	Layer 4 : Subgrade : A-7-5 (A-7-5)	-1	0 ✓	0 ✓

[▶ Run Thickness Optimization](#)

Semi-Rigid Sensitivity Combination

Design Name: Semi-Rigid Example | Design Type: New Pavement | Pavement Type: Semi-Rigid Pavement

General Information

Performance Criteria

Traffic

Climate

Structure

Maintenance Strategy

Calibration

Design Properties

Sensitivity Combination

Thickness Optimization

Run analysis

Sensitivity Combination Is Factorial

Enabled	Layer	Property	Current Value	Minimum Value	Maximum Value	Number of Increments
<input type="checkbox"/>		Two-way AADTT	4000 ✓	0 ✓	0 ✓	0 ✓
<input type="checkbox"/>	Layer 1 : Flexible : Default asphalt concrete	Air voids (%)	7 ✓	0 ✓	0 ✓	0 ✓
<input type="checkbox"/>	Layer 1 : Flexible : Default asphalt concrete	Effective binder content (%)	11.6 ✓	0 ✓	0 ✓	0 ✓
<input type="checkbox"/>	Layer 1 : Flexible : Default asphalt concrete	Thickness (in)	10 ✓	0 ✓	0 ✓	0 ✓
<input type="checkbox"/>	Layer 2 : Chemically Stabilized : Soil cement	Elastic/resilient modulus (psi)	200000 ✓	0 ✓	0 ✓	0 ✓
<input checked="" type="checkbox"/>	Layer 2 : Chemically Stabilized : Soil cement	Thickness (in)	10 ✓	8 ✓	12 ✓	4 ✓
<input type="checkbox"/>	Layer 3 : Subgrade : A-7-5 (A-7-5)	Thickness (in)	8 ✓	0 ✓	0 ✓	0 ✓
<input type="checkbox"/>	Layer 3 : Subgrade : A-7-5 (A-7-5)	Unbound modulus input (variant)	10000 ✓	0 ✓	0 ✓	0 ✓
<input type="checkbox"/>	Layer 4 : Subgrade : A-7-5 (A-7-5)	Thickness (in)	-1 ✓	0 ✓	0 ✓	0 ✓
<input type="checkbox"/>	Layer 4 : Subgrade : A-7-5 (A-7-5)	Unbound modulus input (variant)	10000 ✓	0 ✓	0 ✓	0 ✓

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Sensitivity Factors

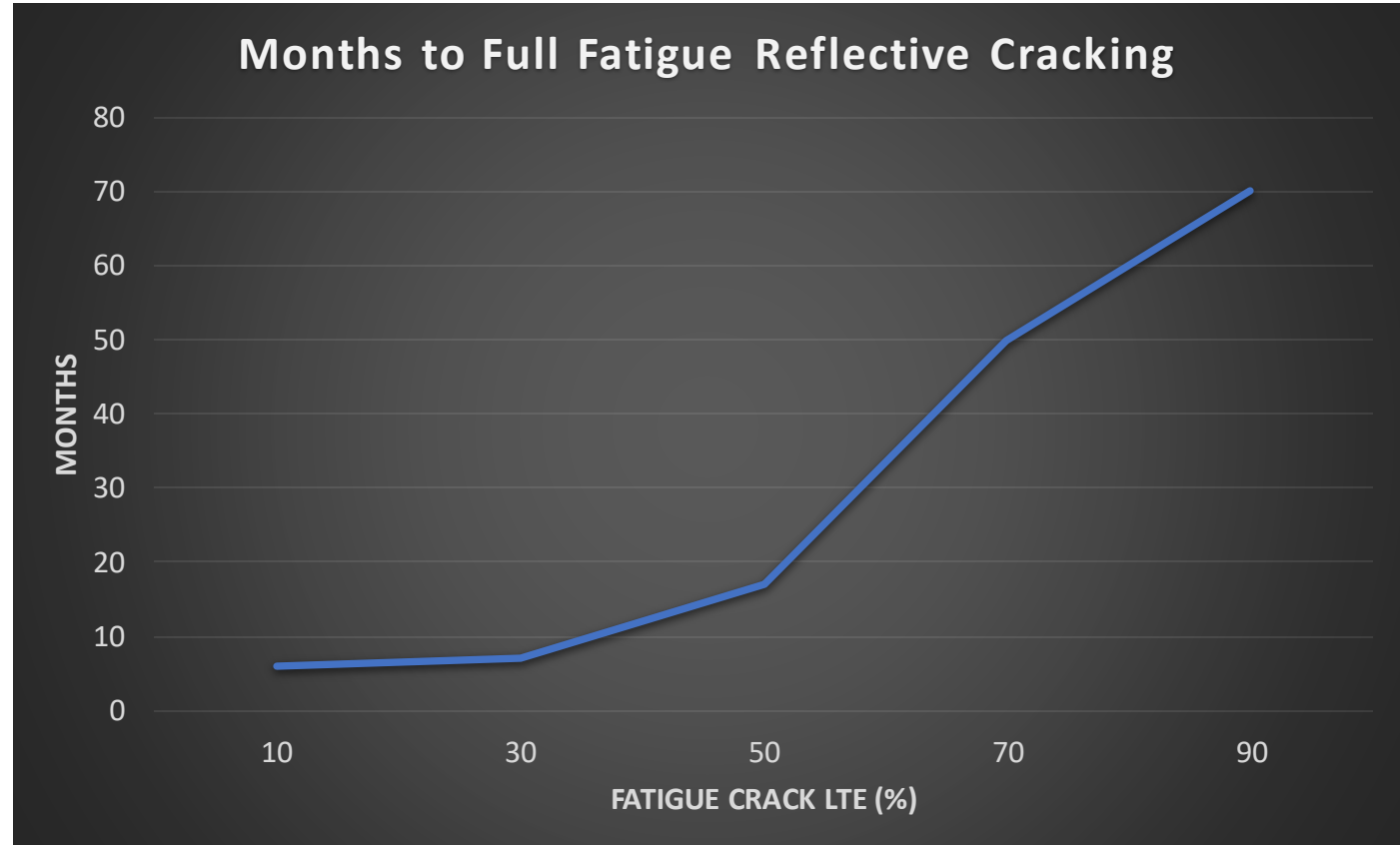
- ▶ CTB
 - Fatigue LTE
 - Transverse LTE
 - Elastic Modulus
 - Flexural Strength
 - Thickness

- ▶ AADTT

CTB Fatigue LTE

► Fixed inputs

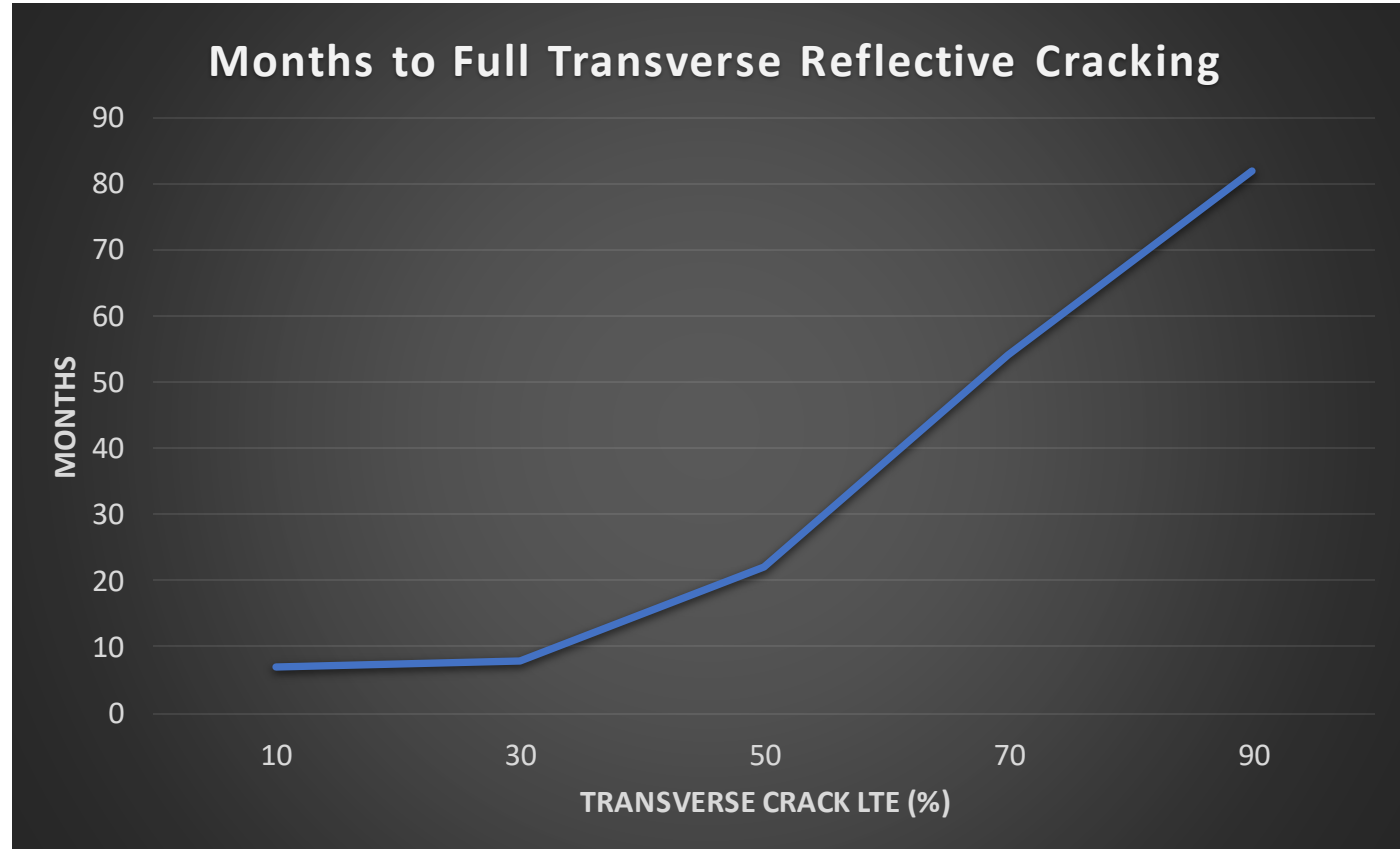
- 10" AC
- 7" CTB
- 25' CTB crack spacing
- Flex – 400 psi
- 10,000 AADTT



CTB Transverse LTE

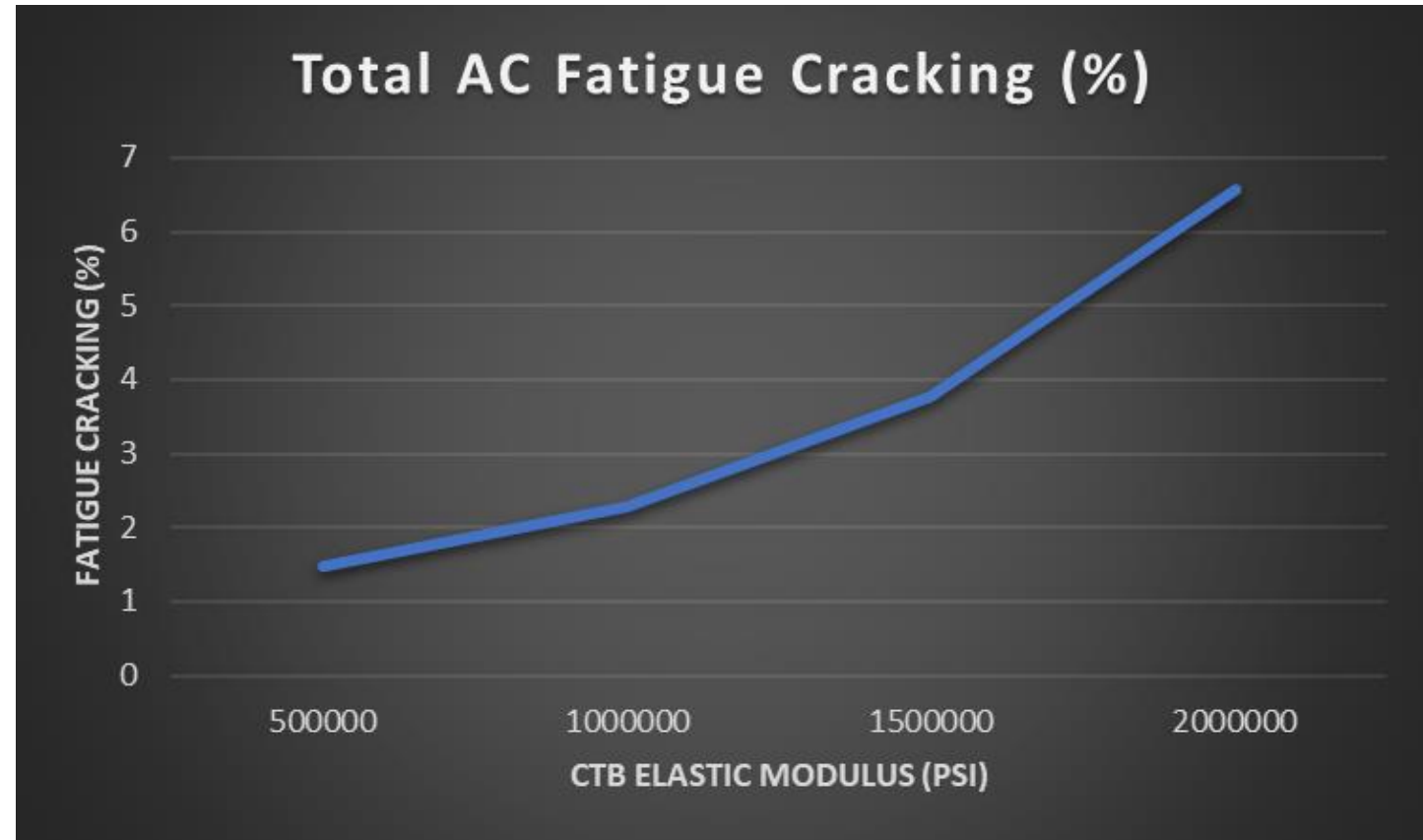
▶ Fixed inputs

- 10" AC
- 7" CTB
- 25' CTB crack spacing
- Flex – 400 psi
- 10,000 AADTT



CTB Elastic Modulus

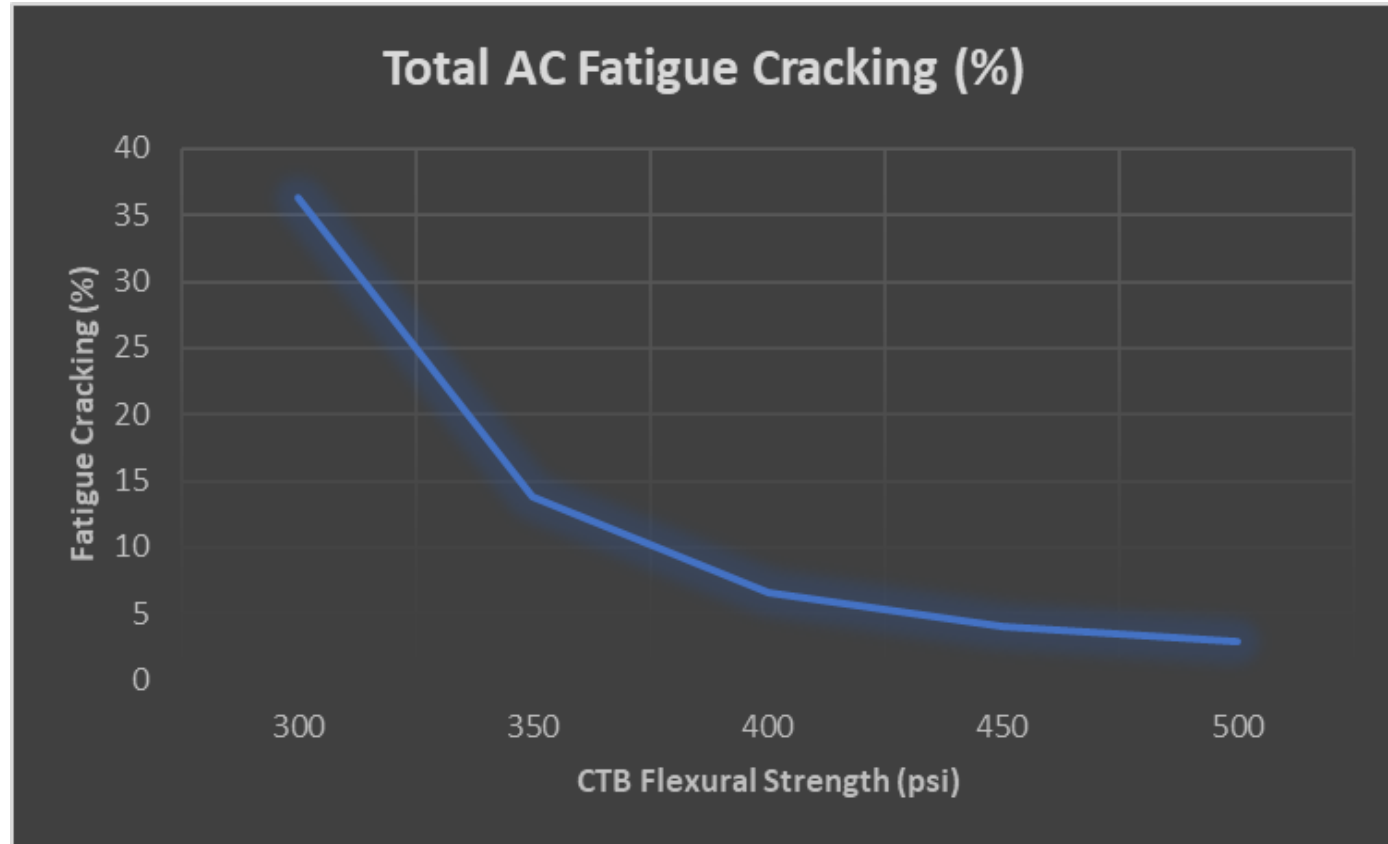
- ▶ Fixed inputs
 - 8" AC
 - 7" CTB
 - 50% transverse LTE
 - 50% fatigue LTE
 - Flex – 400 psi
 - 10,000 AADTT



CTB Flexural Strength

► Fixed inputs

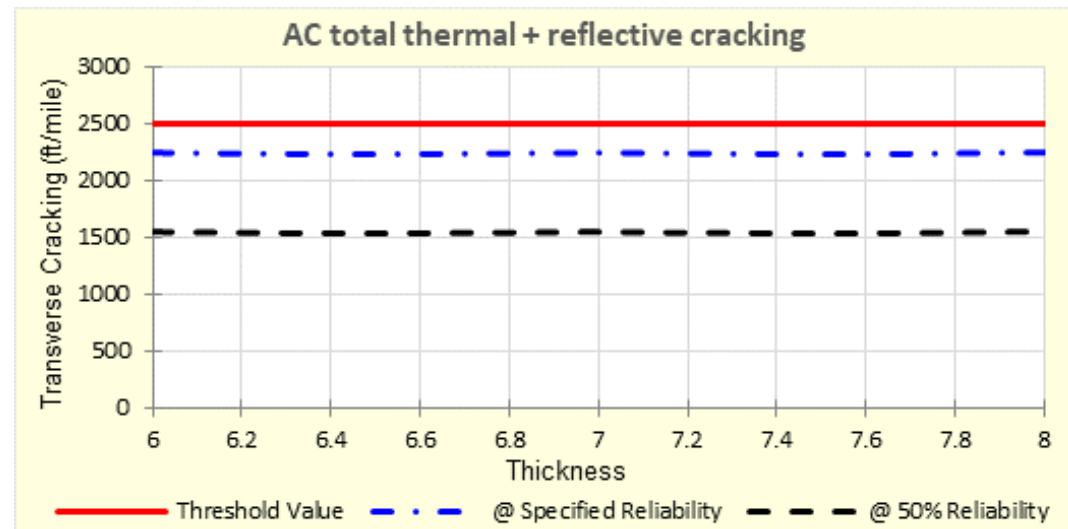
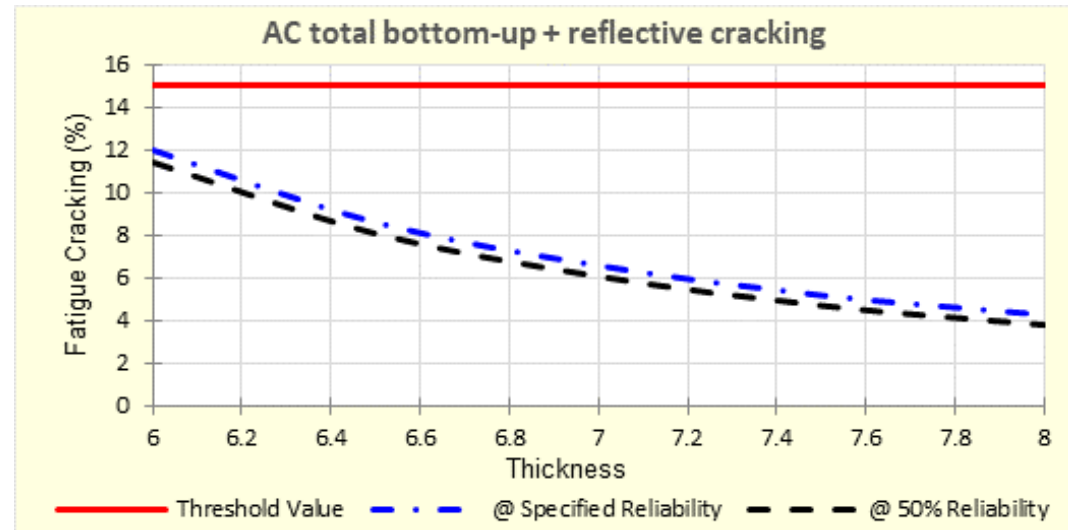
- 8" AC
- 7" CTB
- 50% transverse LTE
- 50% fatigue LTE
- Modulus – 2,000,000 psi
- 10,000 AADTT



CTB Thickness

► Fixed inputs

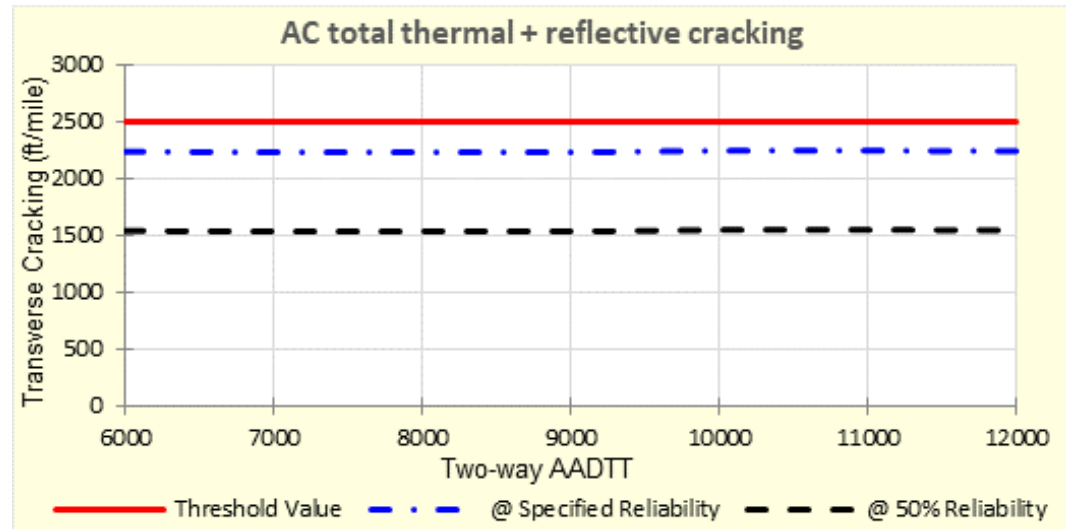
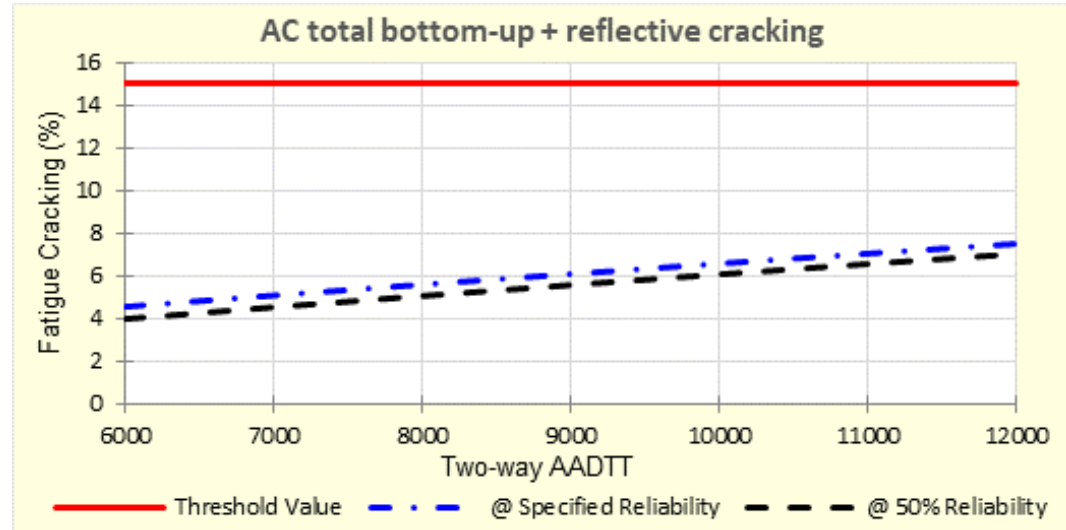
- 8" AC
- 50% transverse LTE
- 50% fatigue LTE
- Flex – 400 psi
- Modulus – 2,000,000 psi
- 10,000 AADTT



Truck Traffic

► Fixed inputs

- 8" AC
- 7" CTB
- 50% transverse LTE
- 50% fatigue LTE
- Flex – 400 psi
- Modulus – 2,000,000 psi



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Semi-Rigid Calibration Coefficients

- ▶ Cement stabilized material (CSM) fatigue
- ▶ CSM cracking
- ▶ Reflective fatigue cracking semi-rigid
- ▶ Reflective transverse cracking semi-rigid

CSM fatigue model predicts cumulative damage in CTB layer.

Design Name: Semi-Rigid Example | Design Type: New Pavement | Pavement Type: Semi-Rigid Pavement

General Information | Performance Criteria | Traffic | Climate | Structure | Maintenance Strategy | Calibration | Design Properties | Sensitivity Combination | Thickness Optimization | Run analysis

AC Cracking Bottom Up | AC Cracking Top Down | AC Fatigue | AC Rutting | IRI | CSM Cracking | **CSM Fatigue** | Reflective Fatigue Cracking Semi-rigid

Reflective Transverse Cracking Semi-rigid | Subgrade Rutting | Thermal Fracture Level 1 | Thermal Fracture Level 2 | Thermal Fracture Level 3 | Identifiers

CSM fatigue BC1	1	✓
CSM fatigue BC2	1	✓
CSM fatigue K1	0.972	✓
CSM fatigue K2	0.0825	✓

Local calibration not practical/possible

CSM cracking model converts damage to cracking in CTB layer.

Design Name: Semi-Rigid Example | Design Type: New Pavement | Pavement Type: Semi-Rigid Pavement

General Information | Performance Criteria | Traffic | Climate | Structure | Maintenance Strategy | Calibration | Design Properties | Sensitivity Combination | Thickness Optimization | Run analysis

AC Cracking Bottom Up | AC Cracking Top Down | AC Fatigue | AC Rutting | IRI | **CSM Cracking** | CSM Fatigue | Reflective Fatigue Cracking Semi-rigid

Reflective Transverse Cracking Semi-rigid | Subgrade Rutting | Thermal Fracture Level 1 | Thermal Fracture Level 2 | Thermal Fracture Level 3 | Identifiers

CSM cracking C1	0	✓
CSM cracking C2	75	✓
CSM cracking C3	2	✓
CSM cracking C4	2	✓
CSM standard deviation	CTB*1	✓

Local calibration not practical/possible

Reflective fatigue cracking semi-rigid model predicts longitudinal cracking area percent.

Design Name: Semi-Rigid Example | Design Type: New Pavement | Pavement Type: Semi-Rigid Pavement

AC Cracking Bottom Up | AC Cracking Top Down | AC Fatigue | AC Rutting | IRI | CSM Cracking | CSM Fatigue | **Reflective Fatigue Cracking Semi-rigid**

Reflective Transverse Cracking Semi-rigid | Subgrade Rutting | Thermal Fracture Level 1 | Thermal Fracture Level 2 | Thermal Fracture Level 3 | Identifiers

Reflective fatigue cracking (Semi-Rigid) C1	1.64	✓
Reflective fatigue cracking (Semi-Rigid) C2	1.1	✓
Reflective fatigue cracking (Semi-Rigid) C3	0.19	✓
Reflective fatigue cracking (Semi-Rigid) C4	62.1	✓
Reflective fatigue cracking (Semi-Rigid) C5	-404.6	✓
Reflective fatigue cracking (Semi-Rigid) K1	0.45	✓
Reflective fatigue cracking (Semi-Rigid) K2	0.05	✓
Reflective fatigue cracking (Semi-Rigid) K3	1	✓
Reflective fatigue cracking (Semi-Rigid) standard deviation	$1.3897 * \text{Pow}(\text{FATIGUE}, 0.2960) + 0.4212$	✓

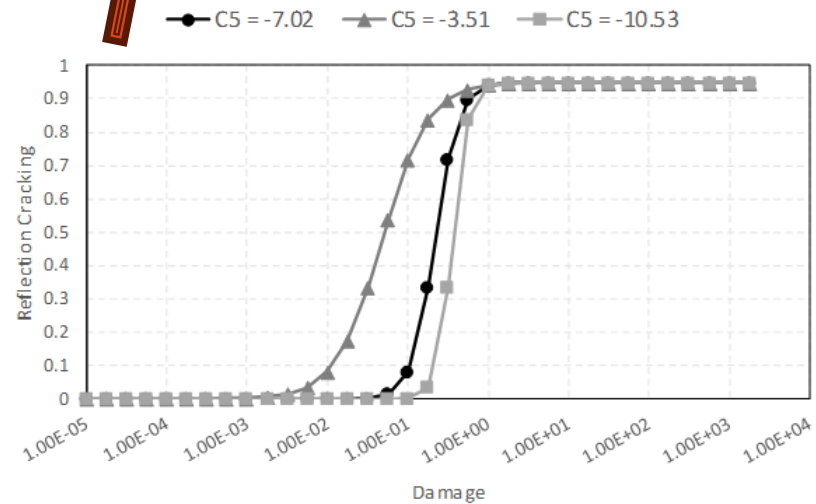
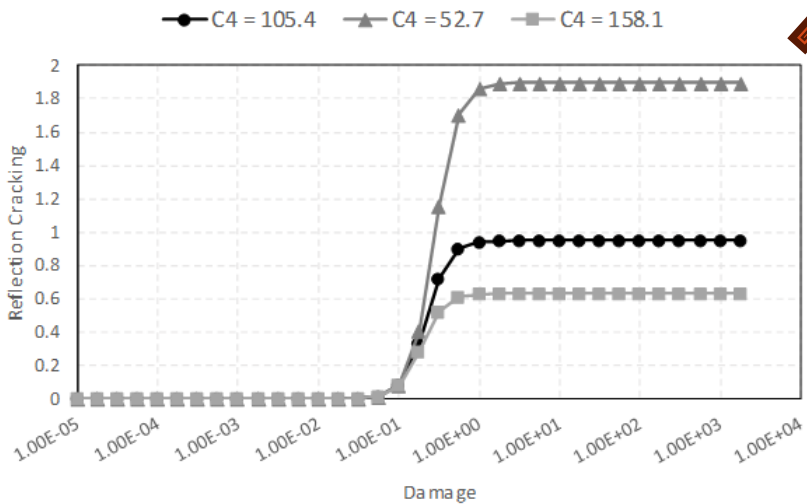
Local calibration possible

Reflective Fatigue Cracking Semi-Rigid Model Calibration

$$\Delta DI_i = \sum_{i=1}^m A \left[C_1 k_1 (\Delta K_B)^n + C_2 k_2 (\Delta K_S)^n + C_3 k_3 (\Delta K_T)^n \right]$$

$$RCR_i = Ckg \left(\frac{100}{C_4 + e^{C_5 \text{Log} DI_i}} \right)$$

↑ C4 = ↓ Cracking
 ↑ C5 = ↑ Cracking



Reflective transverse cracking semi-rigid model predicts longitudinal cracking area percent.

Design Name: Semi-Rigid Example | Design Type: New Pavement | Pavement Type: Semi-Rigid Pavement

AC Cracking Bottom Up | AC Cracking Top Down | AC Fatigue | AC Rutting | IRI | CSM Cracking | CSM Fatigue | Reflective Fatigue Cracking Semi-rigid

Reflective Transverse Cracking Semi-rigid | Subgrade Rutting | Thermal Fracture Level 1 | Thermal Fracture Level 2 | Thermal Fracture Level 3 | Identifiers

Reflective transverse (Semi-Rigid) C1	0.1	✓
Reflective transverse (Semi-Rigid) C2	0.9809	✓
Reflective transverse (Semi-Rigid) C3	0.19	✓
Reflective transverse (Semi-Rigid) C4	165.3	✓
Reflective transverse (Semi-Rigid) C5	-5.1048	✓
Reflective transverse (Semi-Rigid) K1	0.45	✓
Reflective transverse (Semi-Rigid) K2	0.05	✓
Reflective transverse (Semi-Rigid) K3	1	✓
Reflective transverse cracking (Semi-Rigid) standard deviation	$0.000027 * \text{Pow}(\text{TRANSVERSE}, 2.1187) + 399.9$	✓

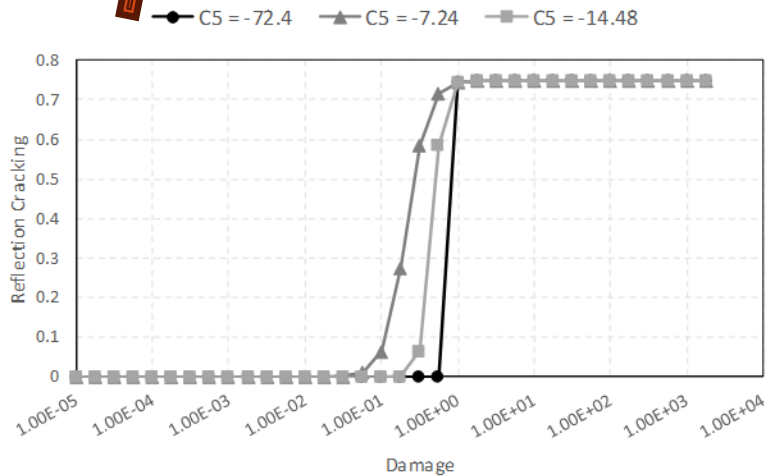
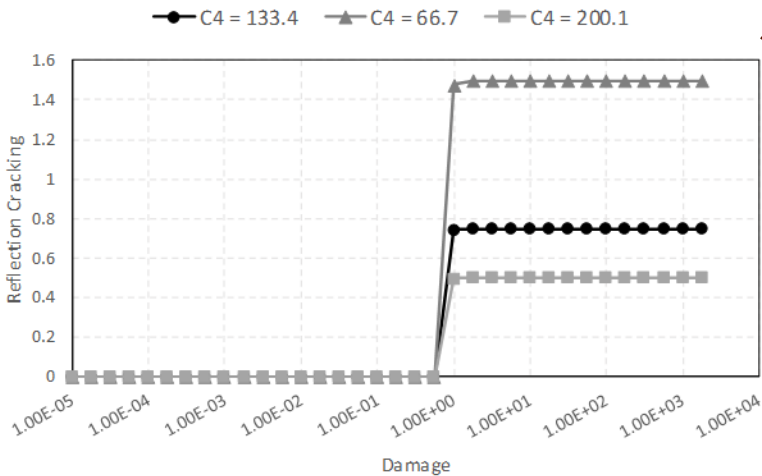
Local calibration possible

Reflective Transverse Cracking Semi-Rigid Model Calibration

$$\Delta DI_i = \sum_{i=1}^m A \left[C_1 k_1 (\Delta K_B)^n + C_2 k_2 (\Delta K_S)^n + C_3 k_3 (\Delta K_T)^n \right]$$

$$RCR_i = Ckg \left(\frac{100}{C_4 + e^{C_5 \text{Log} DI_i}} \right)$$

↑ C4 = ↓ Cracking
 ↑ C5 = ↑ Cracking



FY 2024, Webinar #3: Semi-Rigid Pavement Design

Webinar Outline:

1. Introduction
2. Defining Semi-Rigid
3. PMED Analysis
4. Sensitivity
5. Calibration Coefficients
6. Summary and Takeaways
7. Question and Answer Session

Summary and Takeaways

- ▶ A semi-rigid layer must have flexural strength.
- ▶ PMED requires semi-rigid (CTB) layer directly below AC layer.
- ▶ Crack spacing, input by user, remains constant in analysis.
- ▶ *Total* transverse and fatigue cracking predictions should be primary crack distress indicators for design analysis.

Summary and Takeaways

- ▶ Flexural strength (MR) and elastic modulus (E) have opposite influence on CTB damage accumulation. MR assumed to remain constant, therefore, minimum CTB E input required to prevent full cessation of fatigue damage increase.
- ▶ CTB layer fatigue and transverse LTE determine respective rates of reflective cracking in AC layer.
- ▶ C4 and C5 transfer function coefficients are primary means of calibrating fatigue and transverse reflection cracking models.

FY 2024 Webinar #1 Multiple Asphalt overlays

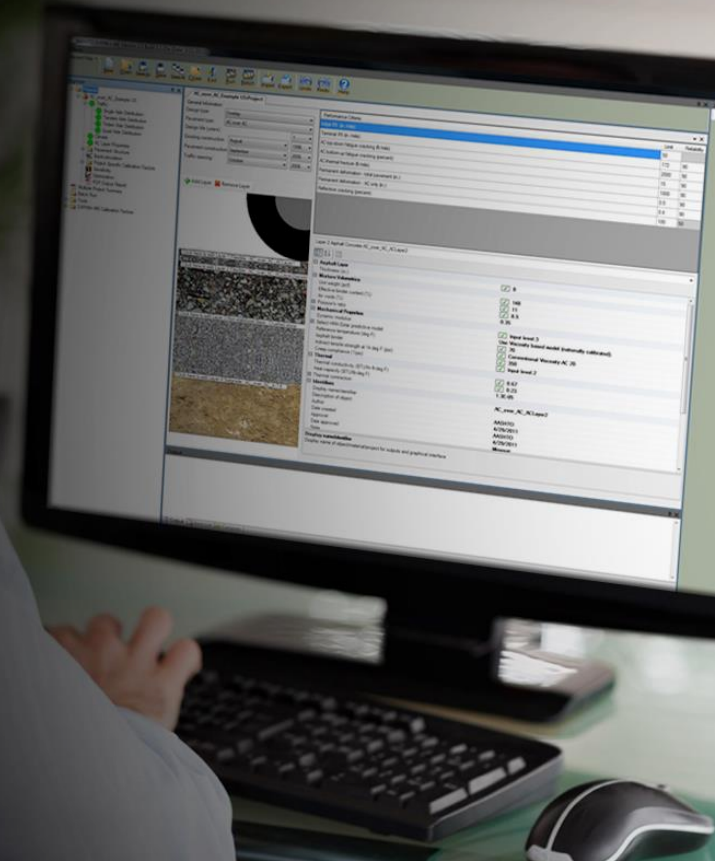
Poll 2: Questions 4 to 6



QUESTION AND ANSWER SESSION



We welcome comments & suggestions for future webinars; Send an email to pavementmedesign@ara.com.



Upcoming Webinars for FY 2024

- ▶ Webinars 3 and 4: Will be announced later this year (defined by the task force in October).
- ▶ Reminder:
 - Slides, Q&A, and recording can be found at:
 - [AASHTOWare Pavement ME Design – Webinar Series \(me-design.com\)](https://me-design.com)

Looking for webinar topics for FY 2025 – Please submit any webinar topic suggestions.



Save the Date!

2024 AASHTOWare PMED User Group Meeting

September 4-5, 2024 | Atlanta, GA

Thank you for Attending the Webinar!

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<https://me-design.com/MEDesign/>

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Webinar is closed.