HMA Performance-Related Specification (HMA-PRS)

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How PRS Works

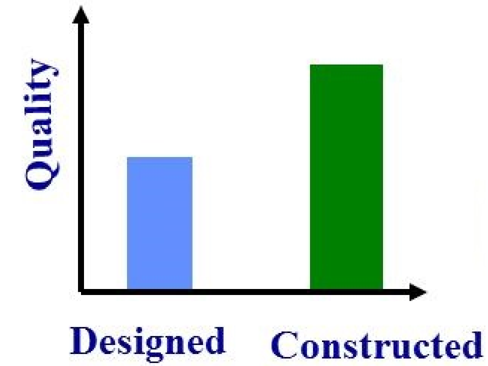
Pavement Design

Planning

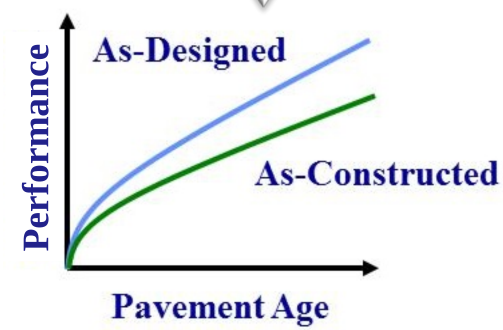
SOFTWARE

Establish Performance Criteria

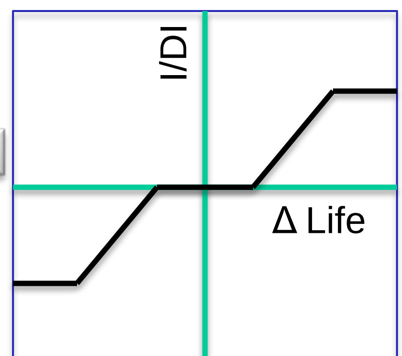
Identify AQCs and Target Values



Design AQC vs. As-Constructed AQC

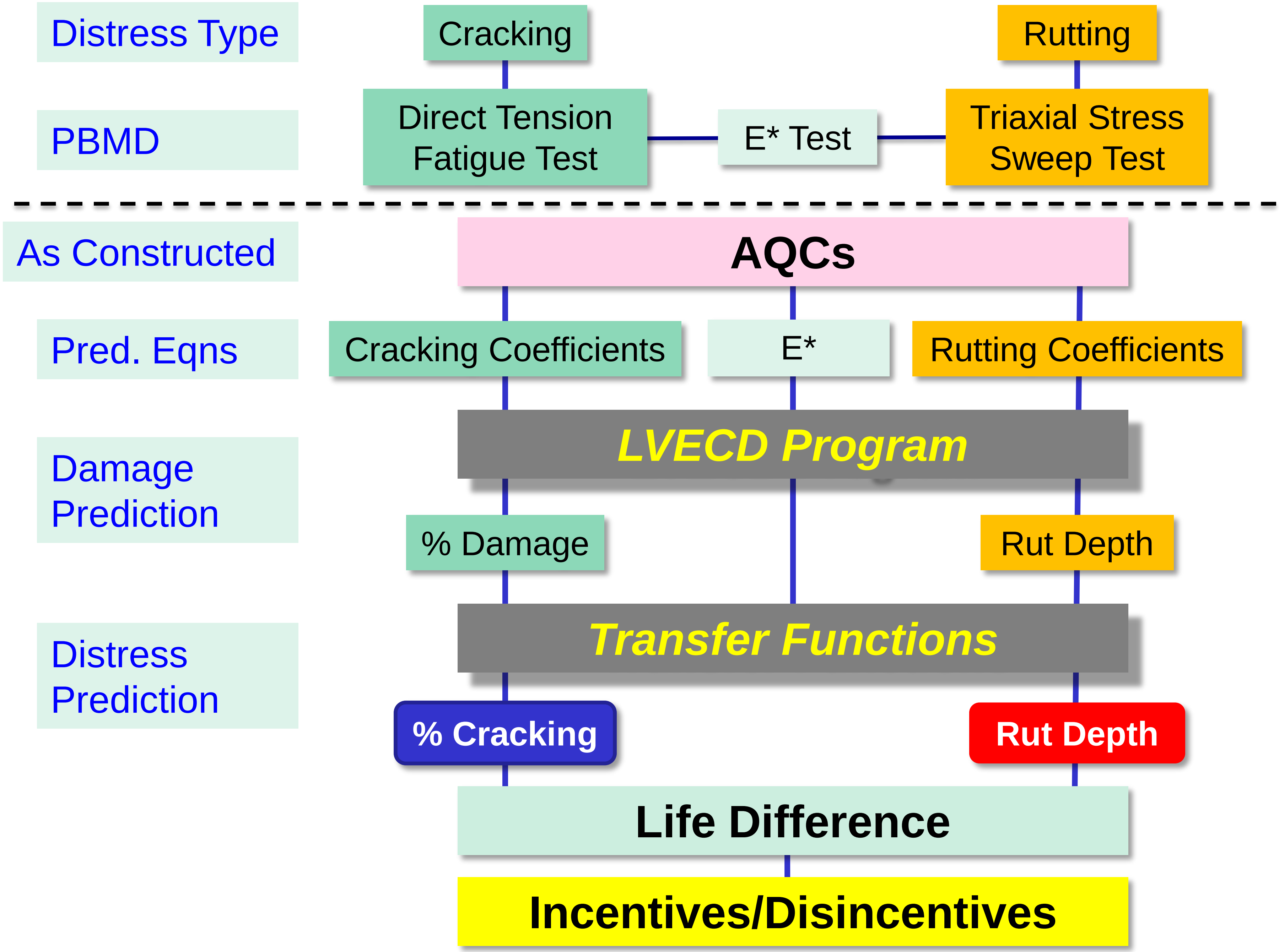


Model Performance



Determine Incentives/ Disincentives

Pay Factor


Distress Type
Cracking
Rutting
PBMD
Direct Tension Fatigue Test
E* Test
Triaxial Stress Sweep Test
As Constructed
AQCs
Pred. Eqns
Cracking Coefficients
E*
Rutting Coefficients
Damage Prediction
LVECD Program
% Damage
Rut Depth
Distress Prediction
Transfer Functions
% Cracking
Rut Depth
Life Difference
Incentives/Disincentives

Challenges in PRS Acceptance

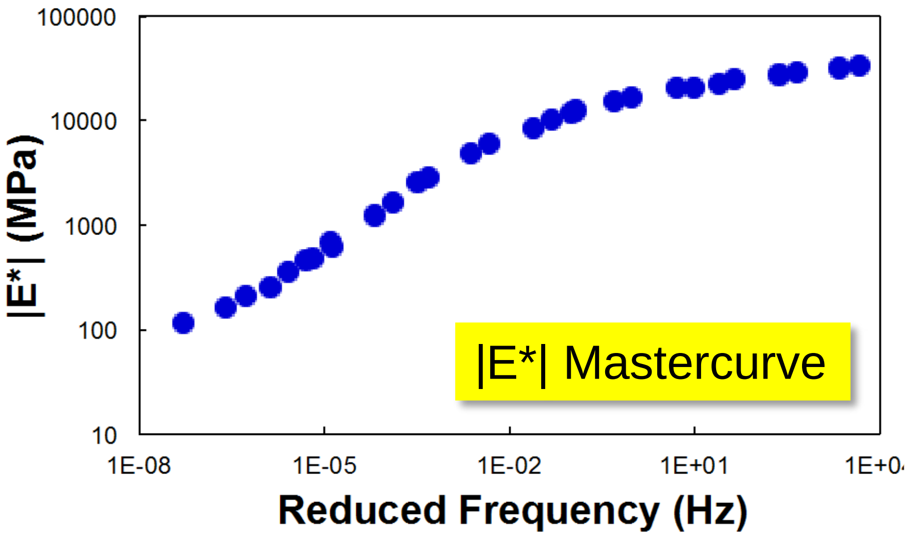
- Testing efficiency and simplicity - **Completed**
- Standardization of test methods - **Ongoing**
- Reliability of performance prediction models - **Completed**
- Predictive relationships between AQCs and performance prediction model parameters - **Ongoing**
- Same principles and methods between mix design and PRS - **Ongoing**

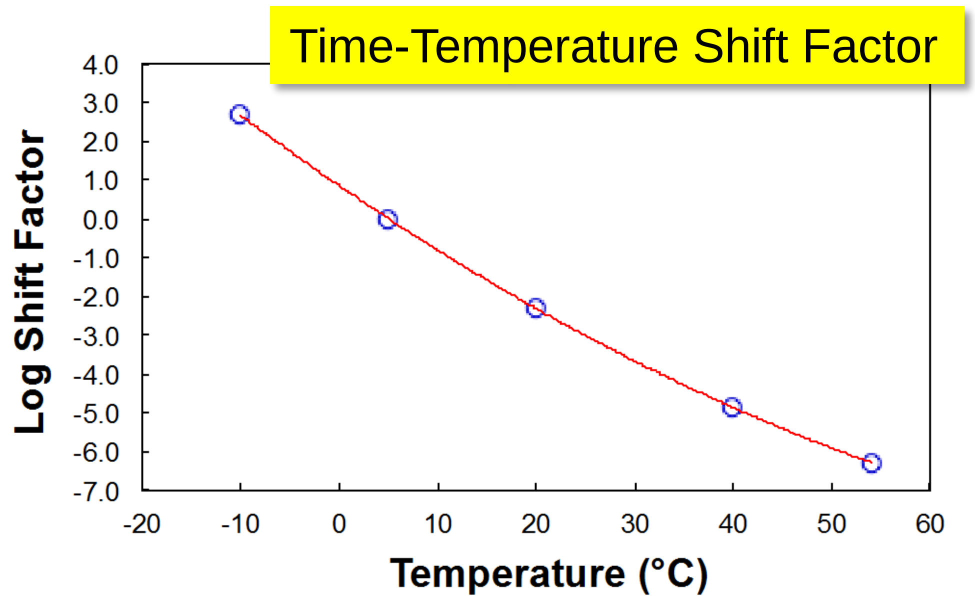
Asphalt Mixture Performance Tester

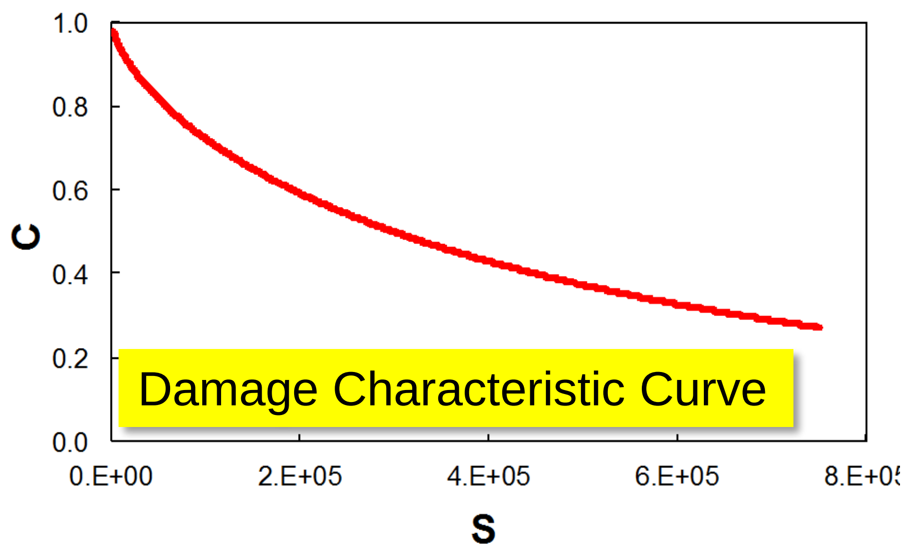
PBMD Laboratory Tests

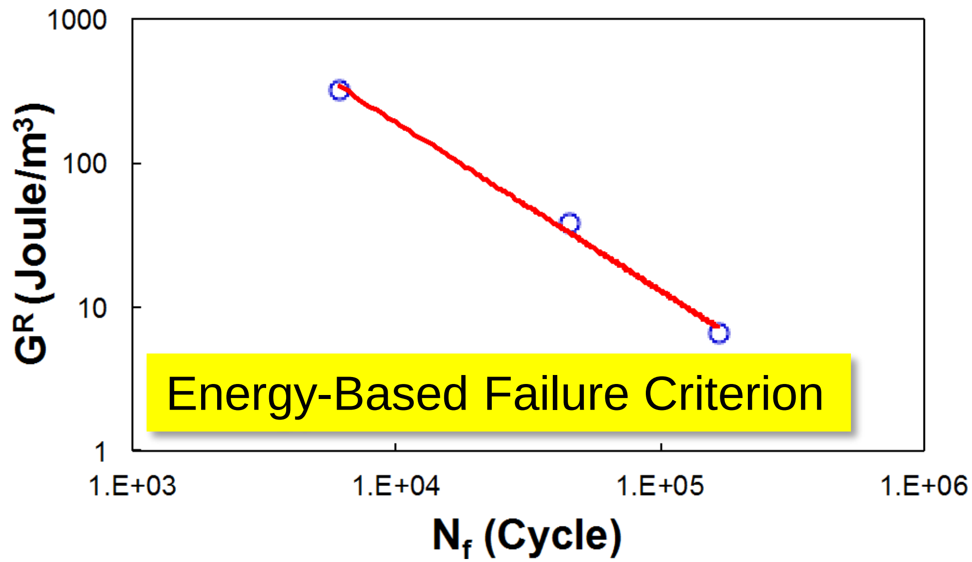
Property	Test Method	# Tests	Testing Time
Modulus	Dynamic modulus test (AASHTO TP 79/PP 61)	3	1 day
Fatigue Cracking/Thermal Cracking	Direct tension cyclic test - SVECD (AASHTO TP 107)	4	1.5 days
Rutting	Triaxial stress sweep test	4	1 day
Total		**11**	**3.5 days**

S-VECD Material Properties



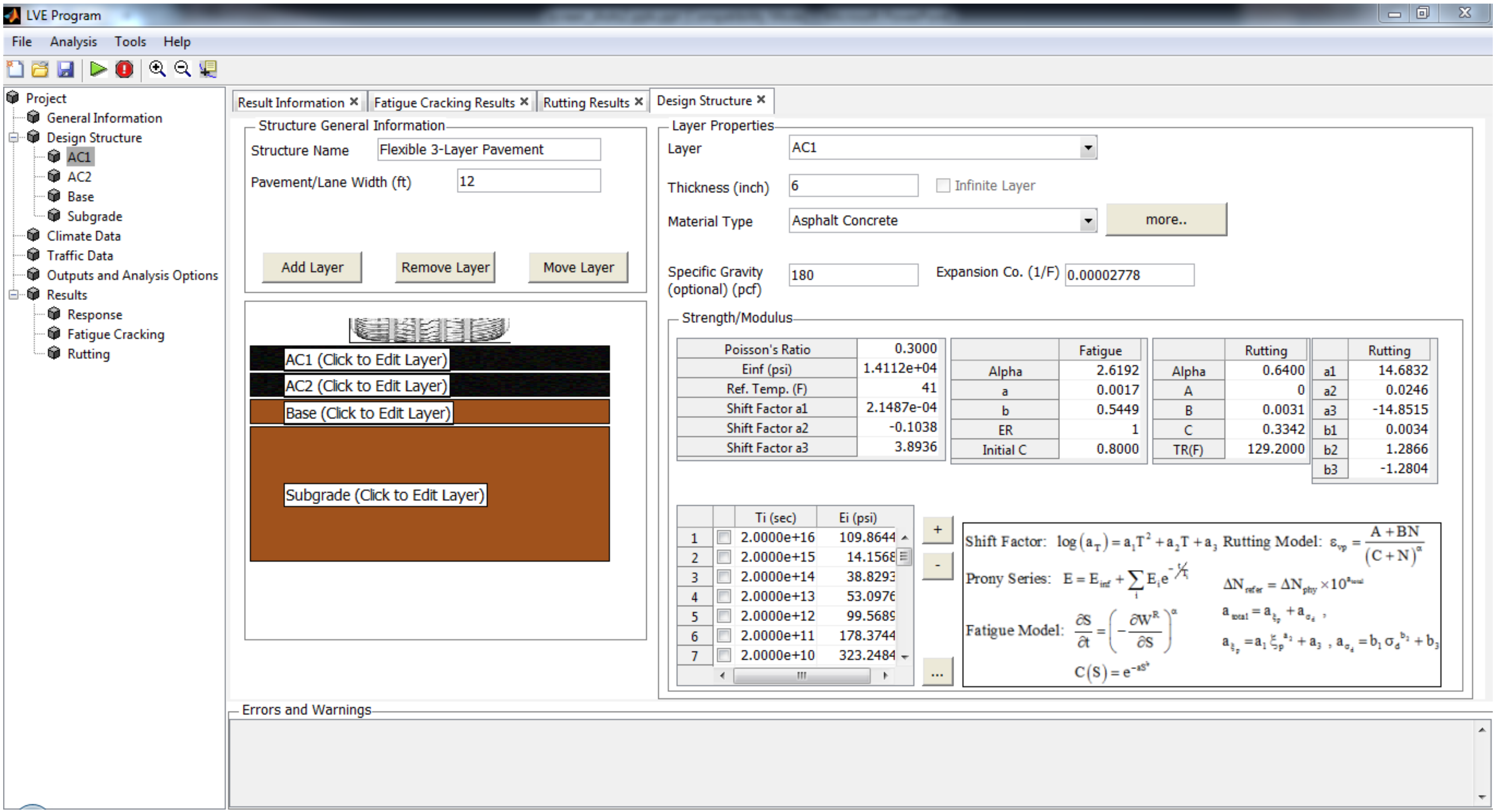




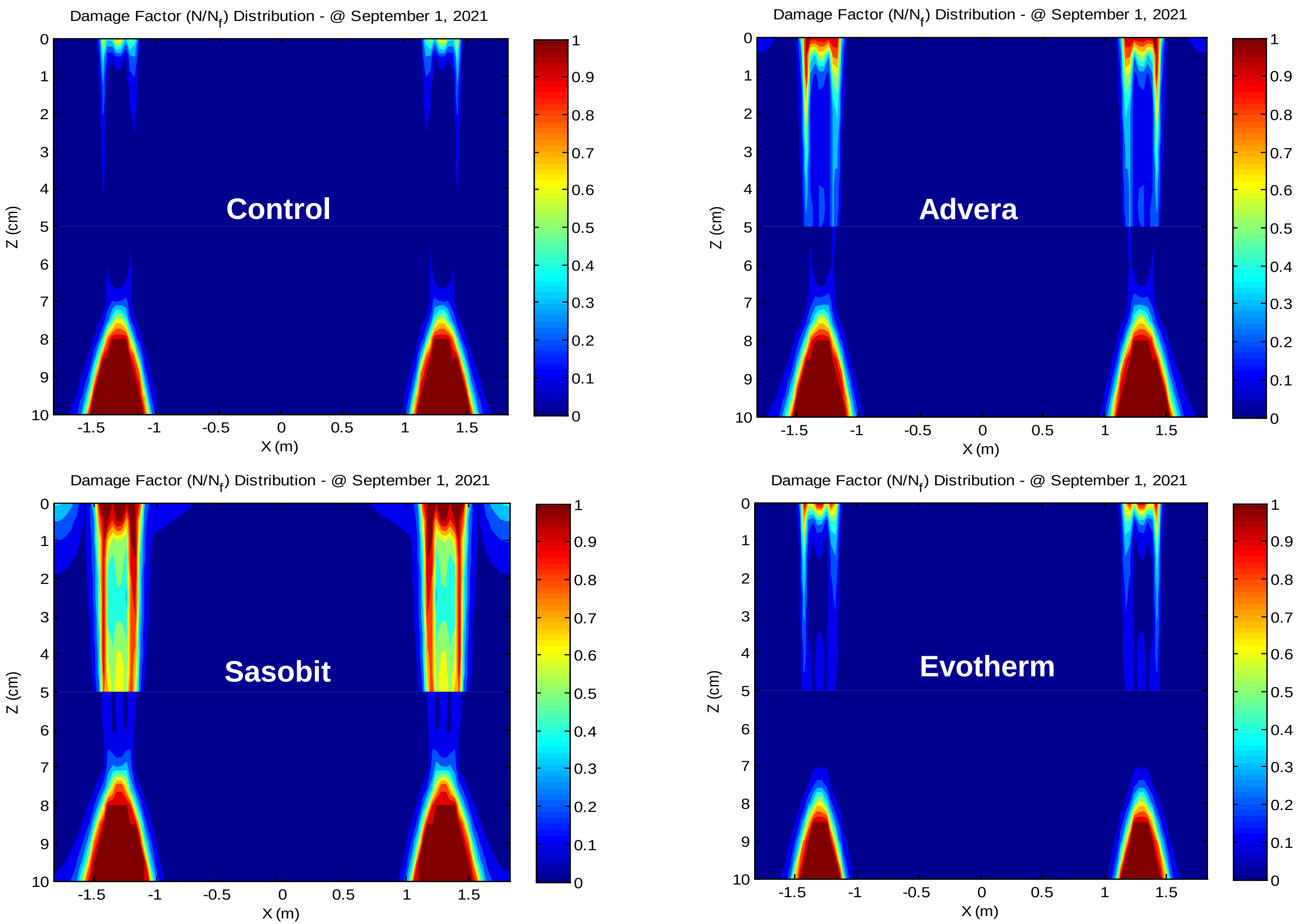


Pavement Performance Prediction

LVECD Program



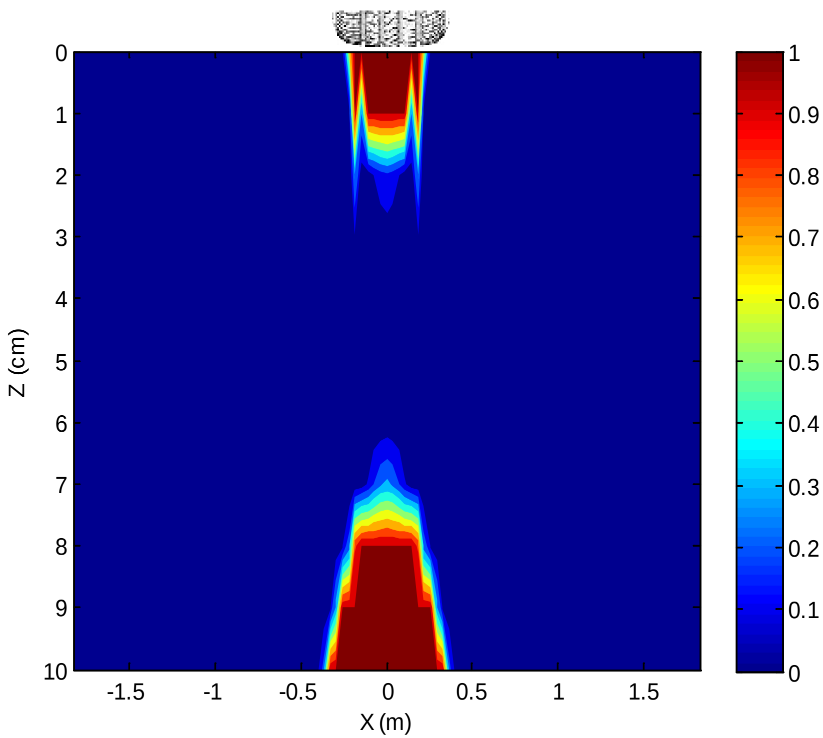
Damage Contours after 20 Years



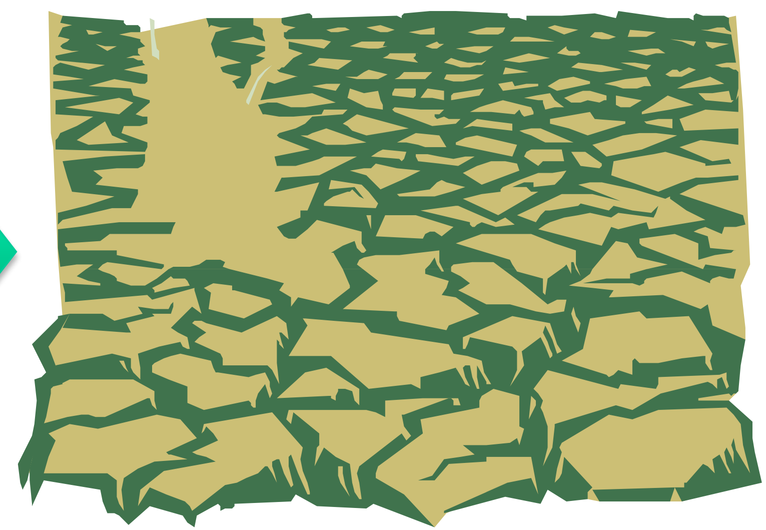
Field Validation of Models

Fatigue Cracking Transfer Function

Damage

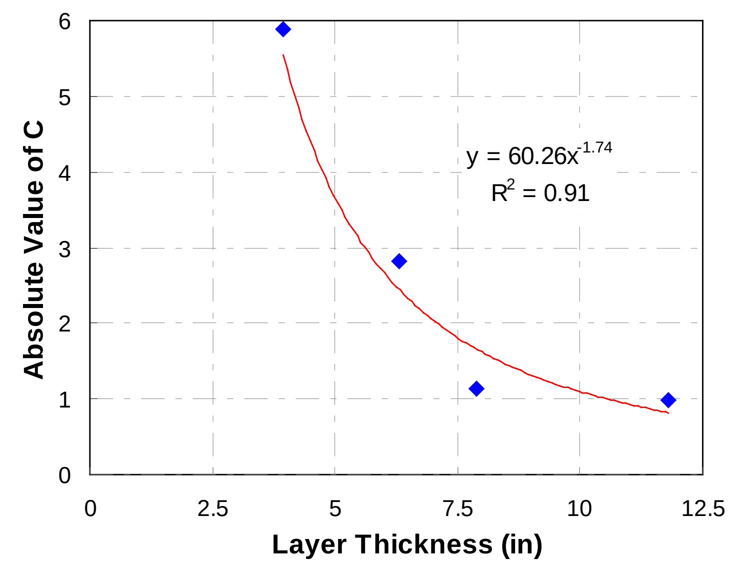


Distress



Transfer Functions

$$\%FC = \frac{100}{1+\left(\frac{2.5D}{100}\right)^{C}}$$



where %FC = % fatigue cracking,

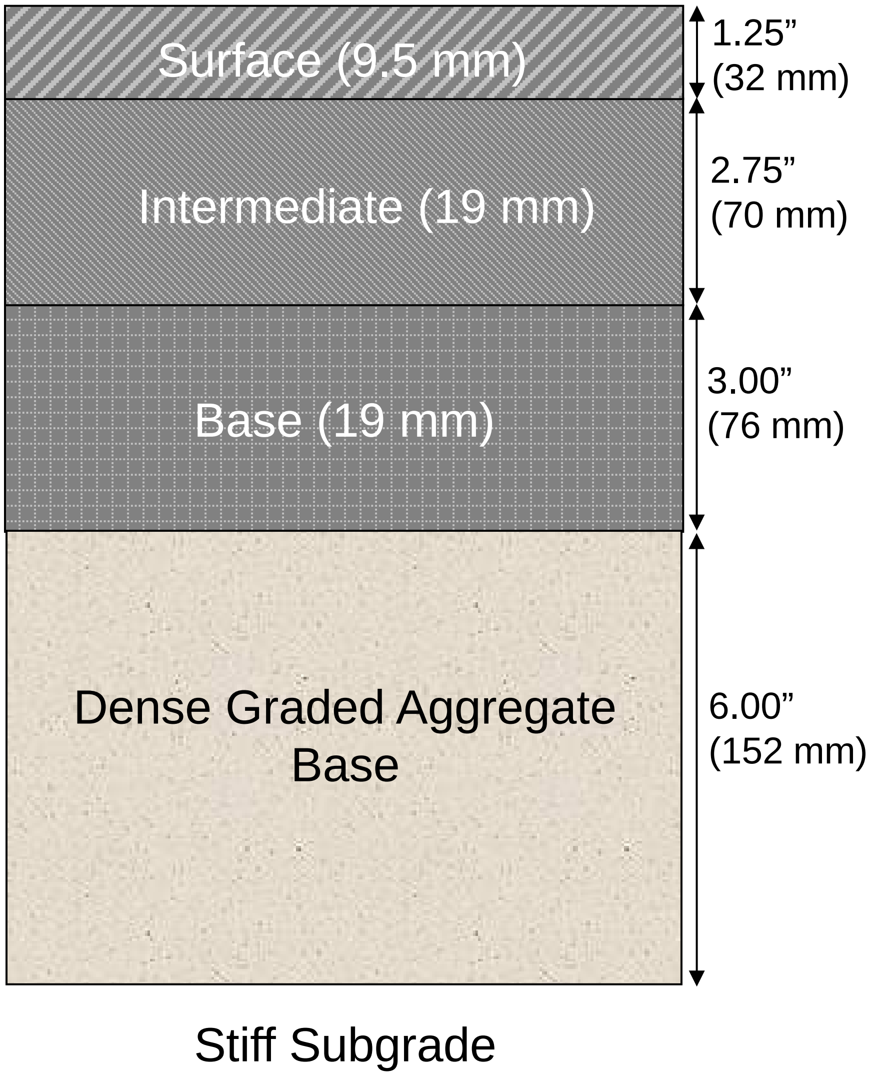
D = % damage predicted from LVECD, and

$$C = -0.83 - 724(1+h_{ac})^{-3.103}$$

$$RD_{Field} = \frac{RD_{LVECD}}{0.6946} - 4.2839$$

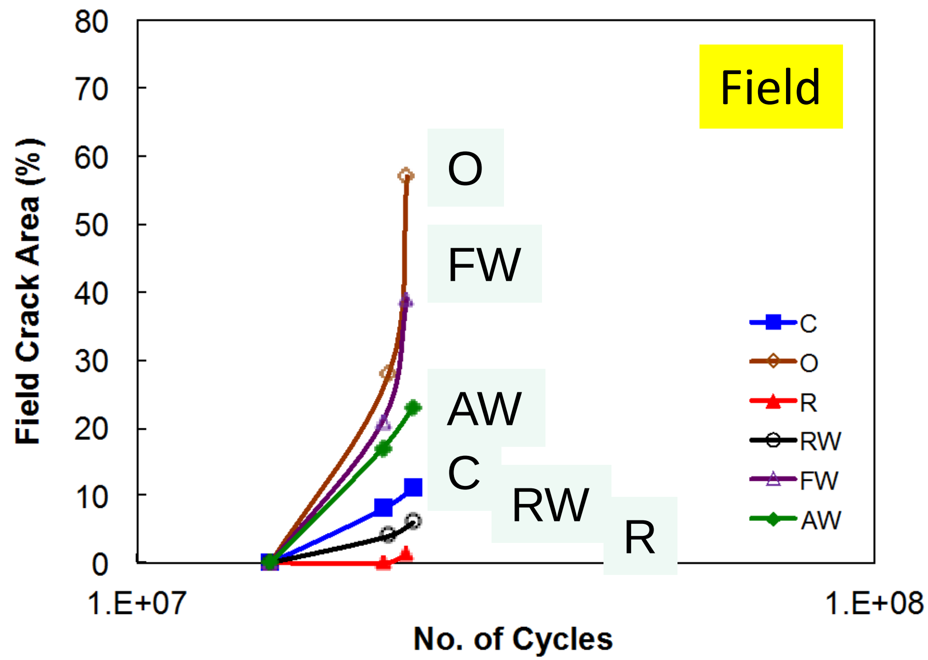
Validation/Calibration Project - I

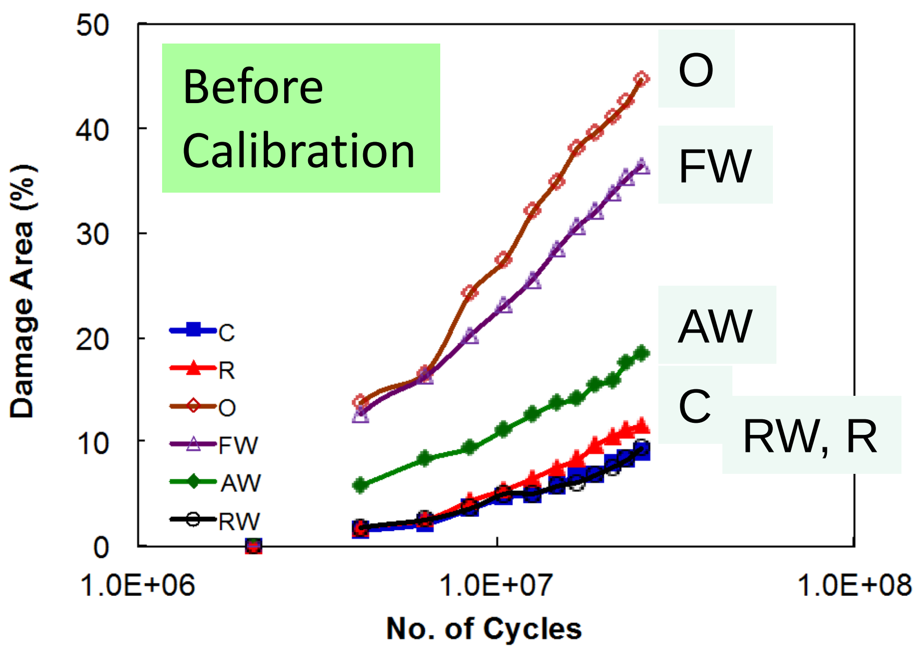
- NCAT Test Sections
  - Control
  - OGFC
  - High RAP
  - RAP + WMA
  - Foam WMA
  - Evotherm

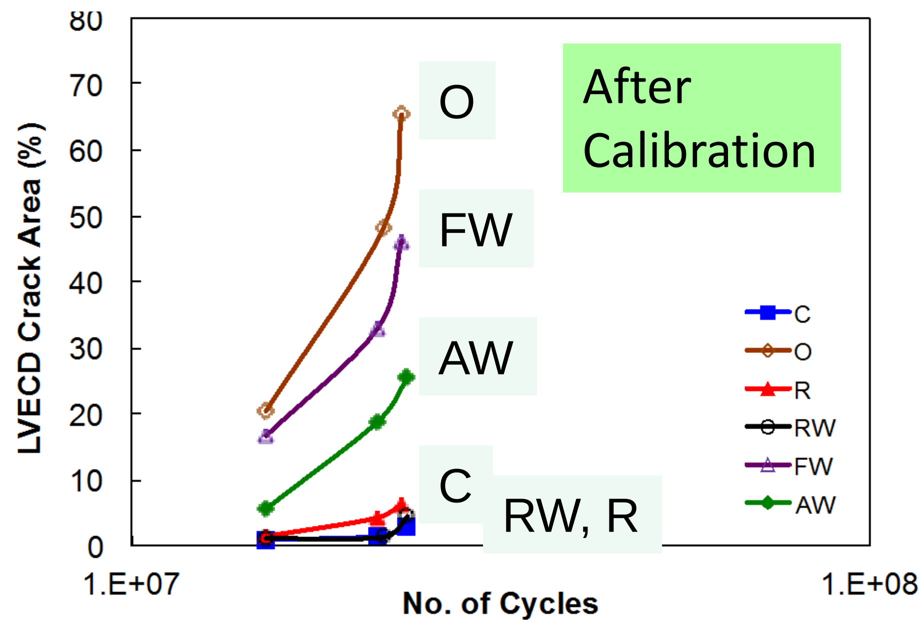


Fatigue Prediction

NCAT

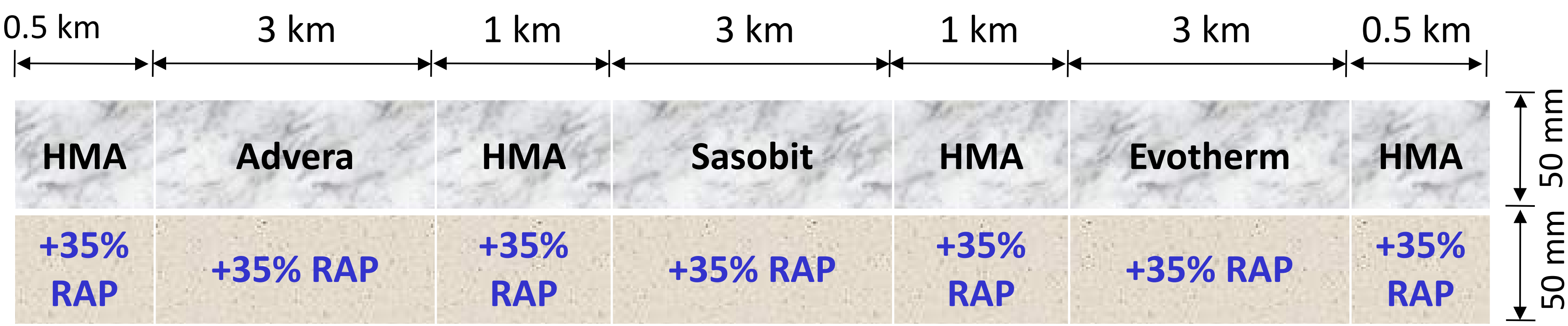




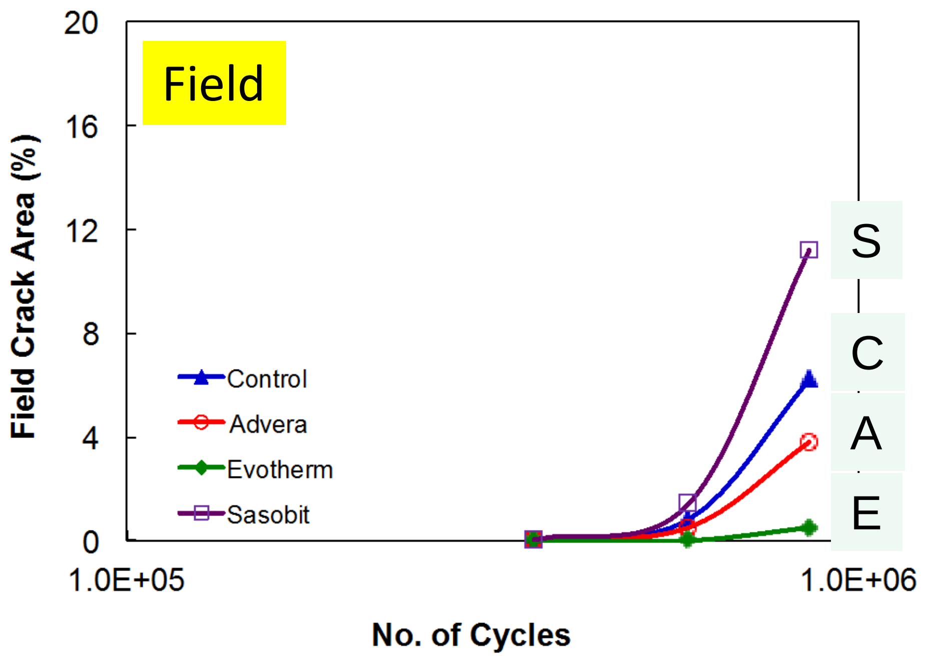


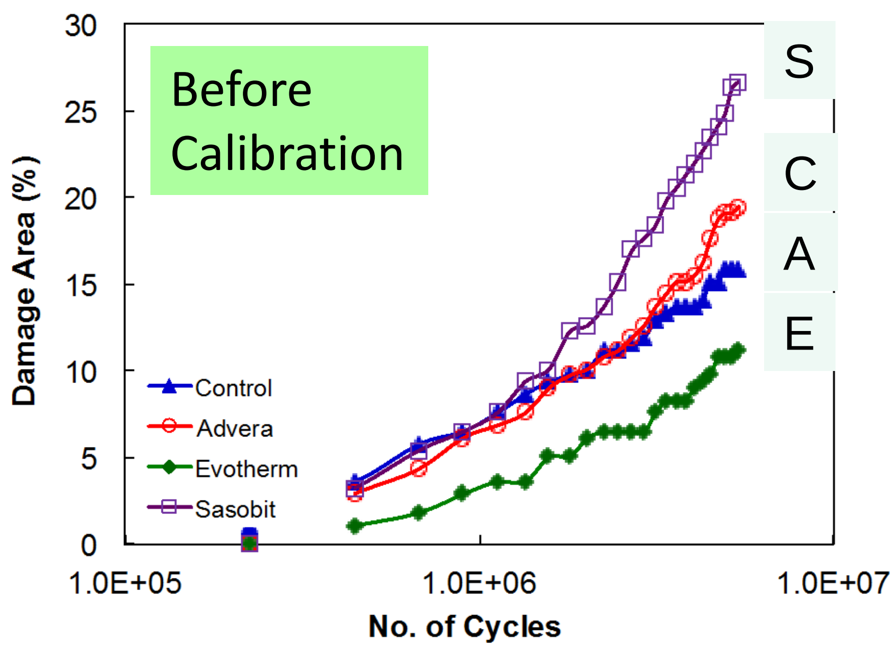
Validation/Calibration Project - II

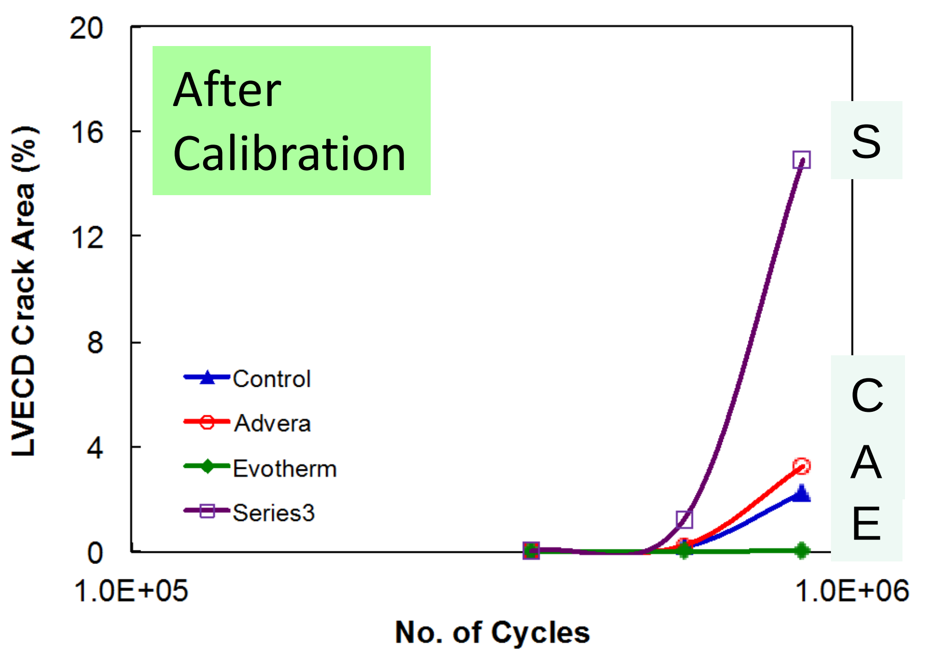
- Manitoba WMA Pavements
  - Surface layer: Control, Advera, Sasobit, Evotherm
  - Intermediate layer: Surface mixture + 35% RAP



Fatigue Prediction
MIT-WMA

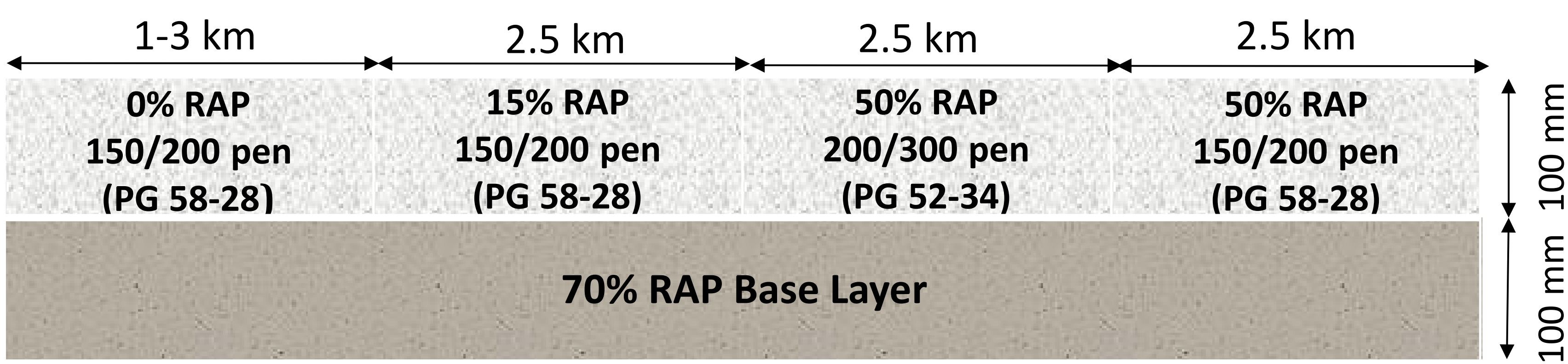






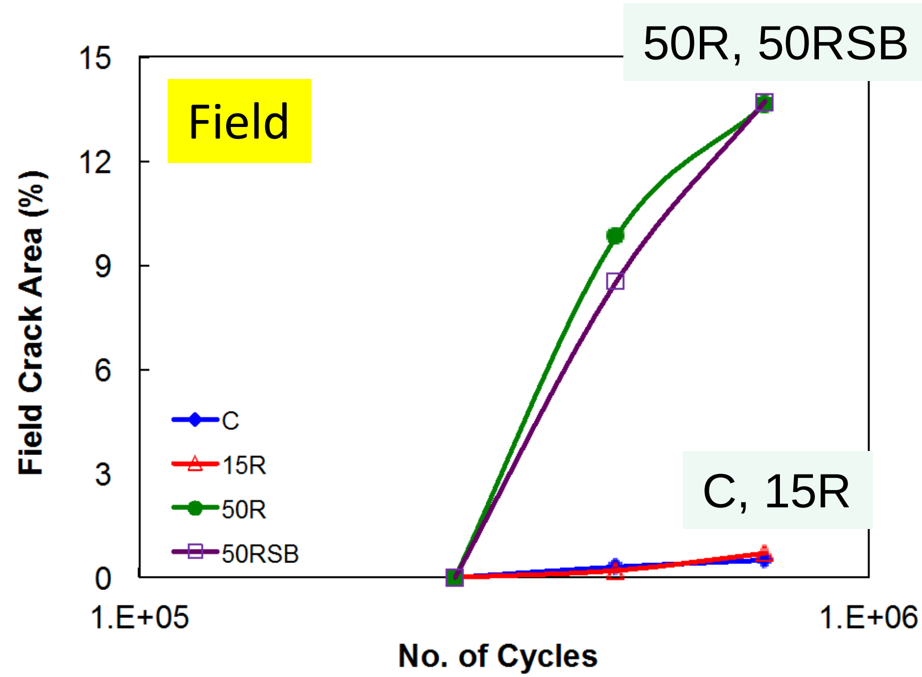
Validation/Calibration Project – III

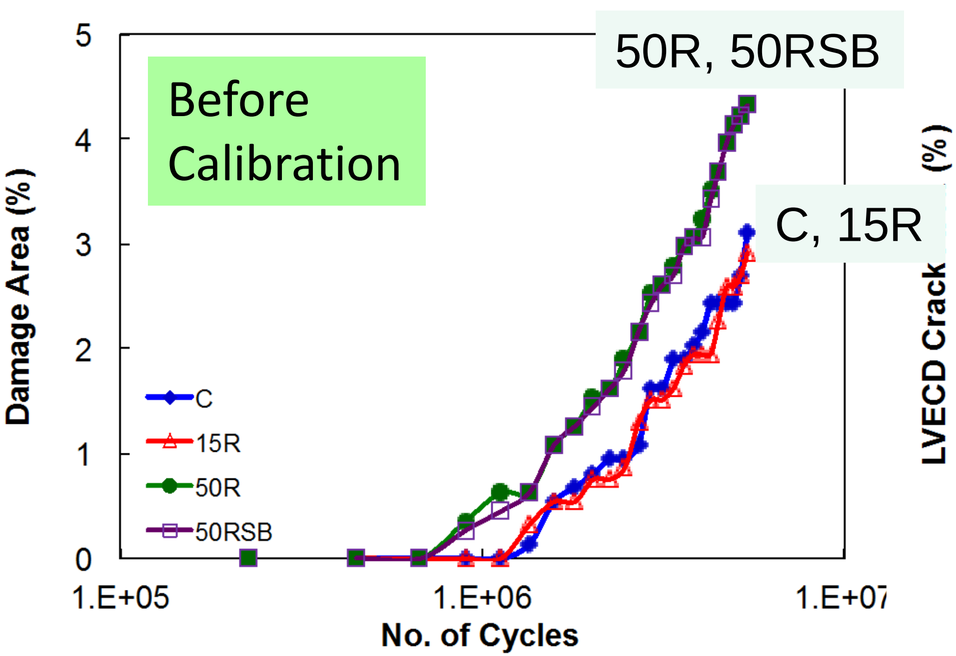
- Manitoba RAP Pavements
  - Surface layer
    - ✓ 0% RAP + PG 58-28
    - ✓ 15% RAP + PG 58-28
    - ✓ 50% RAP + PG 58-28
    - ✓ 50% RAP + PG 52-34 (soft binder)
  - Base layer: PG 58-28 mixture + 70% RAP

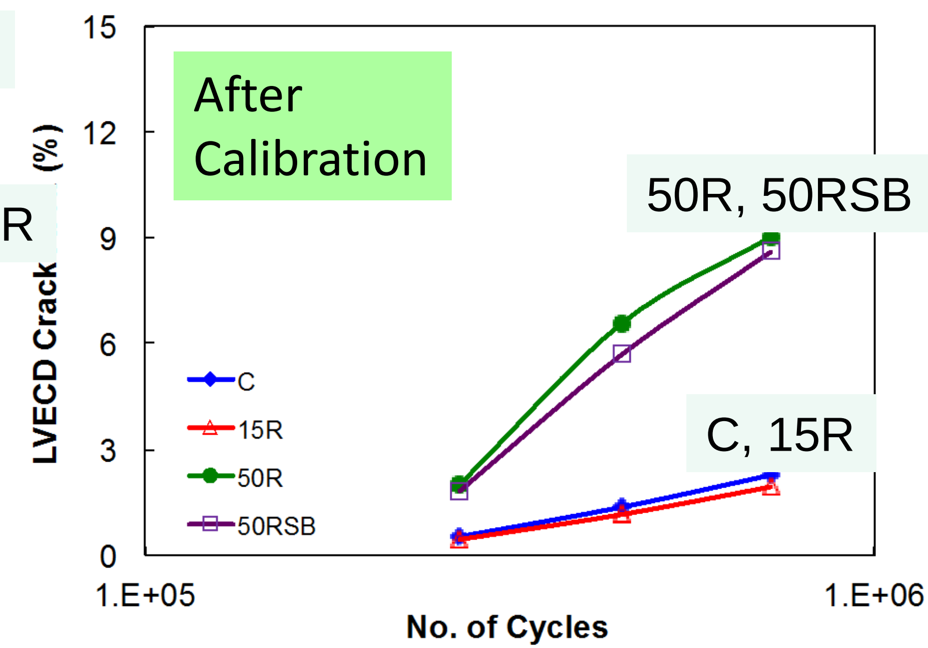


Fatigue Prediction

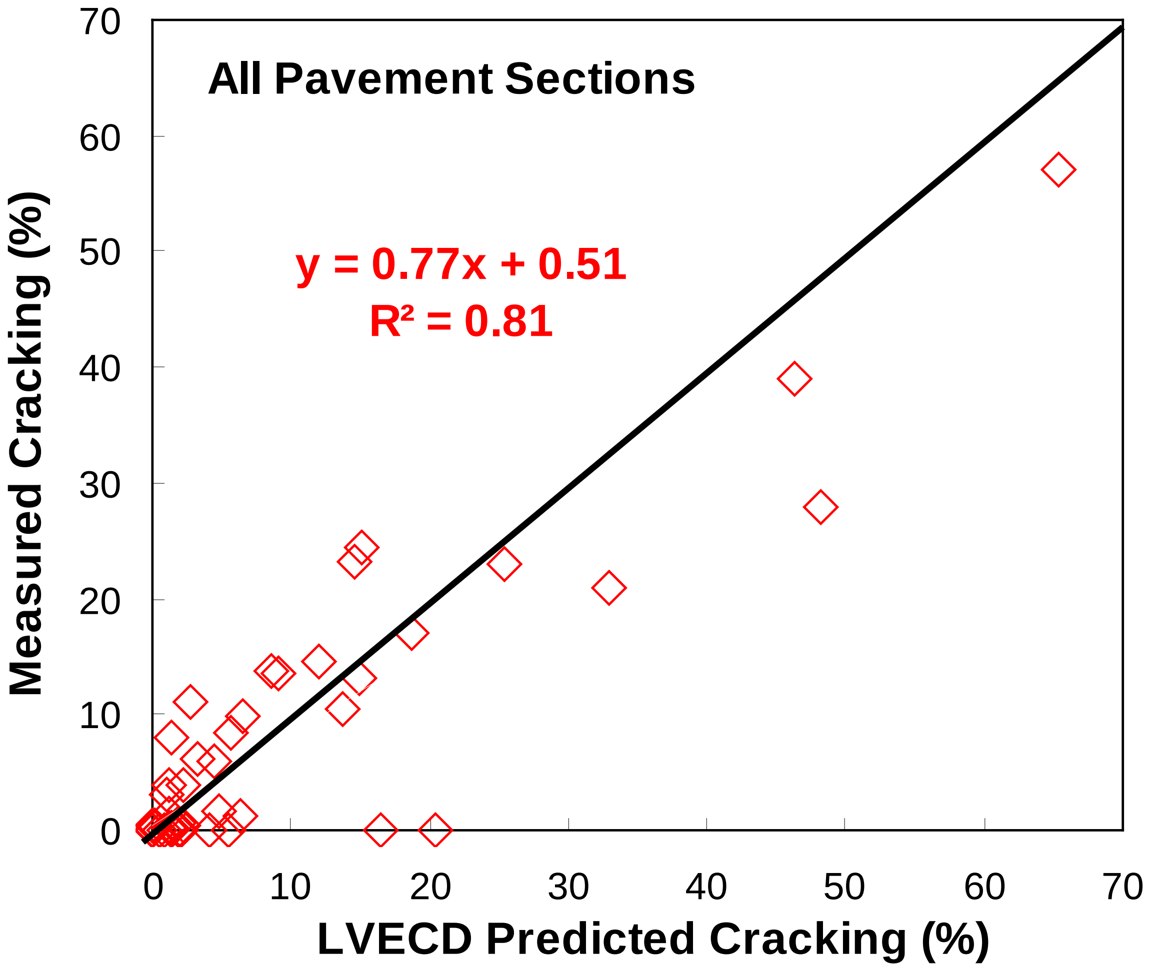
MIT-RAP





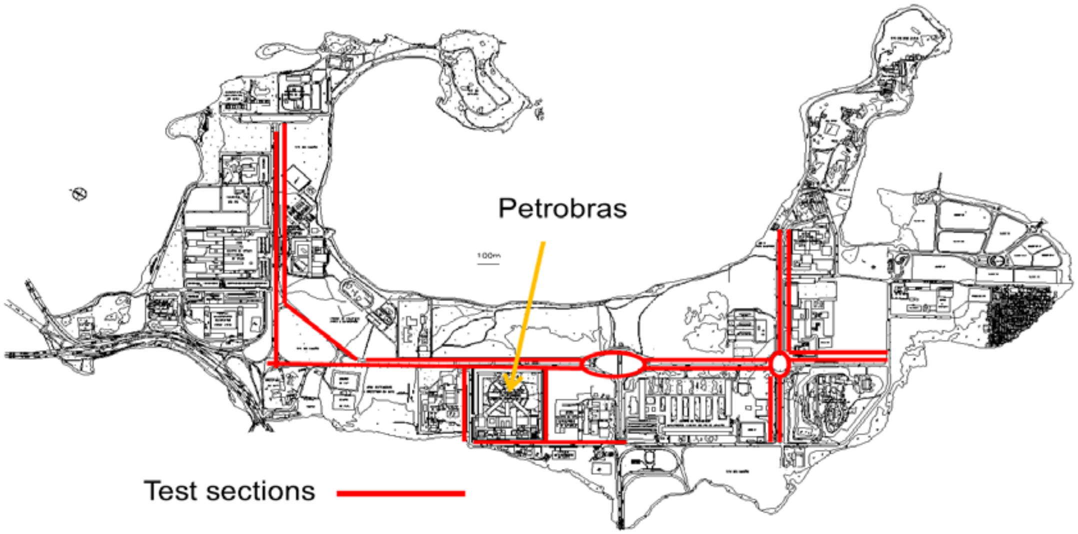


Prediction Accuracy after Calibration



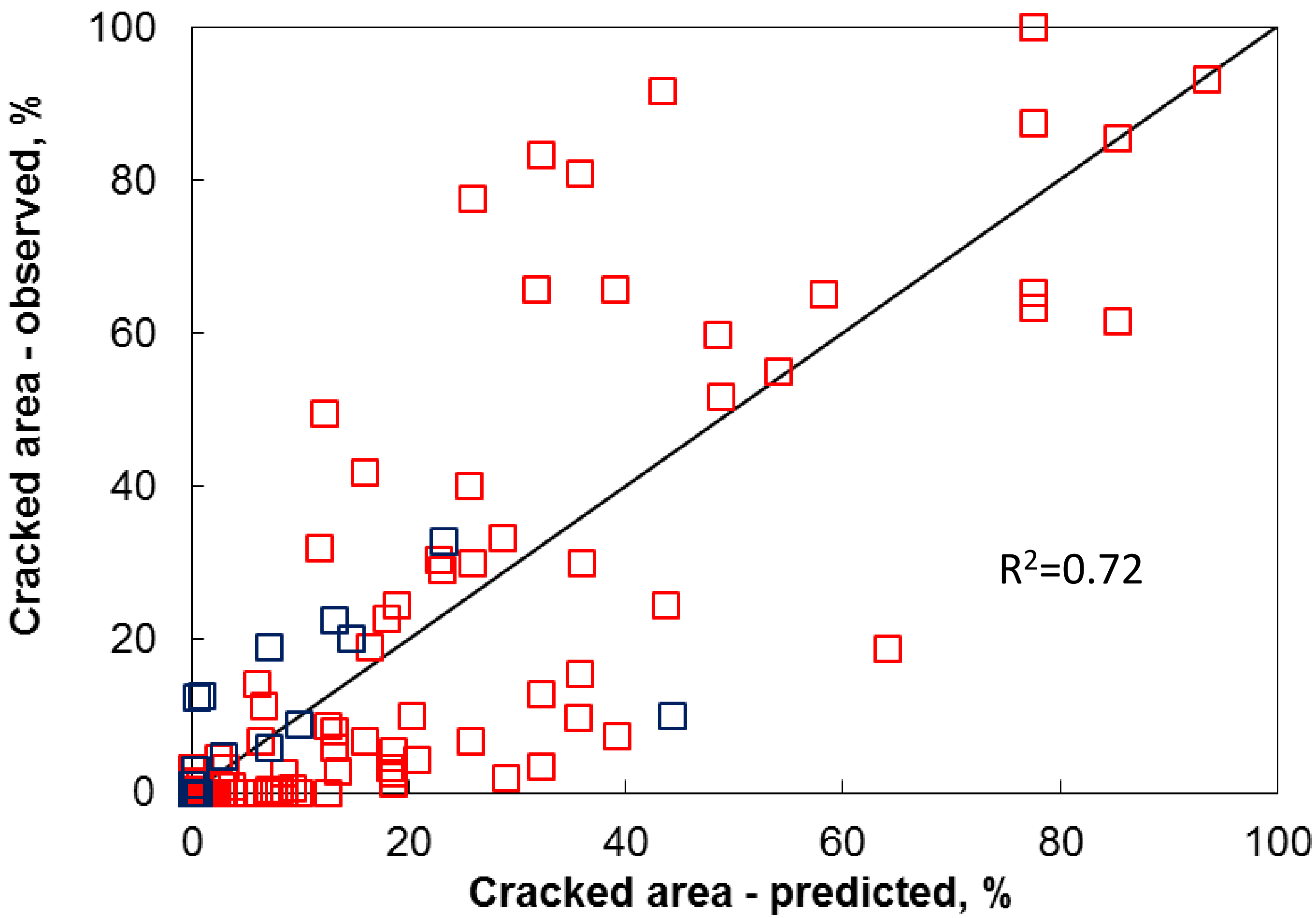
Brazilian Pavements for Development of M-E Pavement Design Method

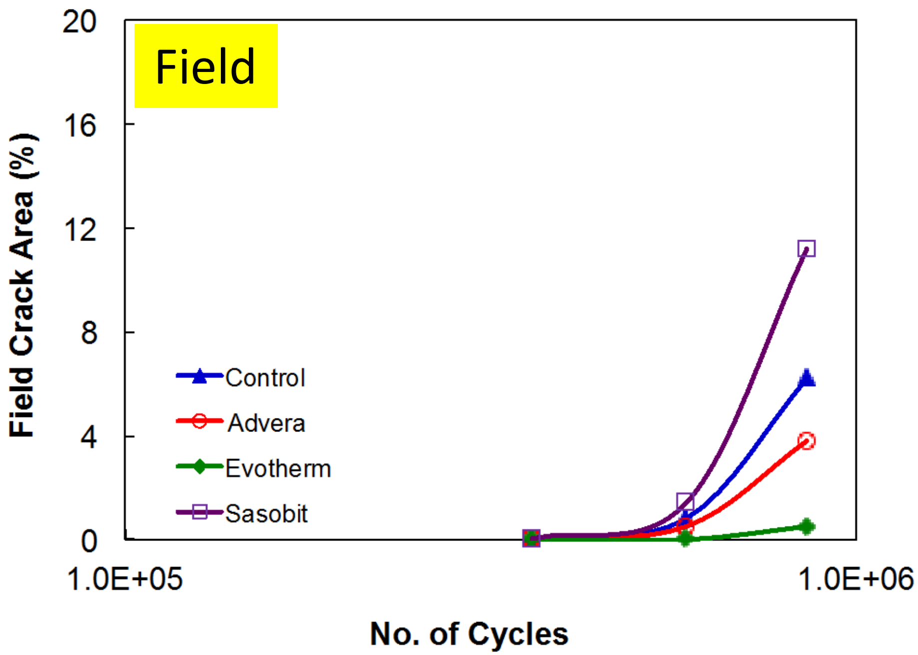
- Fundao project pavement test sections (27)

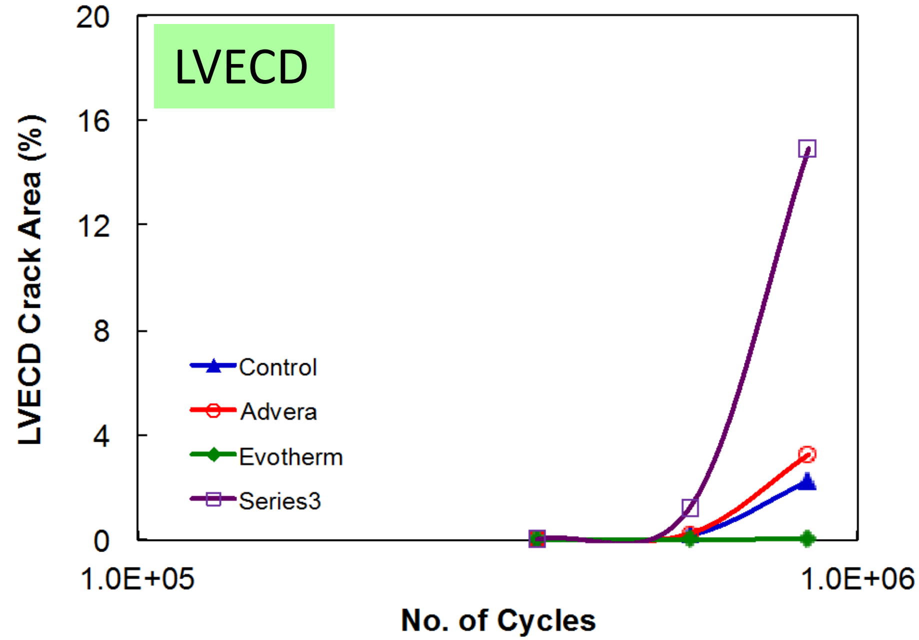


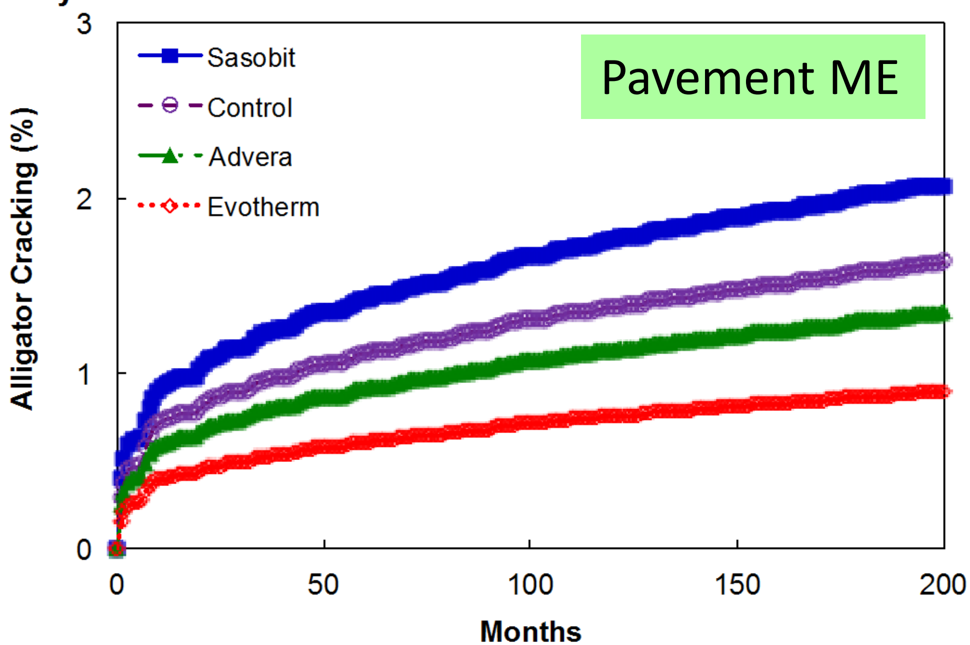
- National M-E project test sections (17)

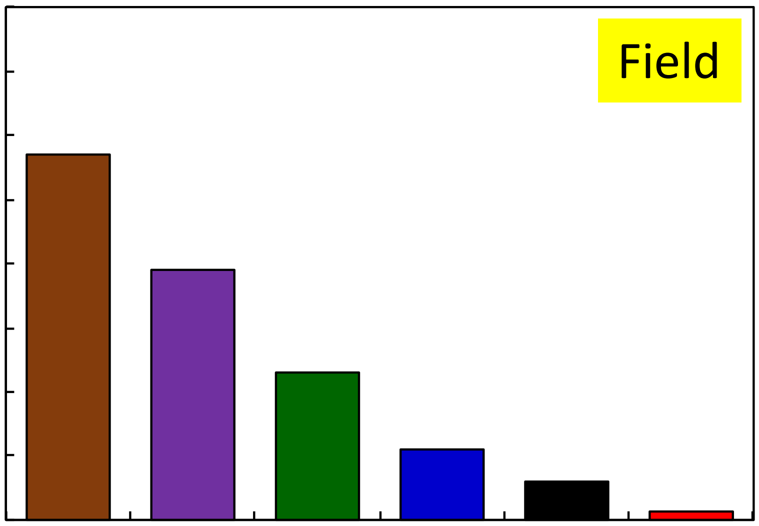
Performance Prediction of Brazilian Pavements

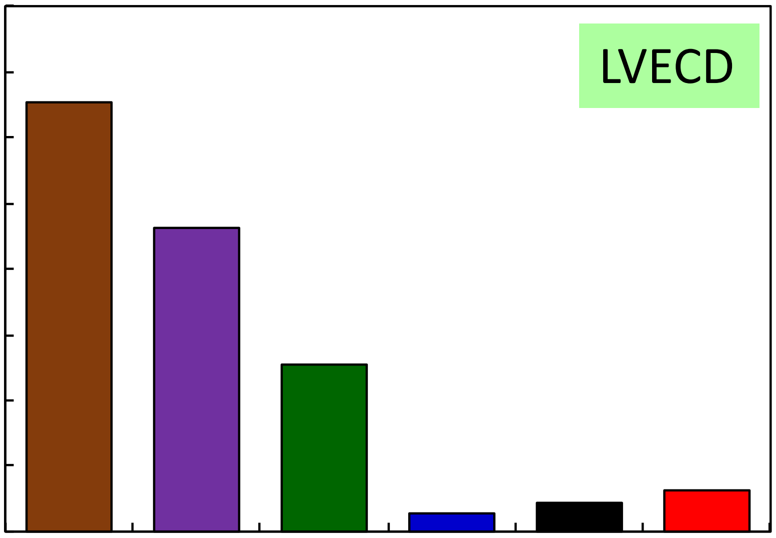



Field
Field Crack Area (%)
20
16
12
8
4
0
Control
Advera
Evotherm
Sasobit
1.0E+05
1.0E+06
No. of Cycles


LVECD
LVECD Crack Area (%)
20
16
12
8
4
0
Control
Advera
Evotherm
Series3
1.0E+05
1.0E+06
No. of Cycles

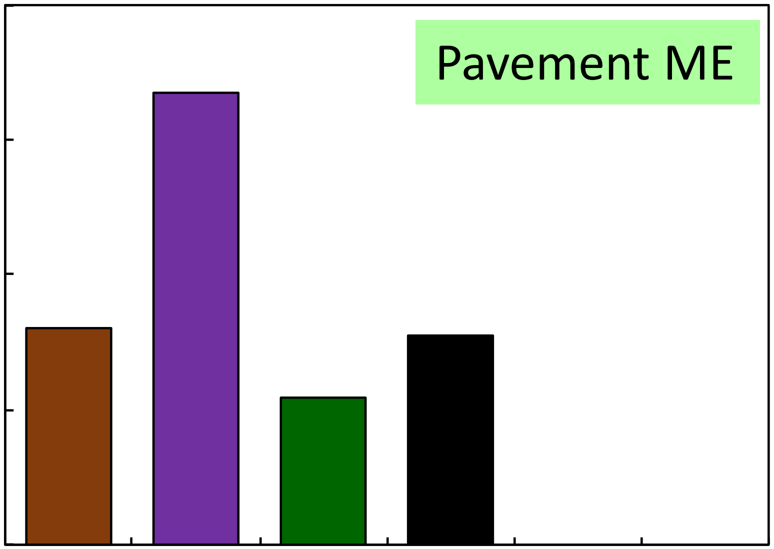

Pavement ME
Alligator Cracking (%)
3
2
1
0
Sasobit
Control
Advera
Evotherm
0
50
100
150
200
Months

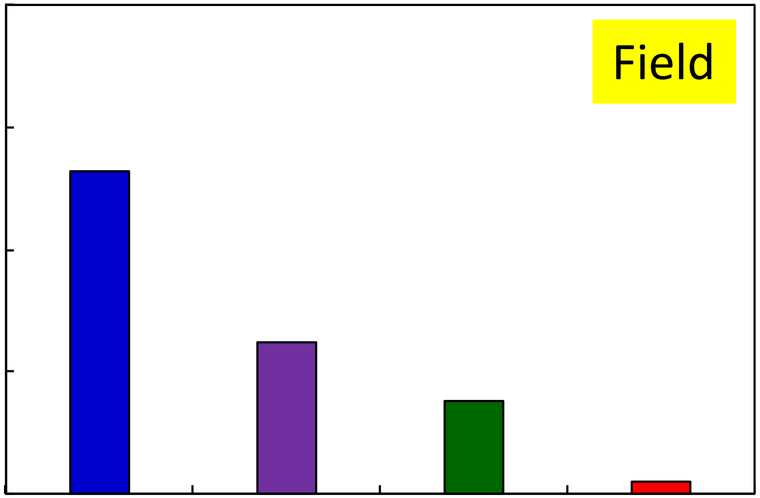


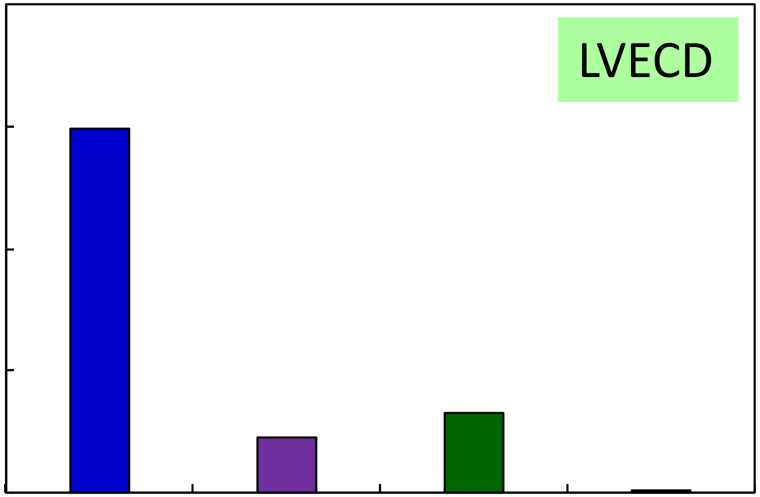


LVECD vs. Pavement ME

NCAT

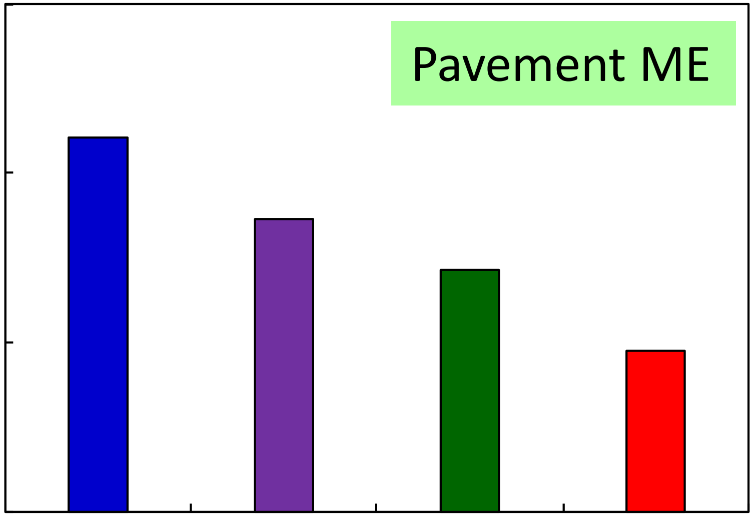


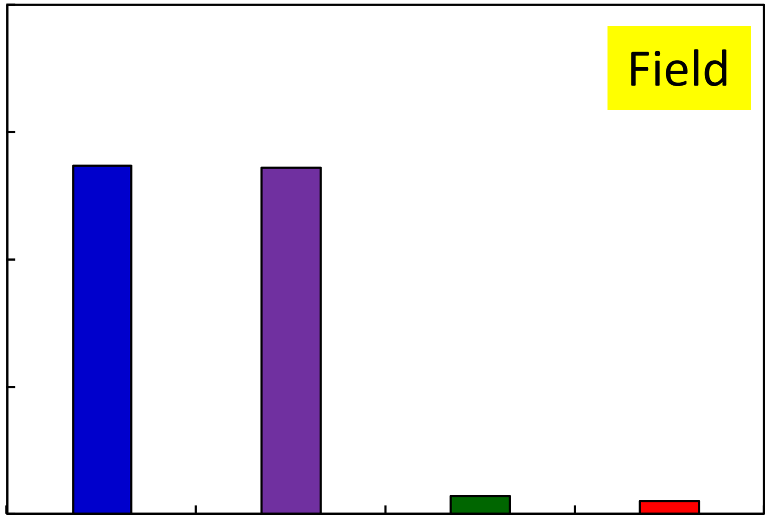


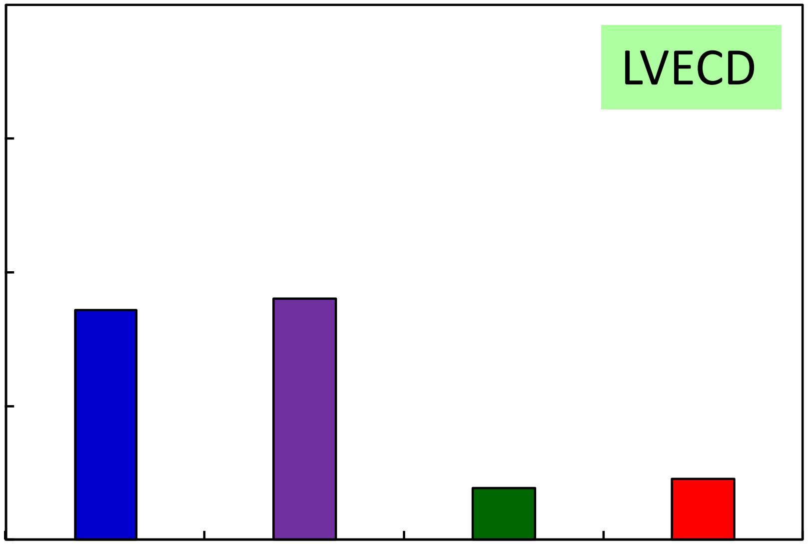


LVECD vs. Pavement ME

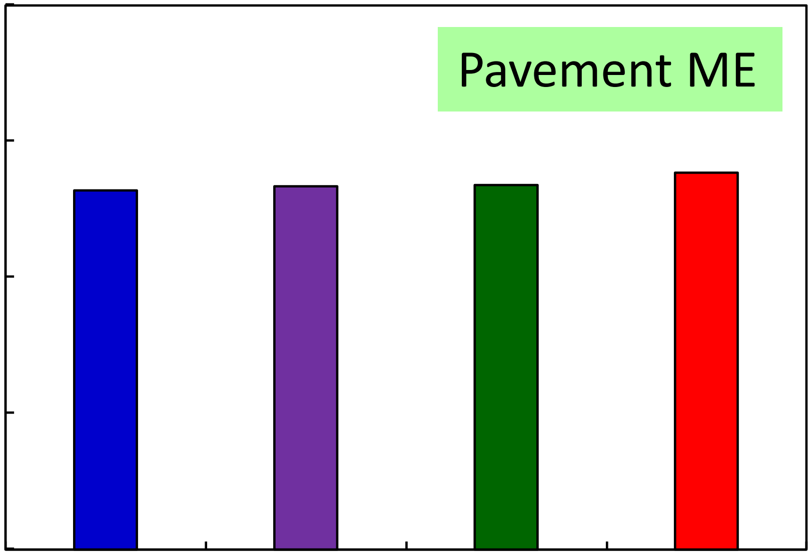
MIT-WMA



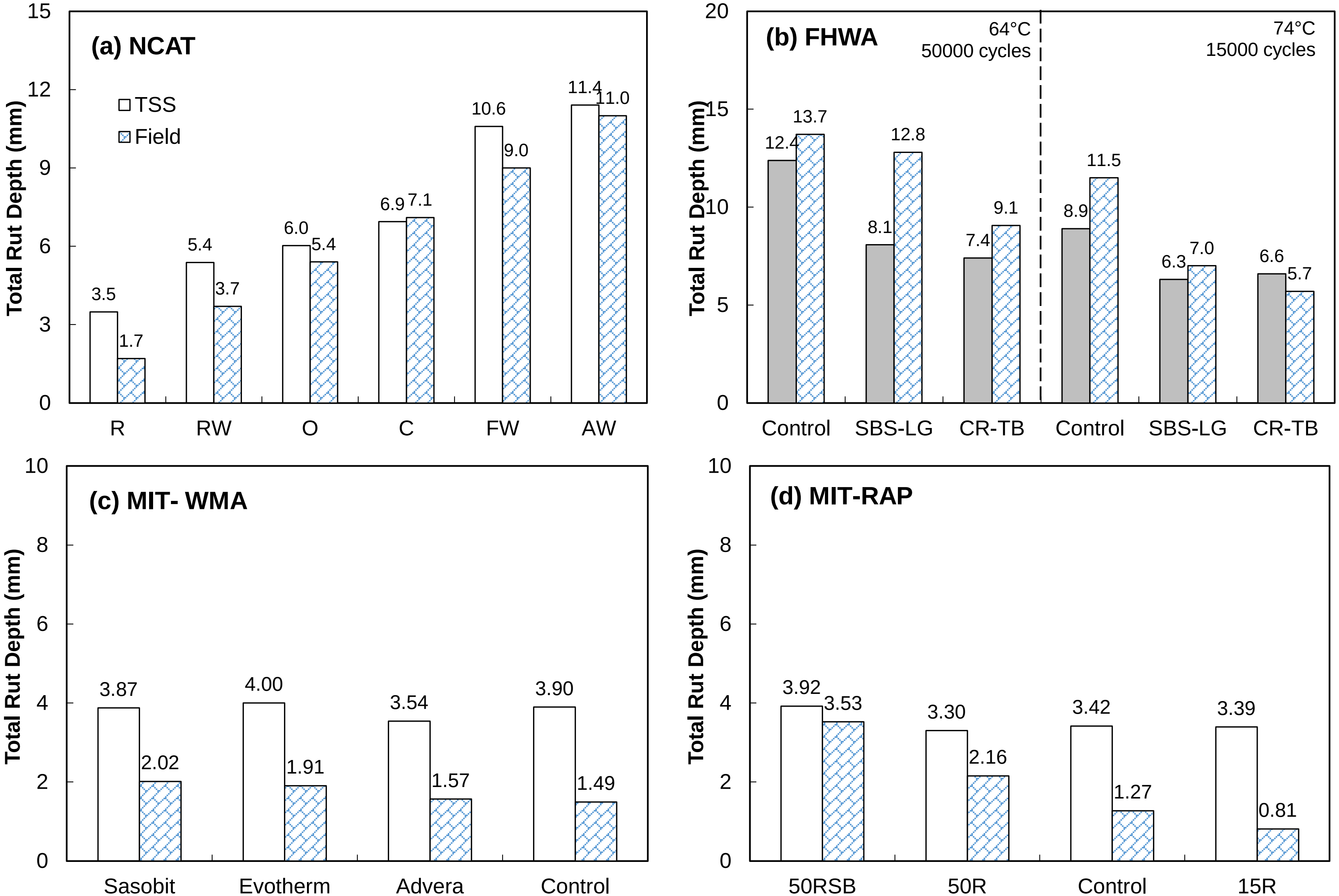




LVECD vs.
Pavement ME
MIT-RAP

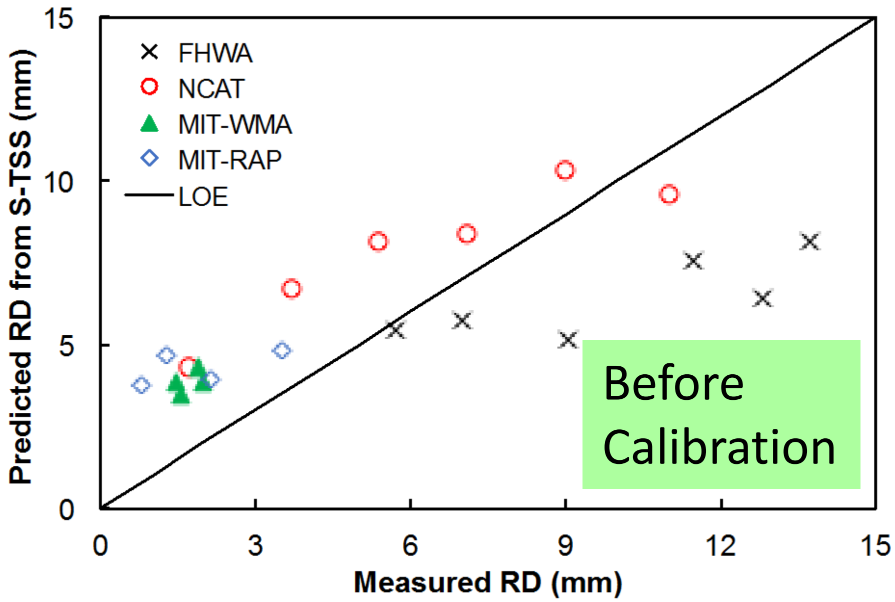


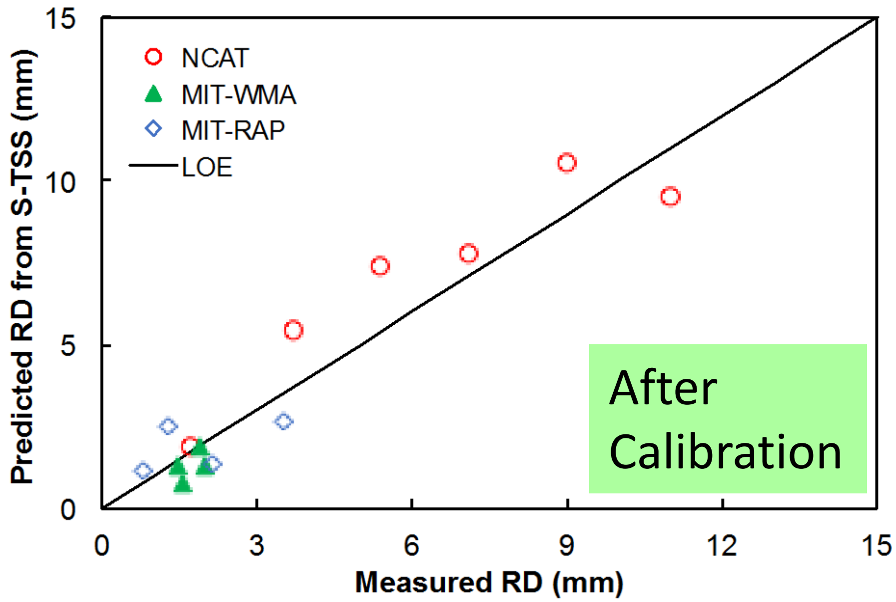
Rut Depth Prediction



Rutting Prediction

All Sections





Steps Involved in HMA-PRS Implementation

Agency Actions Needed

Fact: Pavement structural design is available.

STEP 1: Changes in fundamental properties due to a change in AQCs are estimated using predictive relations (either from agency's material database, or from ongoing research by FHWA and NCSU).

STEP 2: "Typical" fundamental properties and their variance due to the variance of AQCs are input into the PRS software for the specific project in question.

STEP 3: Many automated simulations are performed using the PRS software to determine the predicted life from varying the AQCs in different combinations.

STEP 4: The agency sets the performance acceptance criteria and acceptable variance.

STEP 5: Agency develops a QA plan for

STEP 6: Pay tables are created based on the change in simulated life.

STEP 7: A bidding specification is developed.

Note: Type of testing done (volumetric, index testing, or fundamental properties) will be dictated by the level of sophistication and accuracy desired by the agency.

Contractor Actions Needed

Step 1: Contractor reviews the bidding specification and determines initial job mix formulas (one for each mix type on the project) using their selected materials in an attempt to meet the specifications.

Step 2: Based on the contractor's knowledge, experience, and specific materials available, the contractor evaluates their risk in meeting the specifications. Based on this risk, the contractor makes one of the following decisions (A, B, or C):

A: No Bid.

B: Contractor only does limited testing on the JMFs. Based mostly on volumetric testing and experience and knowledge.

C: Contractor conducts performance testing and/or PBMD to assess risk and determine how to best optimize the mixes to meet the performance criteria and maximize profits.

Step 3: Contractor makes a QC plan, which may or may not be above and beyond what is required by the agency in the specification.

Step 4: The contractor prepares and submits the bid.

Agency and Contractor Actions Needed during a PRS Project

Step 1: The agency determines the winning bid and awards the contract.

Step 2: The winning contractor selects and submits their JMFs to the agency for approval.

Step 3: The agency reviews the JMFs to ensure they each meet the requirements laid out in the specifications. Each mixture will be either:

- Accepted
- Rejected and require re-design

Step 4: Control strips may be used to verify the properties of the accepted mixes and construction process and the agency approves the JMFs for full production and construction.

Step 5: The agency applies their QA procedure for project monitoring.

Step 6: The project is constructed using the approved mixes. During the project AQCs are measured and changes in mixture properties are calculated using predictive relations.

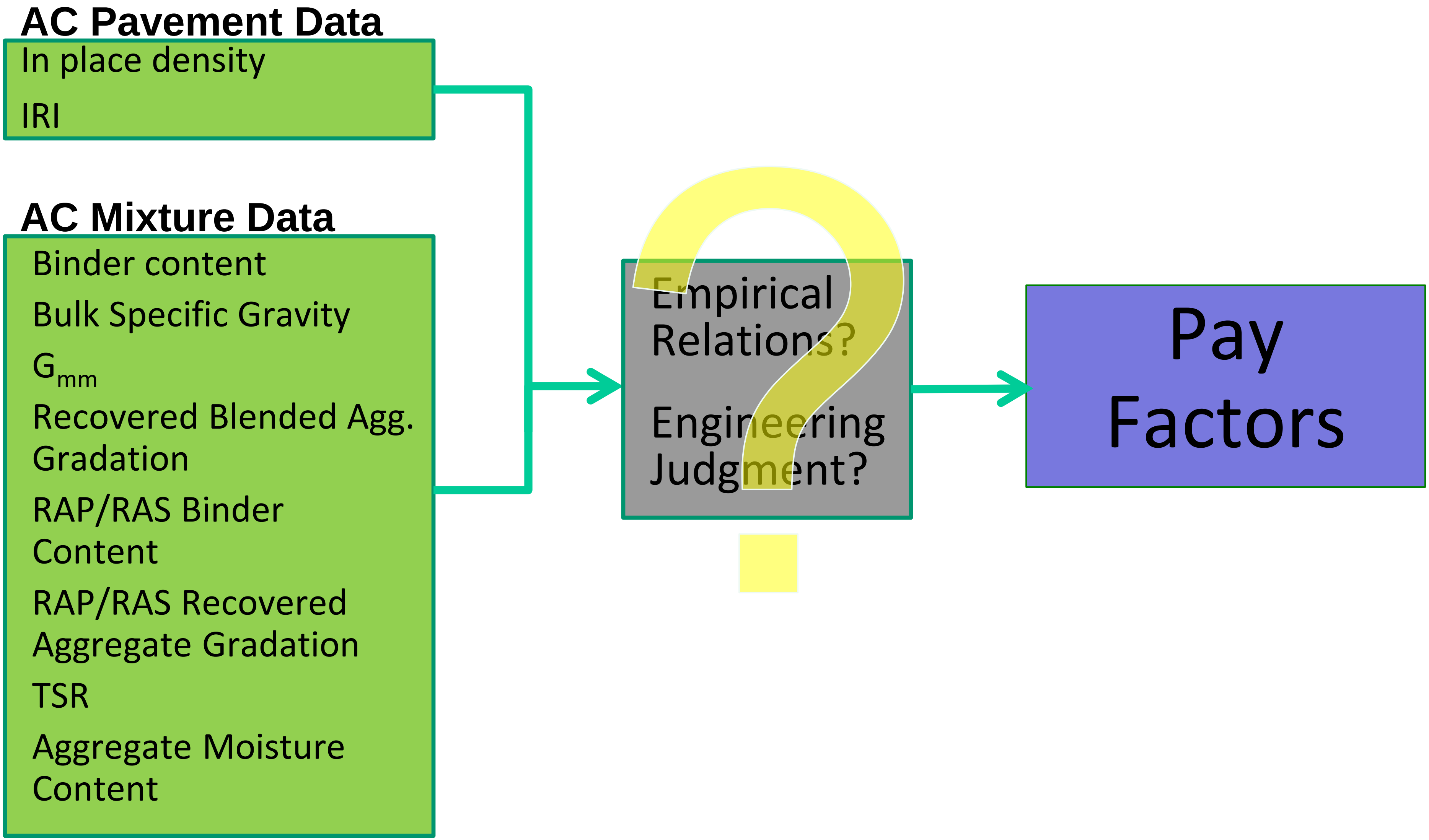
Note: Regular testing of fundamental properties may be feasible during construction.

Step 7: Contractor pay is based on the AQC data and pay tables in the specifications.

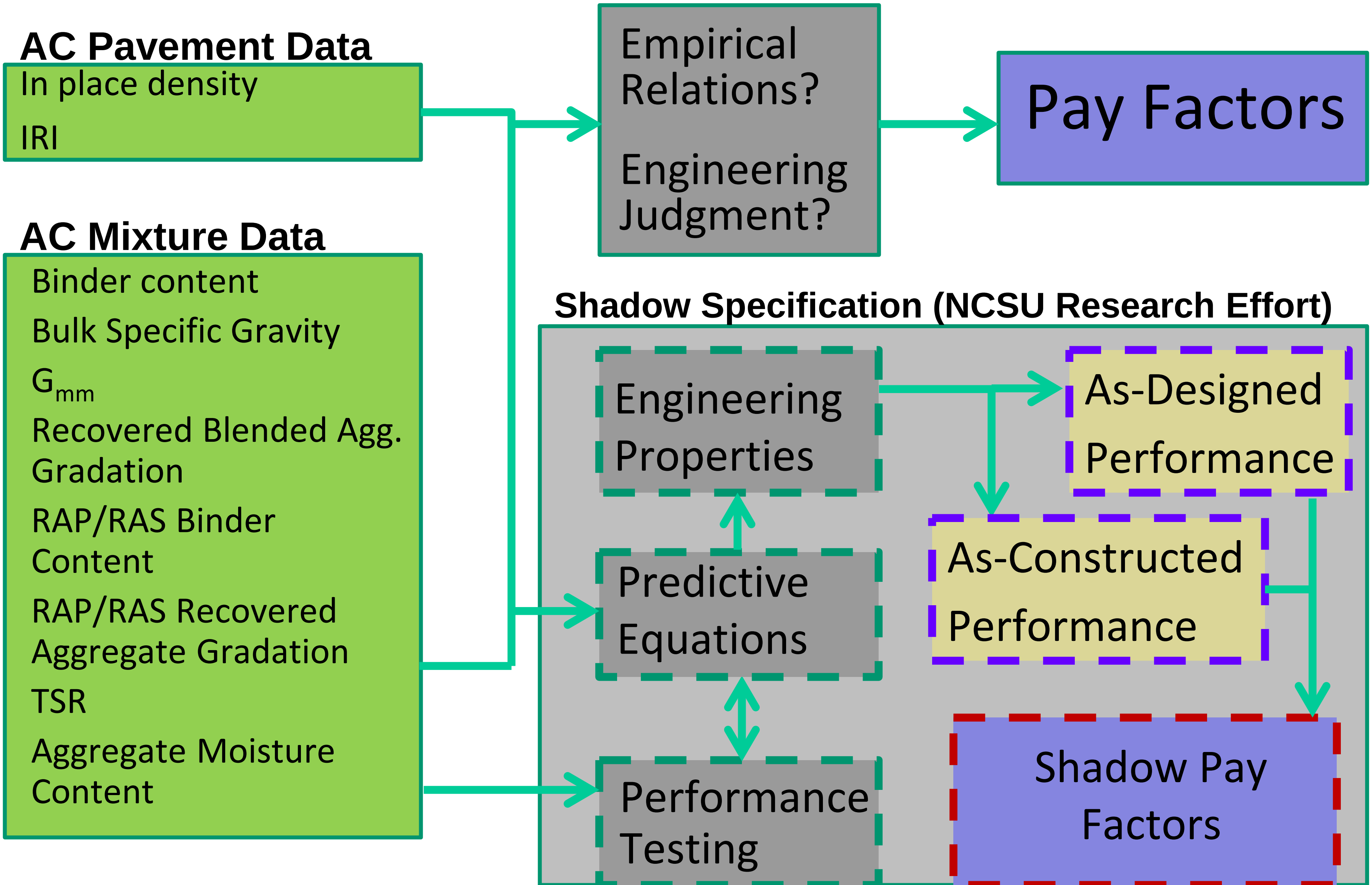
Shadow PRS

- Develop and Evaluate PRS like FULL implementation
- Does not impact contractor pay for the shadow project
- Learning and pre-implementation tool

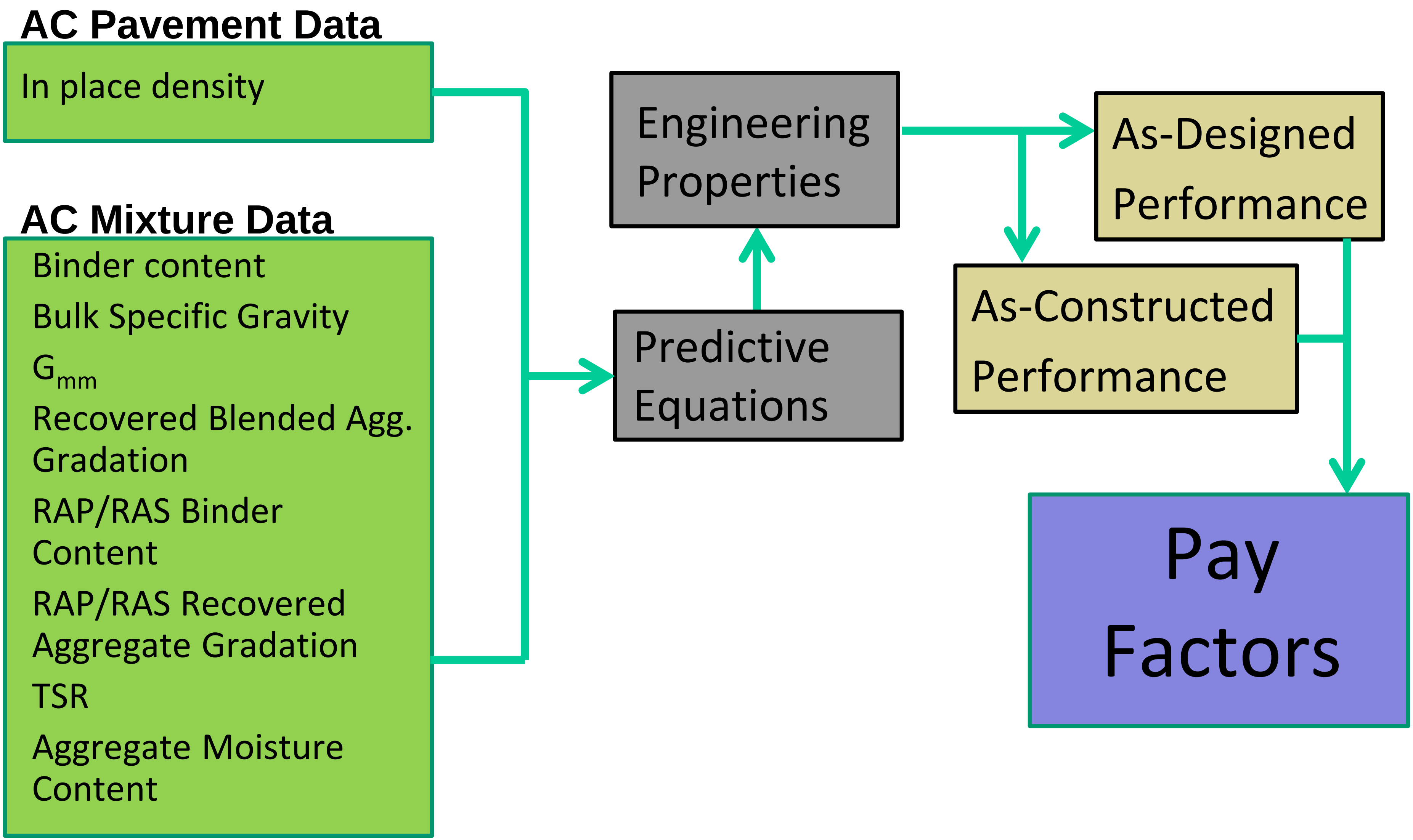
Current HMA Acceptance Procedures



Shadow PRS Acceptance Procedures



Final PRS Acceptance Procedures



Questions?