FDOT MECHANISTIC-EMPIRICAL PAVEMENT DESIGN UPDATE

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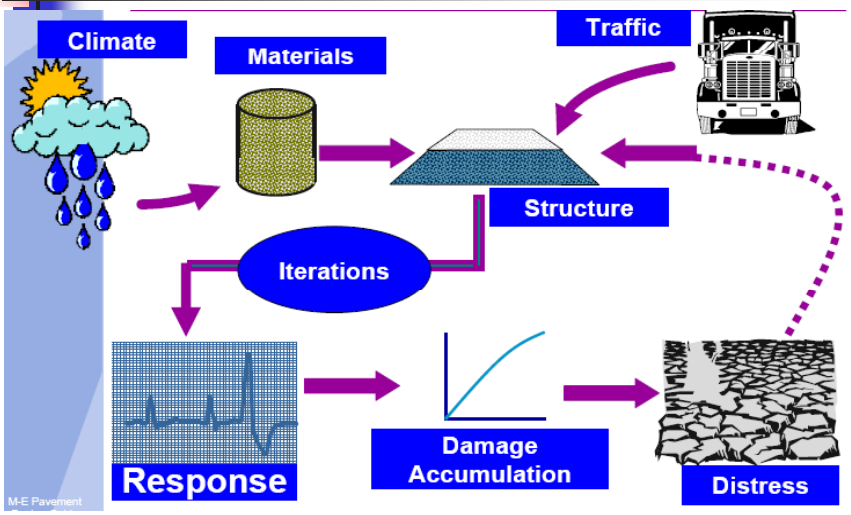
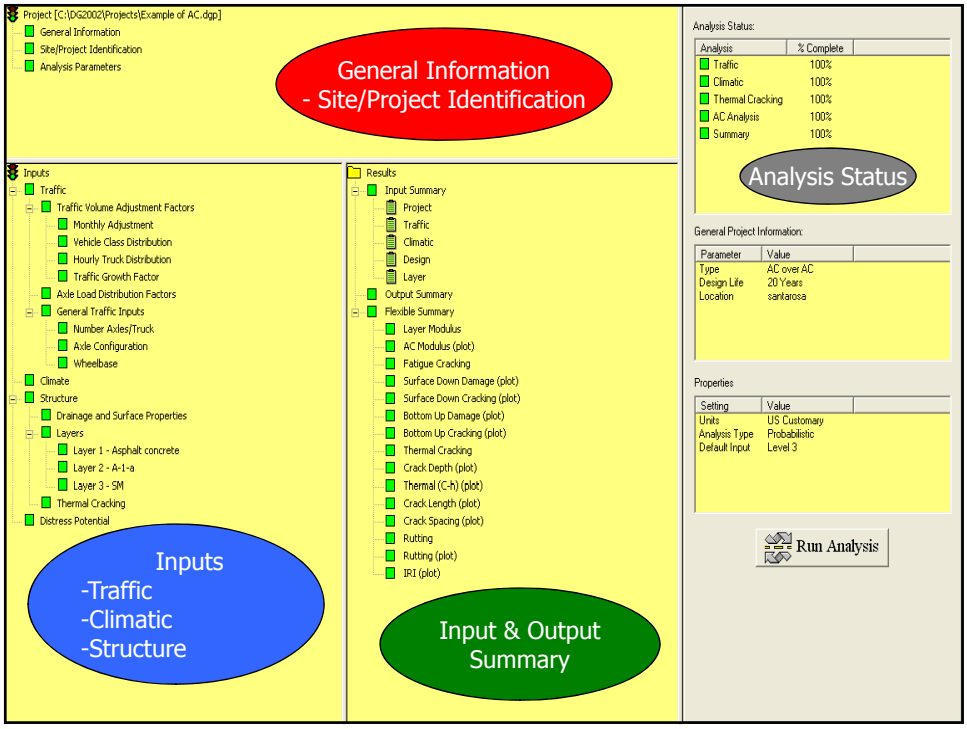
Overview of ME-PDG Program



M-E Pavement Design Program

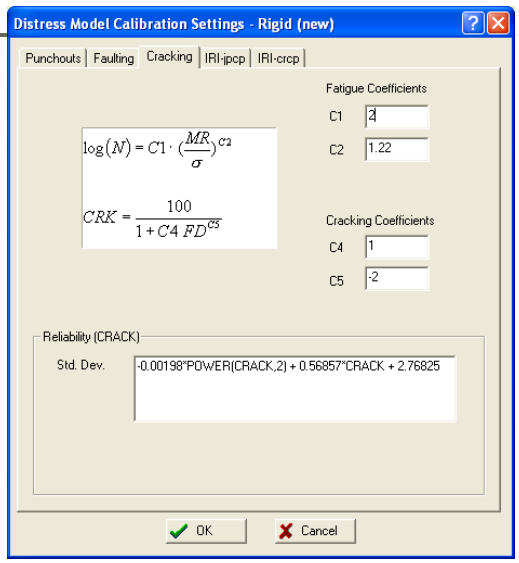
- Available from the web at http://www.trb.org/mepdg/ for evaluation
- Program is a tool for pavement analysis
- Modifications arising from other research are expected
- Consider need for calibration during implementation



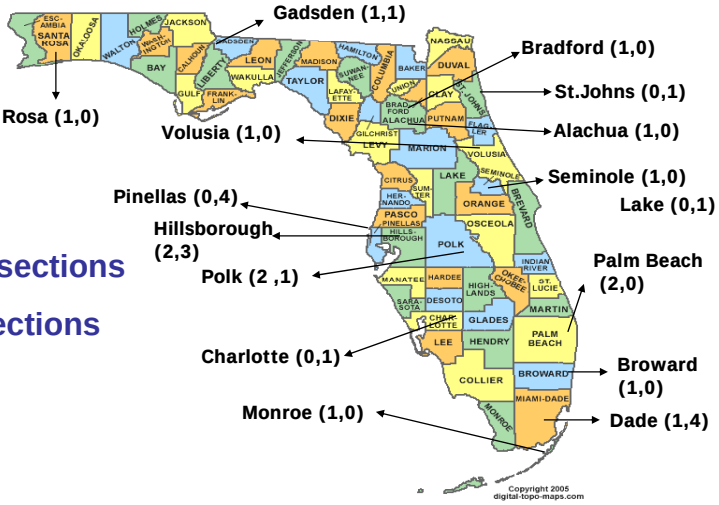
Model Verification/Calibration

- M-E PDG models calibrated using a national data base of LTPP sections
- Calibration to local conditions is important
- Calibration factors input to program for specific distresses

Model Calibration Factors



Map of Calibration Sections



15 HMAC sections

16 PCC Sections

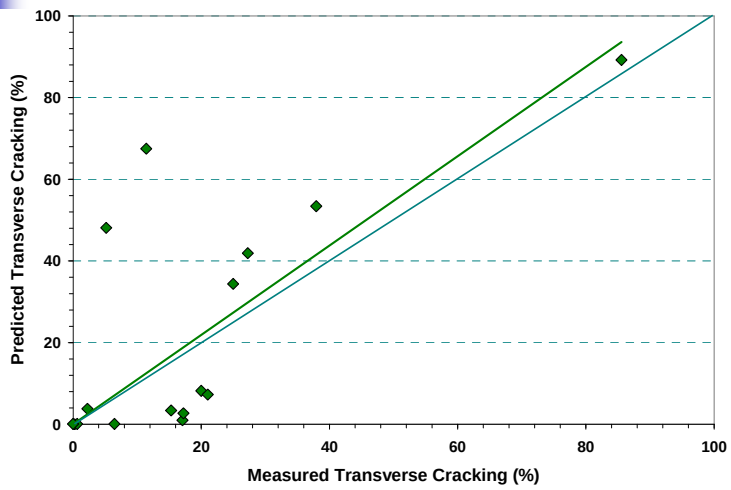
FIELD AND LABORATORY TESTS

Field Tests on
Concrete Sections

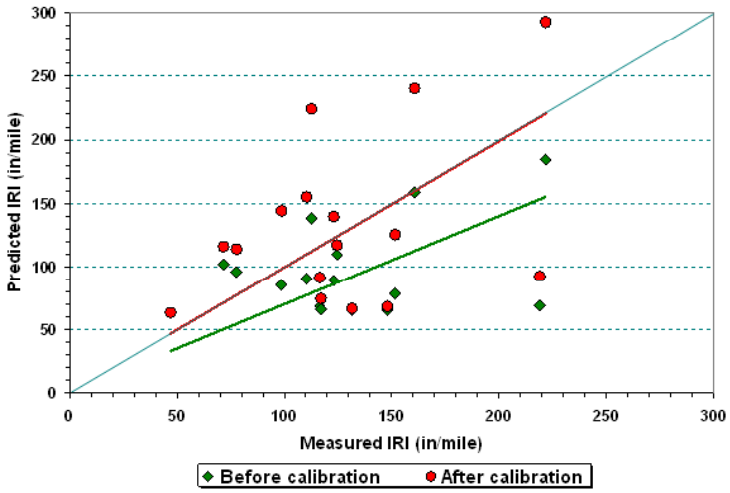
Measurements of joint
spacing & dowel diameter

Verification of M-E PDG Performance Predictions on Calibration Sections

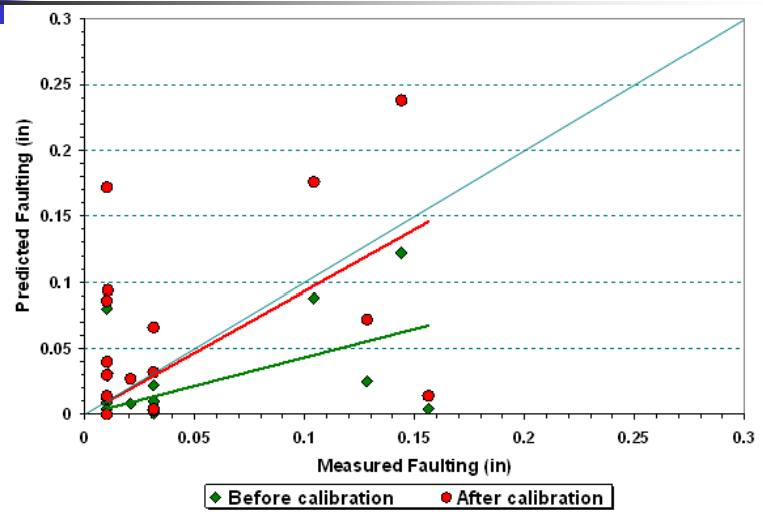
Transverse Cracking on Calibration Sections



IRIs on Calibration Sections

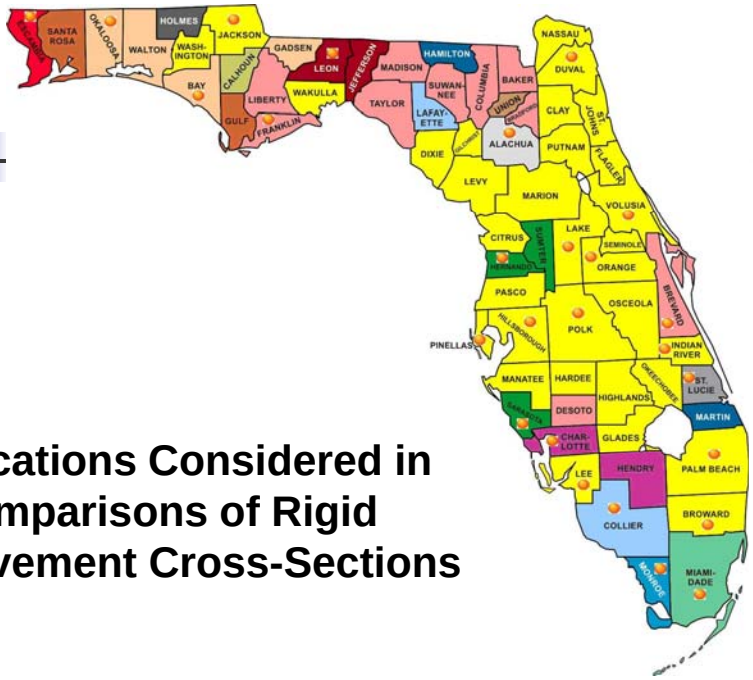


Faulting on Calibration Sections



Failure Criteria for Generating Design Tables

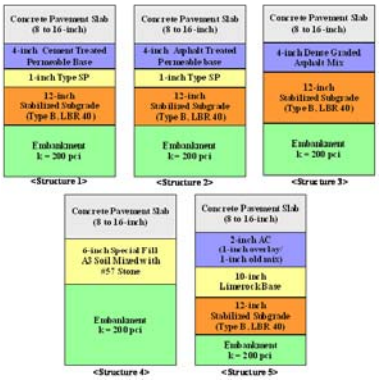
Distress	Criterion
Transverse cracking	10 percent slabs cracked
Faulting	0.12 inch
IRI	180 in per mile



Locations Considered in Comparisons of Rigid Pavement Cross-Sections

Findings from Comparisons of Rigid Pavement Cross-Sections

- Cross-sections 2 and 3 gave same slab thicknesses
- These cross-sections gave up to 0.5-inch thicker slabs than the other cross-sections
- Rigid design tables based on cross-section 3



Port of Tampa
611

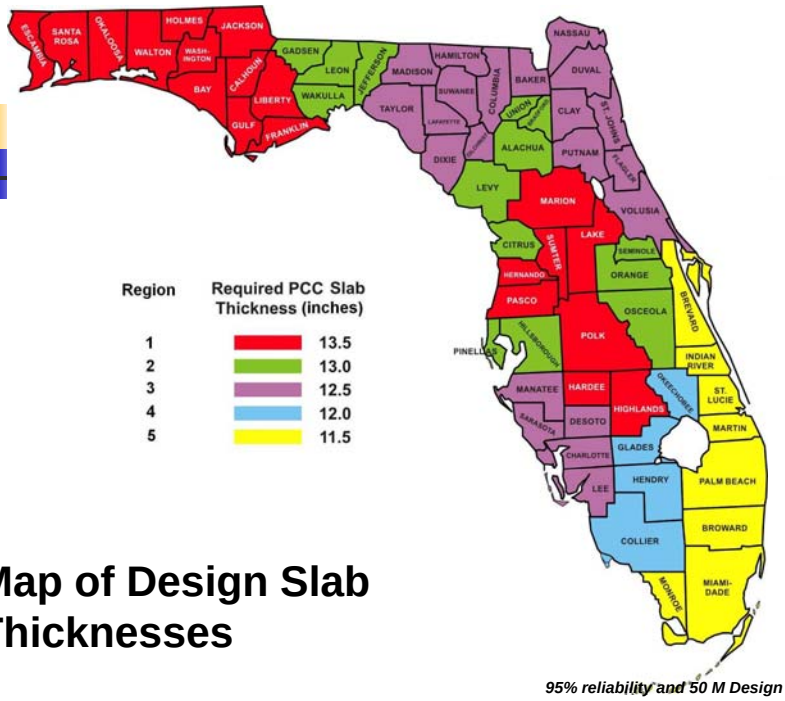
ROAD
CLOSED

Effect of Slab Width

- Performance predictions compared for 12, 13 and 14 ft slab widths
- M-E PDG predicts better performance for 13-ft wide slab with tied shoulders
- Design tables for 13 ft wide slabs developed

Consideration of Regional Conditions

- Used M-E PDG data base to characterize climatic conditions in each county
- Used soil-water characteristic curves established from county soil survey reports and soil suction tests done in the laboratory

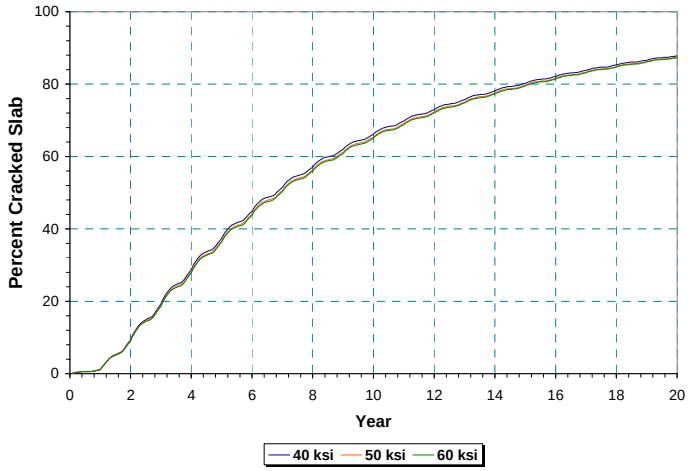


Map of Design Slab Thicknesses

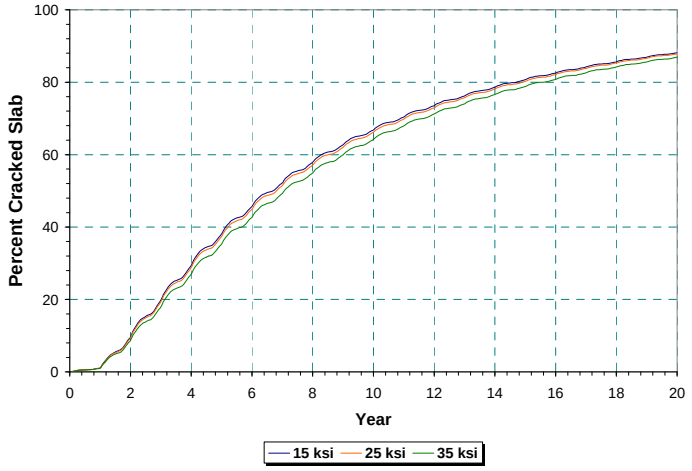
95% reliability and 50 M Design ESALs

SENSITIVITY ANALYSIS

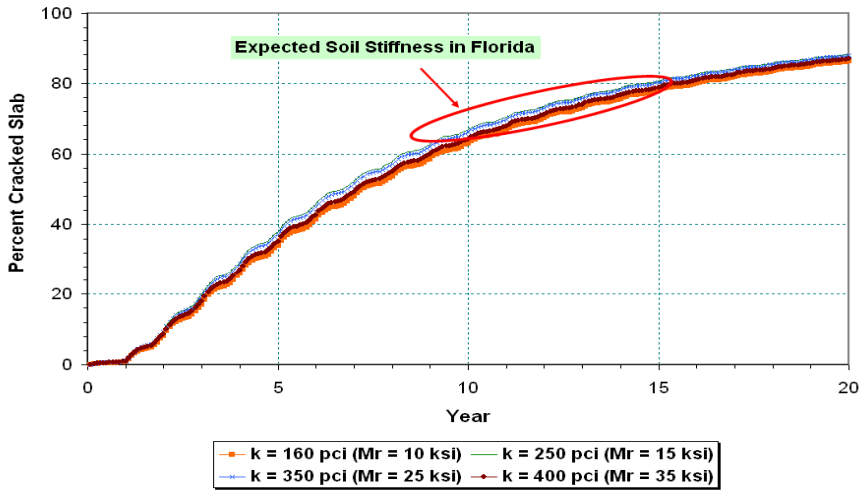
Sensitivity to Base Modulus



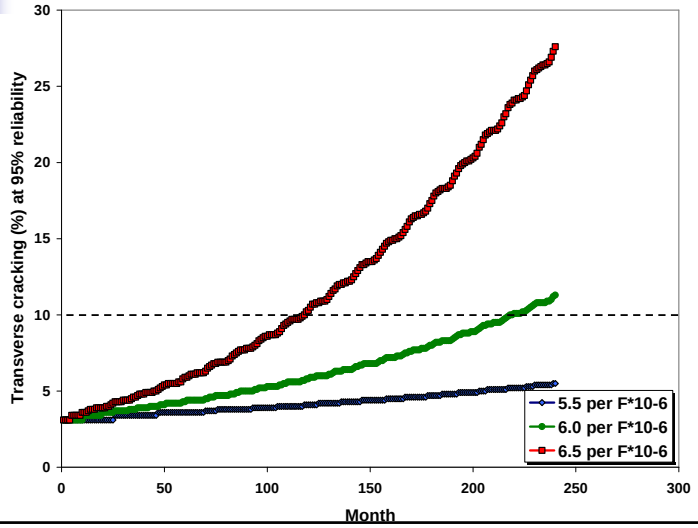
Sensitivity to Subgrade Modulus



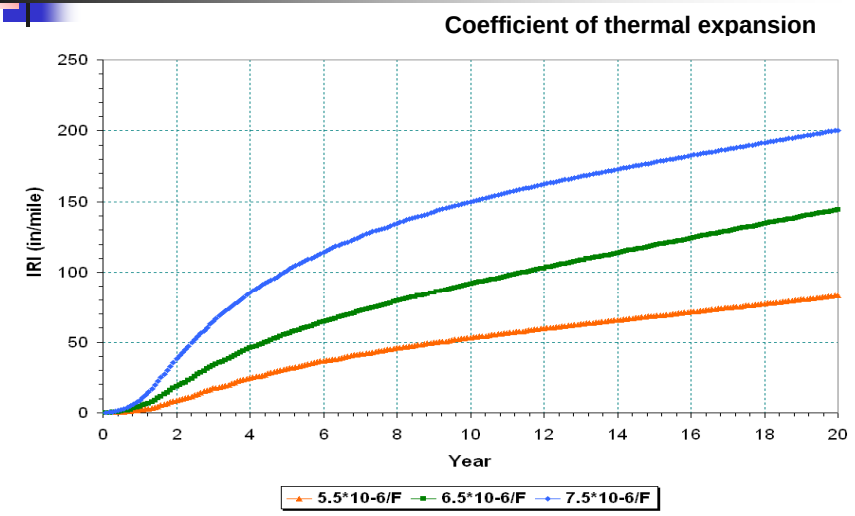
Effect of *k*-value



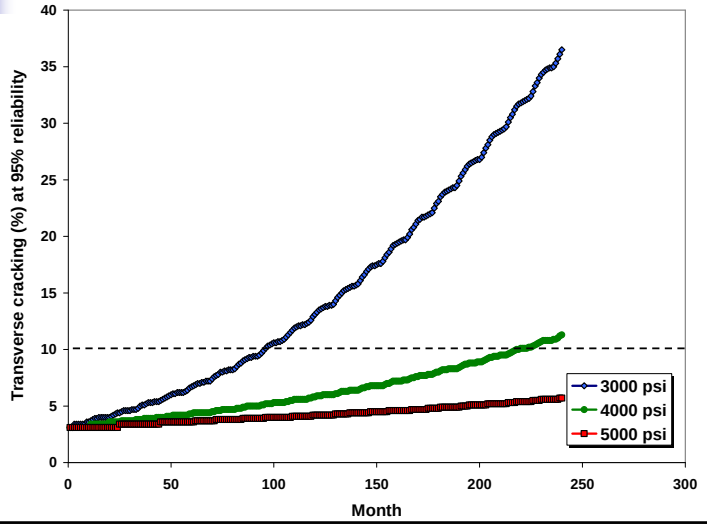
Effect of CTE on Crack Predictions



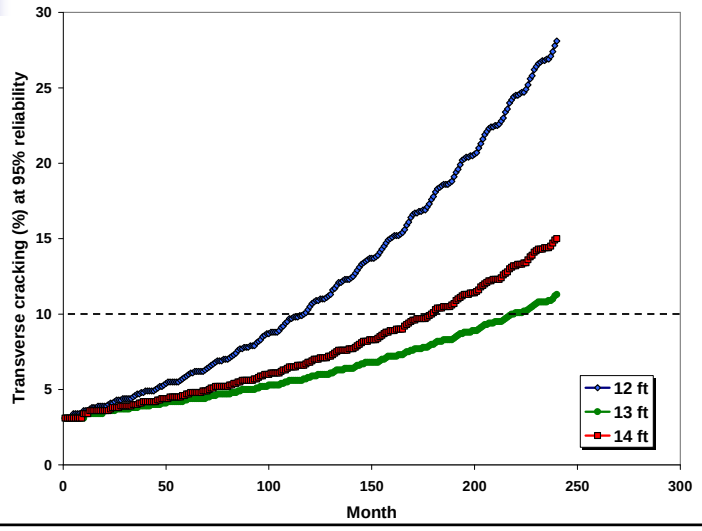
Effect of CTE on Ride Predictions



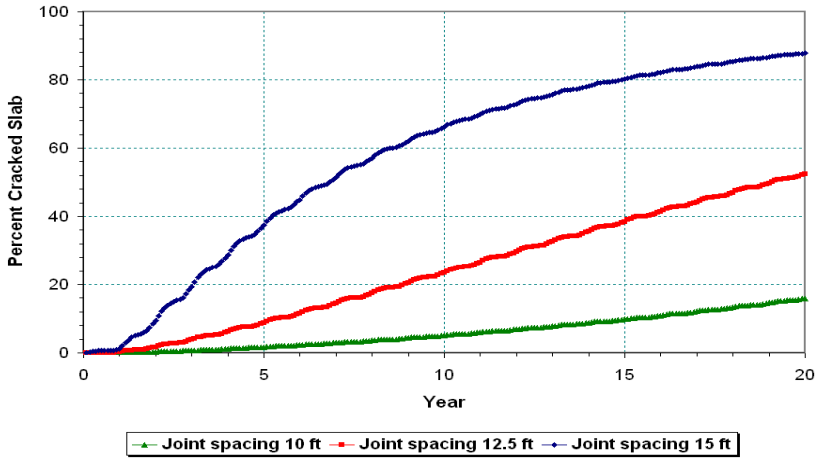
Effect of Concrete Compressive Strength



Effect of Slab Width



Effect of Slab Length



M-E PDG Rigid Pavement Design Tables

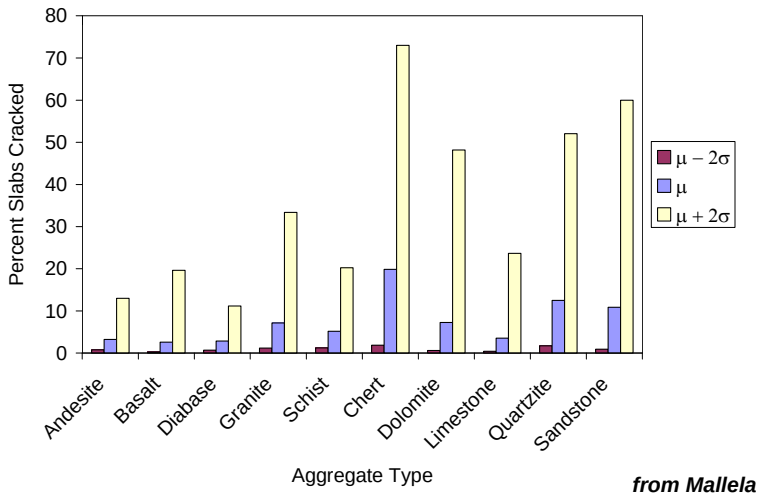
Design Assumptions

- CTE of 6 microstrain per °F
- 28-day compressive strength: 4000 psi
- Slab widths: 13 and 14 ft
- Joint spacing: 15 ft
- Subgrade k-value: 200 lb per in^3
- Initial IRI: 58 inches per mile

Design Assumptions

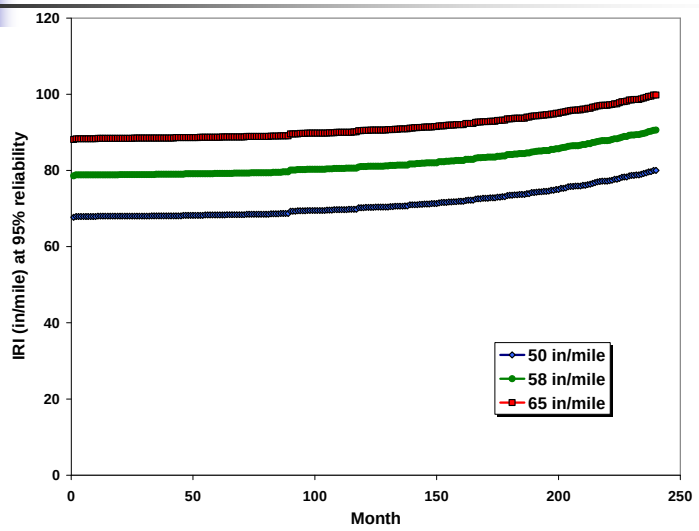
- **Minimum slab thickness of 8 inches**
- **Dowel diameters:**
  - **1 inch for 8 to 8.5-inch slabs**
  - **1.25 inches for 9 to 10.5-inch slabs**
  - **1.5 inches for 11-inch and thicker slabs**

Sensitivity to CTE



from Mallela et al.

Effect of Initial IRI



Implementation Considerations

- **Predicted performance sensitive to CTE**
- **Need to develop and implement specs to measure and control CTEs for construction quality assurance purposes**
- **Predicted performance also sensitive to initial IRI**
- **Need ride specification to get desired initial smoothness**

Establishing Preliminary Flexible Pavement Design Tables

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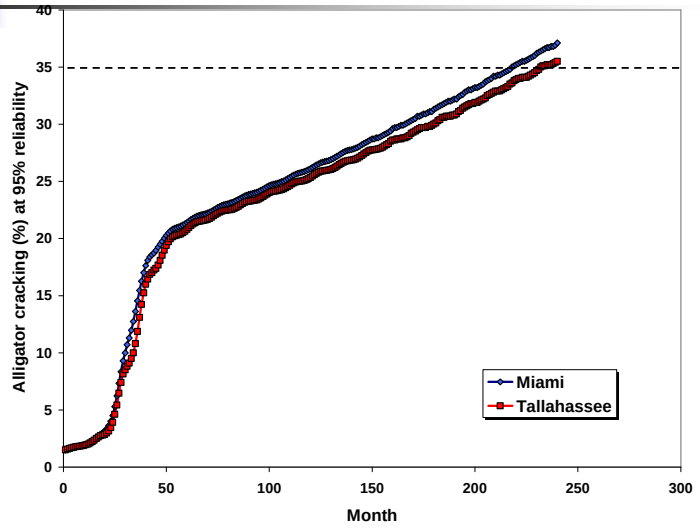
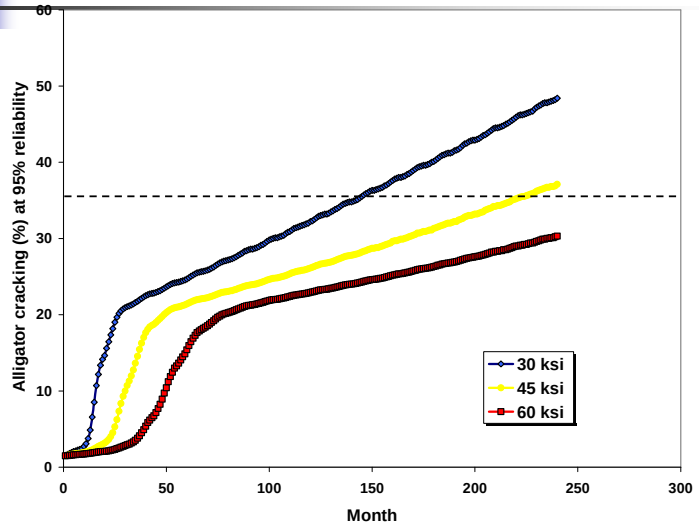
Sensitivity Analysis

- Variables considered in New AC
  - AC Mix combination, AC material property
  - Modulus of Base, Subgrade and Embankment
  - Thickness of Base
  - Cumulative ESALs
  - Environmental Region
  - Reliability

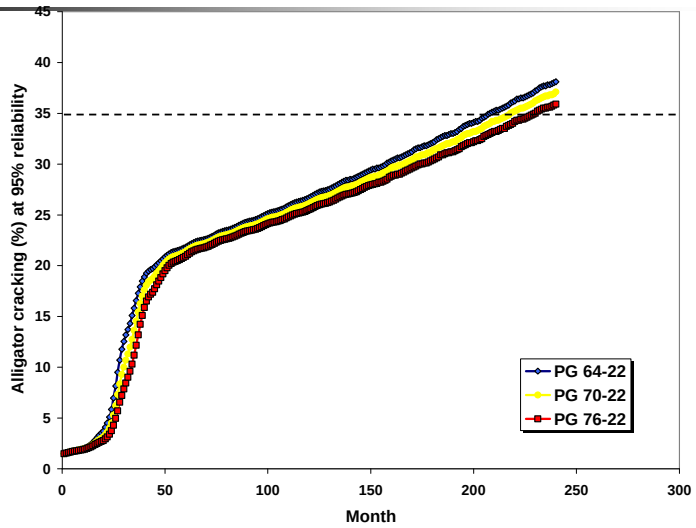
Climatic Effect on Alligator Crack of AC Pavements



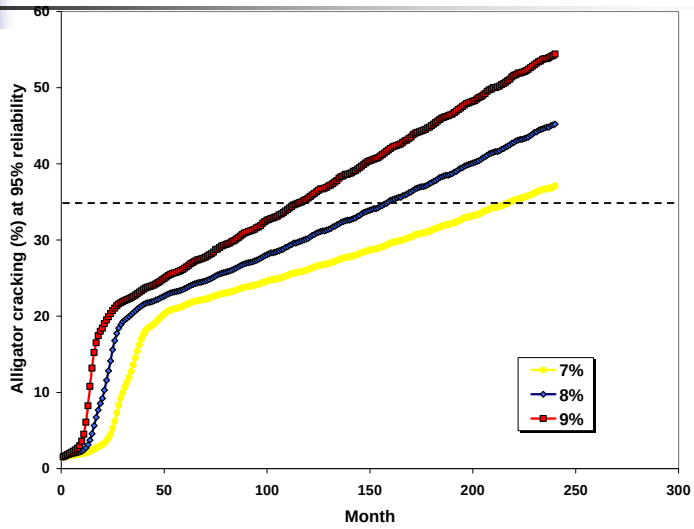
Base Modulus Effect on Alligator Crack of AC Pavements



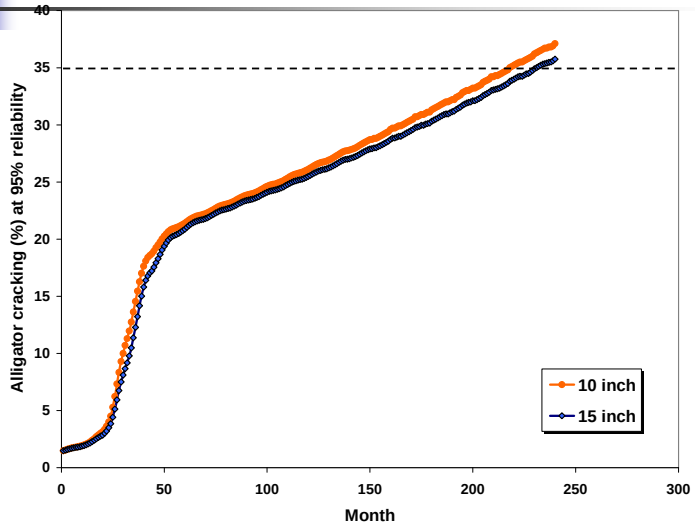
PG Grade Effect on Alligator Crack of AC Pavements



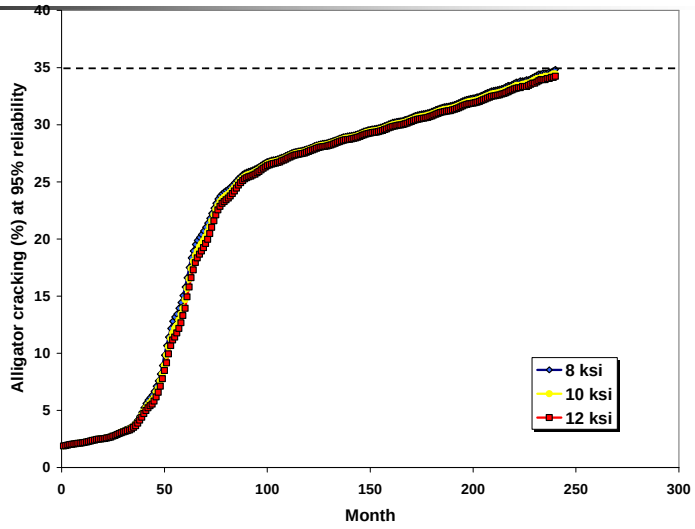
Air Void Effect on Alligator Crack of AC Pavements



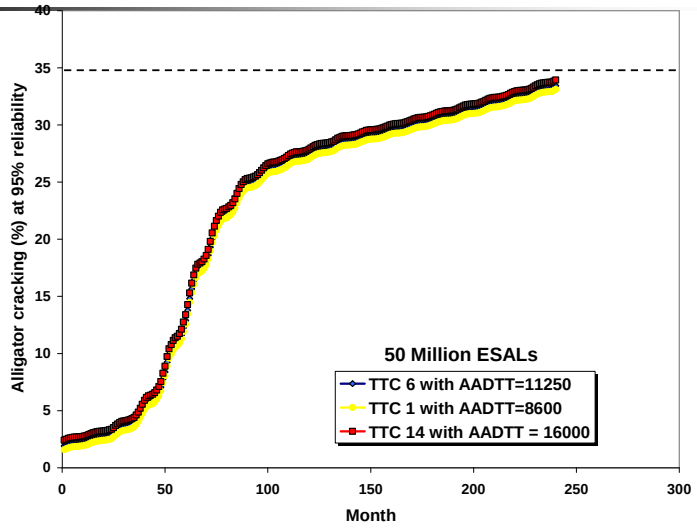
Base Thickness Effect on Alligator Crack of AC Pavements



Embankment Modulus Effect on Alligator Crack of AC Pavements



ESAL Effect on Alligator Crack of AC Pavements



AC Mix Effect on Alligator Crack of AC Pavements

Mixture Combination	FC 5	FC 9.5	FC 12.5
SP 9.5	42.27	41.64	41.81
SP 12.5	42.27	41.64	41.81
SP 19.0	41.99	41.34	41.64
Modified SP	41.27	40.64	40.91

Criteria of Preliminary Design Table for New Construction

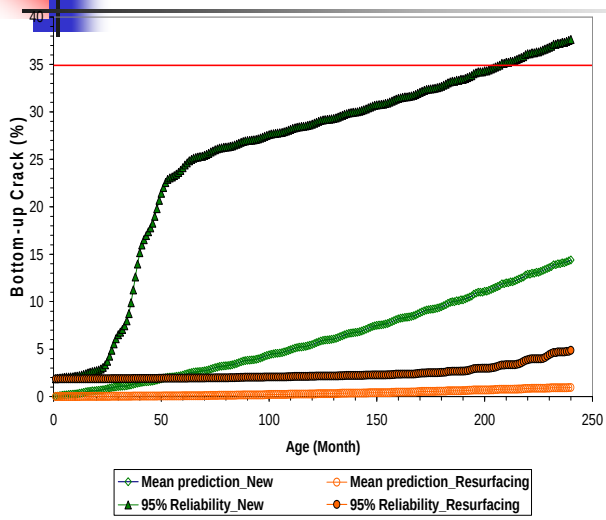
1-inch FC 12.5
SP 12.5
10-inch LR Base
12-inch Stab. Subgrade
Embankment

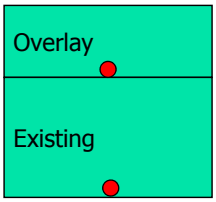
- Only alligator cracking criterion (35%, which is a default limit)
- FC 12.5 over SP 12.5 AC mixture
- Base modulus = 30, 45, and 60 ksi
- Subgrade modulus = 16 ksi
- Embankment modulus = 12 ksi
- Miami weather data used
- 20 yrs design life
- Five reliability levels same as PCC
- Cumulative ESALs considered

Sensitivity Analysis for Overlay

- Variables considered in Overlay AC
  - AC Mix combination, AC material property
  - Modulus of Base, Subgrade and Embankment
  - Thickness of Base
  - Cumulative ESALs
  - Environmental Region
  - Reliability
  - Existing Pavement Condition
  - Existing AC layer thickness after milling

Alligator cracking in New vs. Overlay Pavements with Identical Structures





Where is ε_t from?

Alternative Way to Model Overlay

- Use new/reconstruction options in M-E PDG to model existing and overlay lifts
- Vary PG-Grade or Air Void to represent different existing pavement conditions

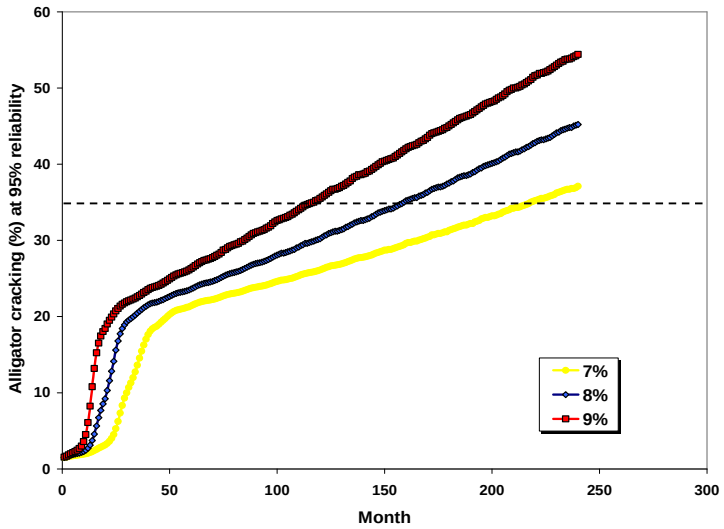
FDOT Practice

Good: No cracking, minor rutting

Fair: Crack rating ≥ 8

Poor: Crack or rutting rating ≤ 7

Effect of PG Grading vs. Air Void



Findings from Alternative Approach

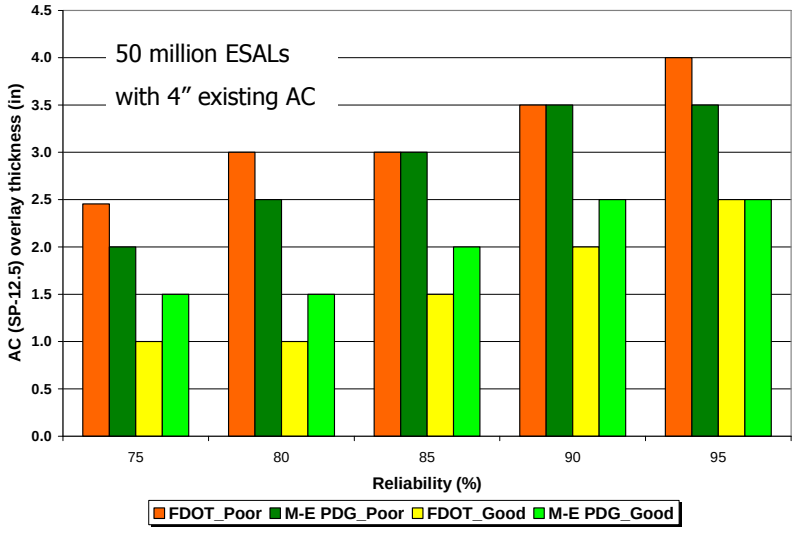
- We use a fixed PG-Grade for existing layer as PG 70-22
- Varying air void of existing layer for different pavement conditions to have comparable overlay thickness to those obtained from FDOT design procedure
  - 8.0 percent for poor condition
  - 7.5 percent for fair condition
  - 7.2 percent for good condition

Criteria of Preliminary Design Table for Overlay Construction

1-inch FC 12.5
Overlay SP 12.5
Existing SP 12.5 2 ~ 6 inch
10-inch LR Base
12-inch Stab. Subgrade
Embankment

- Only alligator cracking criterion (35%, which is a default limit)
- FC 12.5 over SP 12.5 AC mixture
- Base modulus = 30, 45, and 60 ksi
- Subgrade modulus = 16 ksi
- Embankment modulus = 12 ksi
- Miami weather data used
- 20 yrs design life
- Five reliability levels same as PCC
- Cumulative ESALs considered same as PCC
- Poor/Fair & Good condition

Comparison of AC Overlay Design Thickness based on FDOT Practice vs. M-E PDG



Questions?