Development of the ACPA Design Features Catalog

OTEC 2008

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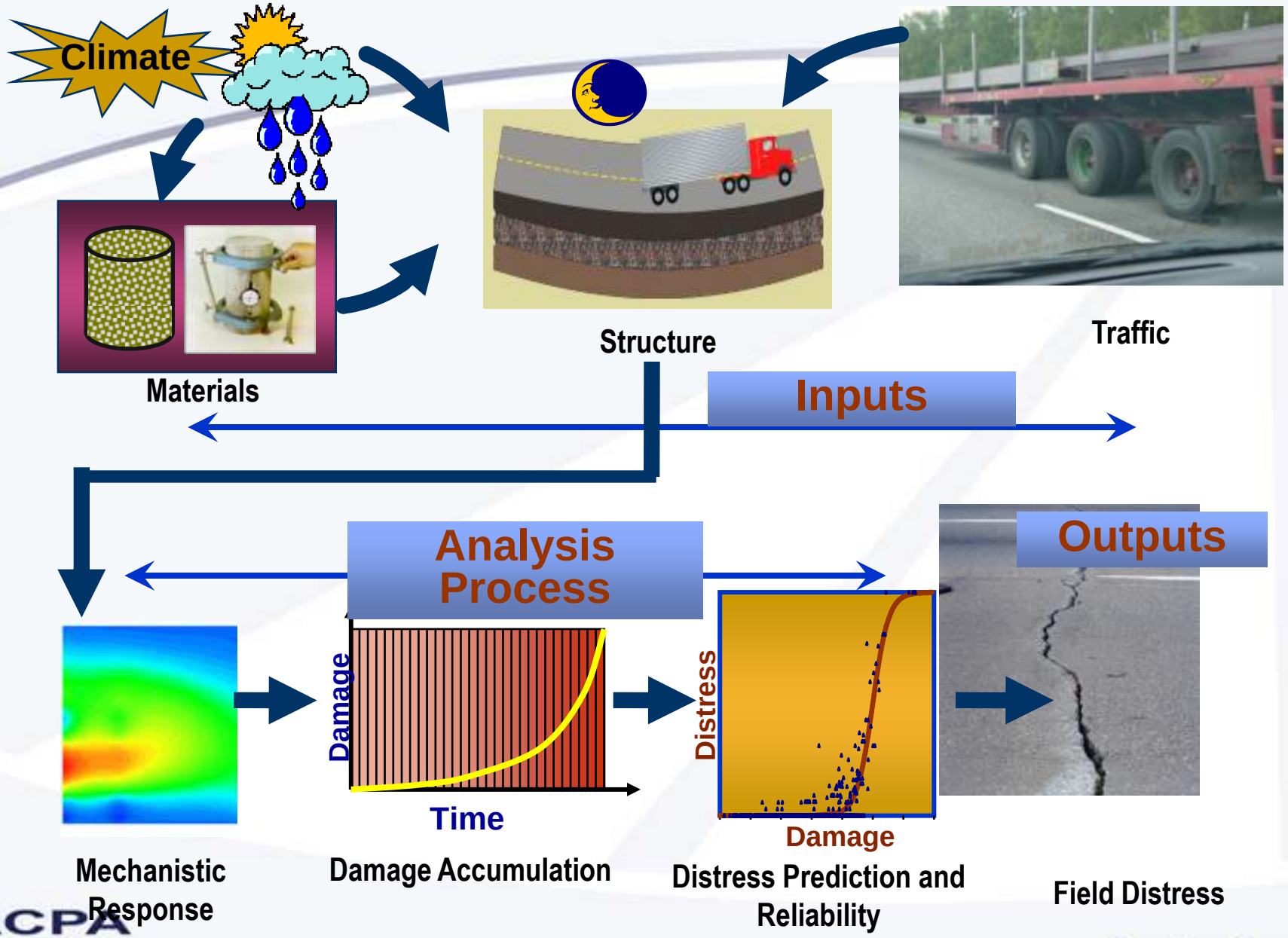

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What is the Design Features Catalog?

- The ACPA Design Features Catalog (DFC) will allow the user to select a preliminary design from a list of viable options based on specified criteria.
- The information will be presented in a straightforward and easy to interpret format.
  - Computer based (web-based and on CD).
- The intent is to:
  - Provide guidance for designers with significant, limited or no experience in rigid pavement design.
  - Provide industry's viewpoint on what features are appropriate for different roadway types.

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What the Catalog Is and Isn't

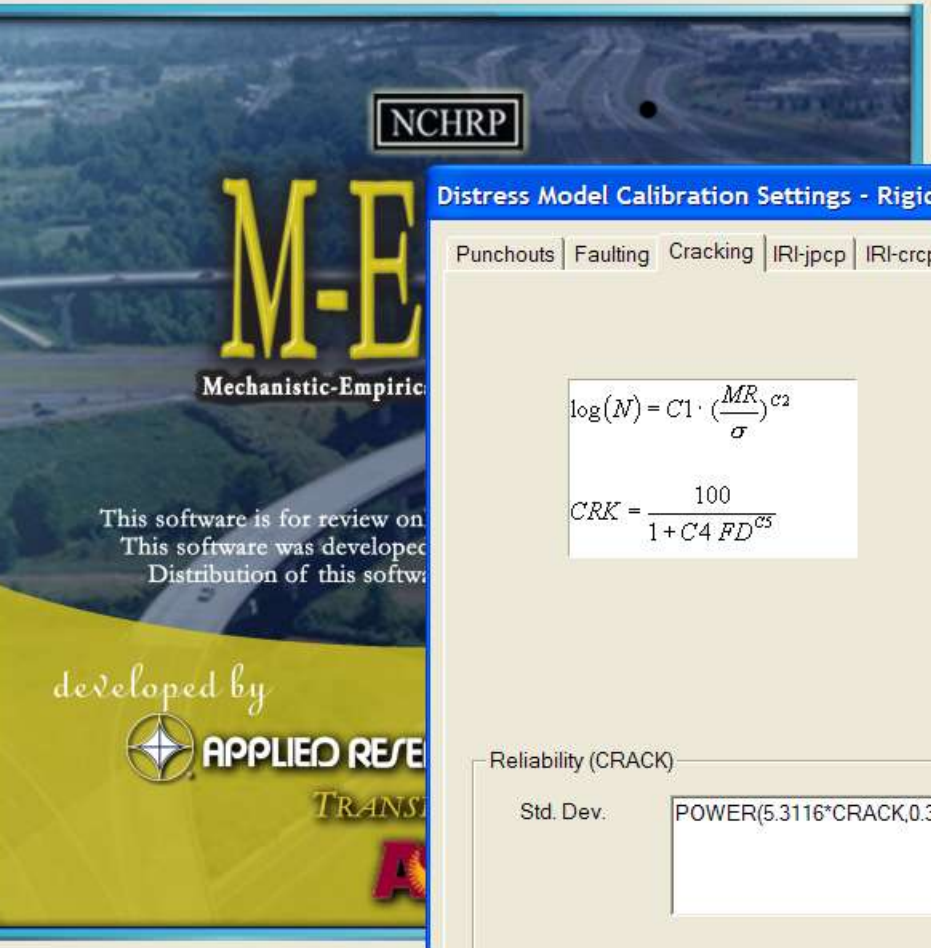
- The DFC is intended to provide workable, but not necessarily, optimized designs.
- Optimized designs using the M-E PDG are site specific. This will be emphasized in the user's guide, often.
- The DFC will provide the first step in developing a comprehensive pavement analysis tool that can be used to balance cost and performance.

Basic Methodology

- The basis for comparison between the various designs (and features) are the 3 standard failure criteria in the M-E PDG.
  - Slab cracking.
  - Joint faulting.
  - Smoothness (as determined by IRI).

Input Values

- The M-E PDG has MANY variables encompassing both site specific and general design parameters.
- The following variables have been included in the initial analyses:
  - Geographic region
  - AADTT
  - Concrete strength
  - Subbase type and thickness
  - Dowel bar size
  - Edge support
  - Reliability
- Additional parameters are still being analyzed.



Distress Model Calibration Settings - Rigid (new)

Punchouts | Faulting | Cracking | IRI-jpcp | IRI-crcp

$$\log(N) = C1 \cdot \left(\frac{MR}{\sigma}\right)^{C2}$$

$$CRK = \frac{100}{1 + C4\,FD^{C5}}$$

Fatigue Coefficients

C1: 2

C2: 1.22

Cracking Coefficients

C4: 1

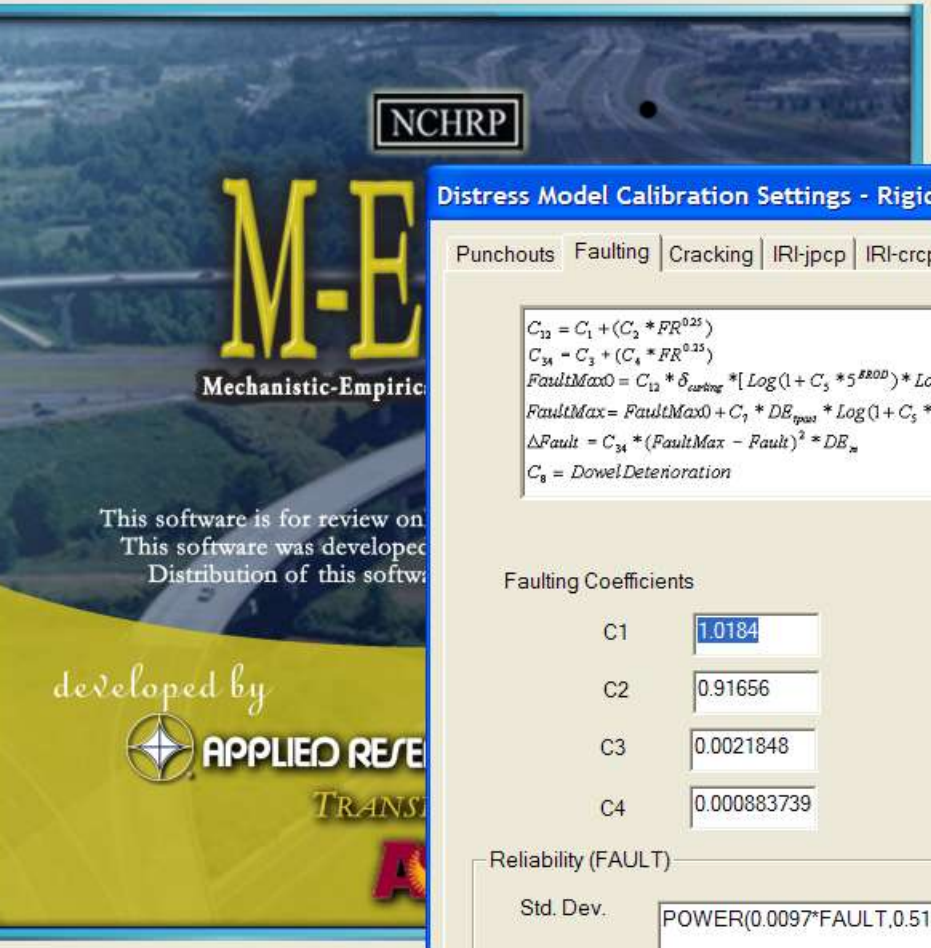
C5: -1.98

Reliability (CRACK)

Std. Dev.: POWER(5.3116*CRACK,0.3903) + 2.99

Version 1.000

Last Build: April 8, 2007



Distress Model Calibration Settings - Rigid (new)

Punchouts | Faulting | Cracking | IRI-jpcp | IRI-crcp

$$C_{12} = C_1 + (C_2 * FR^{0.25})$$
$$C_{34} = C_3 + (C_4 * FR^{0.25})$$
$$FaultMax0 = C_{12} * \delta_{curling} * [Log(1 + C_5 * 5^{ERODE}) * Log(P_{200} * WetDays / p_s)^{C6}$$
$$FaultMax = FaultMax0 + C_7 * DE_{joint} * Log(1 + C_5 * 5^{ERODE})$$
$$\Delta Fault = C_{34} * (FaultMax - Fault)^2 * DE_m$$
$$C_8 = Dowel\ Deterioration$$

Faulting Coefficients

C1	1.0184	C5	250
C2	0.91656	C6	0.4
C3	0.0021848	C7	1.83312
C4	0.000883739	C8	400

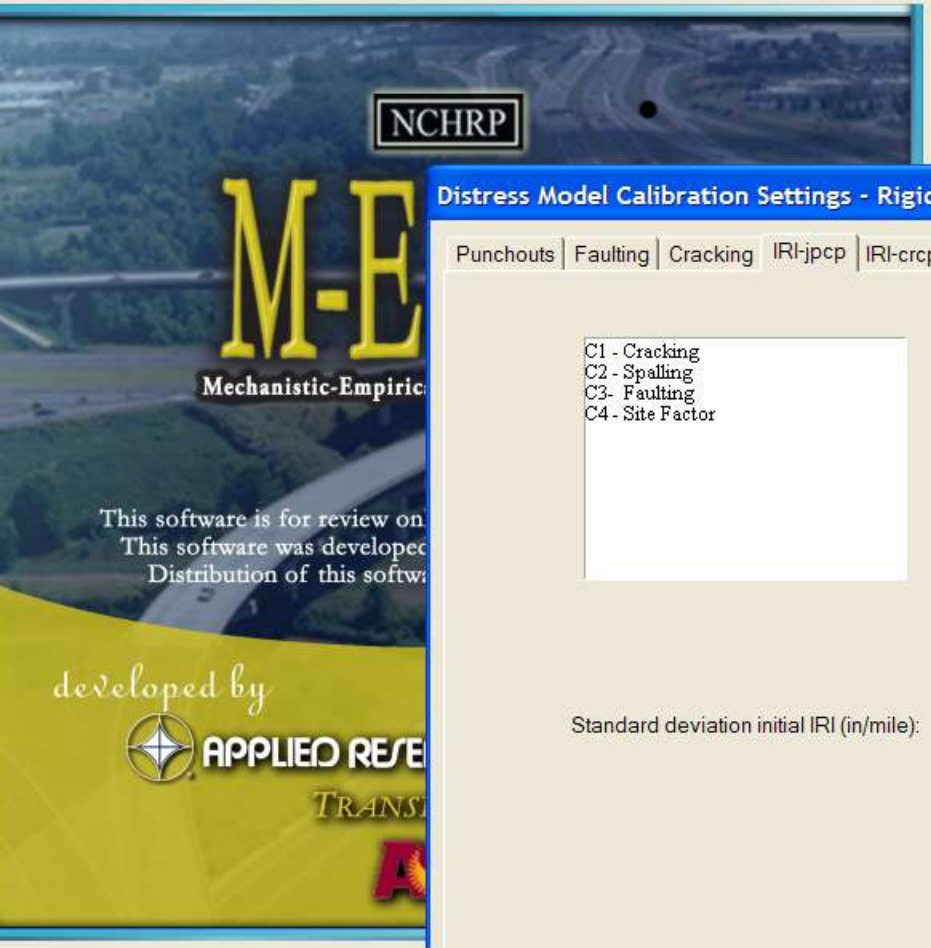
Reliability (FAULT)

Std. Dev. POWER(0.0097*FAULT,0.5178)+0.014

OK

Version 1.000

Last Build: April 8, 2007



Distress Model Calibration Settings - Rigid (new)

Punchouts | Faulting | Cracking | IRI-jpcp | IRI-crcp

C1 - Cracking
C2 - Spalling
C3- Faulting
C4 - Site Factor

C1 0.8203

C2 0.4417

C3 1.4929

C4 25.24

Standard deviation initial IRI (in/mile): 5.4

Version 1.000

Last Build: April 8, 2007

oject [C:\DG2002\Projects\Design Catalog Prob 12.dgp]
General Information
Site/Project Identification
Analysis Parameters

puts
Traffic
Traffic Volume Adjustment Factors
Monthly Adjustment
Vehicle Class Distribution
Hourly Truck Distribution
Traffic Growth Factor
Axle Load Distribution Factors
General Traffic Inputs
Number Axles/Truck
Axle Configuration
Wheelbase
Climate
Structure
Design Features
Layers
Layer 1 - JPCP
Layer 2 - Cement Stabilized
Layer 3 - A-7-5
Layer 4 - A-7-5

Results
Input Summary
Project
Traffic
Climatic
Design
Layer
Output Summary
JPCP Summary
Faulting Summary
Faulting (plot)
LTE (plot)
Cracking Summary
Cumulative Damage (plot)
Cracking (plot)
IRI (plot)

Analysis Status:

Analysis	% Complete
Traffic	100%
Climatic	100%
Modulus	100%
Faulting JPCP	100%
Cracking JPCP	100%
Summary	100%

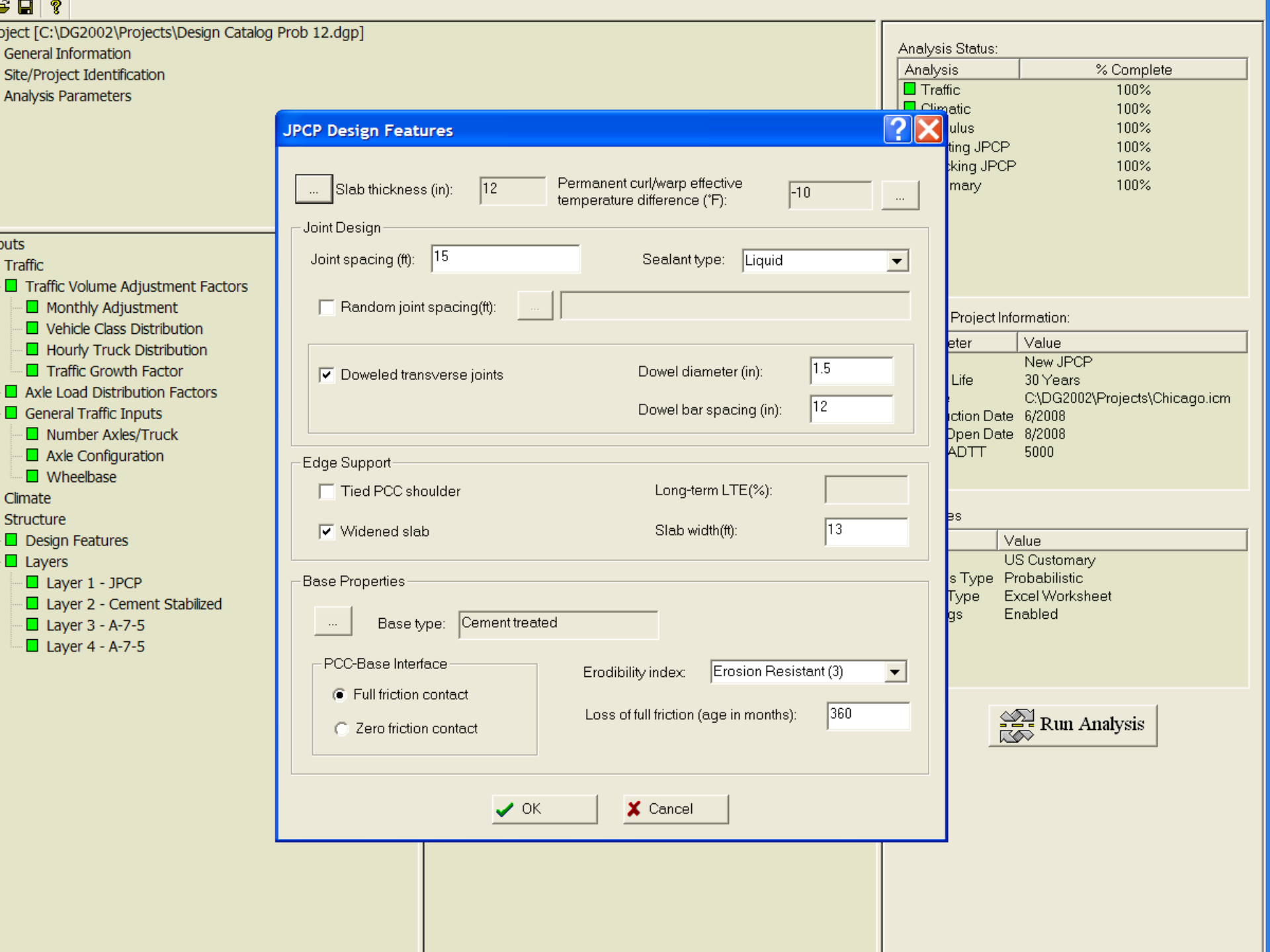
General Project Information:

Parameter	Value
Type	New JPCP
Design Life	30 Years
Climate	C:\DG2002\Projects\Chicago.icm
Construction Date	6/2008
Traffic Open Date	8/2008
Initial AADTT	5000

Properties

Setting	Value
Units	US Customary
Analysis Type	Probabilistic
Output Type	Excel Worksheet
Warnings	Enabled

Run Analysis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General Information
Site/Project Identification
Analysis Parameters
Analysis Status:
Analysis
% Complete
Traffic 100%
Climatic 100%
ulus 100%
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mary 100%
Project Information:
eter
Value
New JPCP
Life 30 Years
C:\DG2002\Projects\Chicago.icm
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Open Date 8/2008
ADTT 5000
es
Value
US Customary
s Type Probabilistic
Type Excel Worksheet
gs Enabled
Run Analysis
puts
Traffic
Traffic Volume Adjustment Factors
Monthly Adjustment
Vehicle Class Distribution
Hourly Truck Distribution
Traffic Growth Factor
Axle Load Distribution Factors
General Traffic Inputs
Number Axles/Truck
Axle Configuration
Wheelbase
Climate
Structure
Design Features
Layers
Layer 1 - JPCP
Layer 2 - Cement Stabilized
Layer 3 - A-7-5
Layer 4 - A-7-5
JPCP Design Features
...
Slab thickness (in):
12
Permanent curl/warp effective temperature difference (°F):
-10
...
Joint Design
Joint spacing (ft):
15
Sealant type:
Liquid
Random joint spacing(ft):
...
Doweled transverse joints
Dowel diameter (in):
1.5
Dowel bar spacing (in):
12
Edge Support
Tied PCC shoulder
Long-term LTE(%):
Widened slab
Slab width(ft):
13
Base Properties
...
Base type:
Cement treated
PCC-Base Interface
Full friction contact
Zero friction contact
Erodibility index:
Erosion Resistant (3)
Loss of full friction (age in months):
360
OK
Cancel

Climate

- The 4 primary climatic zones were analyzed according to the following locations:
  - Wet/freeze, Chicago, Illinois
  - Wet/No freeze, Atlanta, Georgia
  - Dry/freeze, Spokane, Washington
  - Dry/No freeze, Phoenix, Arizona

Traffic

- Traffic is categorized based on the following levels of AADTT:
  - 2500
  - 5000
  - 7500
  - 10000
- The default values for traffic variables in the M-E PDG were used in all cases.
- 100% of the design traffic was allocated to the design lane.
- The compound annual growth rate was fixed at 2%.

Concrete Properties

- To date, the only variable that has been analyzed is the modulus of rupture (MR).
  - 550 psi.
  - 650 psi.
  - 750 psi.
- Future analysis will focus on coefficient of thermal expansion and mix parameters.

Pavement Support

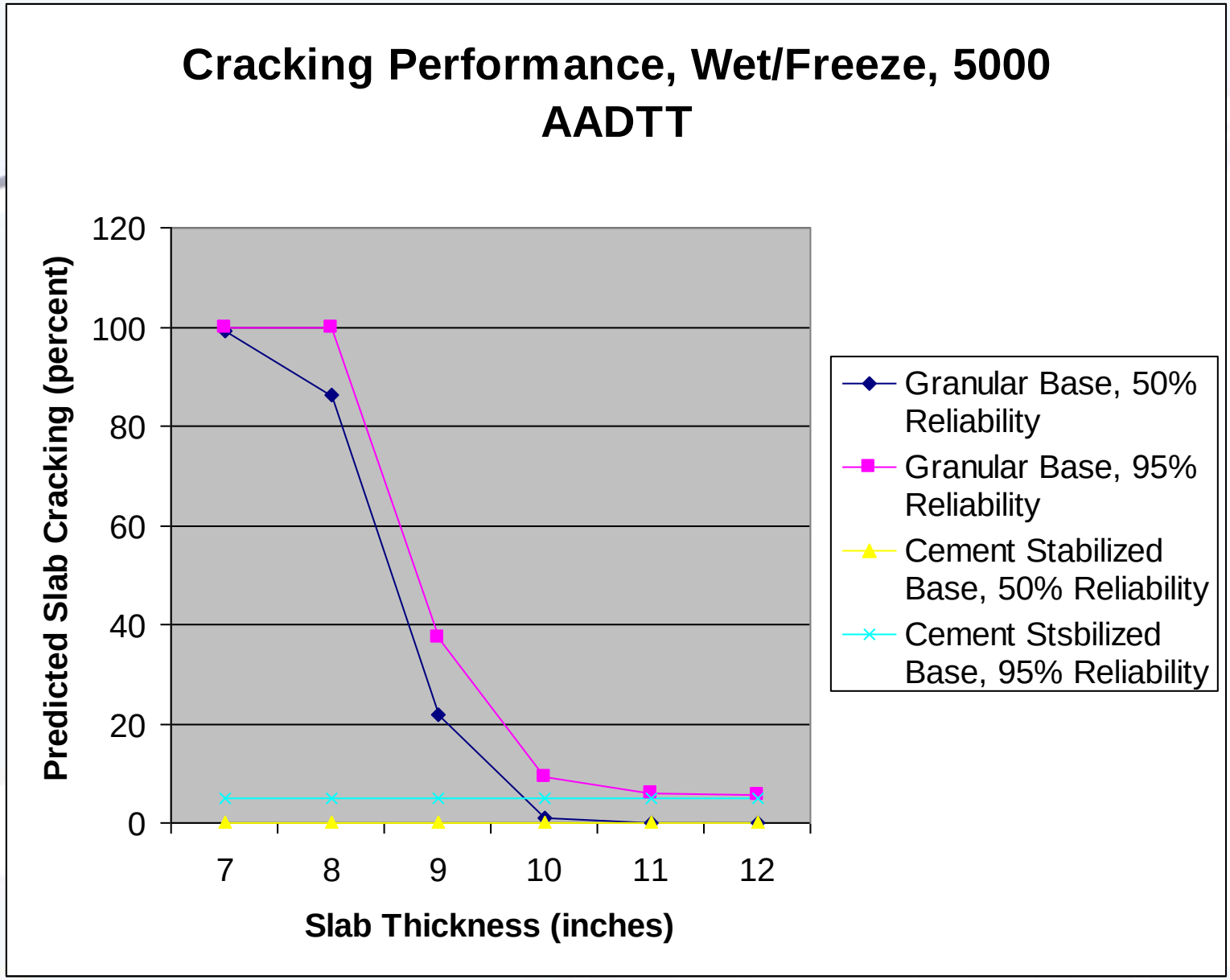
- A single soil type corresponding to an A-6-5 was used in all analyses.
  - K = 150 pci (approximately)
- Unstabilized granular subbases (crushed stone) and cement stabilized subbases were the primary variables.
  - 4 inch and 6 inch thickness.
- An asphalt treated subbase was also analyzed for comparison to the cement stabilized subbase.

Dowel Bar Diameter and Edge Support

- Initial analyses focused on 1-1/2 bars for all pavements.
- Subsequent analyses incorporate the ACPA recommendations for dowel diameters as a function of slab thickness.
- Standard 12 foot lanes and 13 foot widened lanes were analyzed. The diminished benefit/cost of 14 foot widened lanes was verified for selected cases.

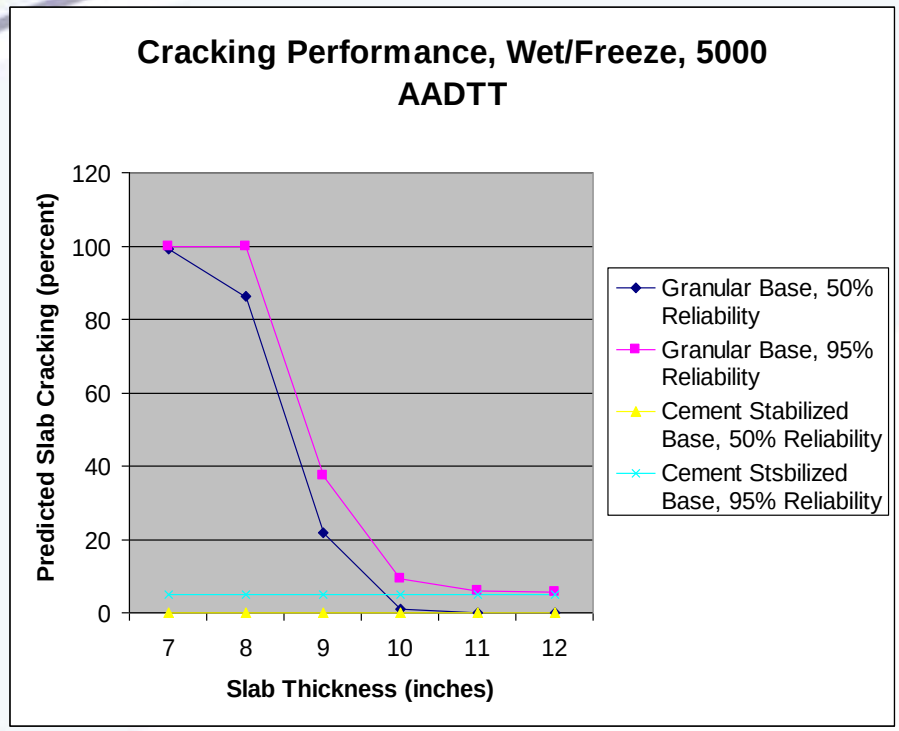
Reliability and Failure Criteria

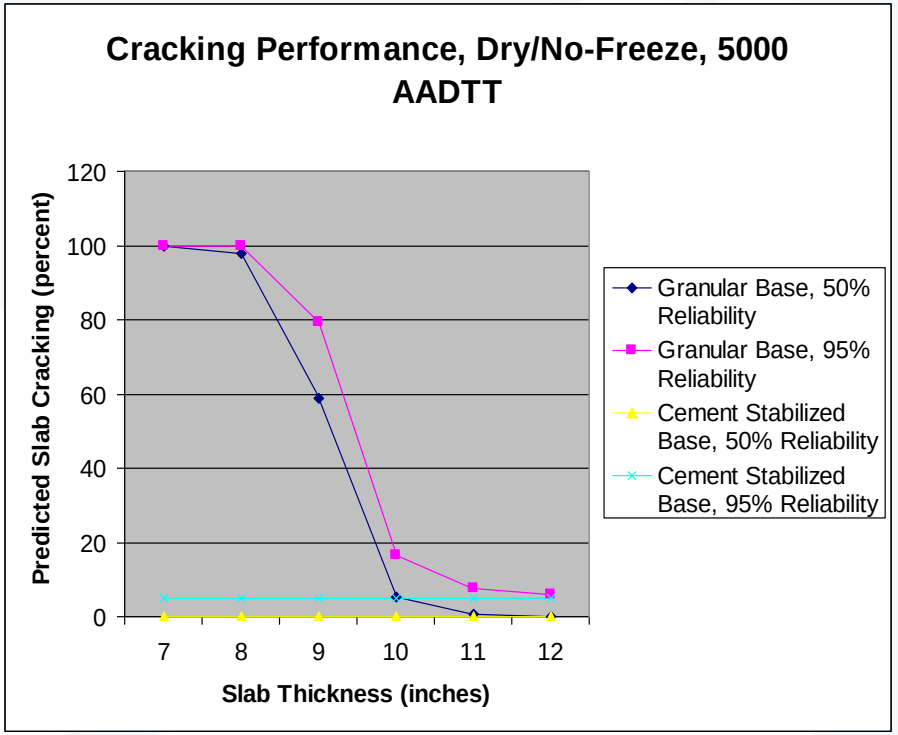
- Two reliability levels were used in all analyses:
  - 50%.
  - 95%.
- Failure criteria was specified at the default values for cracking, faulting and IRI. However, the method of plotting the data facilitates selecting a level of failure corresponding to thickness.



Baseline

Climatic Effects, Cracking





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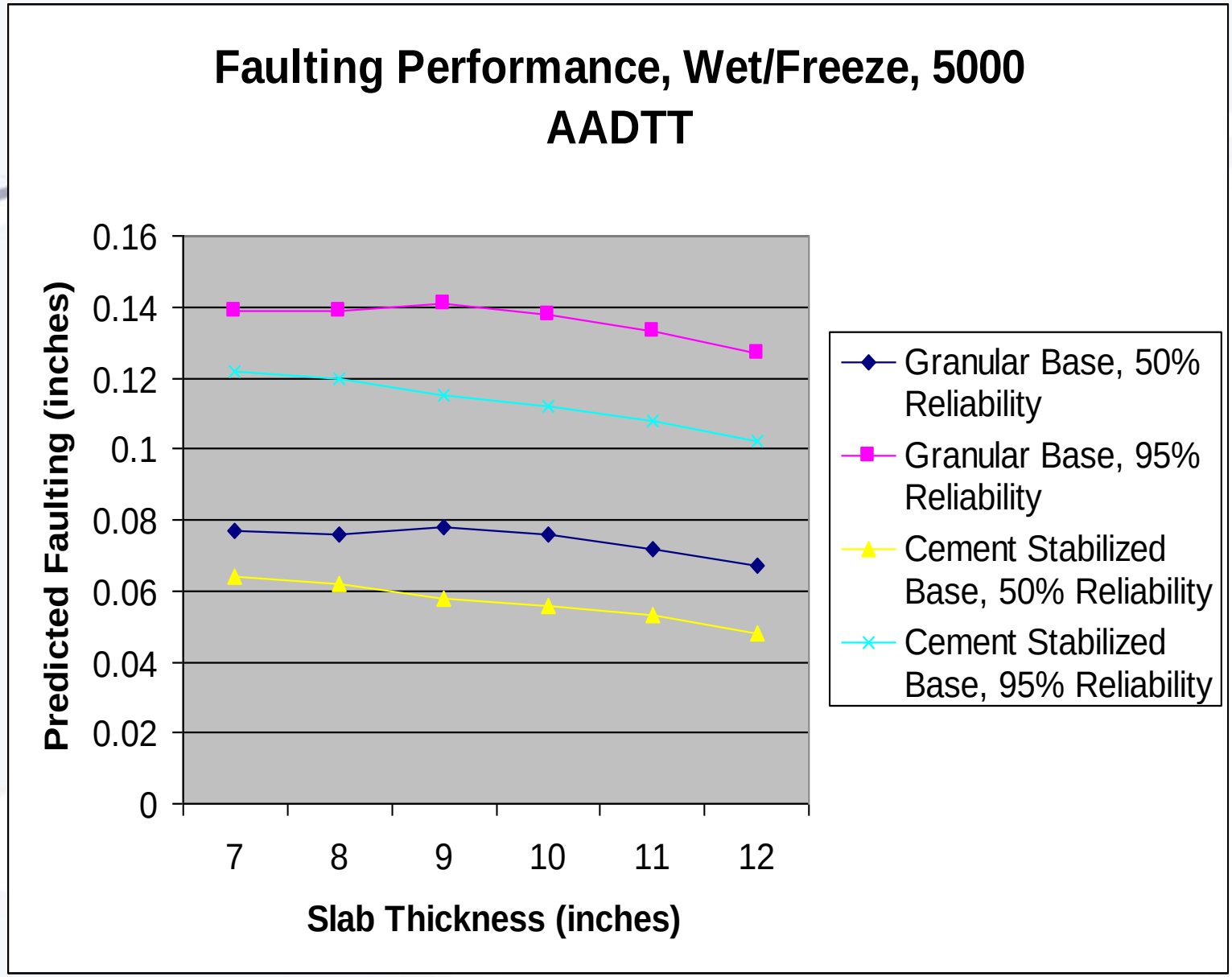
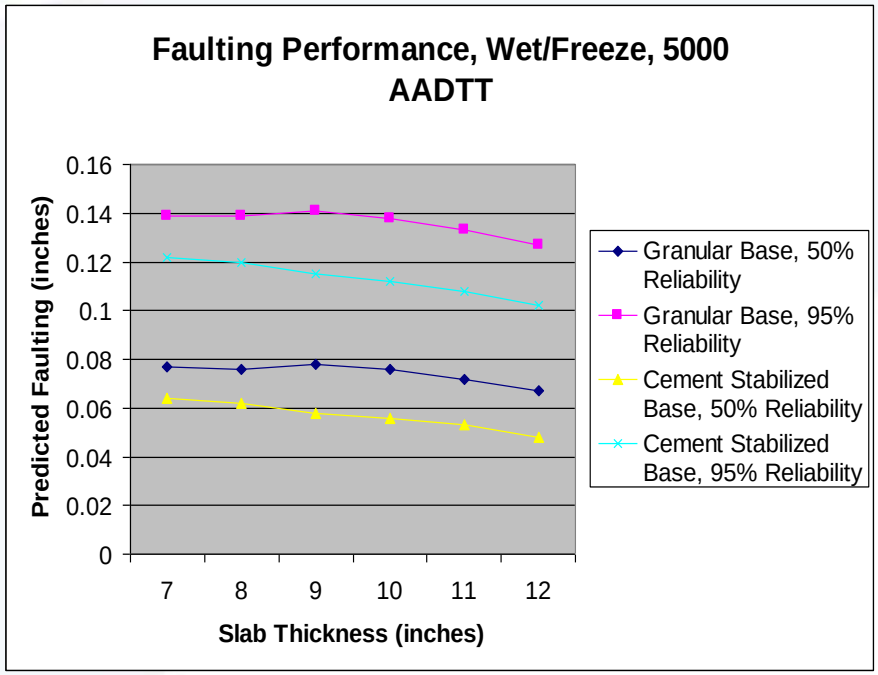
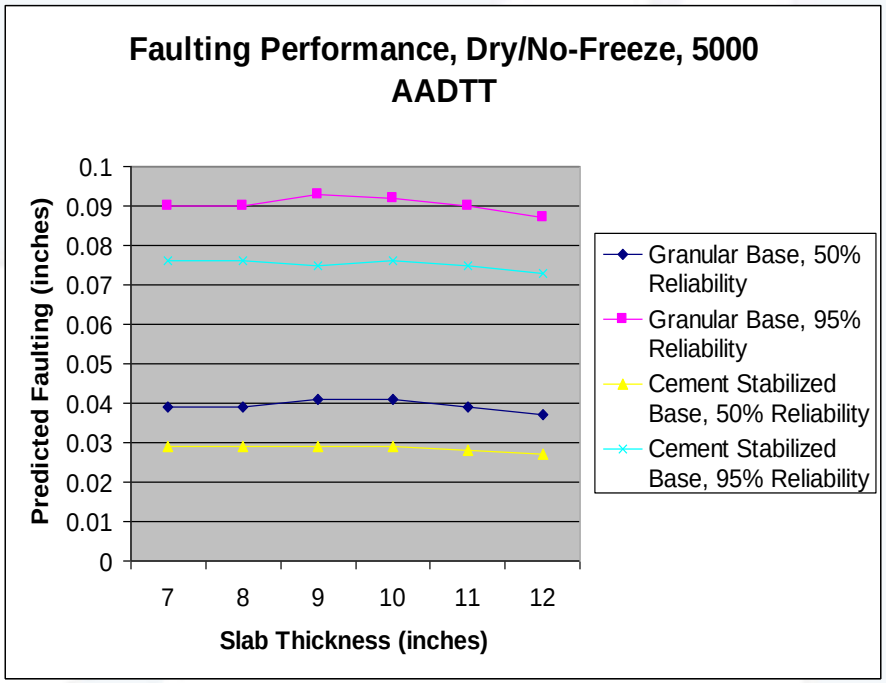
Count on Concrete


Faulting Performance, Wet/Freeze, 5000 AADTT
Predicted Faulting (inches)
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
7
8
9
10
11
12
Slab Thickness (inches)
Granular Base, 50% Reliability
Granular Base, 95% Reliability
Cement Stabilized Base, 50% Reliability
Cement Stabilized Base, 95% Reliability

Climatic Effects, Faulting





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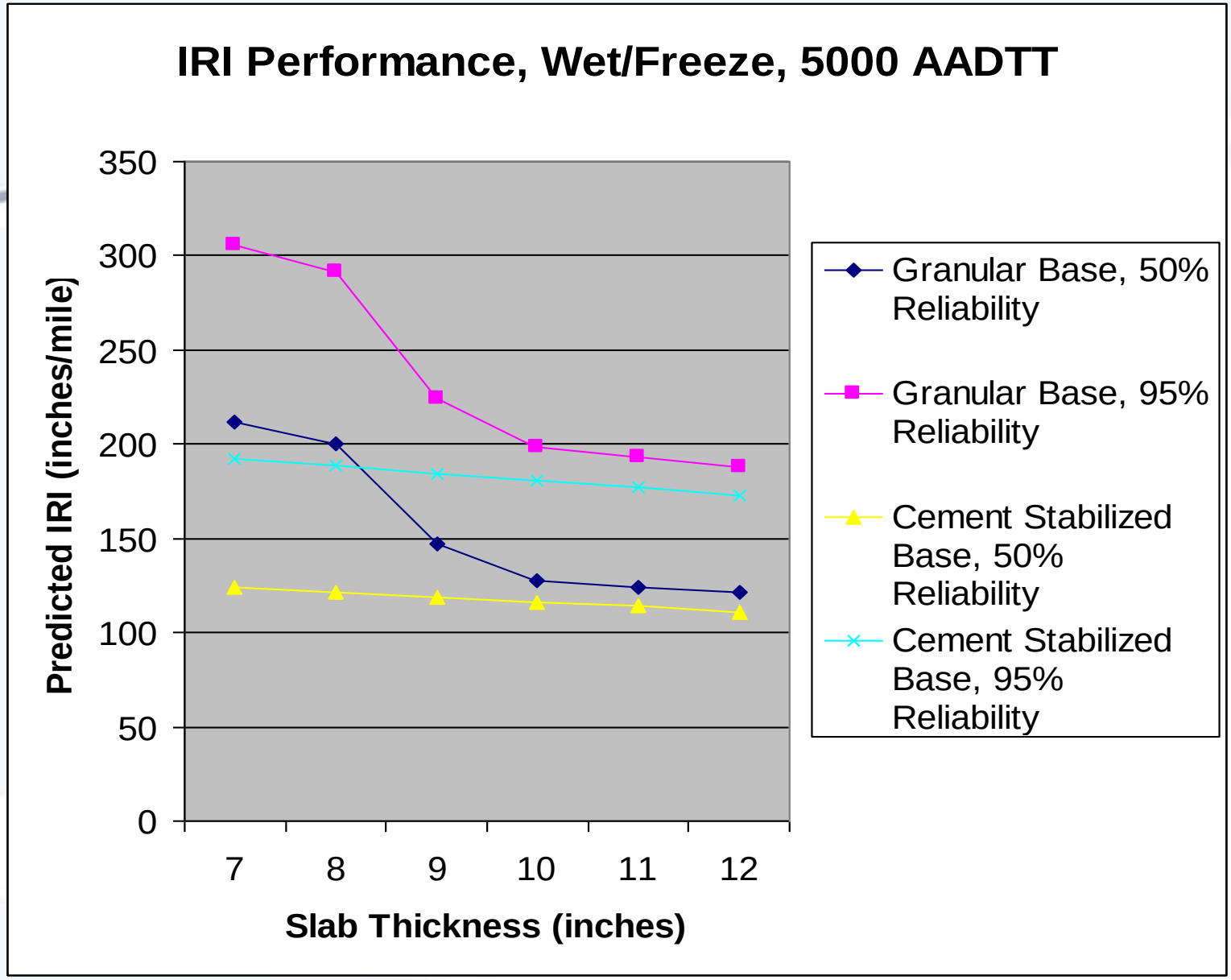
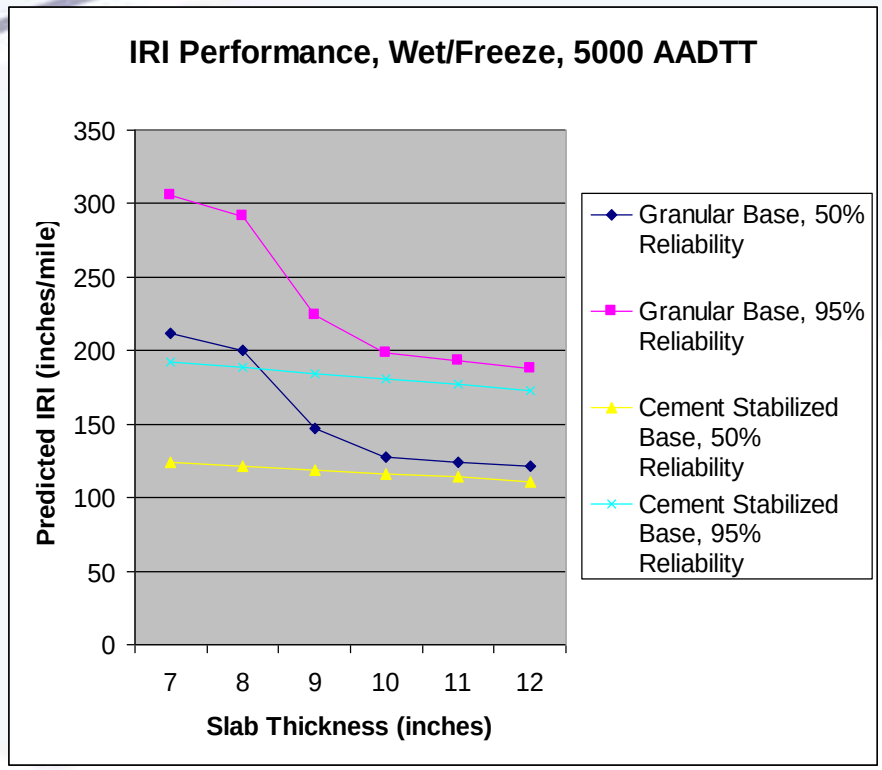
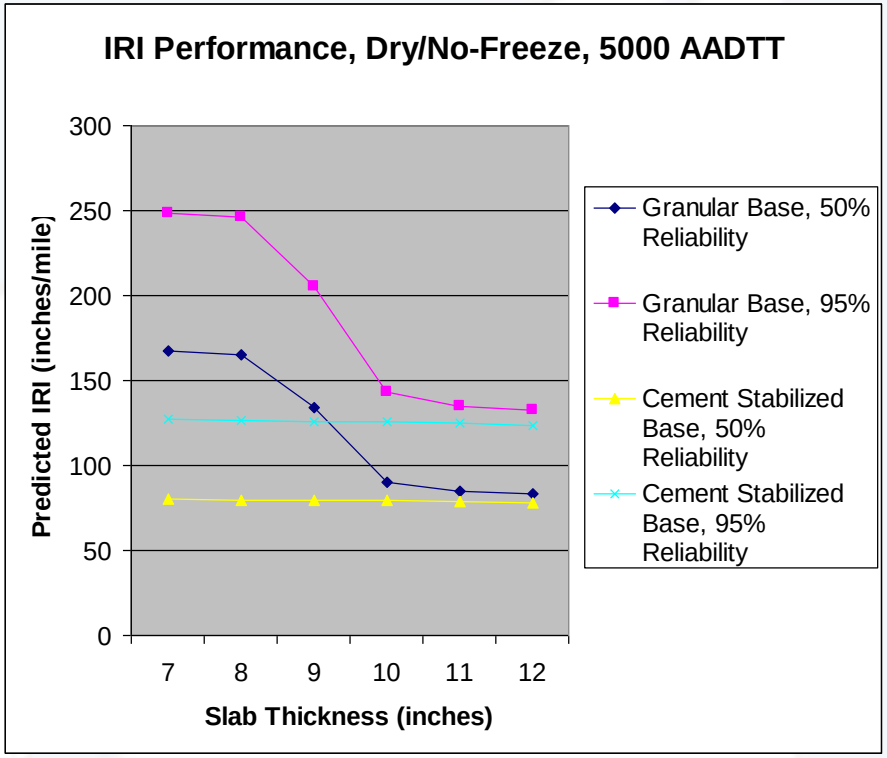
Count on Concrete


IRI Performance, Wet/Freeze, 5000 AADTT
Predicted IRI (inches/mile)
350
300
250
200
150
100
50
0
7
8
9
10
11
12
Slab Thickness (inches)
Granular Base, 50% Reliability
Granular Base, 95% Reliability
Cement Stabilized Base, 50% Reliability
Cement Stabilized Base, 95% Reliability

Climatic Effects, IRI





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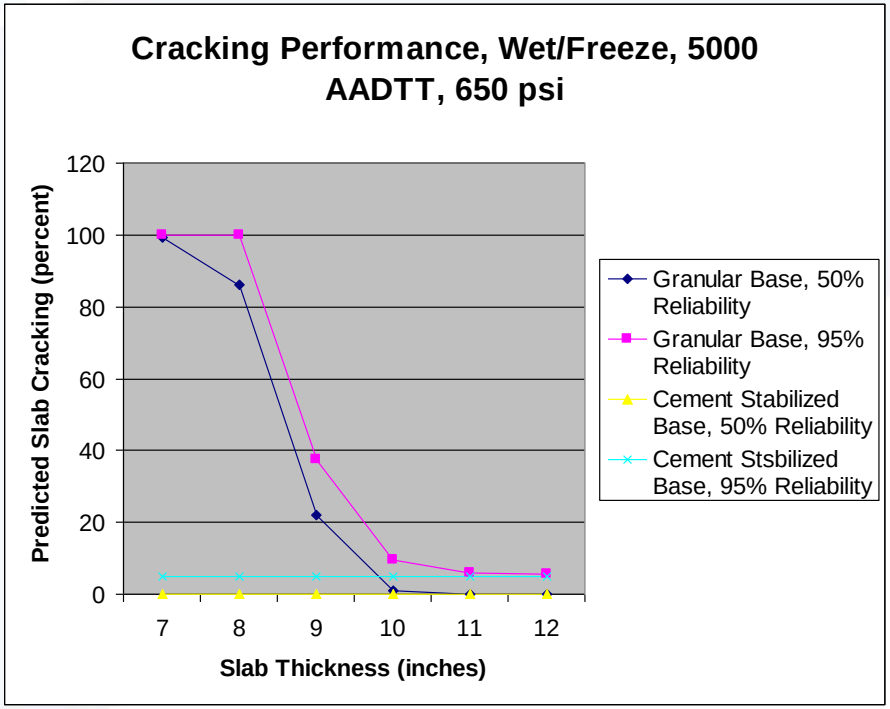
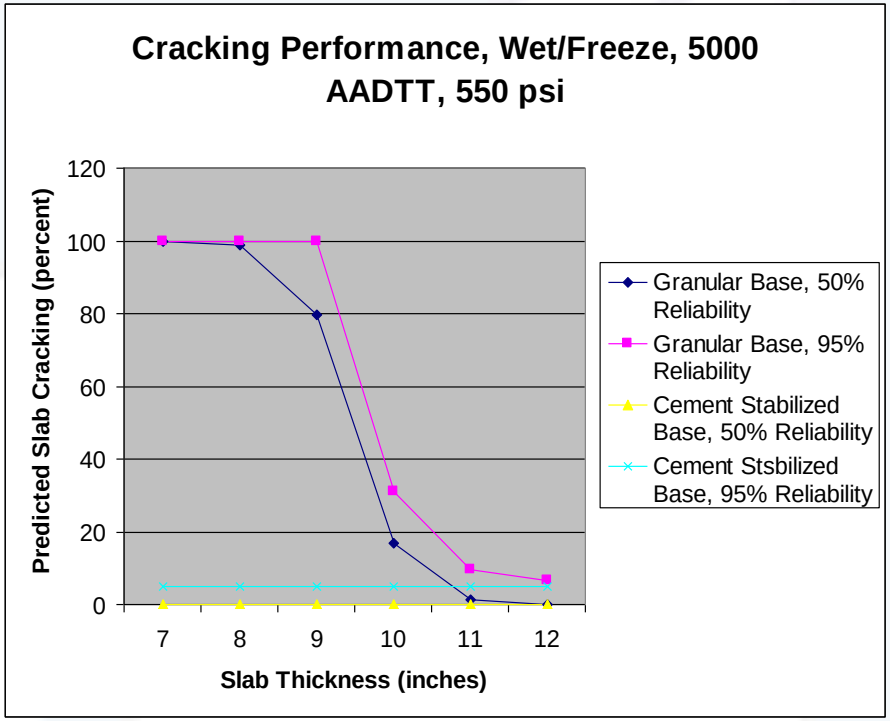
Count on Concrete

Concrete Strength, Cracking





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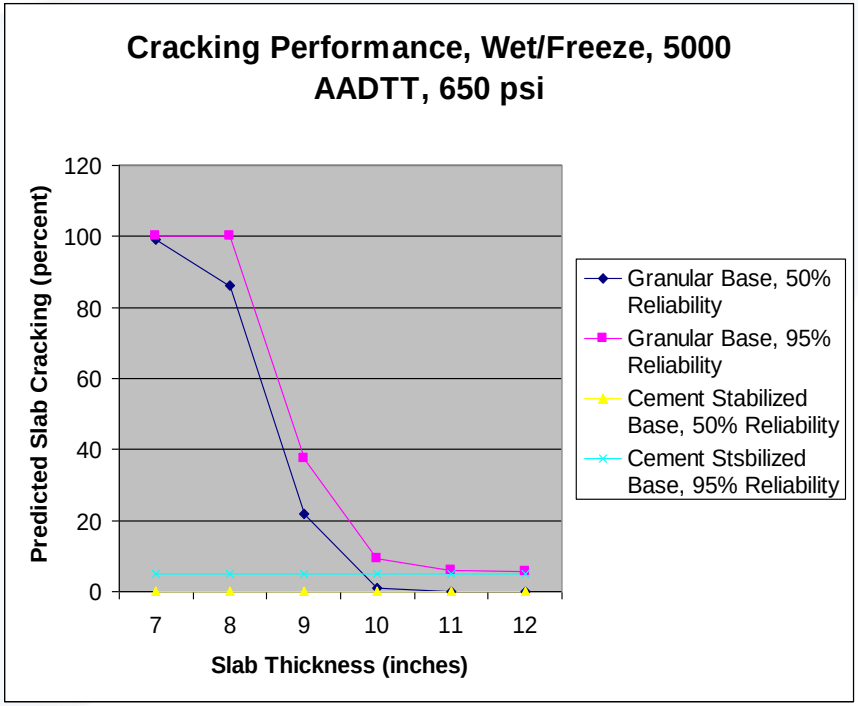
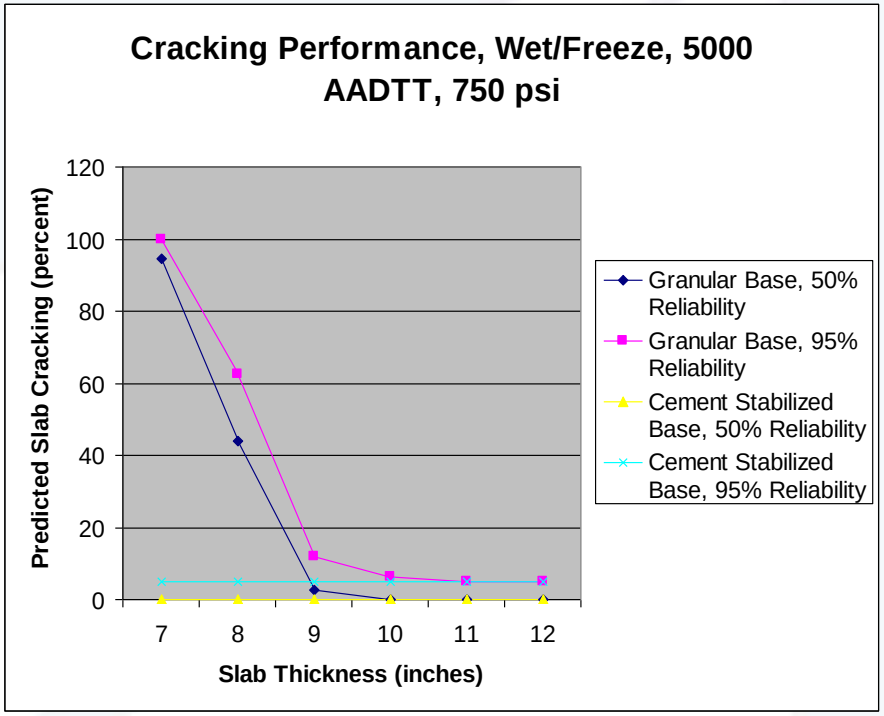
Count on Concrete

Concrete Strength, Cracking





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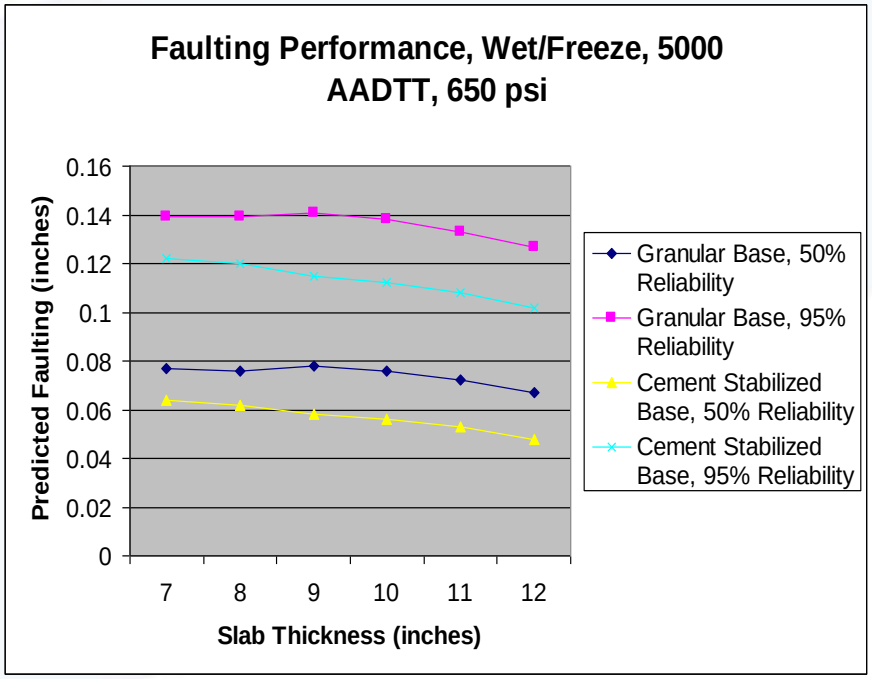
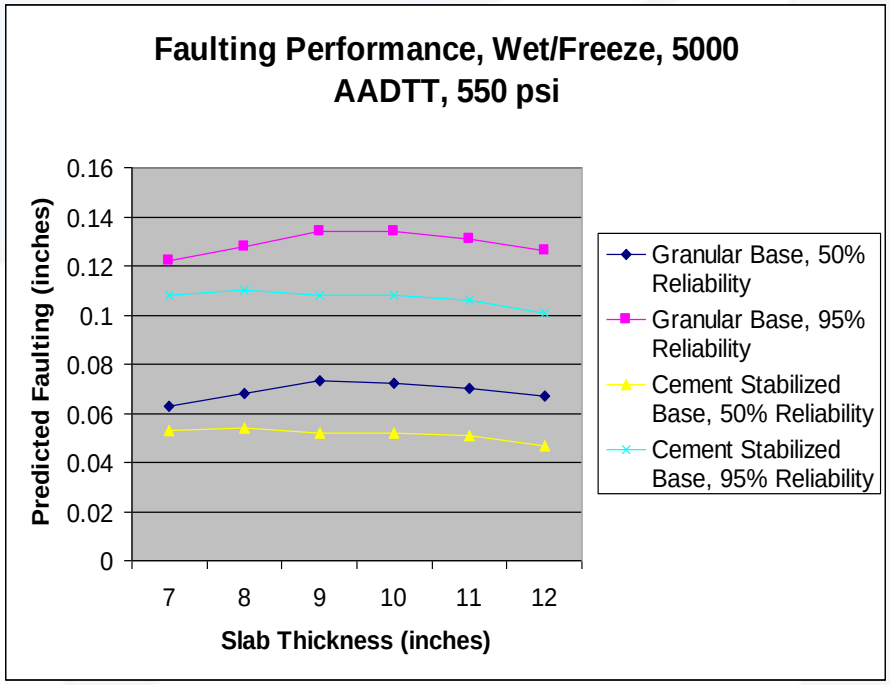
Concrete Strength, Faulting





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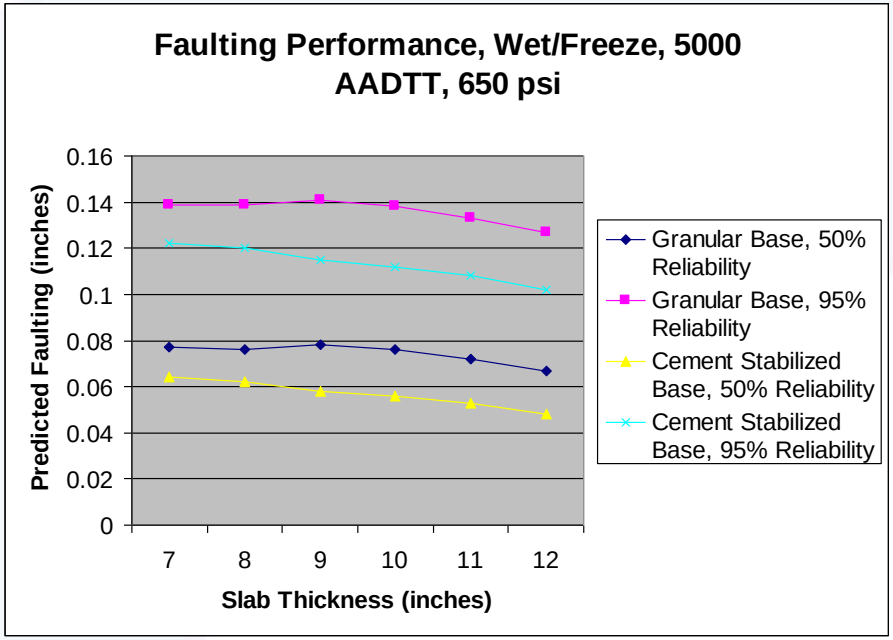
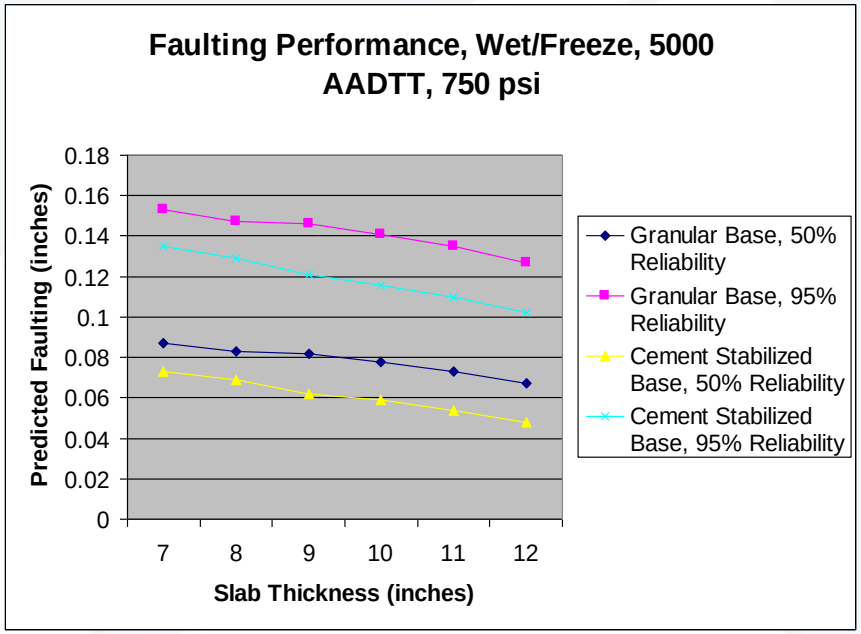
Concrete Strength, Faulting





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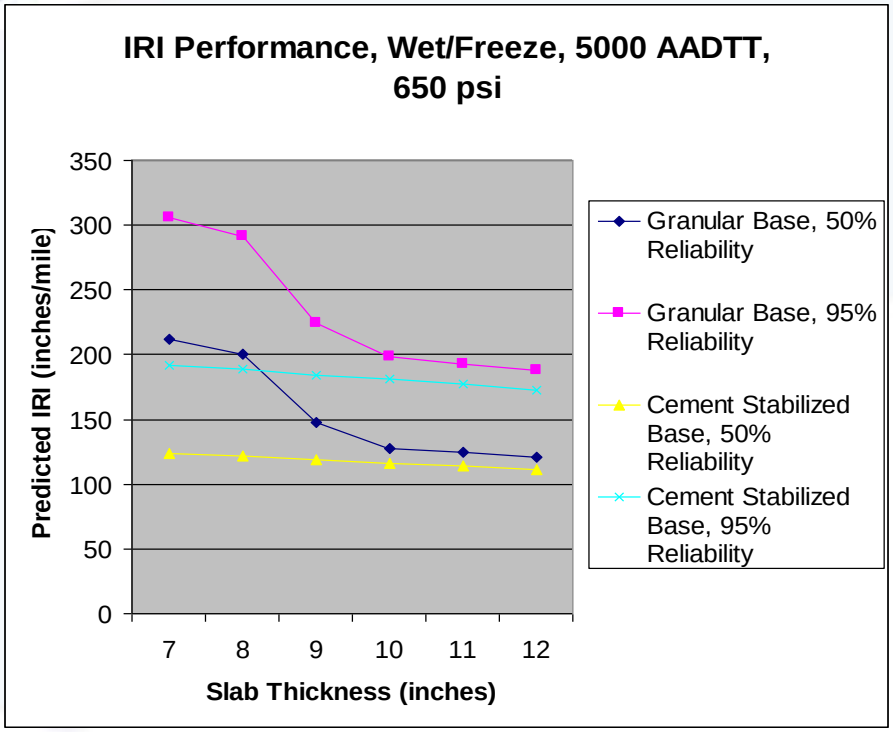
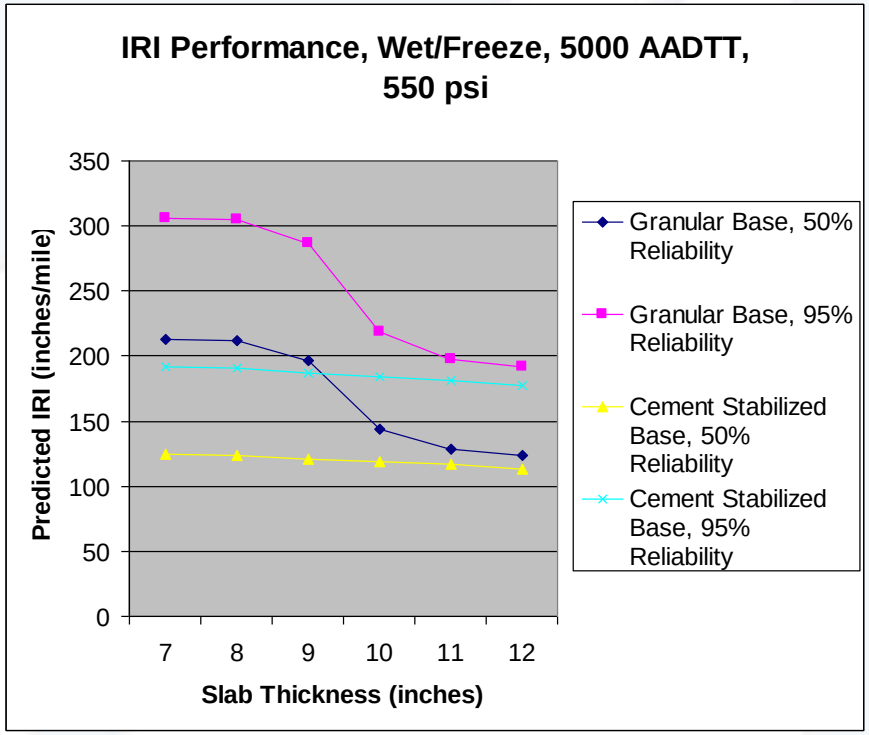
Count on Concrete

Concrete Strength, IRI





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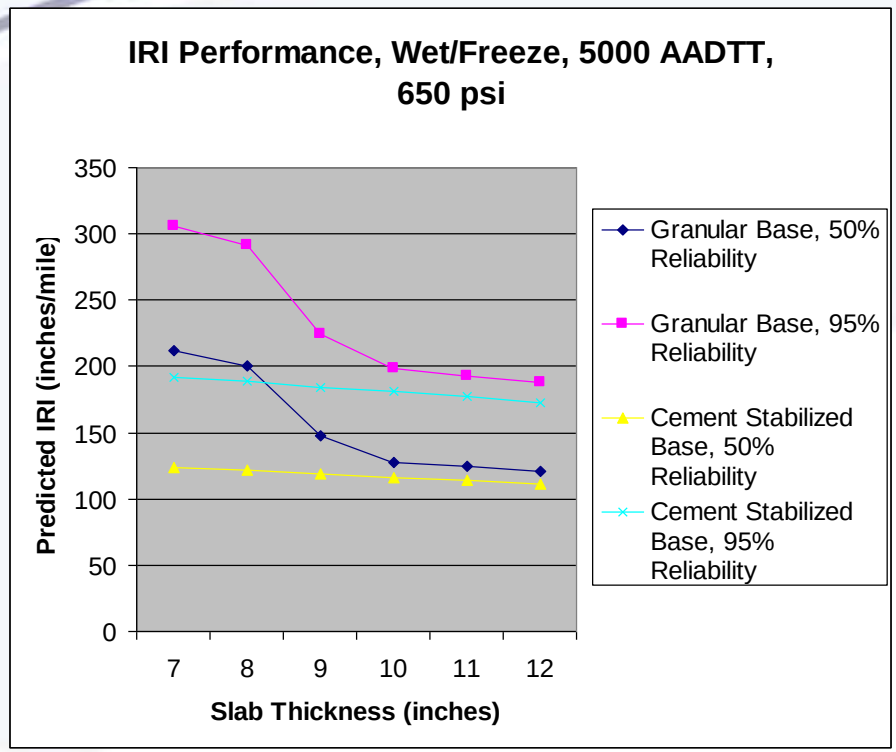
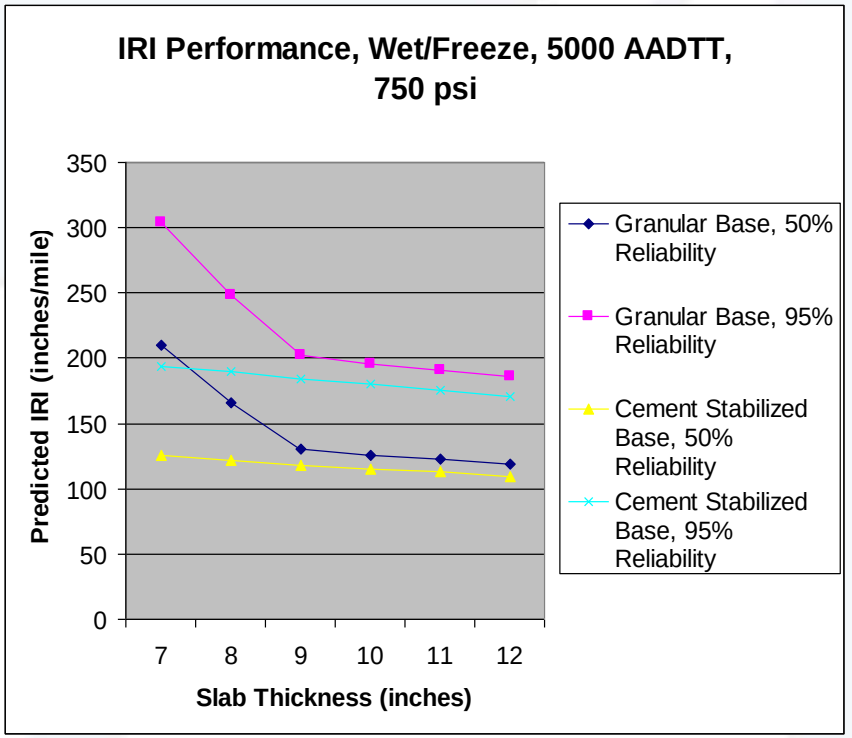
Count on Concrete

Concrete Strength, IRI





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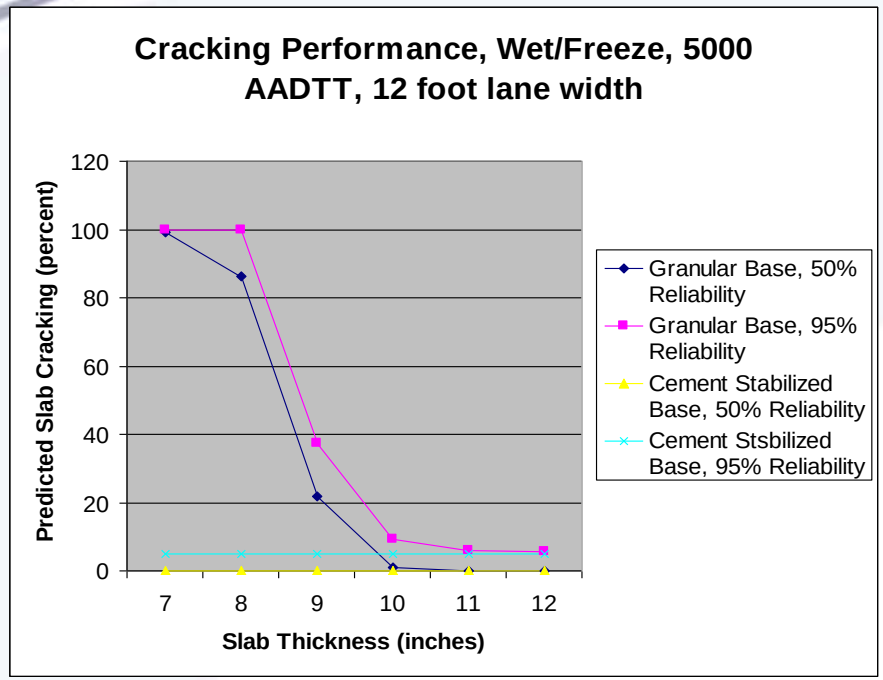
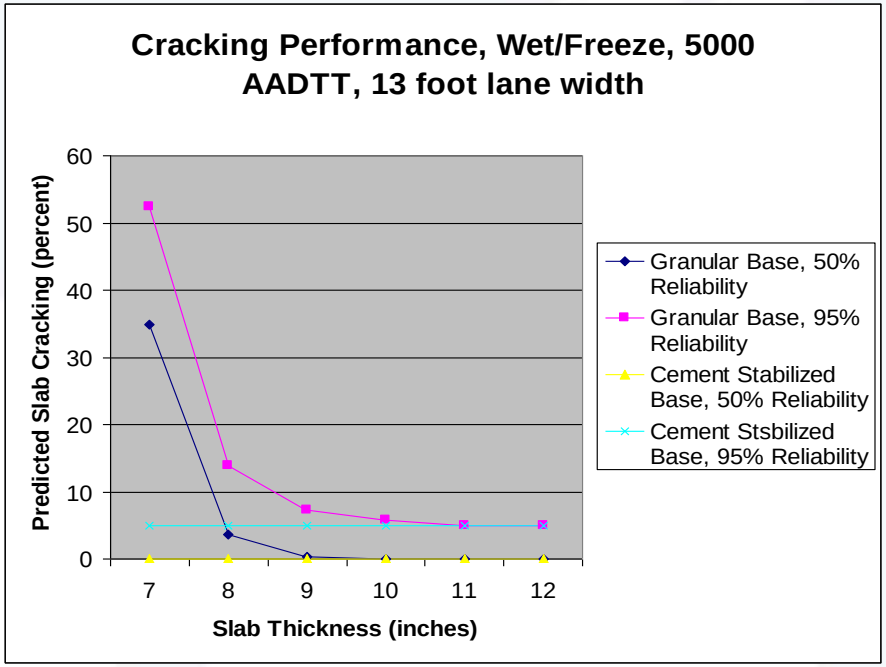
Count on Concrete

Lane Width, Cracking





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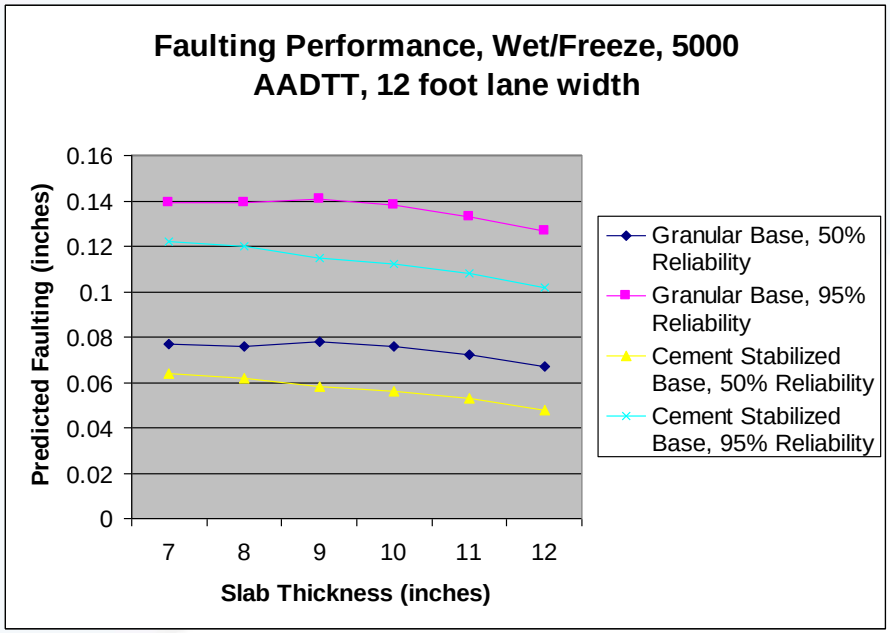
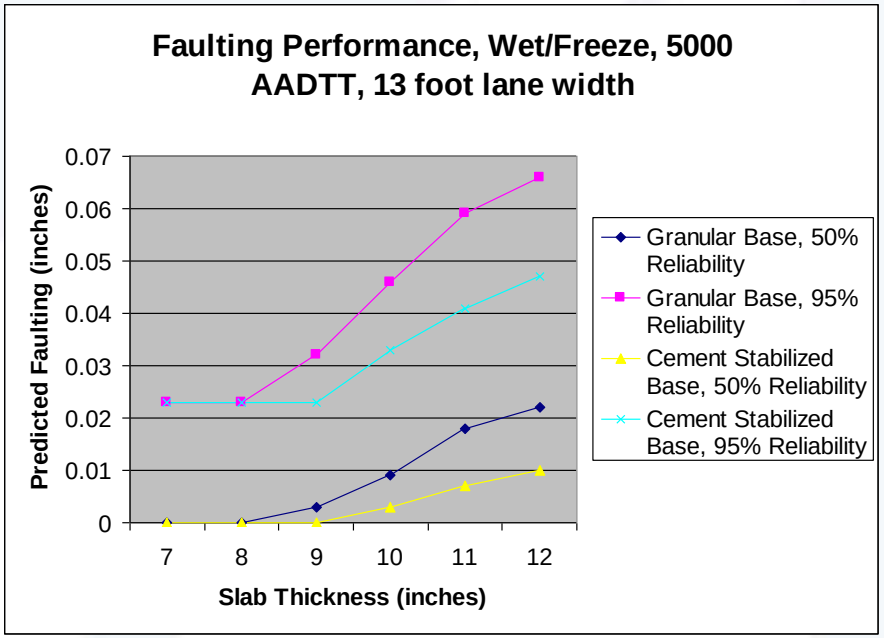
Count on Concrete

Lane Width, Faulting





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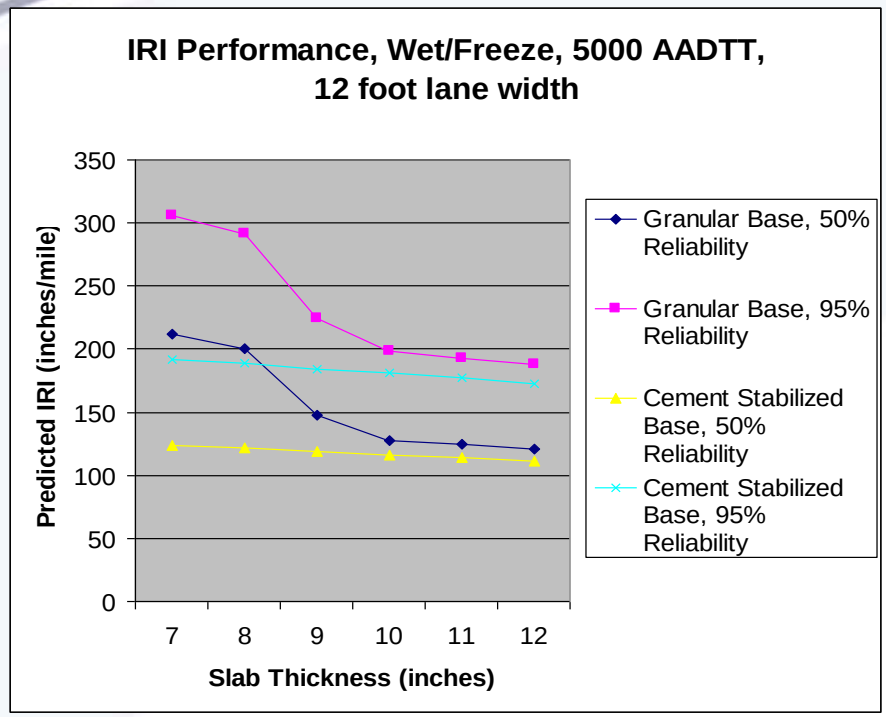
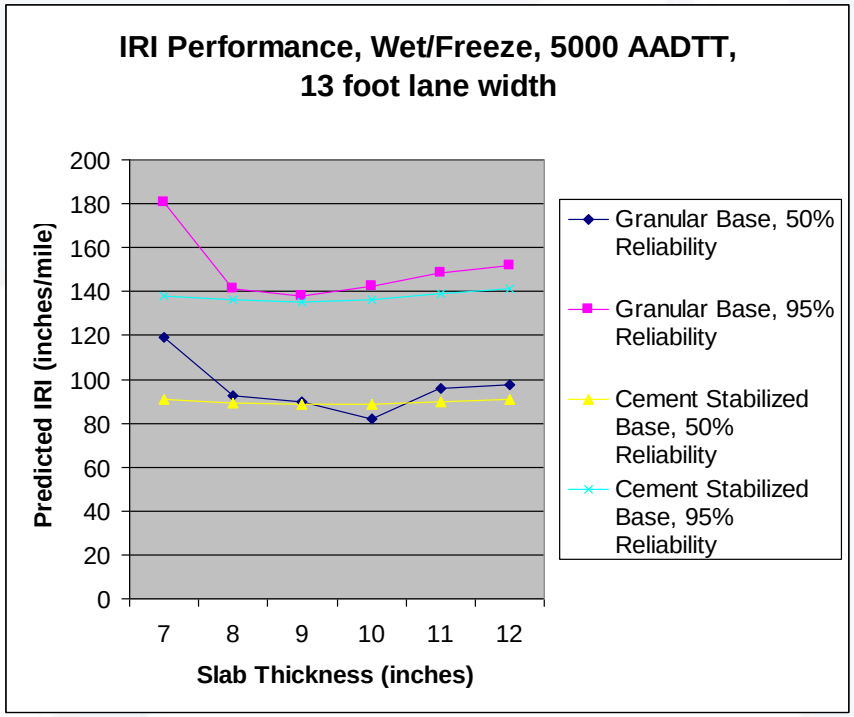
Count on Concrete

Lane Width, IRI





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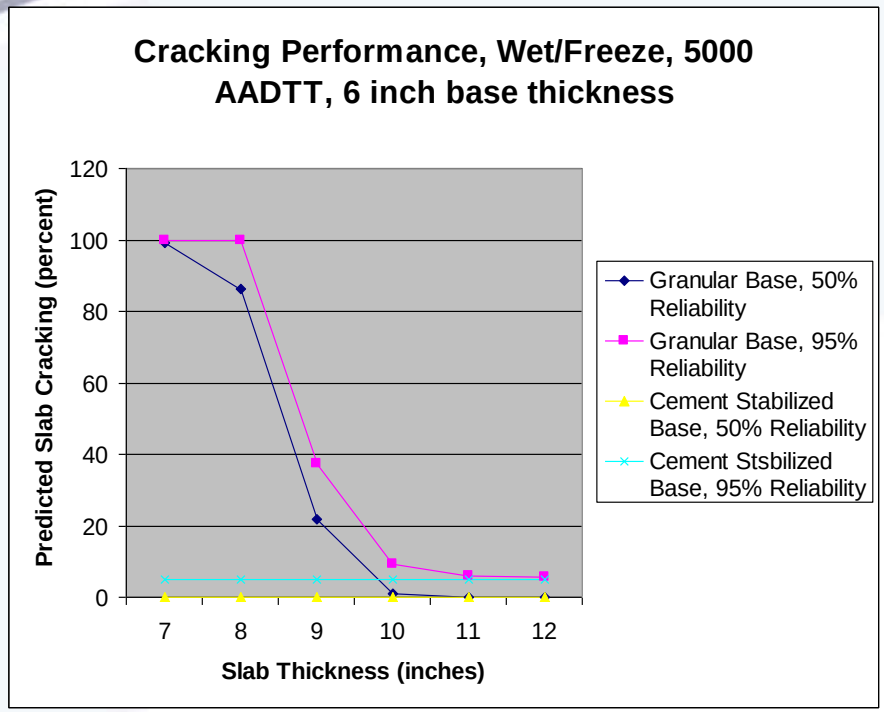
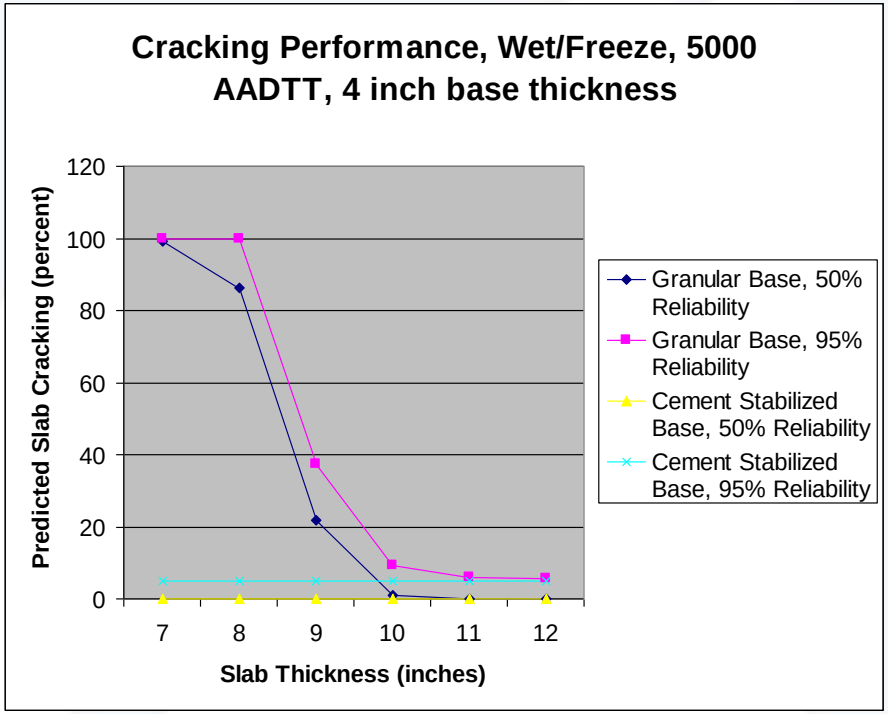
Count on Concrete

Base Thickness, Cracking

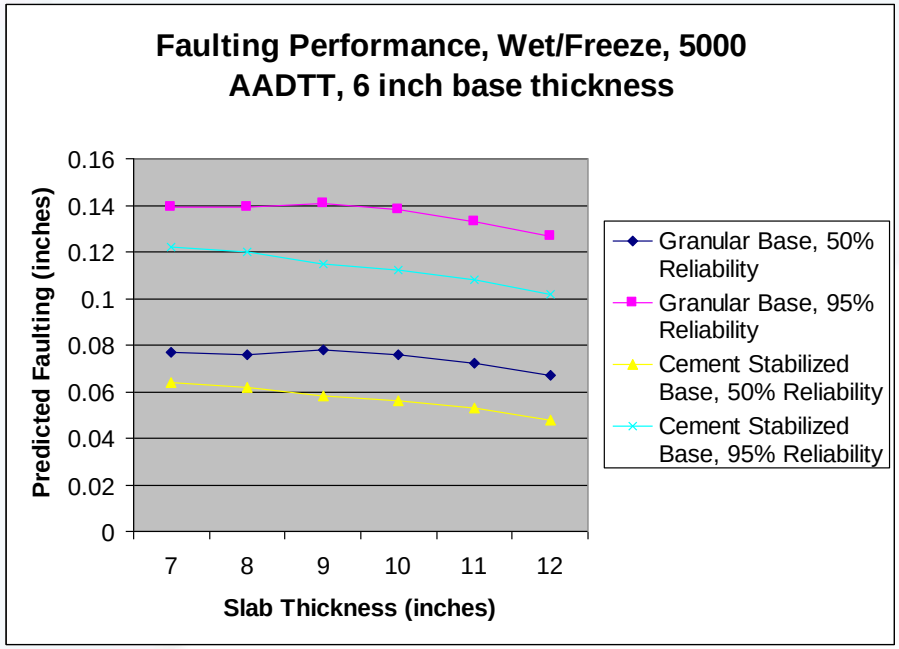


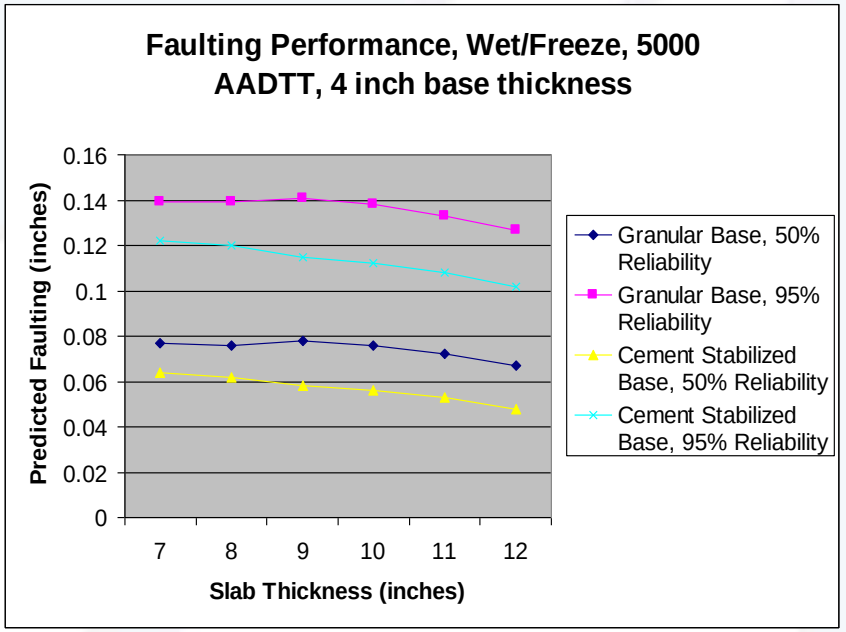


ACPA

Count on Concrete

Base Thickness, Faulting





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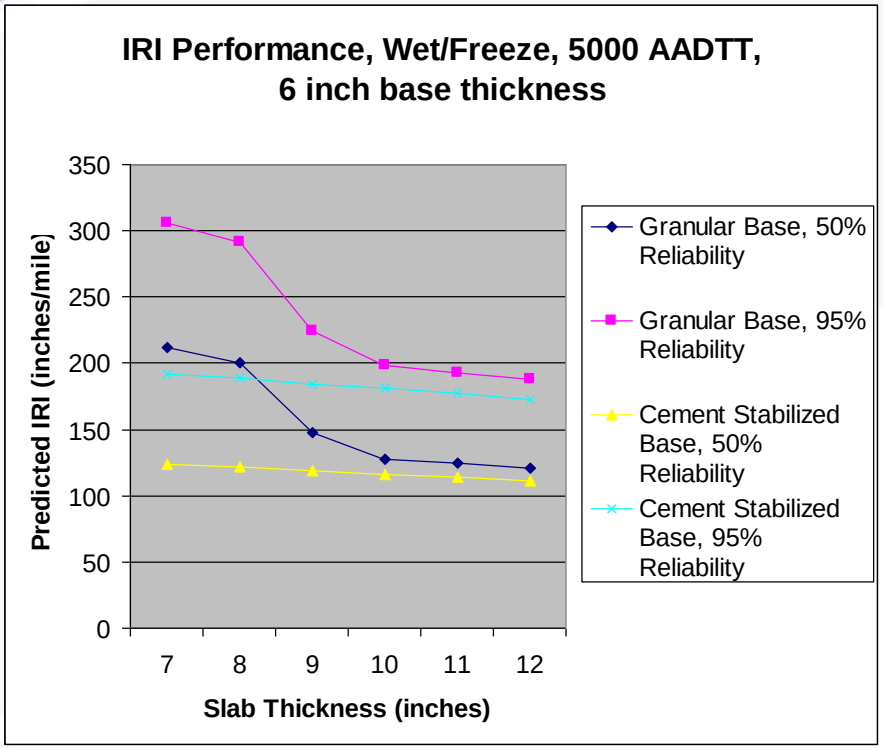
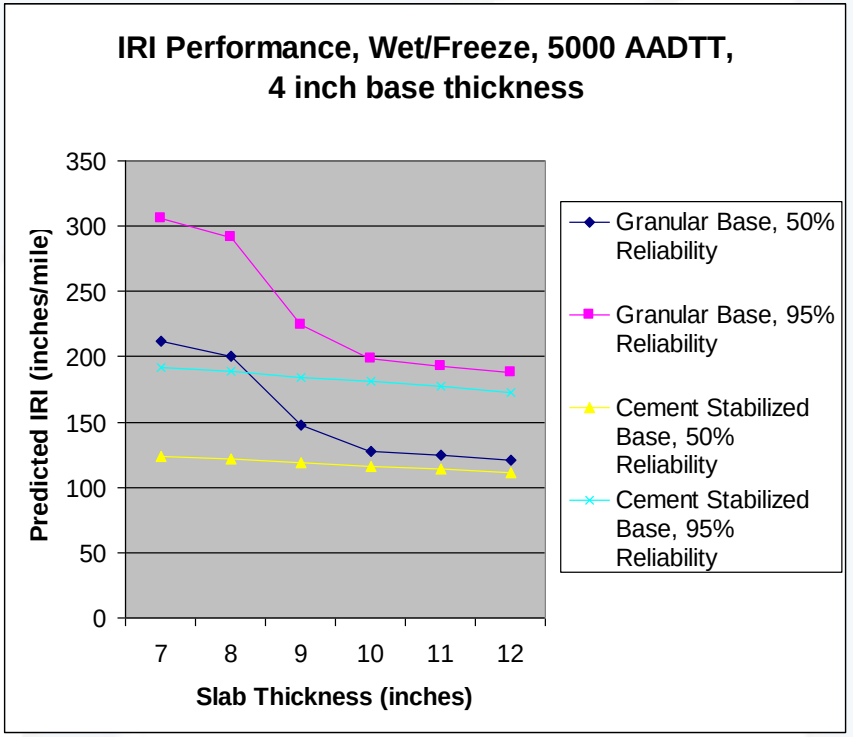
Count on Concrete

Base Thickness, IRI





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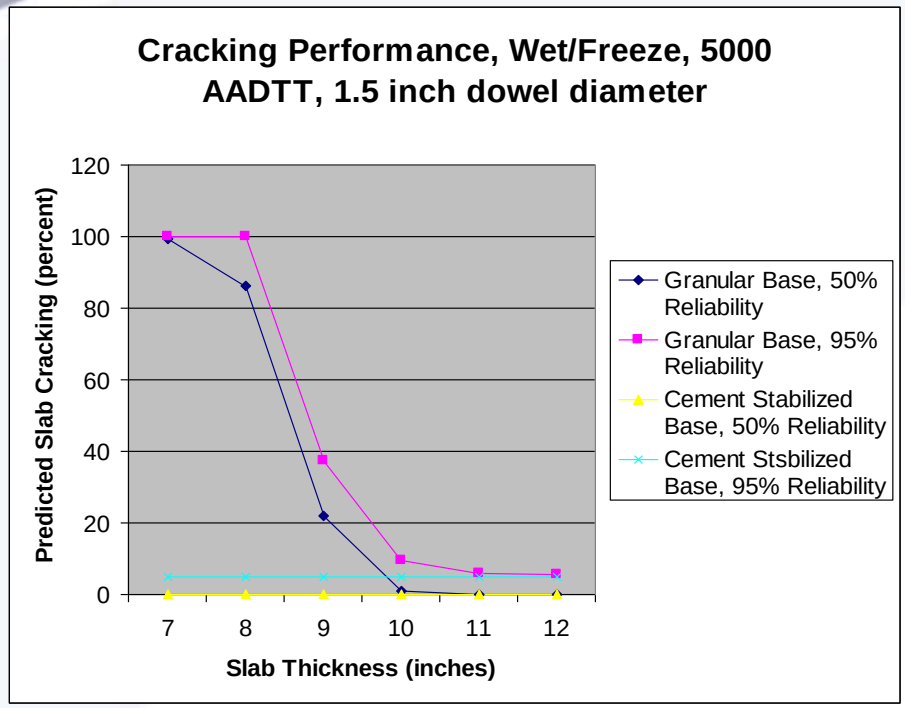
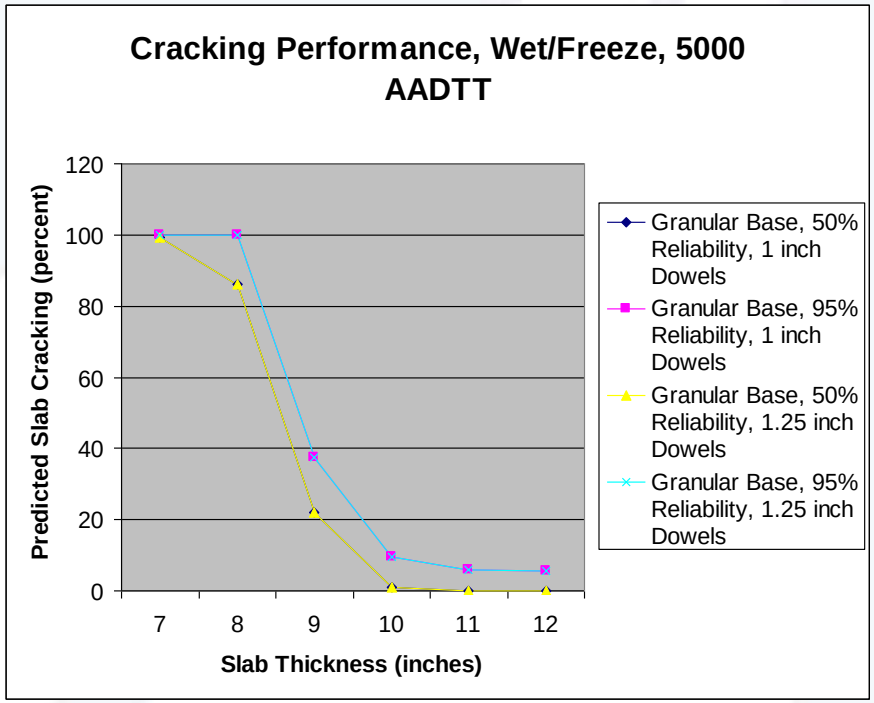
Count on Concrete

Dowel Diameter, Cracking





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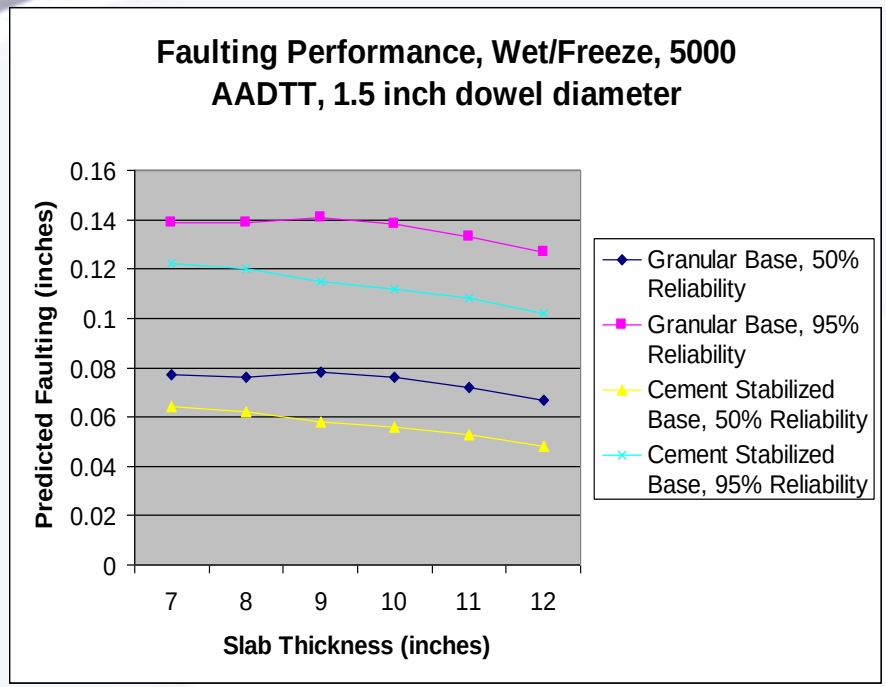
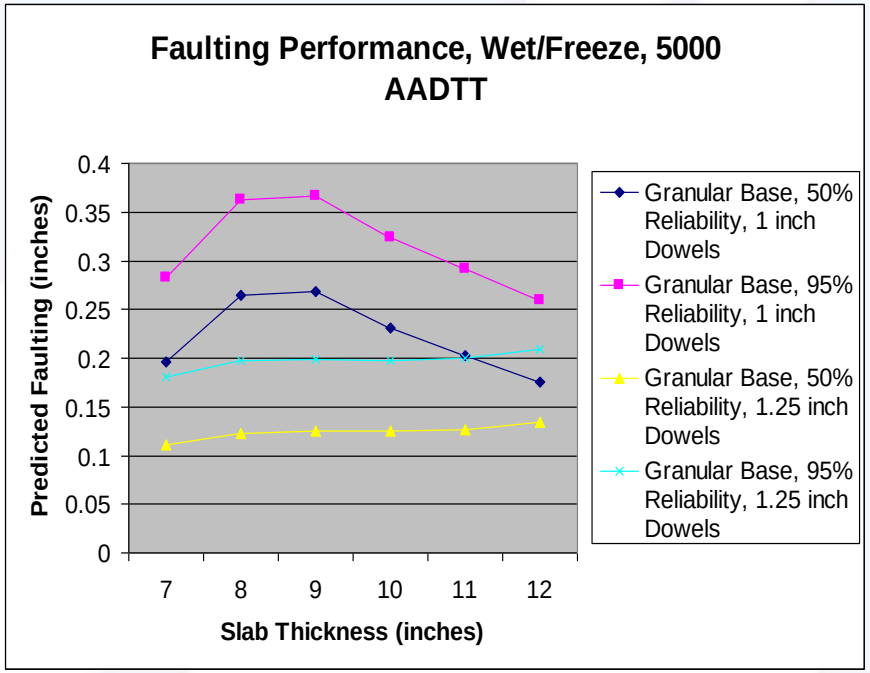
Dowel Diameter, Faulting





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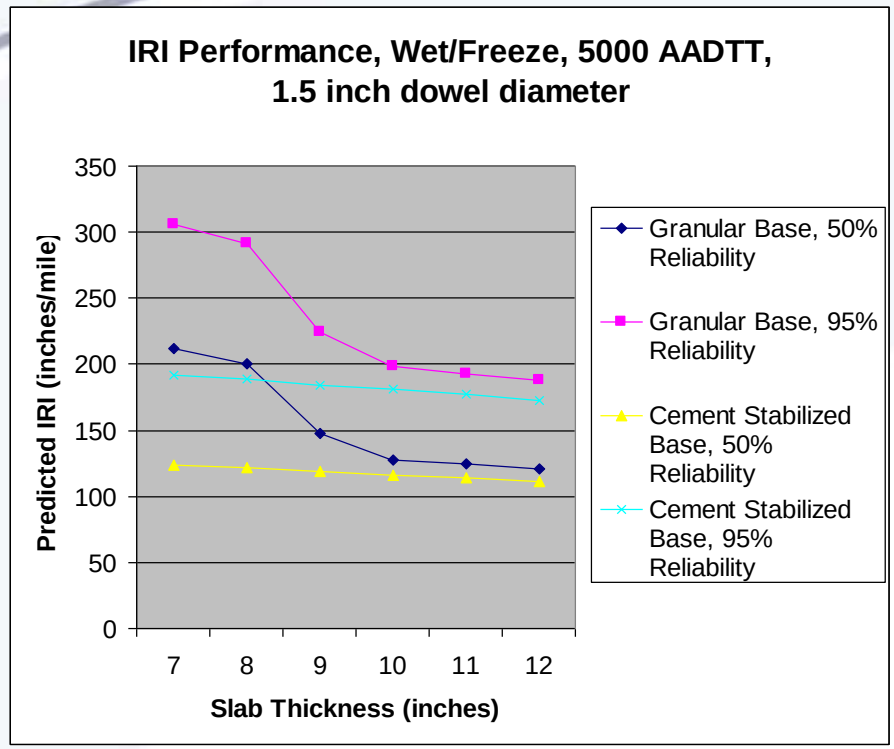
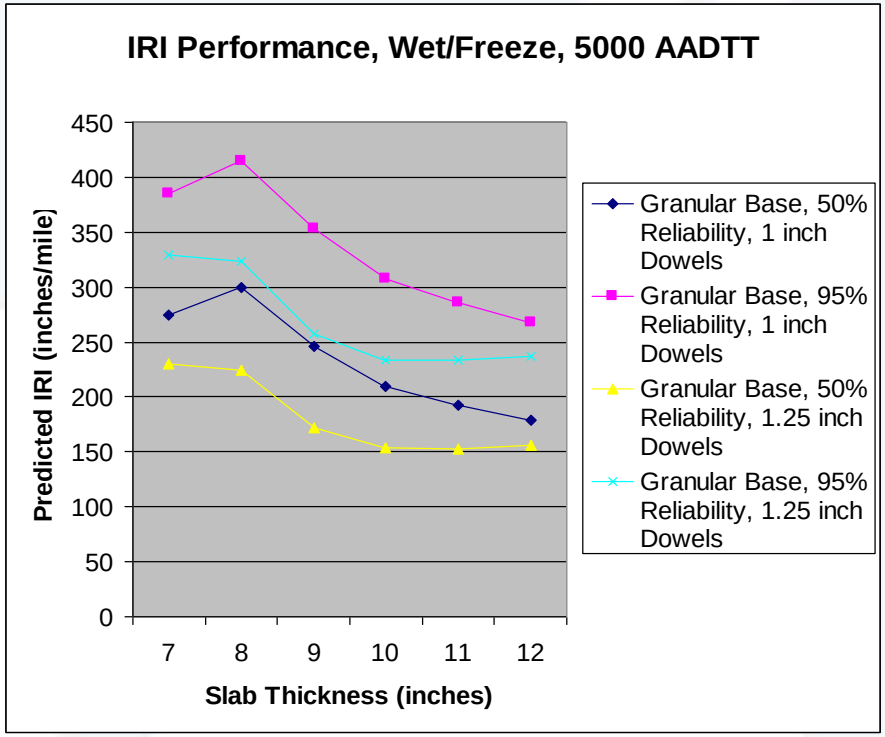
Dowel Diameter, IRI





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What to Expect and When

- Establishment of the phase 1 database has been completed.
- The computer software should be available in draft form by the end of 2008.
- The program will allow even a novice pavement designer to arrive at a number of workable options. ACPA recommendations will be included as part of the output files.

Thank You!!!

Please contact Mike Ayers with questions or comments.

mayers@pavement.com

Visit www.pavement.com for additional information and details of the 2009 training program.

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