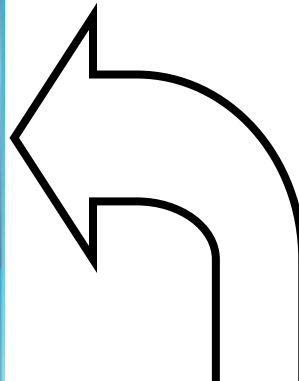
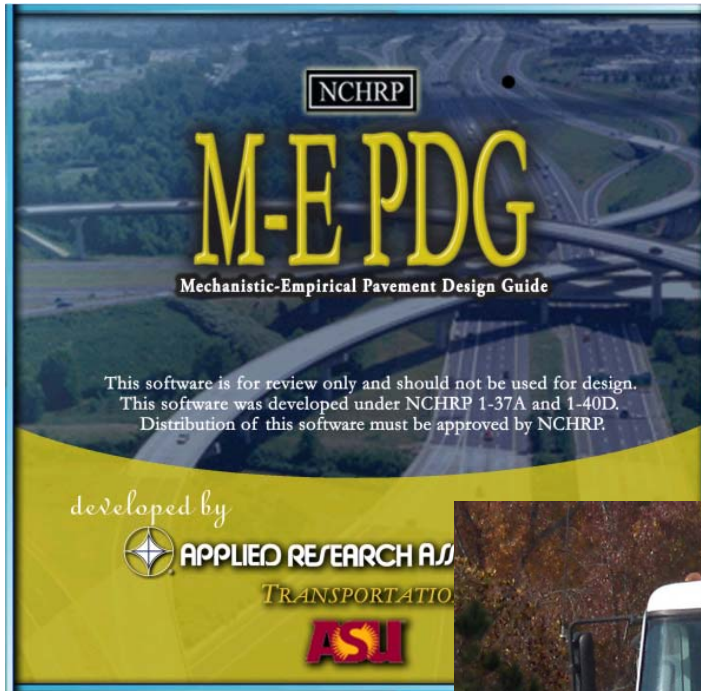


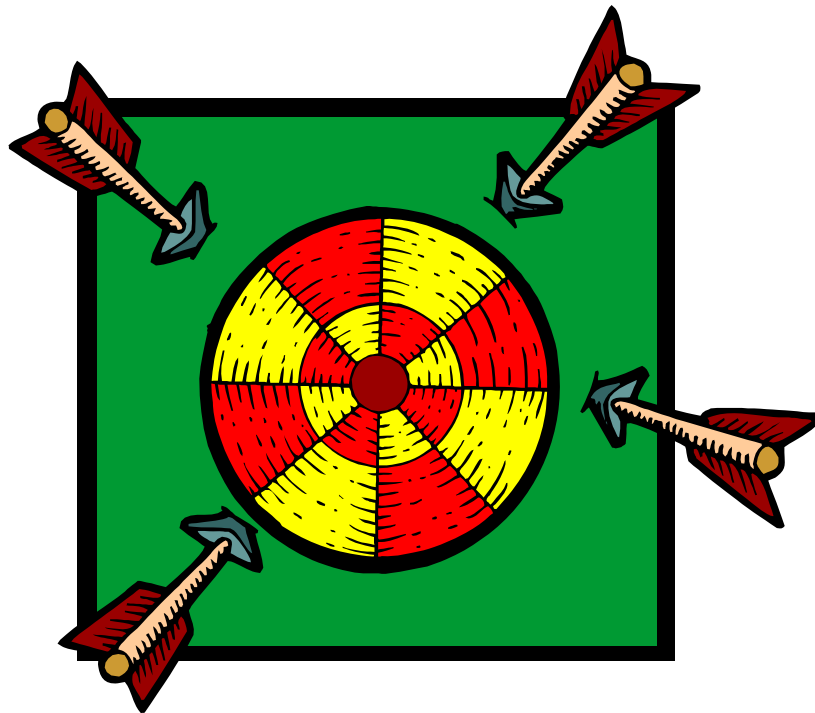
Validation/Calibration of MEPDG



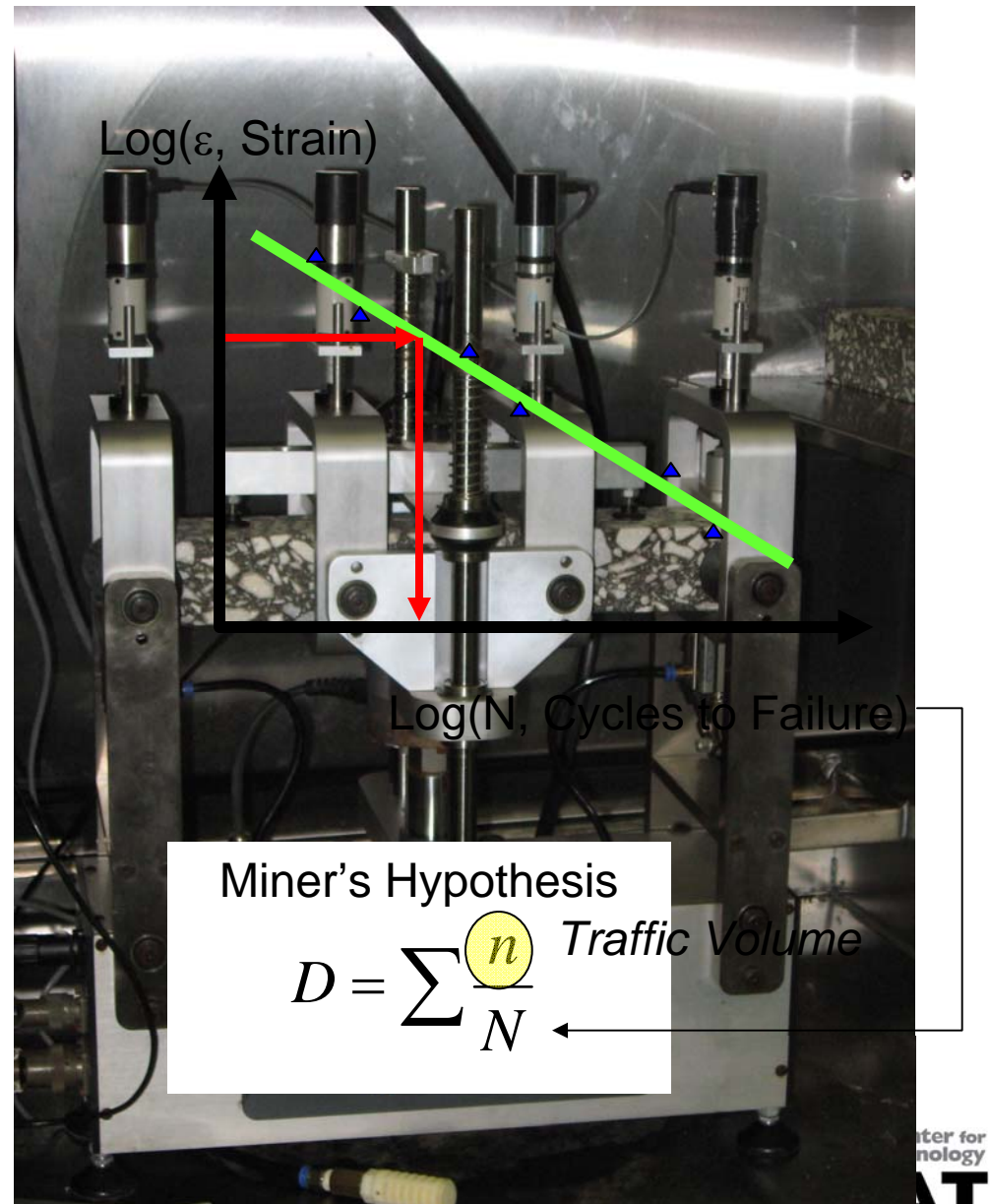
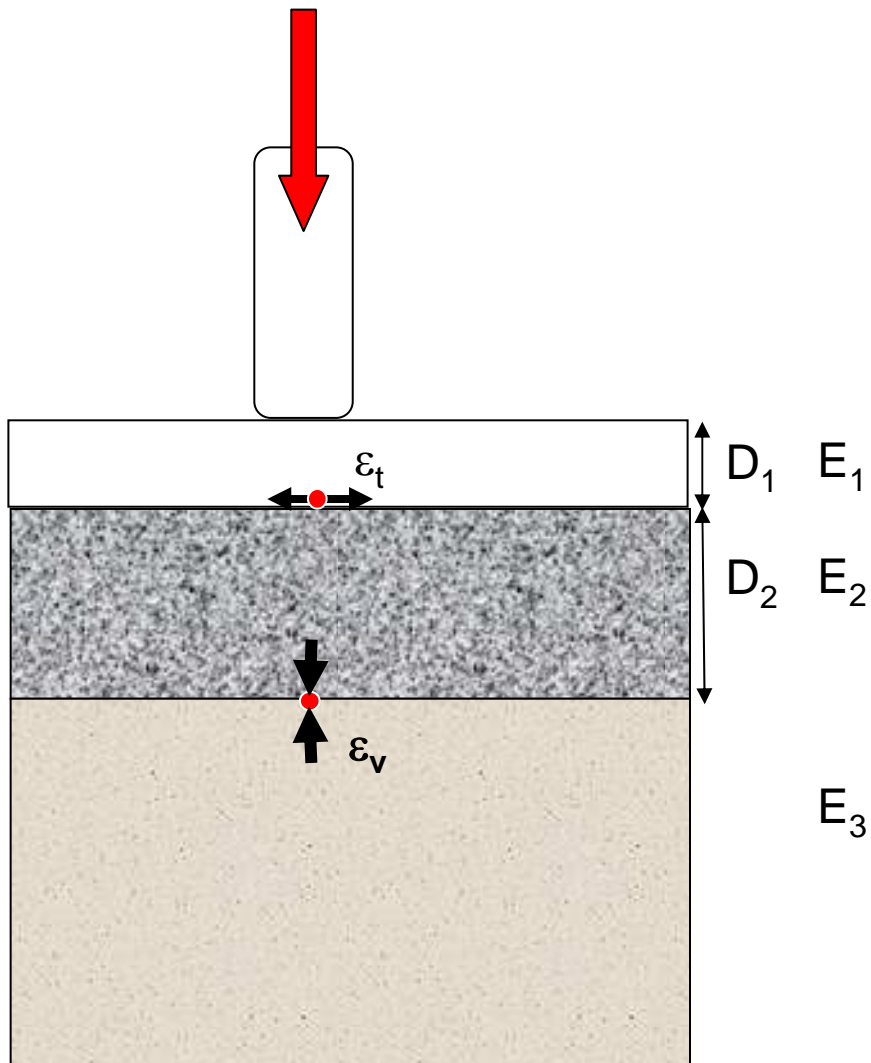
Test Track Sponsor Meeting – May 25, 2010

Background

- M-E Design to be new AASHTO standard
- DarWIN M-E will release in January 2011
- Need for local validation/calibration
 - National calibration did not include modified materials
 - National calibration not applicable to local conditions



M-E Design



N1_2006 - Mechanistic Empirical Pavement Design Guide

File Edit View Tools Help



Project [C:\Kendra\Projects\Calibration-Validation\N1_2006.dgp]

- General Information
- Site/Project Identification
- Analysis Parameters

Inputs

- 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
 - HMA Design Properties
 - Layers
 - Layer 1 - Asphalt concrete
 - Layer 2 - Asphalt concrete
 - Layer 3 - Asphalt concrete
 - Layer 4 - Crushed stone
 - Layer 5 - A-4
 - Thermal Cracking

Results

- Input Summary
 - Project
 - Traffic
 - Climatic
 - Design
 - Layer
- Output Summary
- Flexible Summary
 - Layer Modulus
 - AC Modulus (plot)
 - Fatigue Cracking
 - Surface Down Damage (plot)
 - Surface Down Cracking (plot)
 - Bottom Up Damage (plot)
 - Bottom Up Cracking (plot)
 - Thermal Cracking
 - Crack Depth (plot)
 - Thermal (C-h) (plot)
 - Crack Length (plot)
 - Crack Spacing (plot)
 - Rutting
 - Rutting (plot)
 - IRI (plot)

Analysis Status:

Analysis	% Complete
<input checked="" type="checkbox"/> Traffic	100%
<input checked="" type="checkbox"/> Climatic	100%
<input checked="" type="checkbox"/> Thermal Cracking	100%
<input checked="" type="checkbox"/> AC Analysis	100%
<input checked="" type="checkbox"/> Summary	100%

General Project Information:

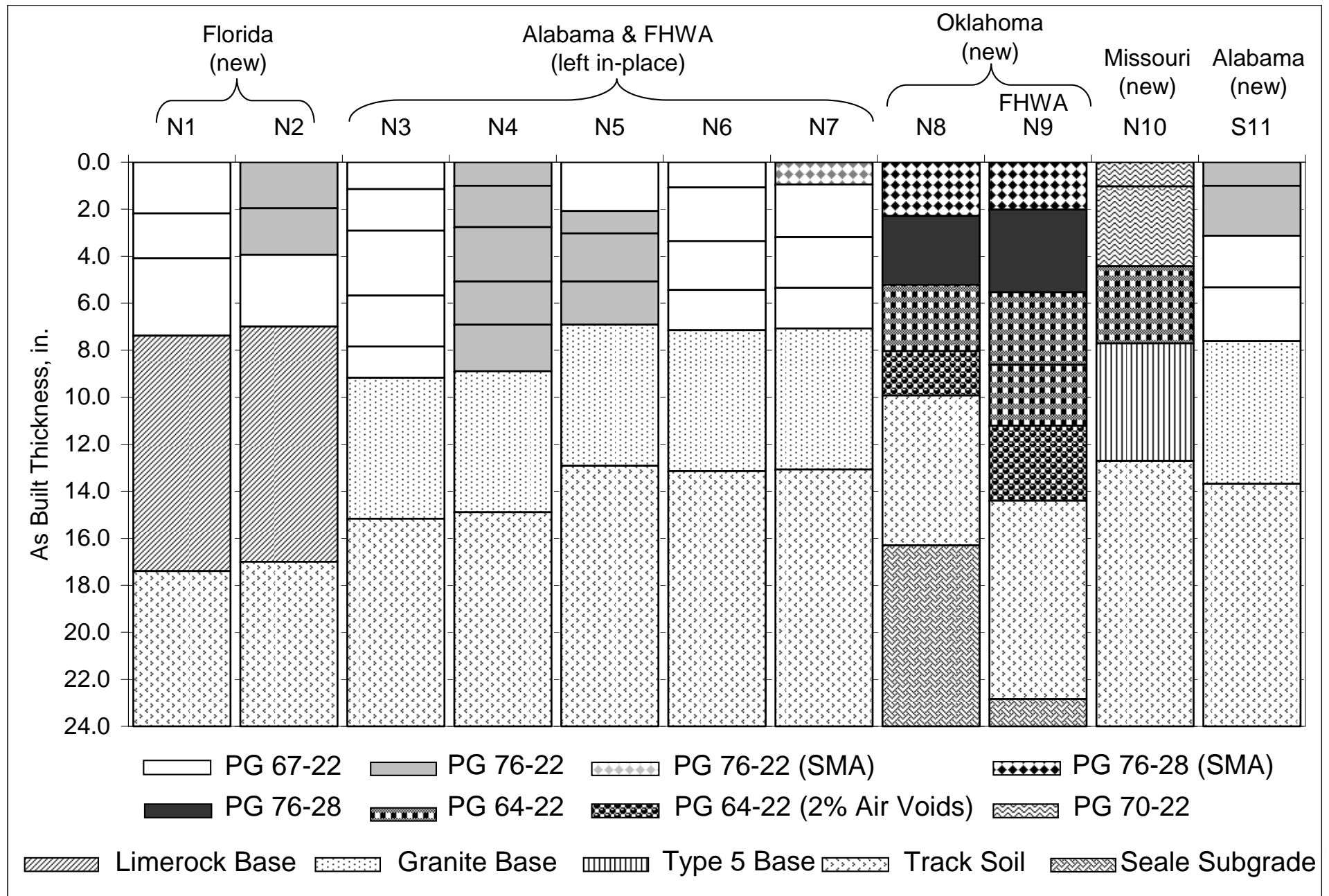
Parameter	Value
Type	New Flexible
Design Life	2 Years
Climate	C:\Kendra\Projects\Calibra
Construction Date	9/2006

Properties

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

 Run Analysis

2006 Test Sections



MEPDG Limitations on Cross-Sections

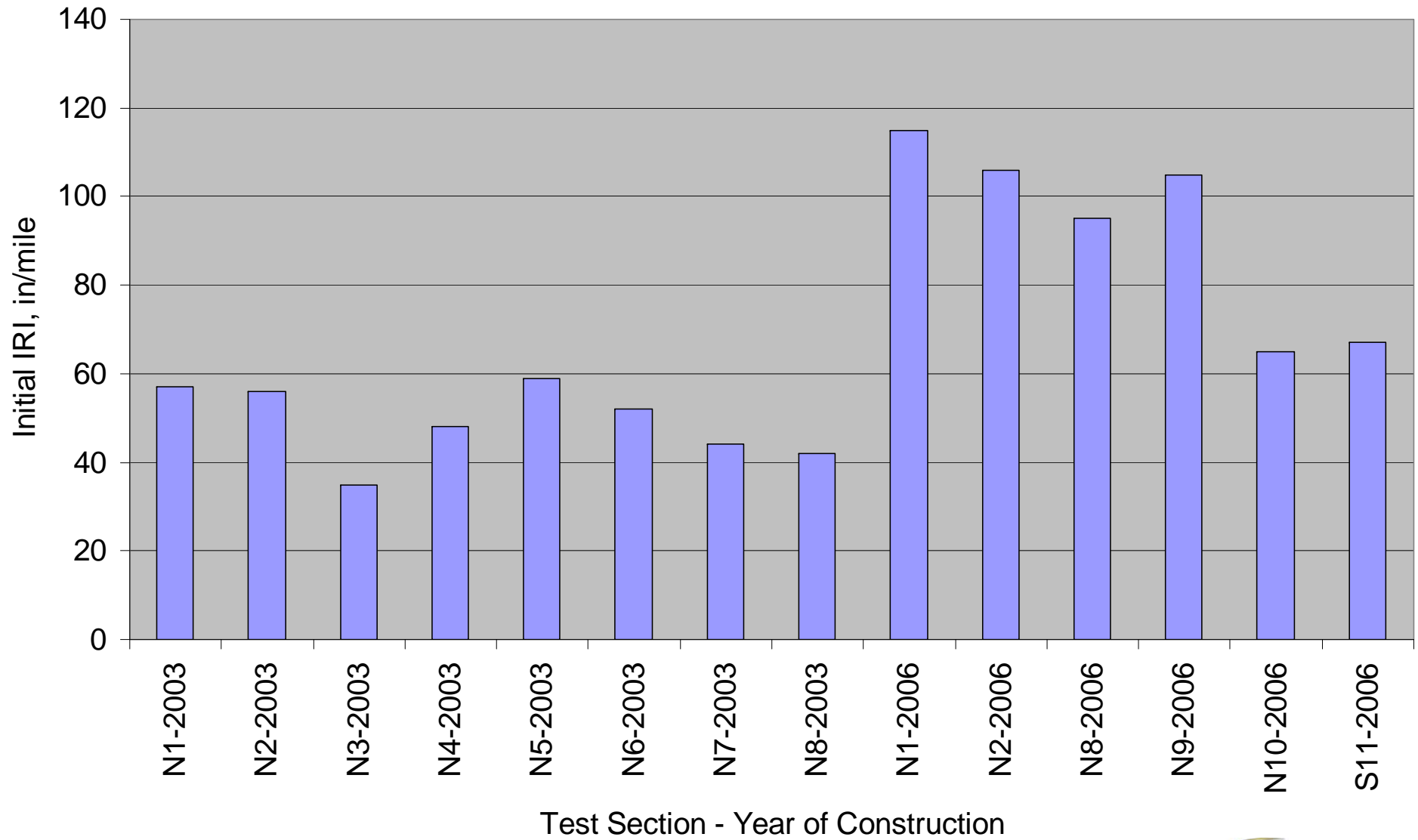
- MEPDG does not allow thicknesses $< 1''$
 - Solution
 - set 1'' and subtract thickness from layer beneath
- MEPDG does not allow > 4 HMA layers
 - Solution
 - Combine similar layers

General Information

- Construction sequencing
- Initial ride quality

Section	Test Cycle	Base/Subgrade Construction Month	Pavement Construction Month	Traffic Opening Month
N1	2003	June	July	October
N2	2003	June	July	October
N3	2003	June	July	October
N4	2003	June	July	October
N5	2003	June	July	October
N6	2003	June	July	October
N7	2003	June	July	October
N8	2003	June	July	October
N1	2006	August	September	November
N2	2006	August	September	November
N8	2006	August	October	November
N9	2006	August	October	November
N10	2006	August	October	November
S11	2006	August	October	November

Initial IRI



Traffic



12k

34k

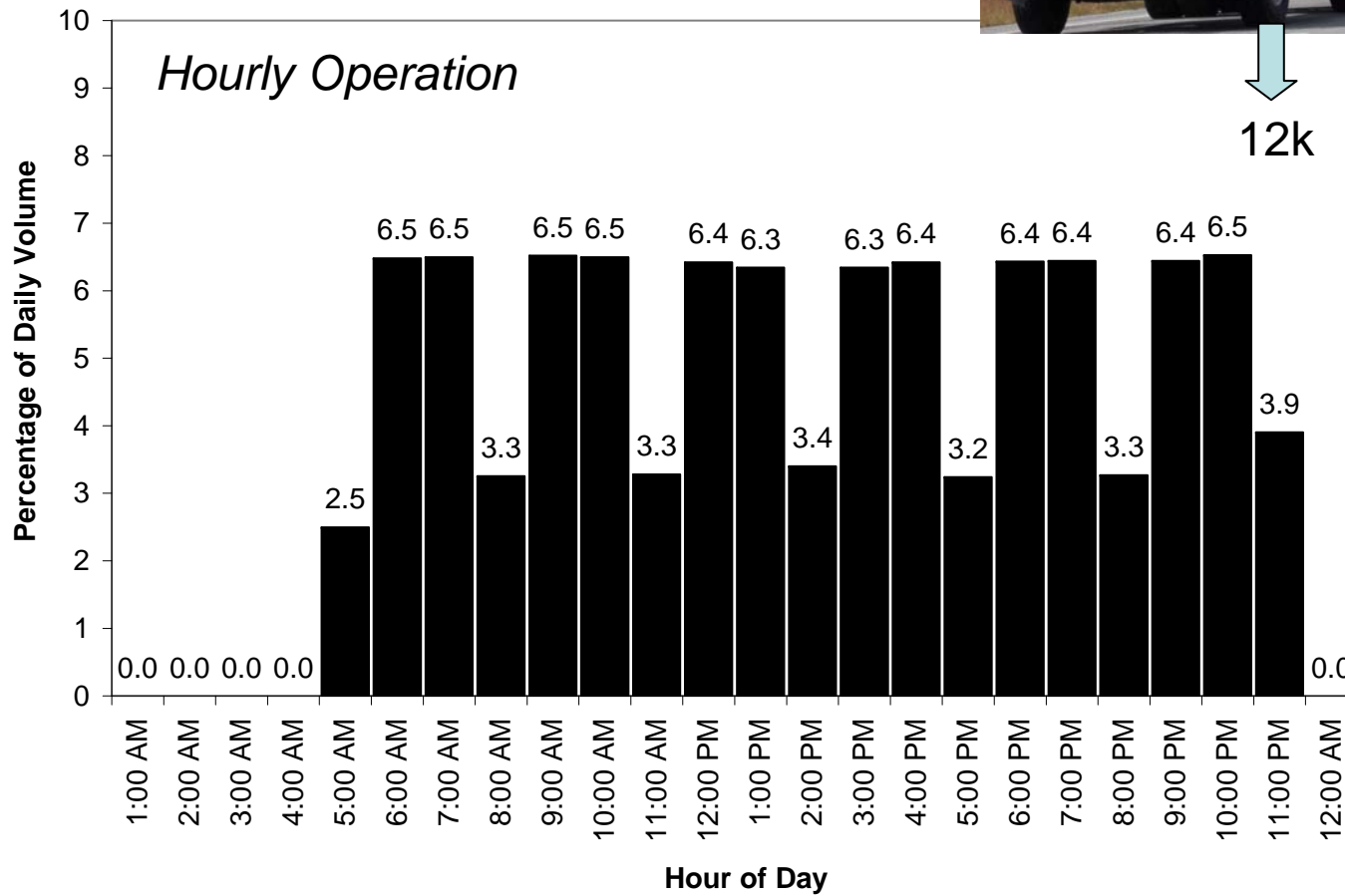
34k



12k

42k

21k * 5 axles



Climate

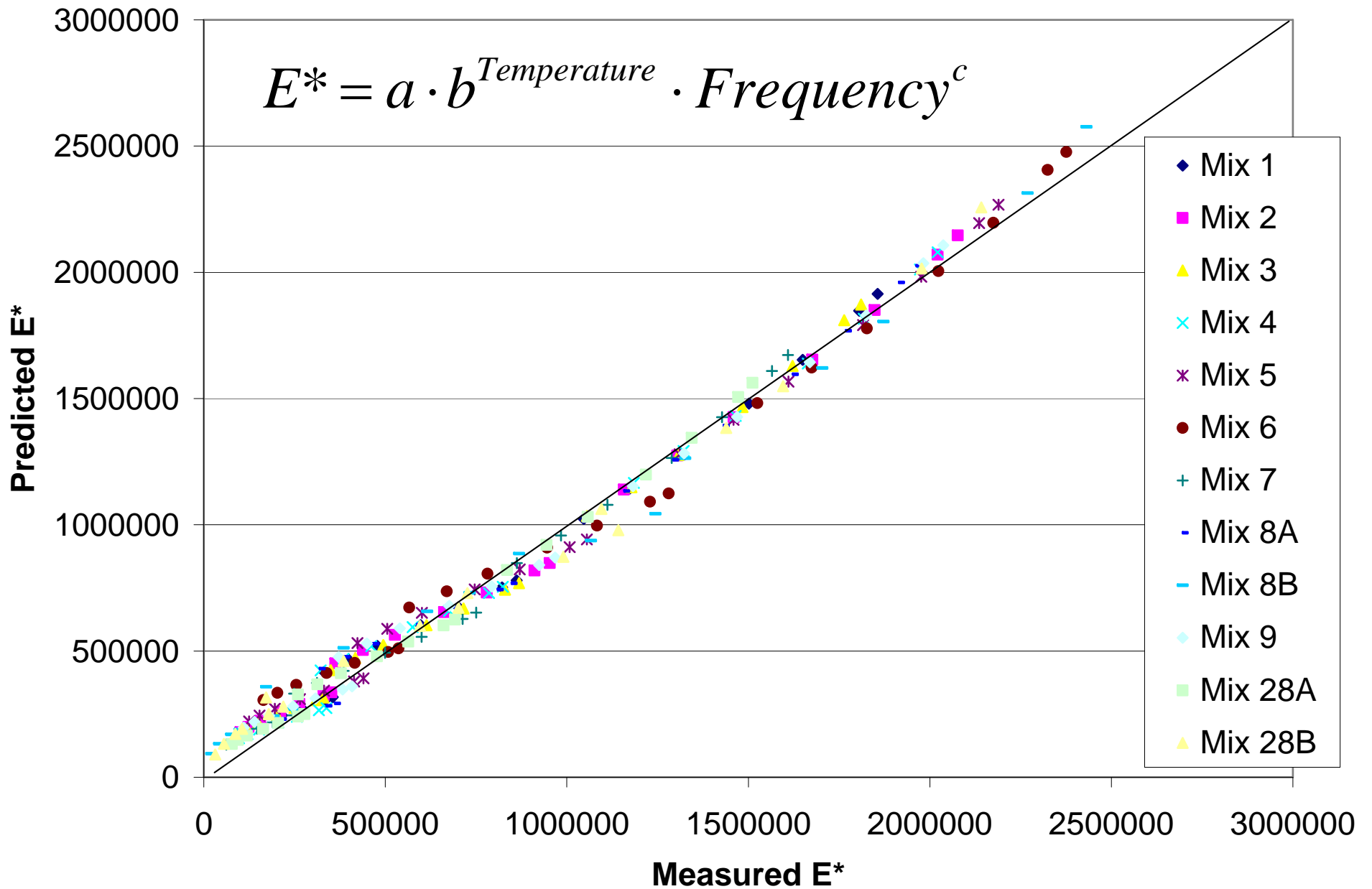
- Climate information
 - Air temperature
 - Rainfall
 - Wind speed
 - Relative Humidity
 - Percent Clouds
- Montgomery, Alabama weather station
 - 1996 – 2006 weather data
- Working on developing site-specific data
 - Current version of MEPDG will not use post 2006 data



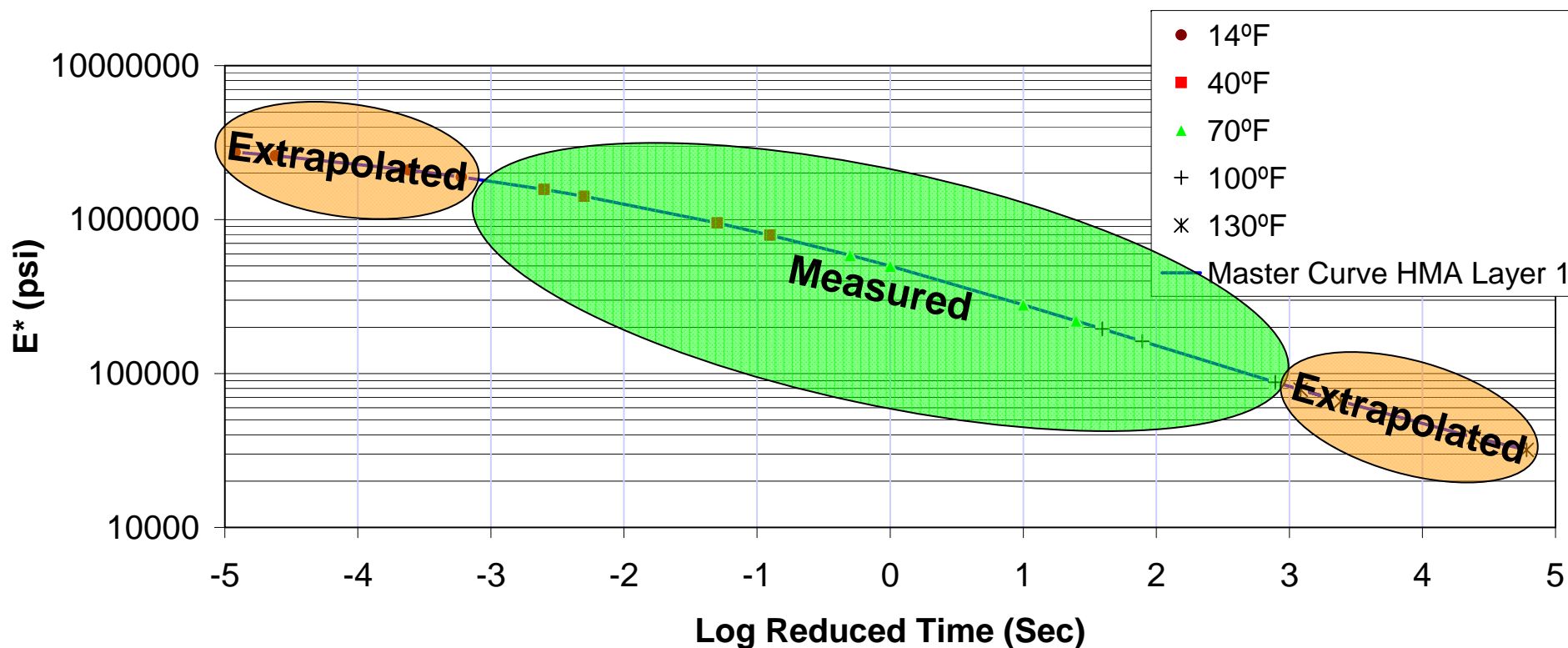
Mechanistic Material Properties

- HMA
 - Dynamic modulus (E^*) using AMPT
 - MEPDG requires 15°F to 130°F
 - Only tested from 40°F to 100°F
 - Needed to extrapolate data
- Granular base and Subgrade
 - Laboratory triaxial resilient (M_r) modulus using field-measured stress state

HMA – E*



HMA Master Curve



N1 – Lift 1 – 2003 Test Track

Other HMA Properties

Quadrant: S
Section: 11
Sublot: 1

Laboratory Diary

General Description of Mix and Materials

Design Method: Super
 Compactive Effort: 60 gyrations
 Binder Performance Grade: 76-22
 Modifier Type: SBS
 Aggregate Type: Gm/Lms/Snd
 Design Gradation Type: Dense

Avg. Lab Properties of Plant Produced Mix

<u>Sieve Size</u>	<u>Design</u>	<u>QC</u>
1":	100	100
3/4":	100	100
1/2":	100	100
3/8":	99	100
No. 4:	83	86
No. 8:	62	67
No. 16:	47	52
No. 30:	34	37
No. 50:	19	21
No. 100:	11	13
No. 200:	5.4	8.6
Asphalt Content:	6.3	6.9
Pill Bulk Gravity:	2.375	2.280
TMD (Rice):	2.474	2.464
Avg Air Voids:	4.0	3.4
Avg VMA:	18.1	18.0

Construction Diary

Relevant Conditions for Construction

Completion Date: October 13, 2006
 24 Hour High Temperature (F): 66
 24 Hour Low Temperature (F): 48
 24 Hour Rainfall (in): 0.00
 Planned Mill / Lift Thickness (in): 1.00
 Paving Machine: Roadtec

Plant Configuration and Placement Details

<u>Component</u>	<u>% Setting</u>
Asphalt Content (Plant Setting)	6.2
89 Columbus Granite	24.0
8910 Opelika Limestone Screenings	27.0
M10 Columbus Granite	30.0
Shorter Coarse Sand	19.0

Approximate Length (ft): 202
 Survey Mill / Lift Thickness (in): 1.0
 Type of Tack Coat Utilized: 07-22
 Target Tack Application Rate (gal/sy): 0.05
 Avg Temperature at Plant (F): 240
 Avg Section Compaction: 93.2%

**EFFECTIVE
BINDER
CONTENT**

**UNIT
WEIGHT**

**LIFT
THICKNESS**

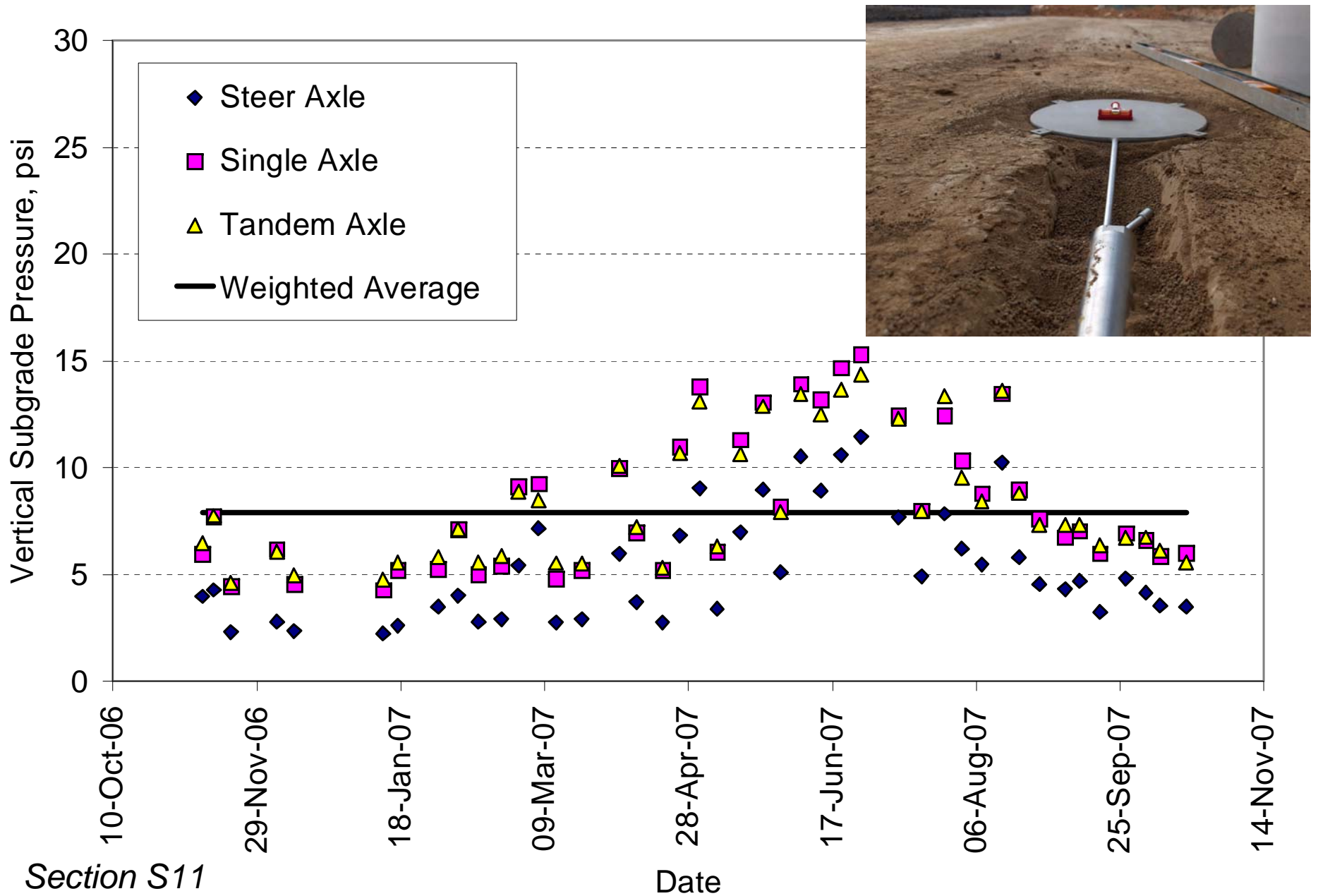
AIR VOIDS



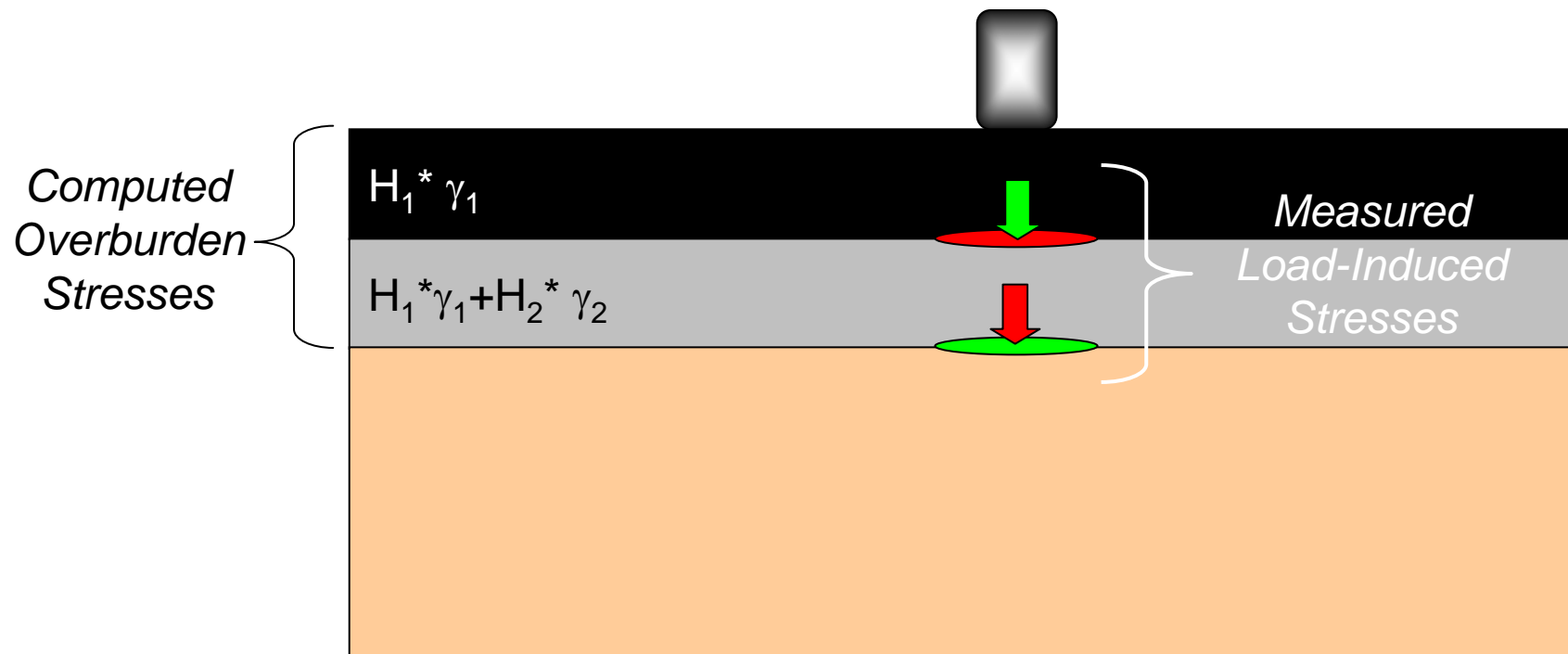
M_r of Soil and Granular Bases

- 2003 Test Sections
 - Used backcalculated data
- 2006 Test Sections
 - Used measured vertical stresses
 - Compute bulk and deviatoric stresses in pvmt
 - Used lab-determined M_r for each material
 - Find M_r corresponding to in situ stress state

Measured Stresses



Stress Computation



$\sigma_1 = \text{Computed Overburden} + \text{Measured Load-Induced Stresses}$

$$\sigma_3 = k_0^* \sigma_1$$

$$\theta = \text{bulk stress} = \sigma_1 + 2\sigma_3$$

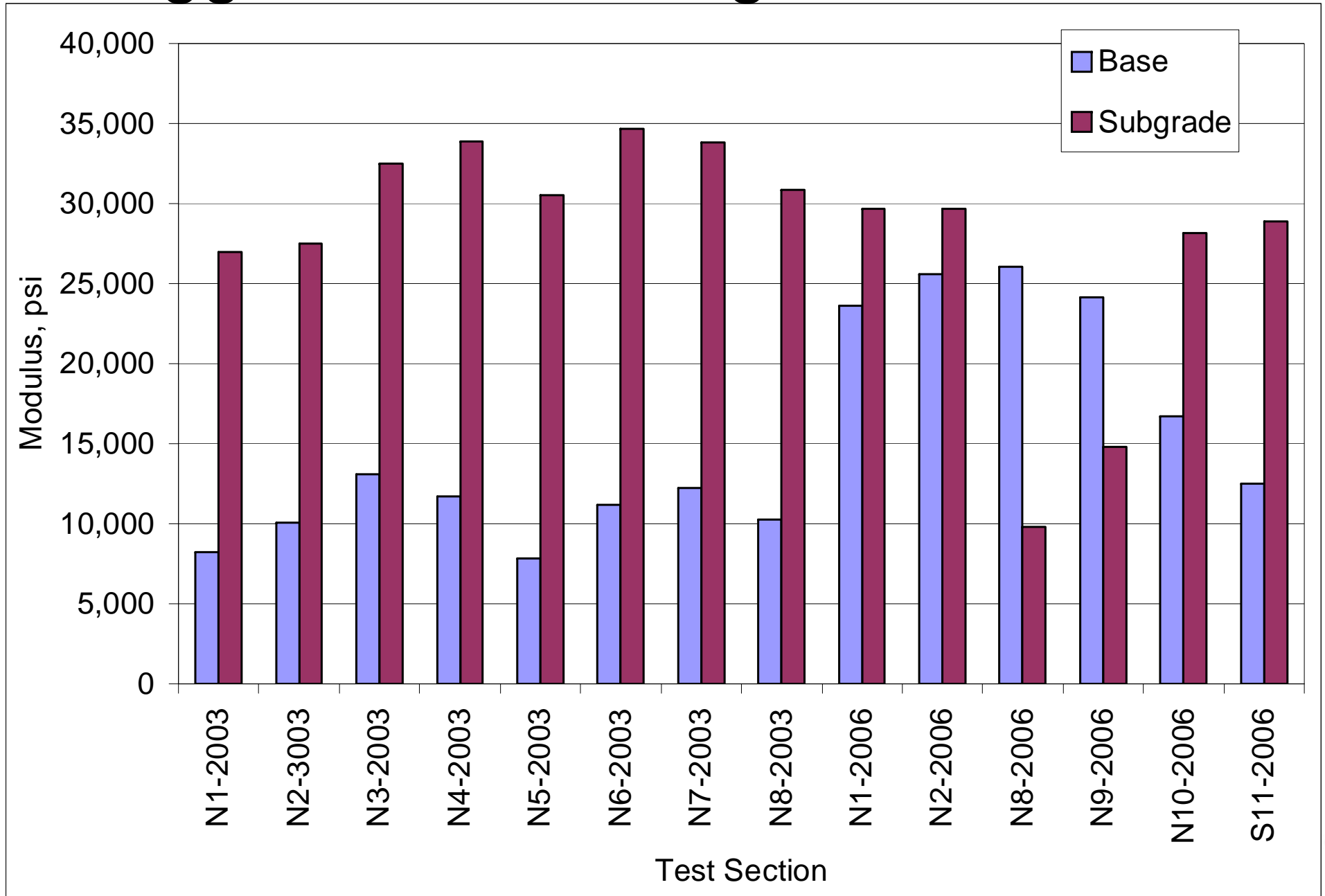
$$\sigma_d = \text{deviatoric stress} = \sigma_1 - \sigma_3$$

Unbound Moduli Determination

$$M_R = k_1 p_a * \left(\frac{\theta}{p_a} \right)^{k_2} * \left(\frac{\sigma_d}{p_a} \right)^{k_3}$$

Material Type	k_1	k_2	k_3
Track Soil	1095.43	0.5930	-0.4727
Crushed Granite	581.08	0.8529	-0.1870
Florida Limestone	717.04	1.2338	-0.5645
Type 5	643.69	1.0318	-0.2833
Seale Subgrade	225.09	0.3598	-0.7751

Agg Base and Subgrade Modulus

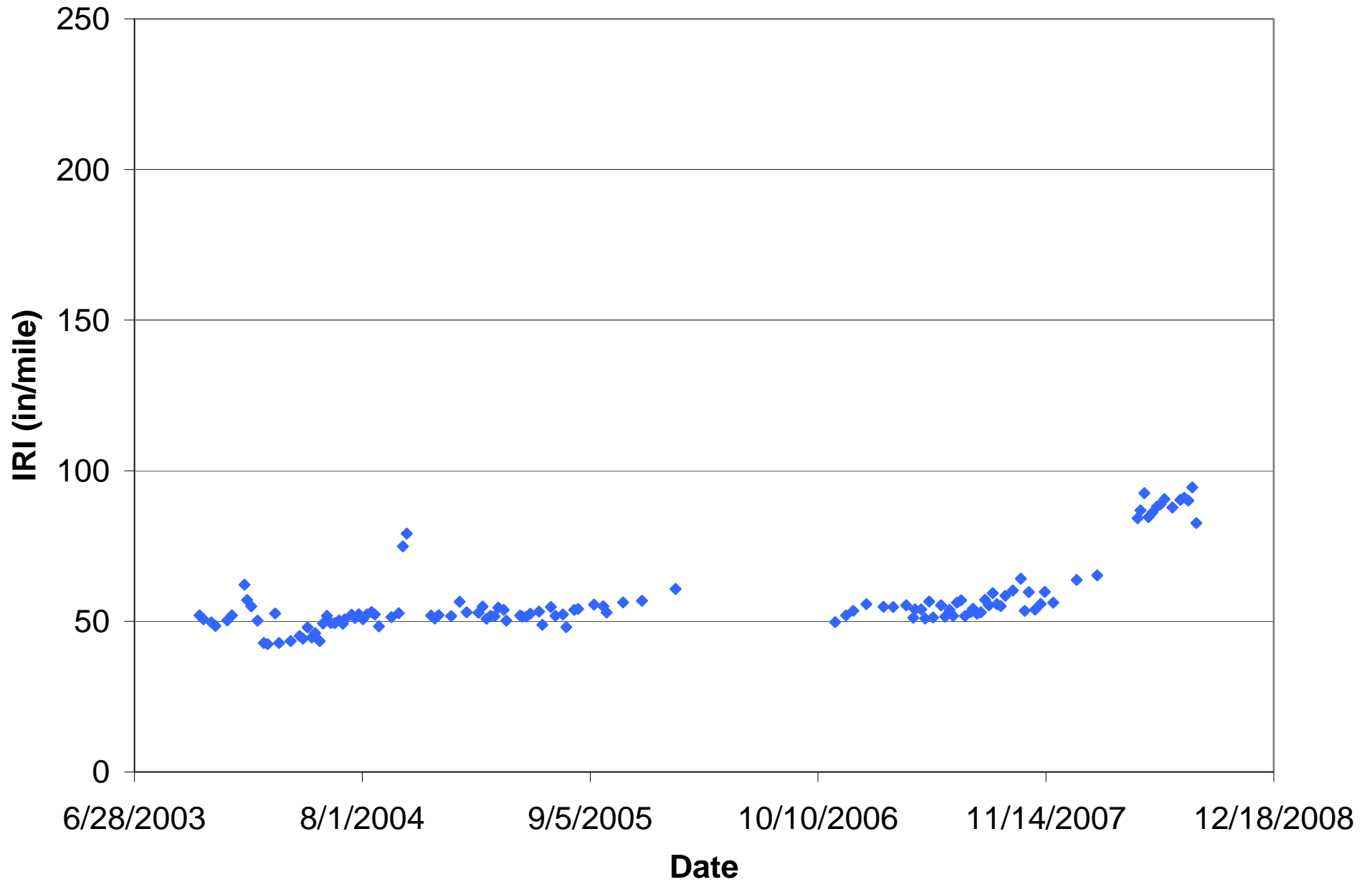


Performance Monitoring

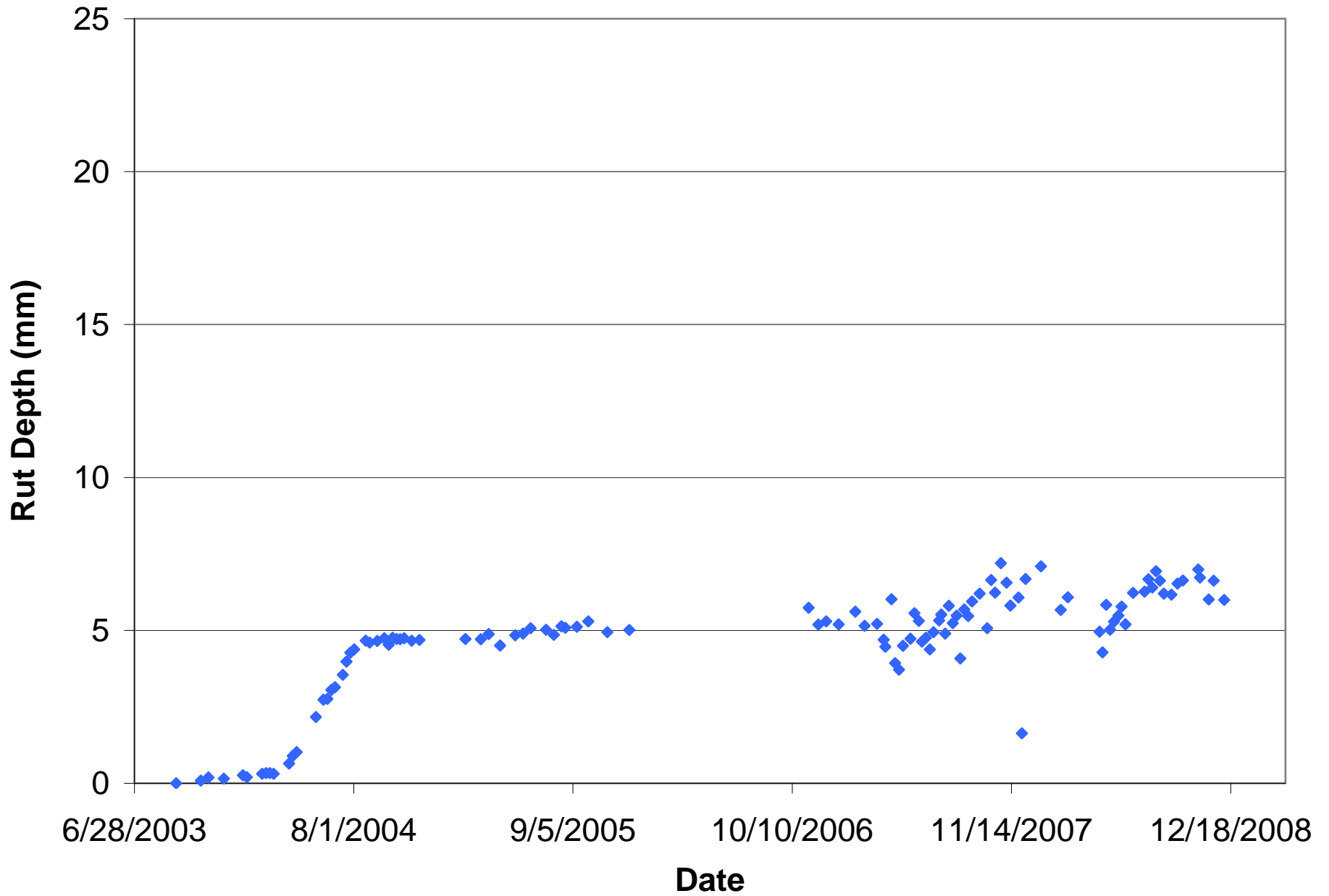
- IRI
- Rut Depth
- Fatigue Cracking



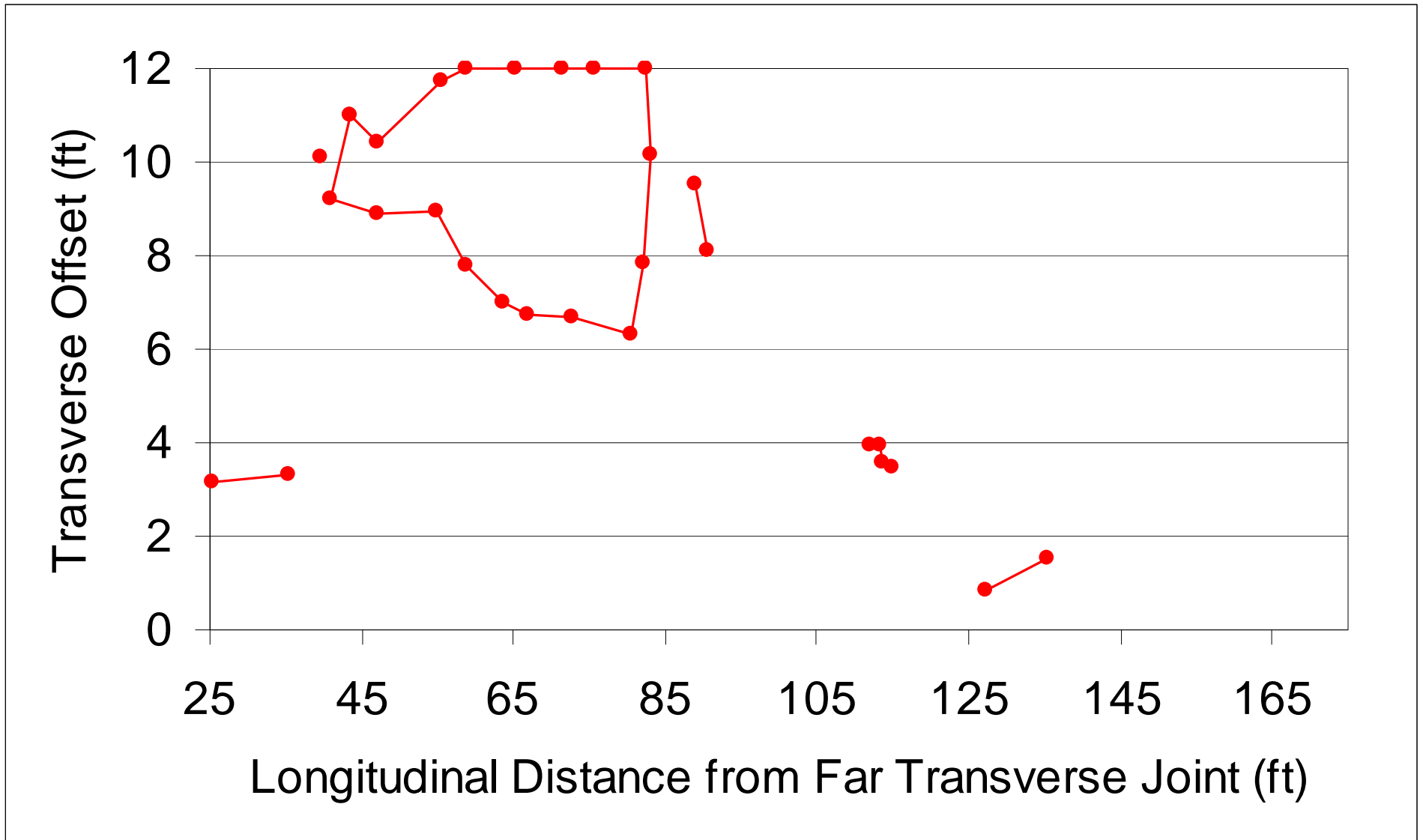
IRI (N6)



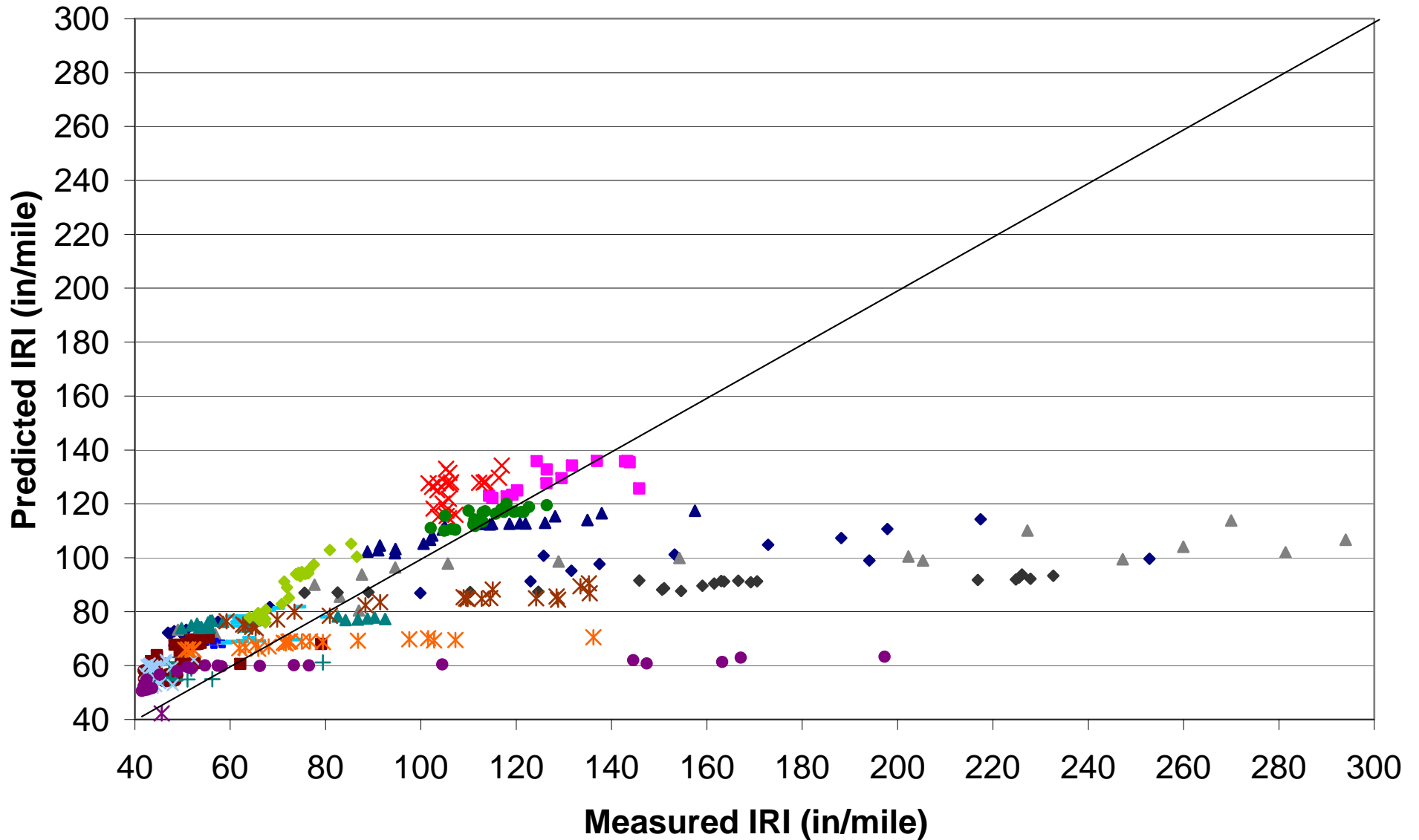
Rut Depth (N6)



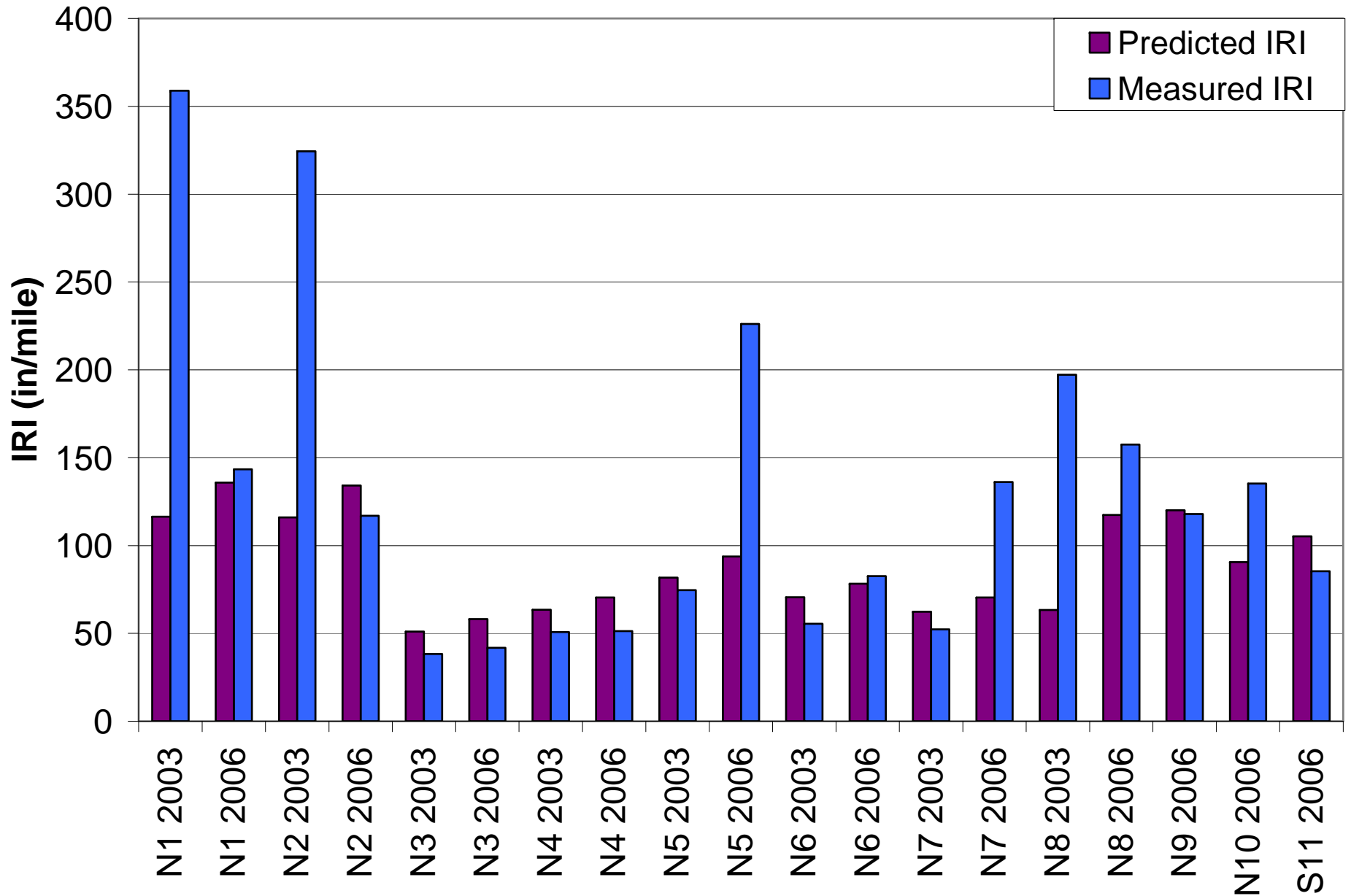
Fatigue Cracking (N6)



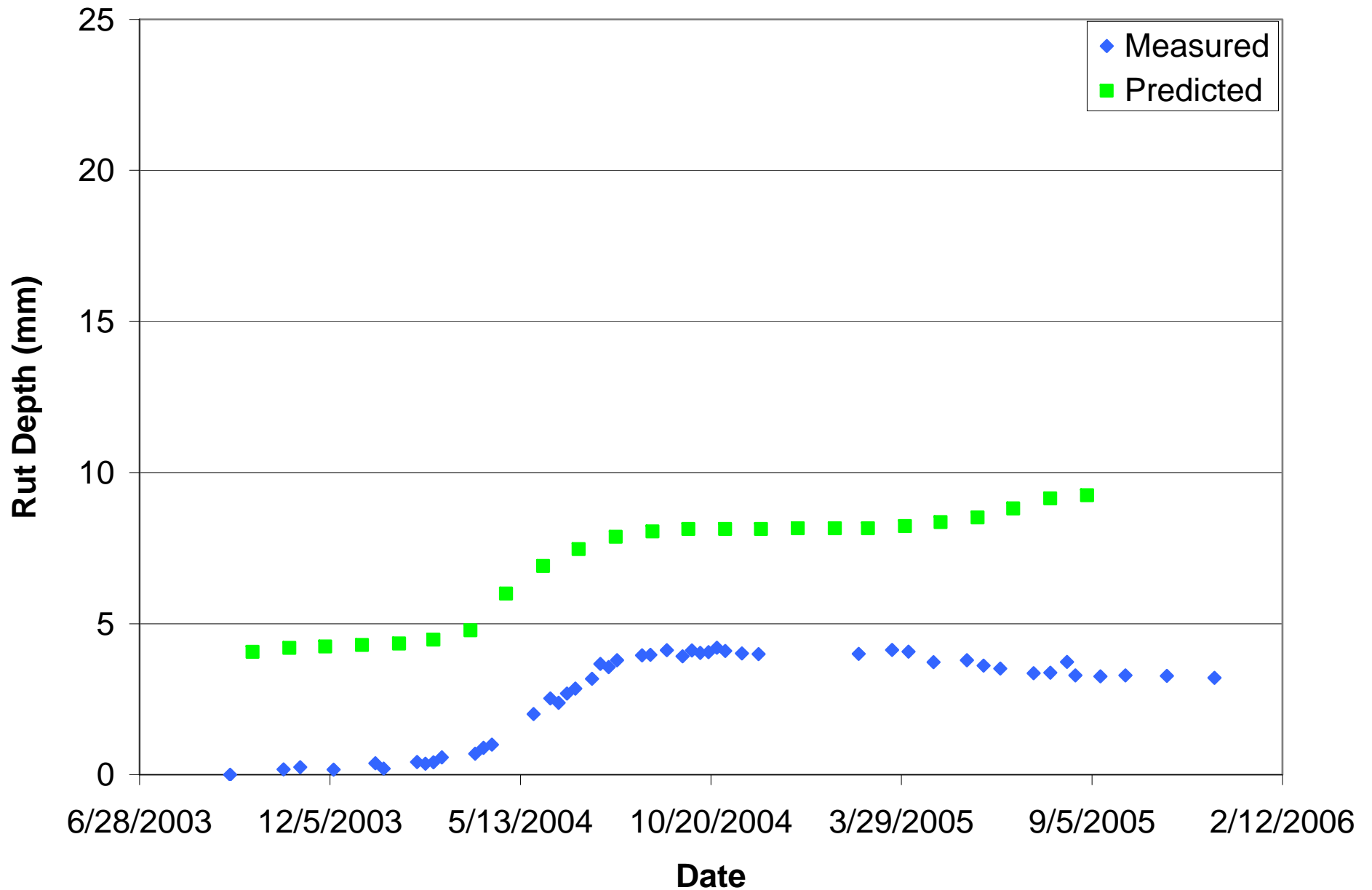
IRI Comparison – All Data



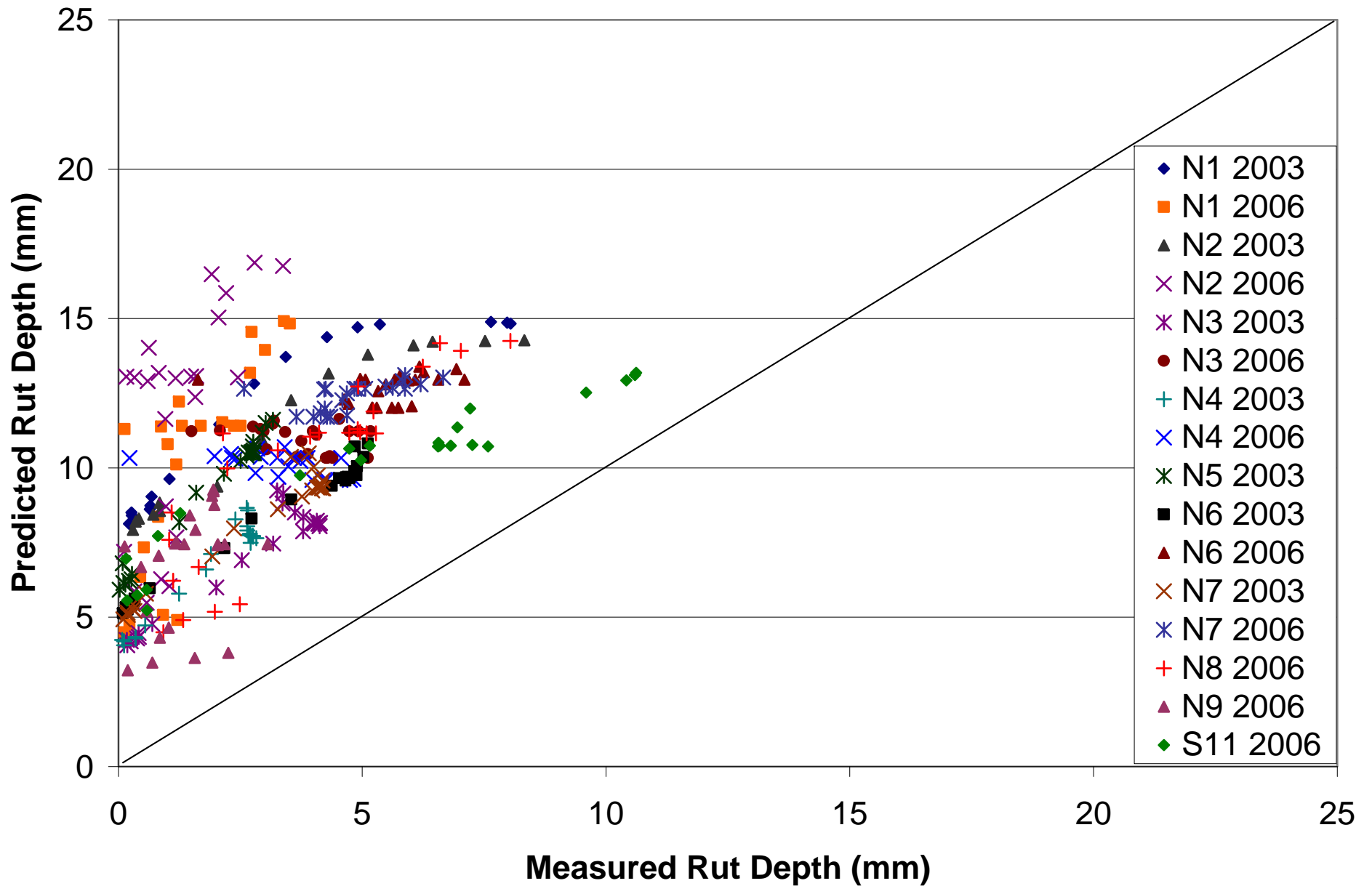
Final IRI – All Sections



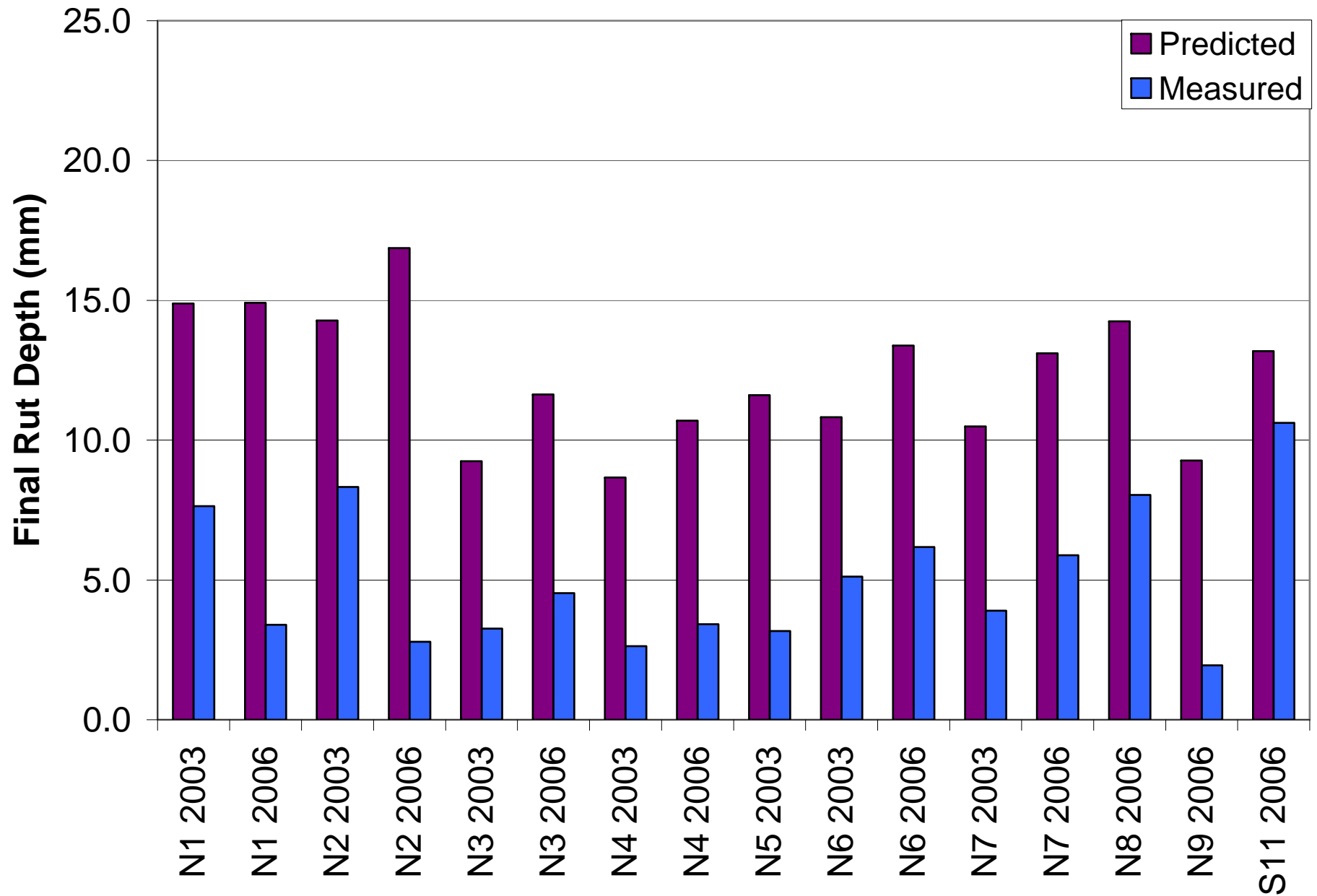
Rutting Comparison – N3 (2003)



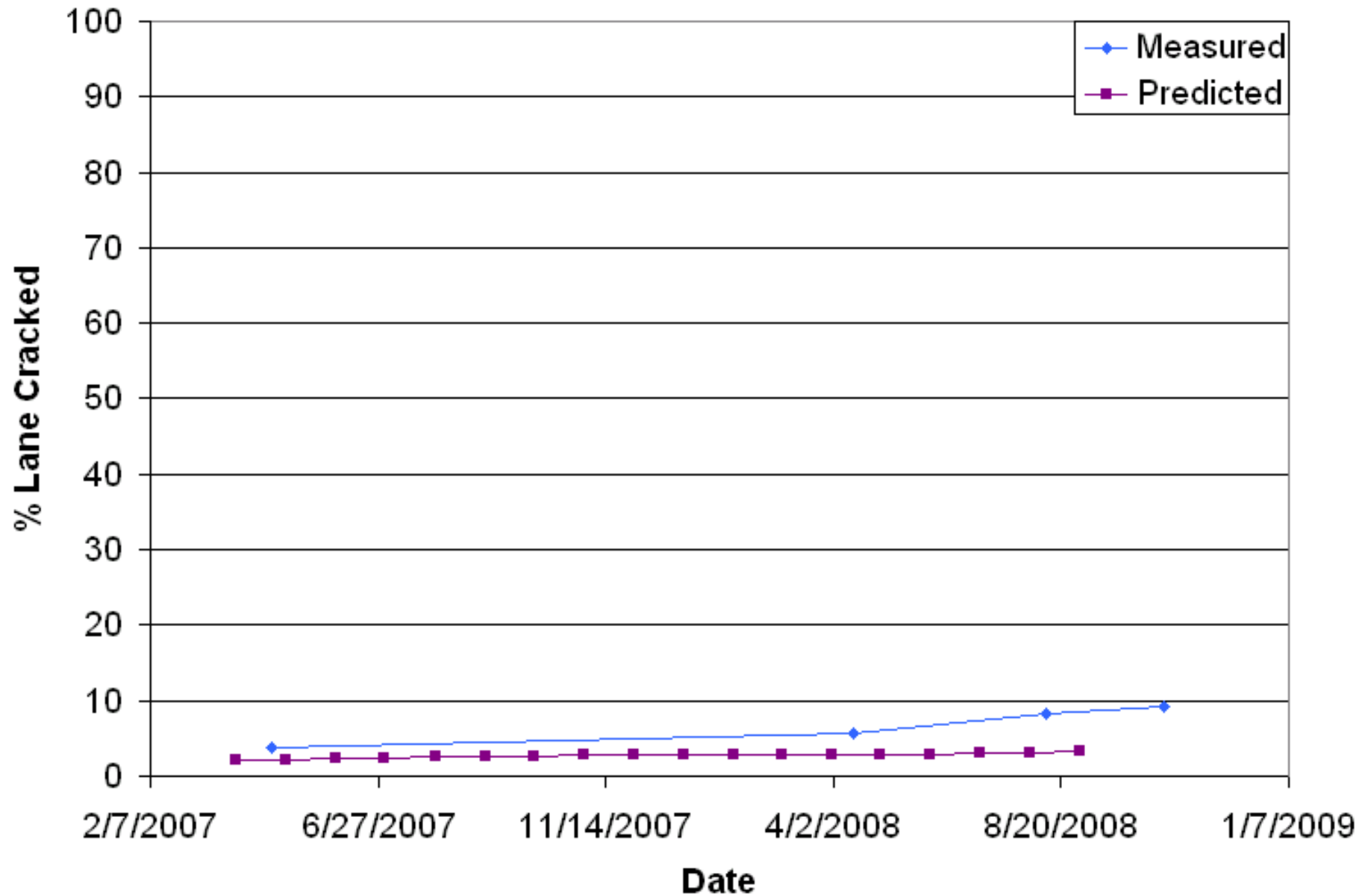
Rutting Comparison – All Data



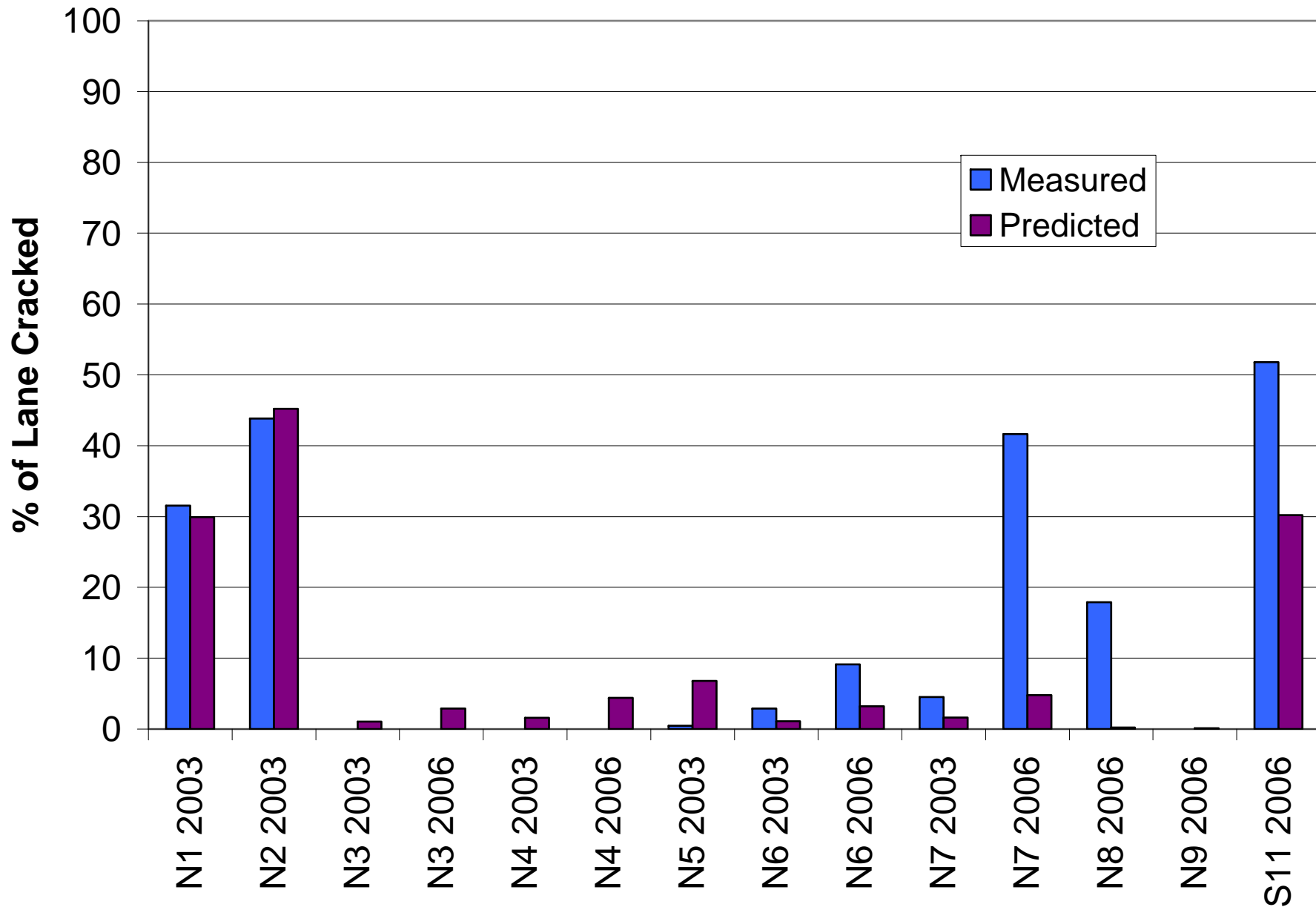
Rutting Comparison – Final Data



Fatigue Cracking Comparison – N6



Fatigue Cracking Comparison – Final Data



Conclusions and Recommendations

- Test Track data works well for local validation
- IRI
 - Closest match between measured & predicted
- Rutting
 - Significant overpredictions
- Fatigue cracking
 - Poorest match with data
- Need to continue with calibration
- Continue with 2009 test sections

Thank you!

