LTPP Data Analysis

Task Order #03

"Effect of Multiple Freeze Cycles and Deep Frost Penetration on Pavement Performance and Cost"

Quarterly Progress Report

January, February, March 2005

Prepared for:

US Department of Transportation
Federal Highway Administration
400 Seventh Street, S.W.
Washington, D.C. 20590

Detailed Technical Summary of NCE Task Order #03 "Effect of Multiple Freeze Cycles and Deep Frost Penetration on Pavement Performance and Cost"

In this quarter, NCE has continued work on Task 8 and Task 9 of Task Order #03 and presented a briefing at TRB as required by Task 7.

Task 7

Prepare and present briefings to the project panel in conjunction with the TRB Annual Meeting each year for the duration of the project.

Two presentations were made on the status of this Task Order during the Annual TRB meeting in January. A presentation was made to the Pavement Performance Data Analysis Forum sponsored by the TRB Data Analysis Working Group on in-progress work performed under this task order on Saturday before the Annual Meeting. NCE also presented a briefing to Pooled Fund State representatives on the Saturday evening before the Annual TRB meeting, as required by Task 7.

A copy of the slides presented to the Pooled Fund Panel can be found in Appendix B.

Task 8

Conduct detailed analysis of the effects of multiple freeze-thaw cycles verses deep frost penetration on pavement performance

The analysis team continues to work on developing regression models to predict various pavement performance measures this quarter. Significant progress has been made and the regression models are nearing completion. Once finished, a thorough comparison of the deterioration trends in each of the frost regions will be performed.

In the previous quarterly report, a discussion on extreme observations in the dataset was presented along with the two methods that can be employed to account for these data points. One method applies a weighting factor to the contribution of extreme cases which limits their impact on the model. This method (the Robust method) should be employed if the observations are truly outliers and/or questionable data points that would negatively impact the model. On the other hand, these cases could be treated like any other with their full impact incorporated into the model (the GLM method) if they are valid data points that represent extreme conditions.

The analysis team investigated these observations during this quarter. To determine which method is more appropriate and will produce the most representative model, the nature of the dataset must be considered as well as the amount of quality control checks performed on the data. If extreme cases are expected (given the design of the experiment) and a rigorous quality review has been performed on the data, it is highly probable that the remaining influential observations are valid and reducing their impact on the model would bias the models prediction capability.

For this study, data comes from a national database in which some of the variables may be set to extreme limits resulting in extreme performance observations. On a small scale, the SPS-1 projects can be used to illustrate this. Each of the 12 test sections at an SPS-1 project has a different structural capacity but all experience the same traffic loading. By experimental design, certain variables (in the case of SPS-1 projects, the ratio of traffic loading to structural capacity) would be set to the extreme ends of the spectrum. As such, extreme observations are to be expected in the dataset and are necessary to generate a model that reflects observed performance.

Additionally, the analysis team performed considerable amounts of logical quality review on the data to identify and remove data that were believed to be erroneous. The data has also undergone the quality control process utilized by the LTPP team prior to releasing the data for public use. Therefore, it is not likely that the remaining influential observations are erroneous or unrepresentative of the data set.

To further compare the two methodologies, two models were developed for absolute IRI of asphalt pavements. One model was developed using the Robust method while the other utilized the GLM procedure. The predicted IRI values from the Robust and GLM models versus the observed IRI values can be found in Figures 1 and 2, respectively. The GLM method produces a model that has less bias than the Robust model. In Figure 1, the majority of the data points are clustered below the line of equality (circled in red). The cluster of the GLM model is more centered on the equality line compared with the Robust model. This indicates that the Robust method of reducing the impact of extreme observations results in a model that generally predicts values less than the observed values.

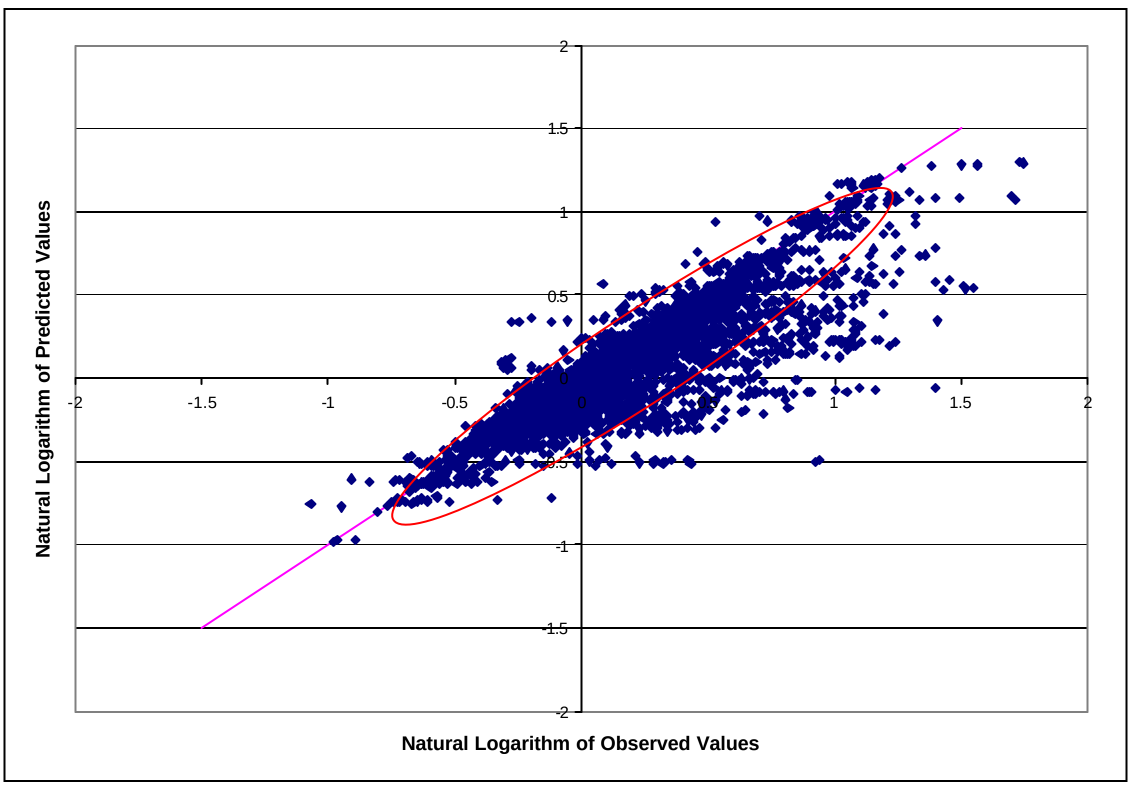


Figure 1. Observed vs. Predicted values of Absolute IRI (normalized) using the Robust method.

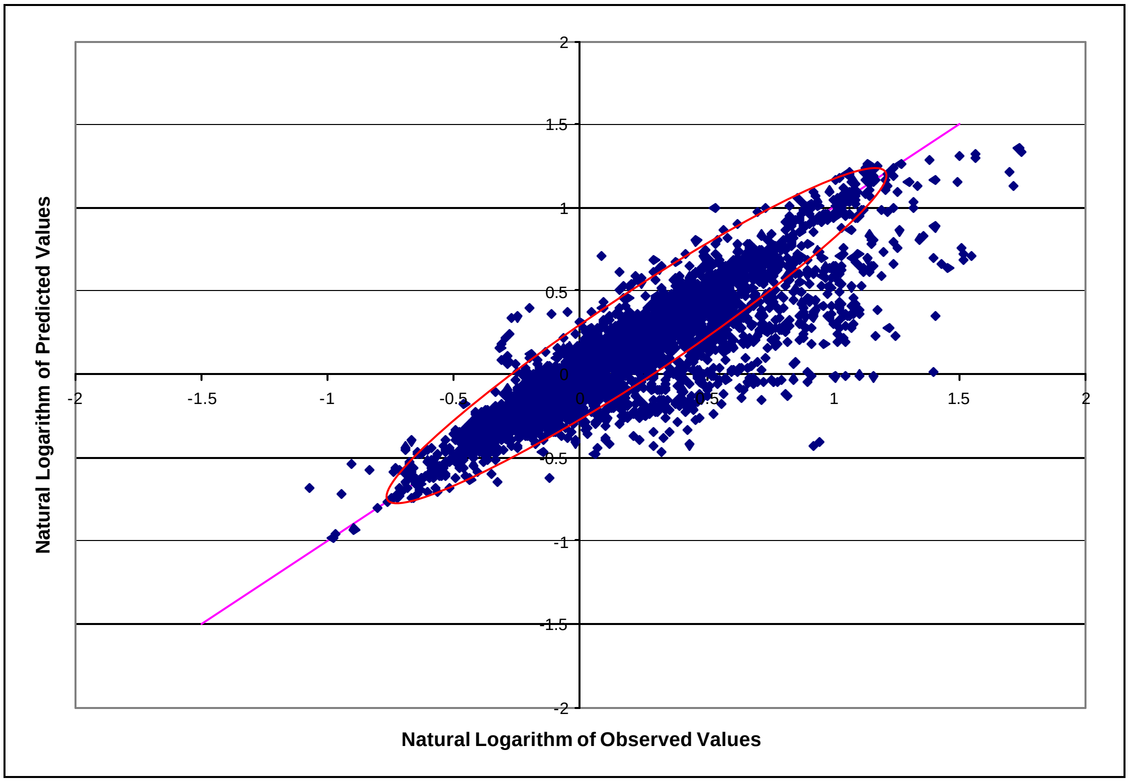


Figure 2. Observed vs. Predicted values of Absolute IRI (normalized) using the GLM method.

Considering the nature of the data set, the level of quality reviews performed on the data, and the results from the previous comparison, the GLM method was chosen to develop regression models for this study.

The analysis team also continued work on the development of the distress regression models. A two step approach has been implemented in predicting the accumulation of distress over time. The first step is the development of a logistic model which will be used to predict the age at which distress initiates. After the distress initiation age is predicted, linear regression models will be developed to predict the accumulation of distress with age (after initiation). To do this, the pavement age had to be adjusted to reflect age after distress initiation.

Some of the test sections were monitored both before and after crack initiation. For these cases, crack initiation was determined as the maximum pavement age where a zero distress value was observed. This crack initiation age was then used to adjust the remaining pavement ages to ages after distress initiation. An example of one such test section is presented in Figure 3. The crack initiation age was determined to be 2.4 years. The remaining ages were then adjusted by subtracting 2.4 years from the pavement age to obtain age after initiation.

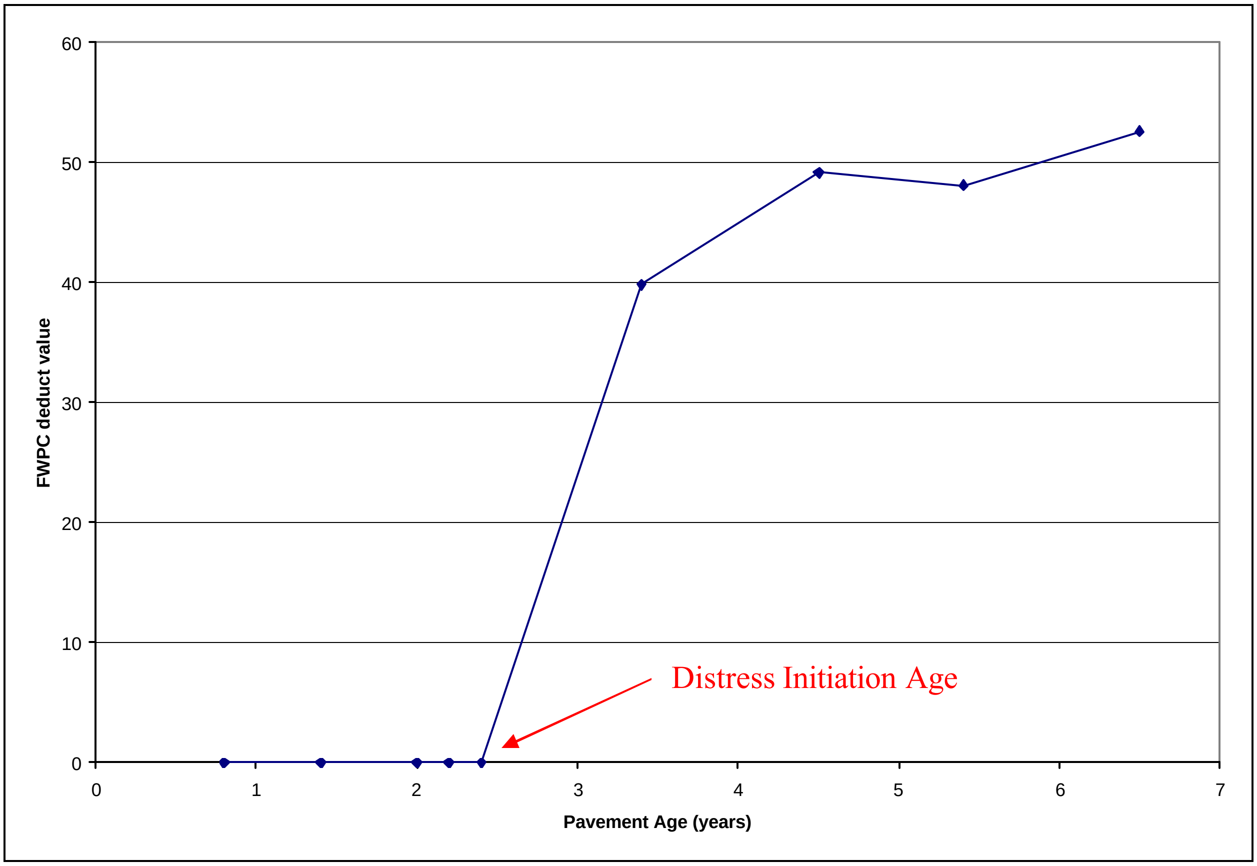


Figure 3. Observed FWPC deduct values for test section 100102.

For test sections that were not monitored before the distress initiation, linear regression was performed on each test section and used to determine the age at which the distress initiated. An example of this is shown graphically in Figure 4. The initiation age estimated from the regression equation was subtracted from subsequent pavement ages to get age after initiation. The regression models are currently being developed using only non-zero distress values (i.e. values recorded after initiation) and replacing age with the adjusted ages.

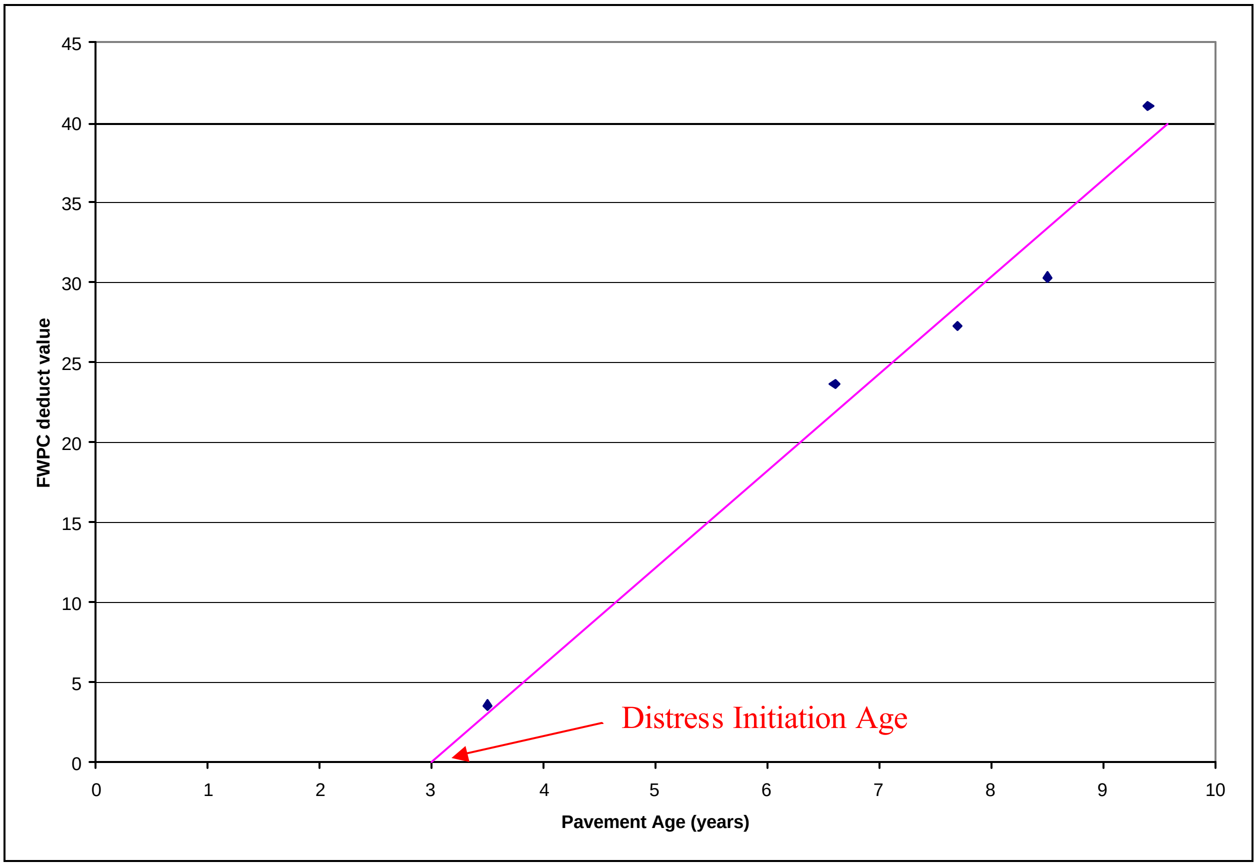


Figure 4. Observed FWPC deduct values for test section 050121 (with regression line).

NCE has no results on comparisons to report at this time. Current work includes evaluating the regression model predictions in different climates to compare performance in the deep freeze, multiple freeze-thaw cycle, and no freeze climates.

Task 9

Conduct detailed analysis of the extent to which local adaptations of materials standards and empirical pavement design practices have been effective at reducing the rate of pavement deterioration

Toward the end of this quarter, NCE received the last of the states' responses to the questionnaire sent out in March, 2004. A summary of the data from the states was presented at the Pooled Fund Panel meeting at the Annual TRB Meeting. The summary indicates a large variation in the typical pavement sections provided by the different states to the design criteria stated in the questionnaire. The variation is not necessarily consistent with trends in frost depth or freeze-thaw cycles. This information will be returned to the Pooled Fund Panel members for review and comments. A copy of the design summaries is attached as Appendix C

NCE will also be requesting contact information for agencies adjacent to the Pooled Fund states where special design practice, might be of use in this study. A separate questionnaire will be sent to those states as well.

NCE is in the process of compiling the information that was submitted by those states that responded to the questionnaire. NCE has neither analyzed the data nor made any conclusions at this time.

Resources Used

Figure D.1 in Appendix D shows the current work schedule for Task Order #03 through March 2005.

This task order remains several months behind schedule compared to the planned timeline. This is a carryover from the delay in starting on Phase 2 from the previously planned schedule and the added work of developing the additional databases that were used in the trend analysis for Task 3, as well as the delay in the return of the state questionnaires. While NCE will continue to concentrate on getting back on schedule, a no-cost time extension will be submitted this next quarter. The current schedule and several options were discussed at the Pooled Fund Panel meeting in January. There was a consensus among the panel members that an extension should be requested and that the timing should be scheduled such that the final panel meeting could take place during the 2006 Annual TRB Meeting in Washington, DC. A six month time extension request will be submitted next quarter to provide for the panel meeting in January 2006 and final edit time after comments at the panel meeting.

The expenditures have continued to be about 30 percent below planned expenditures as a carryover from the earlier delay. Figure D.2 in Appendix D shows the planned costs versus actual costs for Task Order #03 through March 2005. However with a six month extension the current expenditure rate is about where it should be to be fully funded through the time extension.

Appendix B

Task Order #03

Pooled Fund Panel

Meeting Slides

National Pooled-Fund Study TPF-5(013)

Effect of Multiple Freeze-Thaw Cycles vs. Deep Frost Penetration on Pavement Performance

Technical Advisory Committee Meeting
January 8, 2005

Newton Jackson, P.E.
Jason Puccinelli
Nadarajah Suthahar, P.E.

NICHOLS CONSULTING ENGINEERS, CHTD.
Engineering and Environmental Services

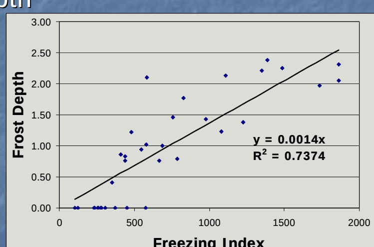
U.S. Department of Transportation Federal Highway Administration

Phase I Findings

- Confirmed contention that LTPP data can support the study
- Data set must be expanded from SMP sites to account for all contributing variables

Phase I Findings-cont'd

- Freezing Index (FI) is representative of Frost Depth



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Phase II

- Task 8
  - Effects of FTC and frost penetration on pavement performance
- Task 9
  - Effectiveness of local adaptations on reducing rate of deterioration
- Task 10
  - Cost Comparisons

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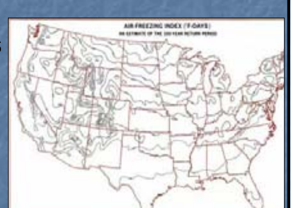
Contributing Variables

- Pavement Types
- Climatic Data
- Frost Depth
- Soils/Material Properties
- Traffic Data
- Performance Data
  - Deflection Data



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Pavement Types

- Flexible Pavement
  - GPS-1: AC over granular base
  - GPS-2: AC over bound base
  - GPS-6: AC overlay over existing AC
  - SPS-1: Structural study of AC
  - SPS-8: Environmental study of AC without heavy loads

Pavement Types-cont'd

- Rigid Pavement (JPCP)
  - GPS-3: Jointed plain concrete pavement (JPCP)
  - SPS-2: Structural study of rigid pavement
  - SPS-8: Environmental study of JPCP without heavy loads

Climatic Data

- Virtual Weather Station Data
  - Cooling Index (CI)

$$\text{Cooling Index} = \sum(\overline{T} - 18.33) \quad \text{if } \overline{T} > 18.33$$
$$\overline{T} = \text{Mean Daily Temperature (°C)}$$

  - Freeze-Thaw Cycles (FTC)
  - Precipitation (PRECIP)
  - Freezing Index (FI)

$$\text{Freezing Index} = \sum(0 - \overline{T}) \quad \text{if } \overline{T} < 0$$
$$\overline{T} = \text{Mean Daily Temperature (°C)}$$

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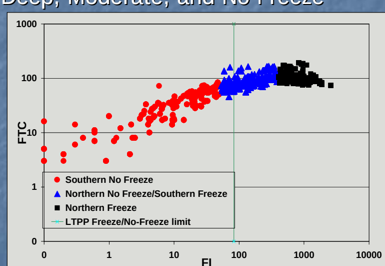
Climatic Zones

- Limits of Deep, Moderate, and No Freeze Regions



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Task Order #03
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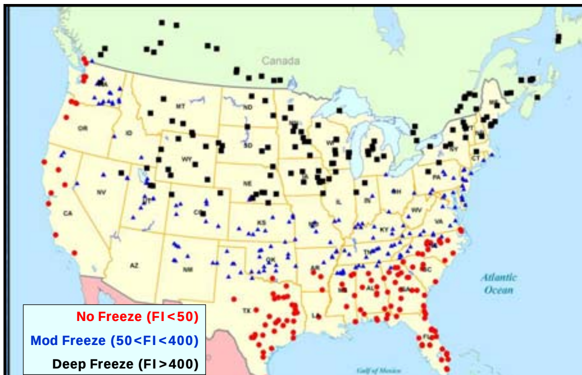

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Soils/Material Properties

- Base Type
  - Dense Graded Aggregate Base (DGAB)
  - Asphalt Treated Base (ATB)
  - Permeable ATB (PATB)
  - Non-bituminous treated base (NONBIT)
  - Full Depth Asphalt (NONE)
  - Lean Concrete Base (LCB)

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Soils/Materials Properties-cont'd

- Subgrade Type
  - Coarse
  - Fine
  - Rock/Stone
- Thickness of surface layer

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Traffic

- Ratio of traffic loading to structural capacity
  - Loading
    - Equivalent Single Axle Loads (ESAL)
    - Annual Average
  - Structural Capacity
    - Structural Number (SN) → **LOG(ESAL) / SN**
    - Depth of PCC (D) → **LOG(ESAL) / D**

Performance Data-Flexible

- Absolute IRI
- Change in IRI
- Rut Depth
- Strain at bottom of AC layer
- Surface Distress
  - Fatigue Cracking
  - Block Cracking
  - Long. WP Cracking
  - Trans. Cracking

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Performance Data-Rigid

- Absolute IRI
- Change in IRI
- Trans. Joint Faulting
- Surface Distress
  - Corner Breaks
  - Long. Cracking
  - Trans. Cracking

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Logical Checks/Quality Review

Pavement Type	Performance Measure	Reduction Criteria that Warrants Investigation
A-CC	IRI	>0.4 m/km reduction
A-CC	DISTRESS	>30% reduction in sum of key distress types
A-CC	RUTDEPTH	>10 mm reduction
P-CC	IRI	>0.4 m/km reduction
P-CC	DISTRESS	>30% reduction in sum of key distress types
P-CC	FAULTING	>2 mm reduction

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Regression Considerations

- Variable Interaction Analysis
- Significance of Explanatory Variables
- Transformations

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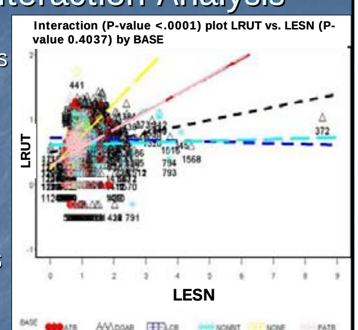
Variable Interaction Analysis

- Categorical Variables (i.e., base type)
  - Graphical ID
  - Tested within SAS
- Numerical Variables (i.e., FI)
  - ID and tested in SAS



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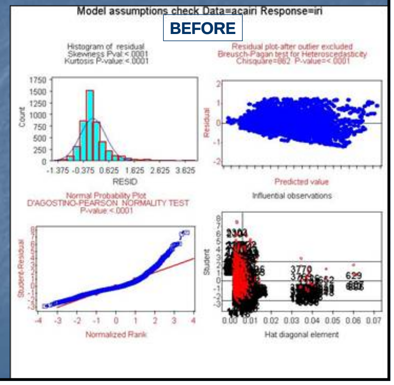
Significance Testing

Parameter Estimates								
Parameter		DF	Estimate	Standard Error	95% Confidence		Chi-Square	Pr > ChiSq
Intercept		1	-0.4137	0.2354	-0.875	0.0476	3.09	0.0788
LESN		1	0.4492	0.166	0.1239	0.7745	7.33	0.0068
ACTHICK		1	-0.022	0.0078	-0.037	-0.007	8.01	0.0046
FTC		1	0.003	0.0012	0.0007	0.0052	6.41	0.0114
FI		1	-0.0001	0.0002	-4E-04	0.0003	0.19	0.6593
CI		1	0.0004	0.0001	0.0003	0.0006	47.61	<.0001
PRECIP		1	-0.0004	0.0001	-5E-04	-2E-04	26.42	<.0001
LRUT_AGE		1	0.3914	0.0145	0.3629	0.4198	726	<.0001
LESN*FTC		1	0.0013	0.0008	-2E-04	0.0028	2.76	0.0965
FI*PRECIP		1	0	0	0	0	39.5	<.0001
BASE	ATB	1	0.6562	0.1796	0.3041	1.0083	13.34	0.0003
BASE	DGAB	1	0.9938	0.1576	0.685	1.3026	39.78	<.0001
BASE	LCB	1	1.2078	1.0724	-0.894	3.3096	1.27	0.26
BASE	NONBIT	1	1.2084	0.2006	0.8152	1.6017	36.27	<.0001
BASE	NONE	1	0.0913	0.3975	-0.688	0.8703	0.05	0.8184
BASE	PATB	0	0	.	.	.	.	.

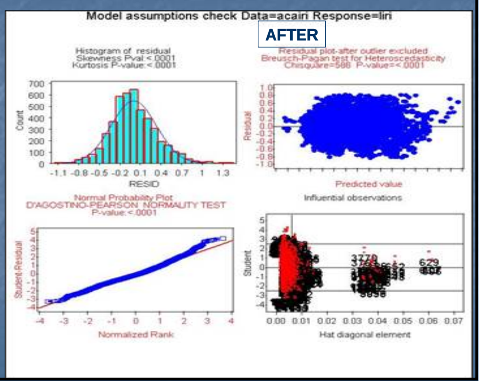
Transformation

- Before
  - Non-Normality
  - Unequal Error Variance



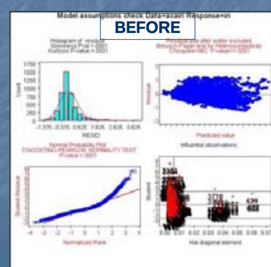
Transformation

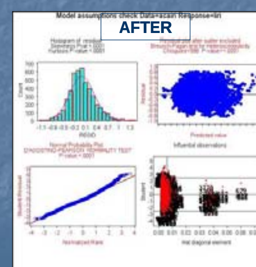
- After



Transformation

- Improves validity of assumptions used in developing the model





Change in IRI

- R-squared≈0.03
  - Initial IRI used to calculate ΔIRI taken at various ages

Section 086002 Initial IRI taken at age 21.3

Section 100101 Initial IRI taken at age 1.1

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Absolute IRI-AC

- Differences in initial IRI
  - Incorporated initial IRI and initial IRI age as explanatory variables in model
  - Functional Class found to be insignificant in the model
- R-squared≈0.45

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Task Order #03

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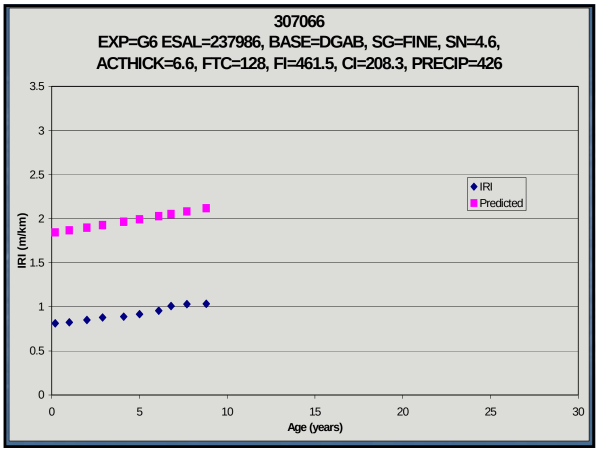
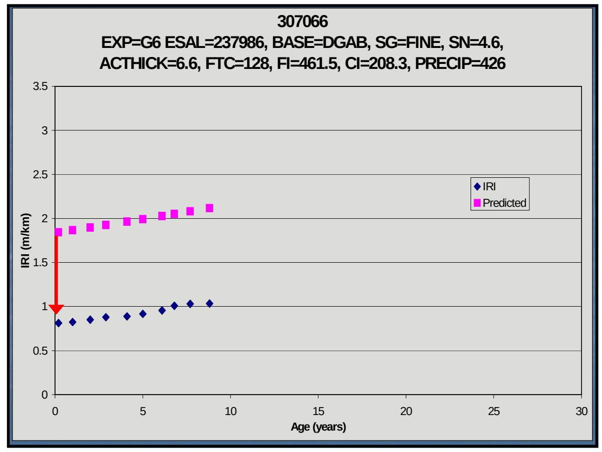

307066
EXP=G6 ESAL=237986, BASE=DGAB, SG=FINE, SN=4.6,
ACTHICK=6.6, FTC=128, FI=461.5, CI=208.3, PRECIP=426
IRI (m/km)
Age (years)
IRI
Predicted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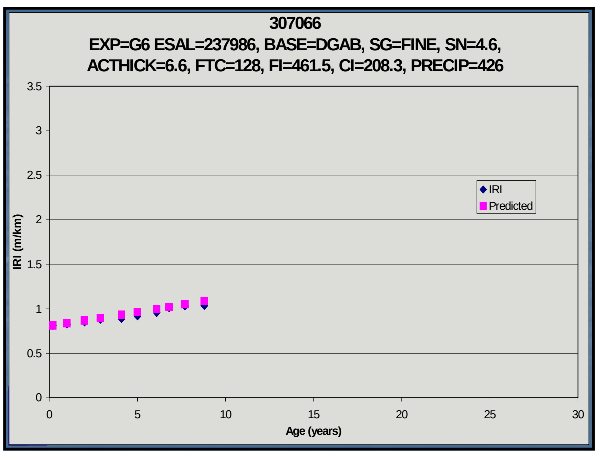
IRI (m/km)
Age (years)
IRI
Predicted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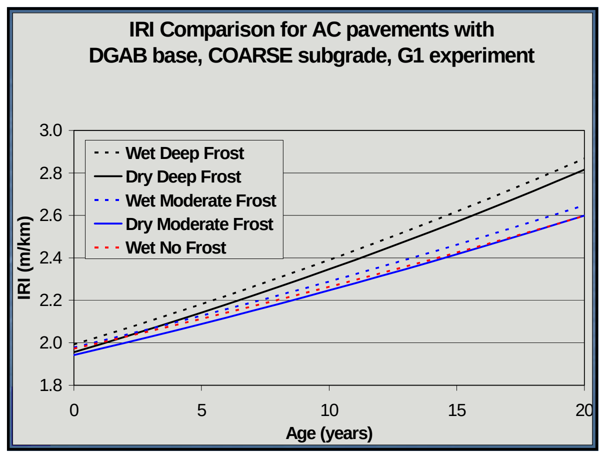
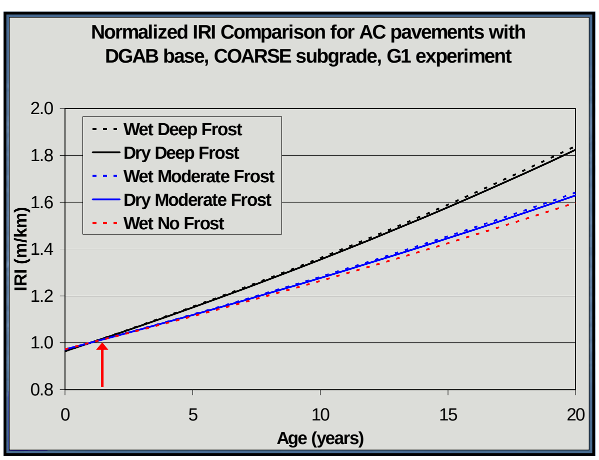
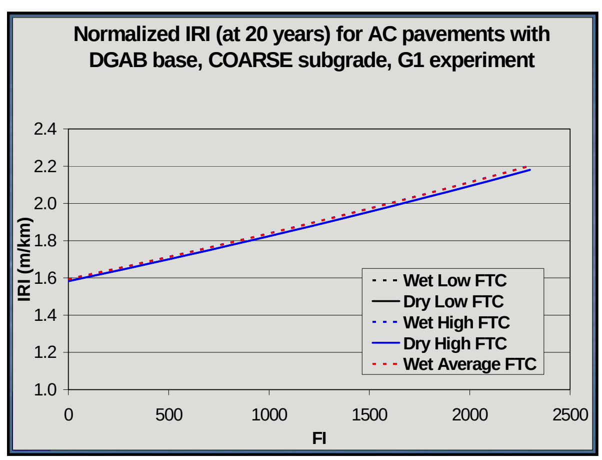
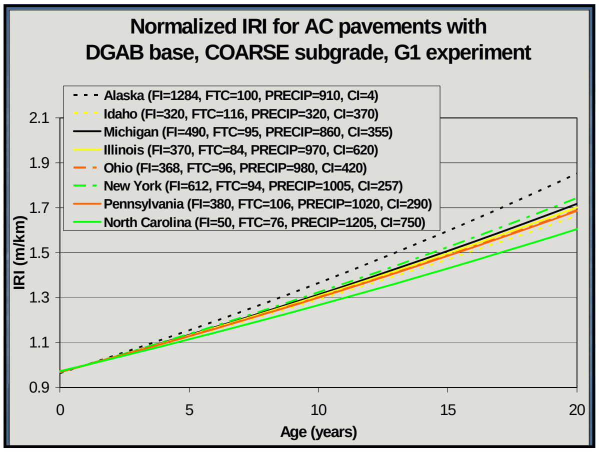
IRI (m/km)
Age (years)
IRI
Predicted


IRI Comparison for AC pavements with
DGAB base, COARSE subgrade, G1 experiment
IRI (m/km)
Age (years)
Wet Deep Frost
Dry Deep Frost
Wet Moderate Frost
Dry Moderate Frost
Wet No Frost

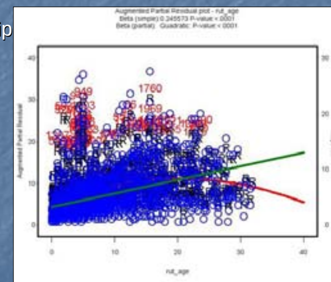

Normalized IRI Comparison for AC pavements with
DGAB base, COARSE subgrade, G1 experiment
IRI (m/km)
Age (years)
Wet Deep Frost
Dry Deep Frost
Wet Moderate Frost
Dry Moderate Frost
Wet No Frost


Normalized IRI (at 20 years) for AC pavements with
DGAB base, COARSE subgrade, G1 experiment
IRI (m/km)
FI
Wet Low FTC
Dry Low FTC
Wet High FTC
Dry High FTC
Wet Average FTC



Rut Depth

- Exploratory analysis
  - Quadratic Relationship between RUT and AGE



Rut Depth

- Applied natural log relationship between AGE and Rut Depth
  - R-squared≈0.26

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Task Order #03
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Rut Depth Model

INTERCEPT	-0.413742995
LESN	0.449234546
ACTHICK	-0.022044857
FTC	0.002951616
FI	-7.99004E-05
CI	0.000432592
PRECIP	-0.000383704
LRUT_AGE	0.391377526
LESNFTC	0.001307693
FIPRECIP	7.99968E-07
BASEATB	0.656204194
BASEDGAB	0.993815007
BASELCB	1.207797664
BASENONBIT	1.208424614
BASENONE	0.091273515
BASEPATB	0

BASEATBLESN	-0.55092
BASEDGABLESN	-0.80496
BASELCBLESN	-0.99154
BASENONBITLESN	-0.98669
BASENONELESN	0.072385
BASEPATBLESN	0
BASEATBFI	-0.00092
BASEDGABFI	-0.0005
BASELCBFI	-0.00446
BASENONBITFI	-0.00135
BASENONEFI	-0.00043
BASEPATBFI	0
EXPG1	0.617596
EXPG2	0.58349
EXPG6	0.631349
EXPS1	0.391322
EXPS8	0

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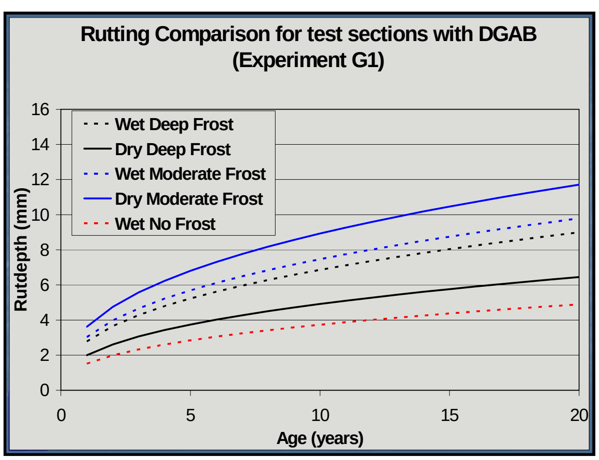
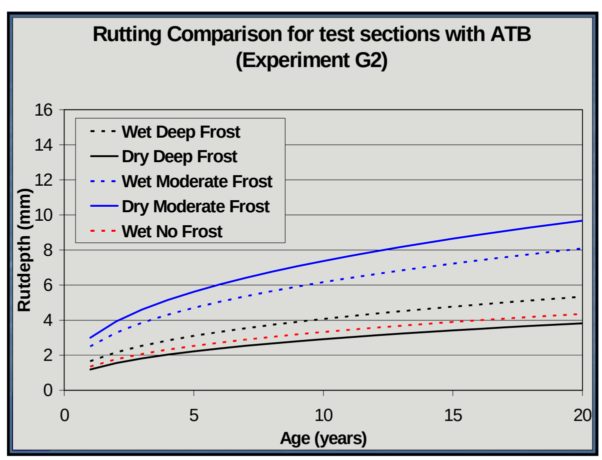
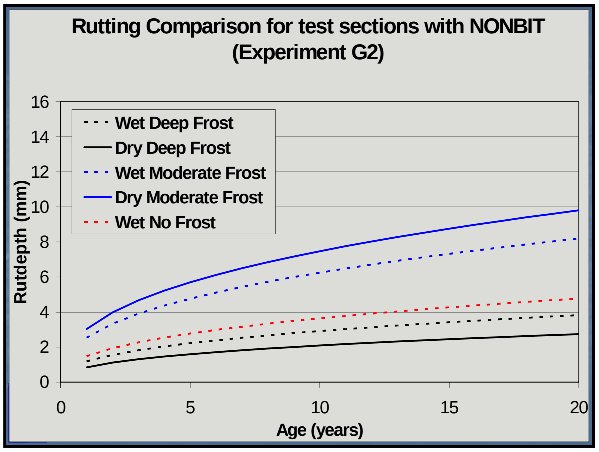
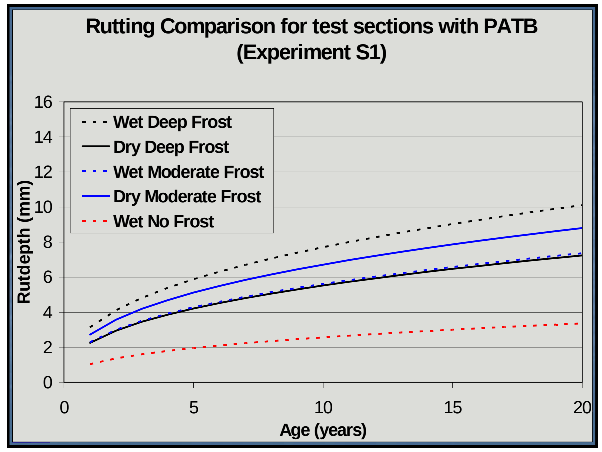
Task Order #03
U.S. Department of Transportation Federal Highway Administration









Strain

$$\log(\varepsilon_T) = 0.9977 * \log(BDI) + 1.7142$$

$$BDI = D_{12} - D_{24}$$

$$\varepsilon_{RT} = \frac{\varepsilon_T}{\alpha_1}$$

$$\alpha_1 = 10^{-0.8189[\log(E_T) - \log(E_{RT})]}$$

ε_T = strain at bottom of AC for measurement temperature

ε_{RT} = strain at bottom of AC for reference temperature

D_{12}, D_{24} = Deflections at 12" and 24" offsets (normalized to standard load)

E_T = resilient modulus of AC at measurement temperature

E_{RT} = resilient modulus of AC at reference temperature

Strain-cont'd

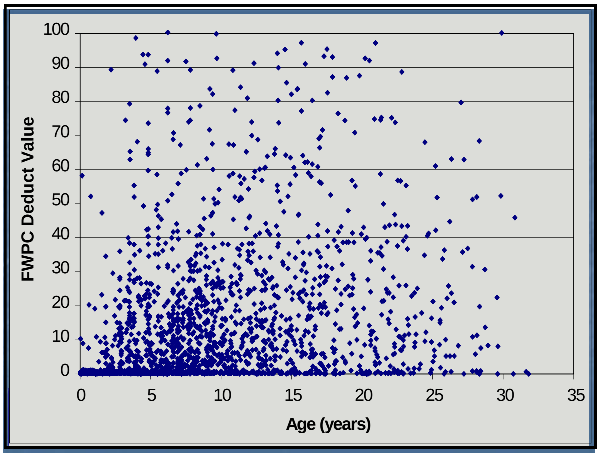
- Temperature dependent
  - Use of broad and general temp-modulus curve
- Layer thickness variations
- Model predicts a decrease in strain with age

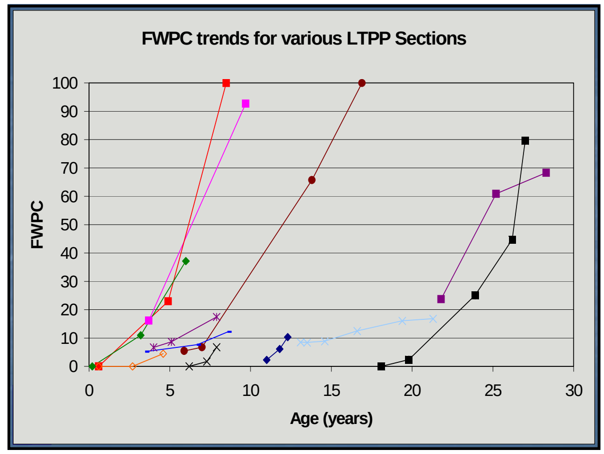
Distress-Flexible

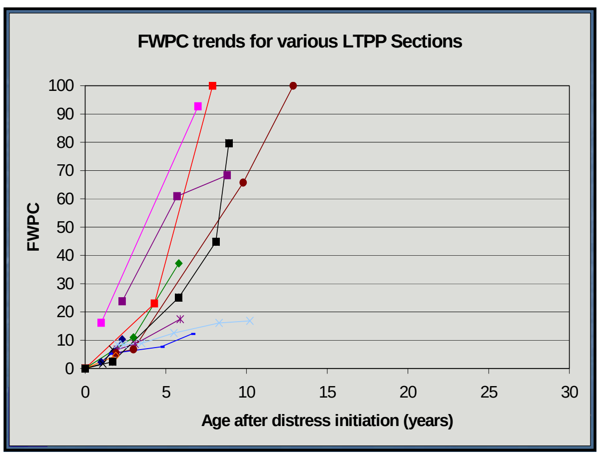
- Severity levels converted to deduct values
- Deduct values combined for each distress type
- Fatigue and Longitudinal Wheelpath (LWP) cracking combined
  - Multiplied length of LWP by 0.3 m
  - Grouped all severities of LWP as low severity to compute deduct values

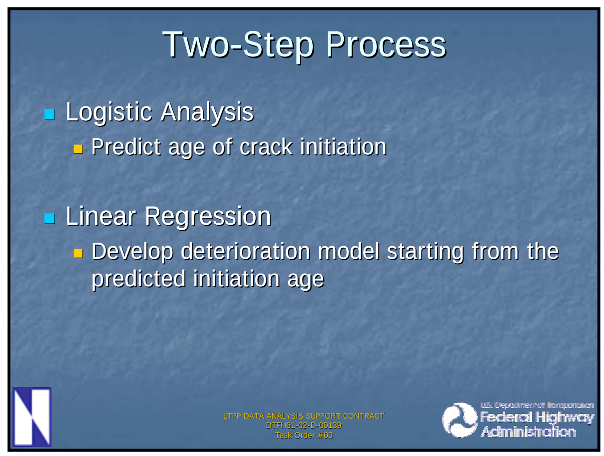
Distress-Rigid

- Unable to apply deduct values
- Summed severities of each distress type


FWPC Deduct Value
Age (years)


FWPC trends for various LTPP Sections
FWPC
Age (years)


FWPC trends for various LTPP Sections
FWPC
Age after distress initiation (years)


Two-Step Process
Logistic Analysis
Predict age of crack initiation
Linear Regression
Develop deterioration model starting from the predicted initiation age
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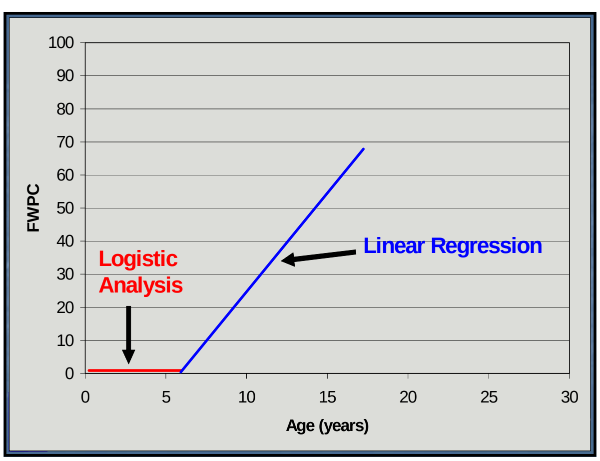
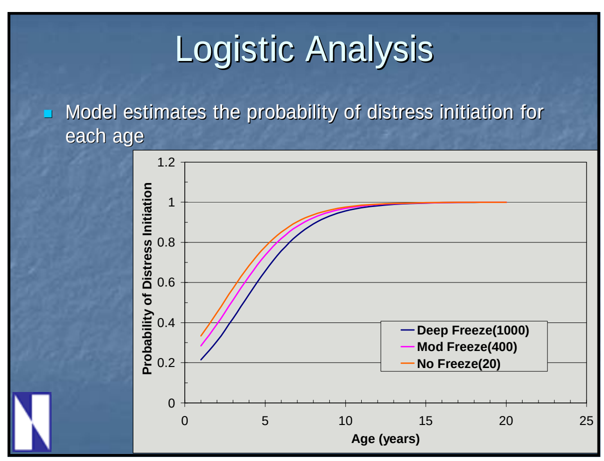

FWPC
Logistic Analysis
Linear Regression
Age (years)


Logistic Analysis
Model estimates the probability of distress initiation for each age
Probability of Distress Initiation
Deep Freeze(1000)
Mod Freeze(400)
No Freeze(20)
Age (years)

Logistic Analysis

- A cut-off probability is determined
  - Events and non-events predicted with equal accuracy

Prob Level	Correct Event	Correct Non-Event	Incorrect Event	Incorrect Non-Event	Percentages Correct	Sensi-tivity	Speci-ficity	FALSE POS	FALSE NEG
0.05	1277	0	443	1	74.2	99.9	0	25.8	100
0.1	1276	5	438	2	74.4	99.8	1.1	25.6	28.6
0.15	1273	61	382	5	77.5	99.6	13.8	23.1	7.6
0.2	1268	116	327	10	80.4	99.2	26.2	20.5	7.9
0.25	1261	164	279	17	82.8	98.7	37	18.1	9.4
0.3	1255	195	248	23	84.3	98.2	44	16.5	10.6
0.35	1233	216	227	45	84.2	96.5	48.8	15.5	17.2
0.4	1216	251	192	62	85.2	95.1	56.7	13.6	19.8
0.45	1186	267	176	92	84.4	92.8	60.3	12.9	25.6
0.5	1162	285	158	116	84.1	90.9	64.3	12	28.9
0.55	1134	312	131	144	84	88.7	70.4	10.4	31.6
0.6	1106	333	110	172	83.6	86.5	75.2	9	34.1
0.65	1087	353	90	191	83.7	85.1	79.7	7.6	35.1
0.7	1042	366	77	236	81.8	81.5	82.6	6.9	39.2
0.75	994	377	66	284	79.7	77.8	85.1	6.2	43
0.8	938	390	53	340	77.2	73.4	88	5.3	46.6
0.85	860	403	40	418	73.4	67.3	91	4.4	50.9
0.9	782	414	29	496	69.5	61.2	93.5	3.6	54.5
0.95	668	432	11	610	63.9	52.3	97.5	1.6	58.5
1	0	443	0	1278	25.7	0	100	.	74.3

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Task Order #03

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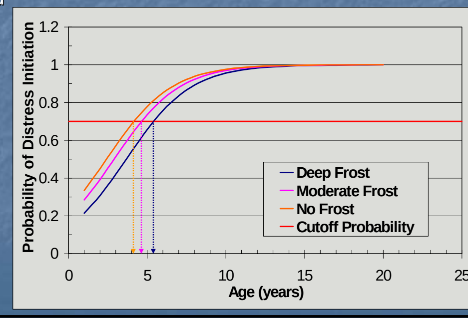
Logistic Analysis

- Distress initiates at age where the cut-off probability is achieved



Logistic Analysis

- Fatigue and WP cracking (FWPC)
  - Cut-off probability 70%
    - R-squared ≈ 0.55
    - 82% accuracy
  - Significant Factors
    - AGE
    - LESN
    - CI
    - FI

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Task Order #03

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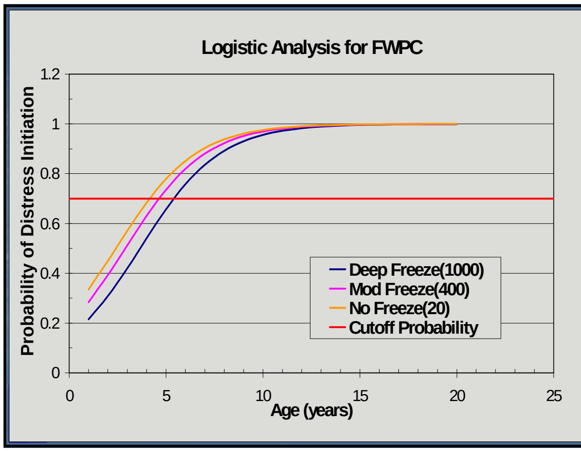

Logistic Analysis

- Transverse cracking (TC)
  - Cut-off probability 85%
    - R-squared ≈ 0.27
    - 74% accuracy
  - Significant Factors
    - AGE
    - CI

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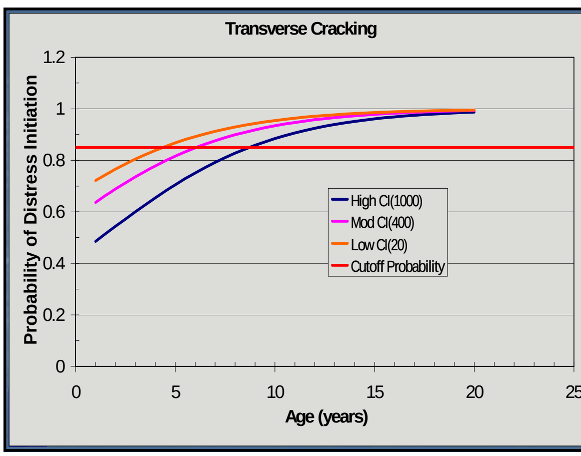
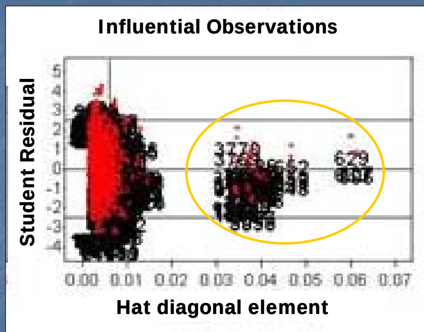


Extreme Observations



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Extreme Observations

- No reason to be labeled as errors
- Removing would create bias
- Very influential to General Linear Regression Model (GLM)

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Task Order #03

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Robust Analysis

- Uses residuals to dampen the effect of extreme observations
- Iterative process beginning with GLM
  - Applies a weighting factor to influential cases
  - Impact from these cases is reduced

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Task Order #03

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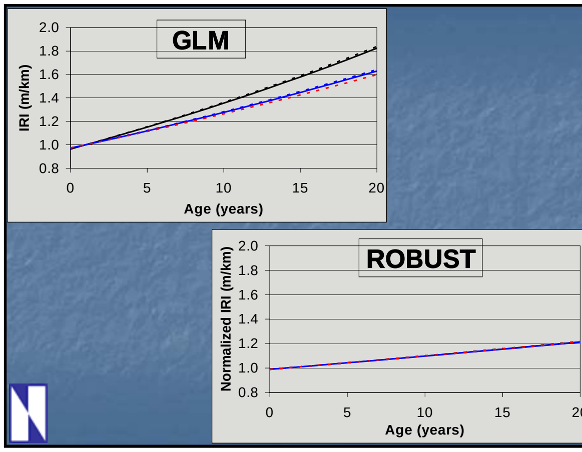

GLM vs. Robust

- Full (not dampened) effect of extreme observations may be needed to completely account for differences in performance

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Task Order #03

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On-going Task 8 Activities

- Validating and Testing Models
  - General Linear Model (GLM) vs. Robust Model
  - Relationships between Performance Measure and Age
  - Distress Regression Analysis
- Performance Comparison using models

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Task Order #03

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Task 9

- Analysis of the extent to which local adaptation of materials standards and empirical pavement design practices have been effective at reducing the rate of pavement deterioration

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Task Order #03
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Task 9 Activities

- Developed and Submitted Questionnaire
  - Standard Roadway Section
    - Rural Interstate
      - 30 yr, 30 Mil ESAL, 10,000 PSI M_R
      - Rigid, Flexible
    - Rural Primary
      - 30 yr, 5 Mil ESAL, 10,000 PSI M_R
      - Rigid, Flexible

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Task Order #03
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Task 9 Activities

- Questionnaire (Continued)
  - Standard Roadway Section
  - Standard Specification
  - Test Procedures
  - Average Unit Bid Prices
  - Typical Service Life
    - Treatments
    - Timing
    - Distress at treatment time
  - Adjacent State Treatments

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Task Order #03
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	Flexible Pavement Interstate				
	Total AC	Drainage	Untreated	Total	Lime Treated
Alaska	NA				
Idaho	7.8"		24"	31.8"	
Illinois	20.25"		0"	20.25"	12"
New York	7"	4"ATPB	12"	23"	
N. Carolina	16"		10"	26"	
Michigan					
Ohio	11.5"		6"	17.5"	
Pennsylvania	16.5"		10"	26.5"	

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Task Order #03
U.S. Department of Transportation Federal Highway Administration

	Rigid Pavement Interstate					
	PCCP	Drainage	Treated	Untreated	Total	Lime Treated
Alaska	NA					
Idaho	12"		2"	12"	28"	
Illinois	10.5"		4"		14.5"	12"
New York	10"	4" ATPB		12"	26"	
N. Carolina	11"		4.5"		15.5"	8"
Michigan						
Ohio	11.5"			6"	17.5"	
Pennsylvania	13"	4"		4"	21"	

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Task Order #03
U.S. Department of Transportation Federal Highway Administration

	Flexible Pavement Primary				
	Total AC	Drainage	Untreated	Total	Lime Treated
Alaska	5"		19"	24"	36" S
Idaho	6.6"		12"	18.6"	
Illinois	14"		0"	14"	12"
New York	6"	4"ATPB	12"	22"	
N. Carolina	10.5"		10"	20.5"	
Michigan					
Ohio	8"		6"	14"	
Pennsylvania	17.5"			17.5"	

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Task Order #03
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Rigid Pavement Primary

	PCCP	Drainage	Treated	Untreated	Total	Lime Treated
Alaska	NA					
Idaho	9"		2"	12"	23"	
Illinois	9.75"		4"		13.75"	12"
New York	10"	4" ATPB		12"	26"	
N. Carolina	8"		4.5"		12.5"	8"
Michigan						
Ohio	8"			6"	14"	
Pennsylvania	8"	4"		4"	16"	

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Task Order #03

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Task 9 Activities

- Complete Work on Roadway Sections
- Complete investigation on Construction Specifications & Materials Test Procedures
  - Moving targets, since performance models represent older specifications and test proc.
  - Will adoption of Superpave Specifications normalize differences in past State Specifications and Test Procedures?
- Extend query to help identify adjacent State approaches.

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Task Order #03

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Task 10 Activities

- Develop cost modeling procedures to analyze costs associated with different pavement design, specifications, and test procedures as well as performance differences across environmental zones.
- Compute cost differences based on each State's average roadway costs.

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Task Order #03

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Questions?

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Task Order #03

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Appendix C

Task Order #03

Summary Sheets
from
State Questionnaire Responses

Table C-1 Summary of Interstate Flexible Pavement Design

States	Flexible Pavement Interstate				
	Total AC	Drainage	Untreated	Total	Lime T
Alaska	NA				
Idaho	7.8"		24"	31.8"	
Illinois	20.25"		0	20.25	12"
New York	7"	4"ATPB	12"	23"	
N. Carolina	16"		10"	26"	
Michigan	7.25"		24"	31.25"	
Ohio	11.5"		6"	17.5"	
Pennsylvania	16.5"		10"	26.5"	

Table C-2 Summary of Interstate Rigid Pavement Design

States	Rigid Pavement Interstate					
	PCCP	Drainage	Treated	Untreated	Total	Lime T
Alaska	NA					
Idaho	12"		2"	12"	28"	
Illinois	10.5"		4"		14.5"	12"
New York	10"	4" ATPB		12"	26"	
N. Carolina	11"		4.5"		15.5"	8"
Michigan	11.5"	6 " UTB		10"	27.5"	
Ohio	11.5			6"	17.5"	
Pennsylvania	13	4"		4"	21"	

Table C-3 Summery of Primary Flexible Pavement Design

Sates	Flexible Pavement Primary				
	Total AC	Drainage	Untreated	Total	Lime T
Alaska	5"		19"	24"	
Idaho	6.6"		12"	18.6"	
Illinois	14"		0	14"	12"
New York	6"	4"ATPB	12"	22"	
N. Carolina	10.5"		10"	20.5"	
Michigan	6.5"		24"	31.25"	
Ohio	8"		6"	14"	
Pennsylvania	17.5"			17.5"	

Table C-4 Summary of Primary Rigid Pavement Design

States	Rigid Pavement Primary					
	PCCP	Drainage	Treated	Untreated	Total	Lime T
Alaska	NA					
Idaho	9"		2"	12"	23"	
Illinois	9.75"		4"		13.75"	12"
New York	10"	4" ATPB		12"	26"	
N. Carolina	8"		4.5"		12.5"	8"
Michigan	8.5"	6 " UTB		10"	24.5"	
Ohio	8"			6"	14"	
Pennsylvania	8"	4"		4"	16"	

Appendix D

Task Order #03

Work Summaries

Through March 2005

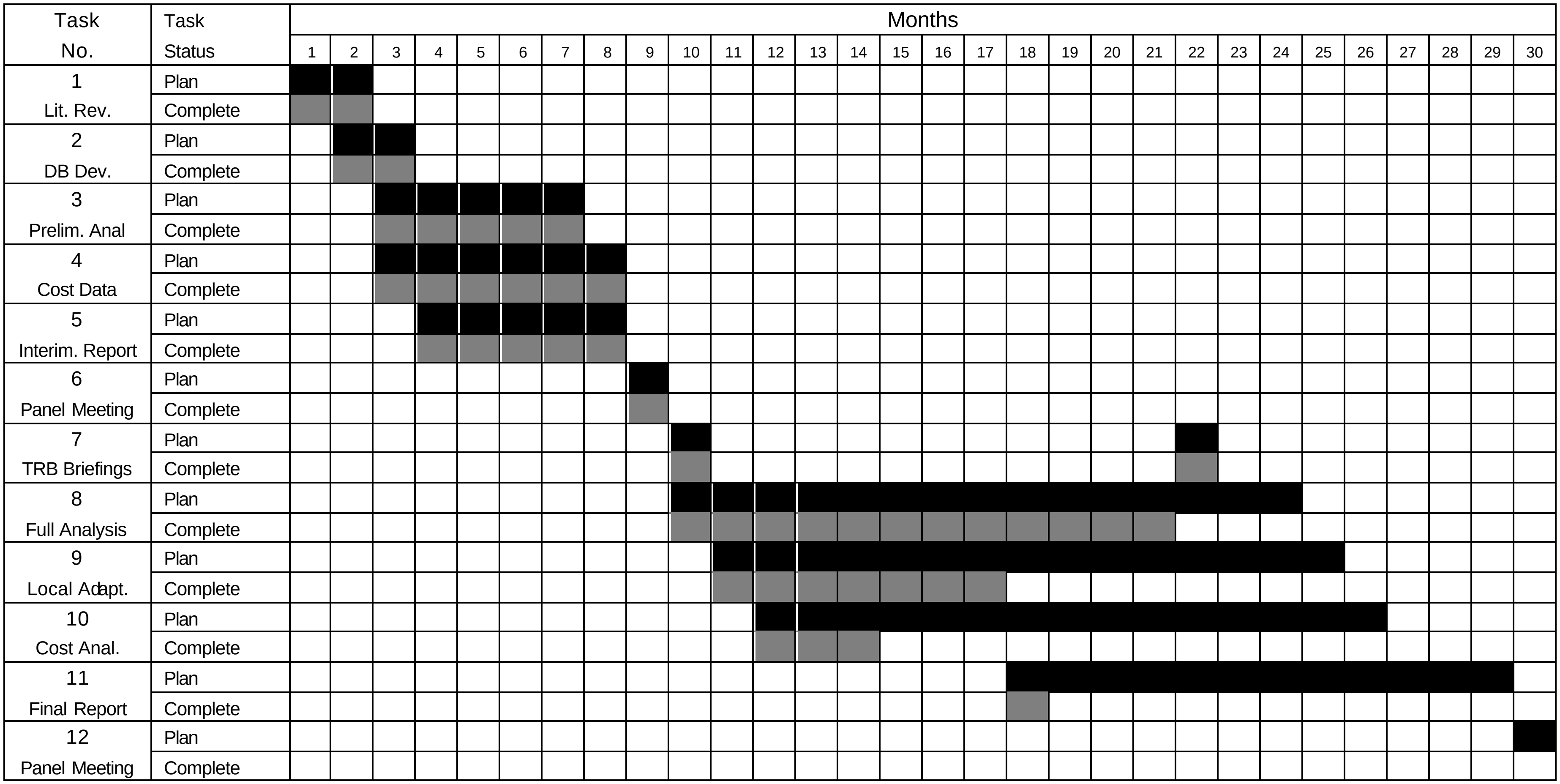

Figure D.1 Work Schedule for Task Order #03 through March, 2005