

# Integrating Database Systems

Towards Validating Pavement  
Performance Models

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# Research Questions

- What databases does TxDOT maintain?
- Useful for pavement engineering?
- Can these be integrated?
- What determines sustainability?
- Lesson's learnt?
- What does the future hold?

# Pavement Databases in Texas

- Design & Construction (DCIS)
- Pavement Management (PMIS)
  - Texas Reference Marker (TRM)
  - Maintenance Management (MMIS)
- SiteManager
  - Laboratory Management (LIMS)
- TxHMA PathFinder
- Flexible Pavements Databases (TxFlex)
- Excellent Performing & Experimental Sections
- Cartographic Information System (TxCIT)

# Design & Construction (DCIS)

- Details all construction projects
- Construction and estimated completion dates
- Location (limited)
- Items specified
- Quantities & Prices listed

# Pavement Management (PMIS)

- Details network level performance for all state maintained roads
- Section performance and condition data

# PMIS Data (per section per year)

- Traffic (AADT & 18 kip)
- Maintenance costs
- Location
  - Route
  - Lane (roadbed)
  - Beginning & Ending Reference Markers
- Performance measures (Visual & Profiler)

# PMIS Performance Measures

- Condition Scores/Indices
- International Roughness Index (IRI)
- Visual Rutting (Shallow, Deep, Severe)
- Visual Cracking (Block, Alligator, Longitudinal, Transverse)
- Visual Patching
- Automated rutting & cracking + video
- Falling Weight Deflectometer (FWD)
- Skid & Texture

# SiteManager

- Construction diary
- Construction quality control & assurance (QC/QA)
- Materials design data
- Pay Factors

# Sitemanager QCQA Lessons

- No input validation/verification
- No calculated fields
- Inefficient database structure

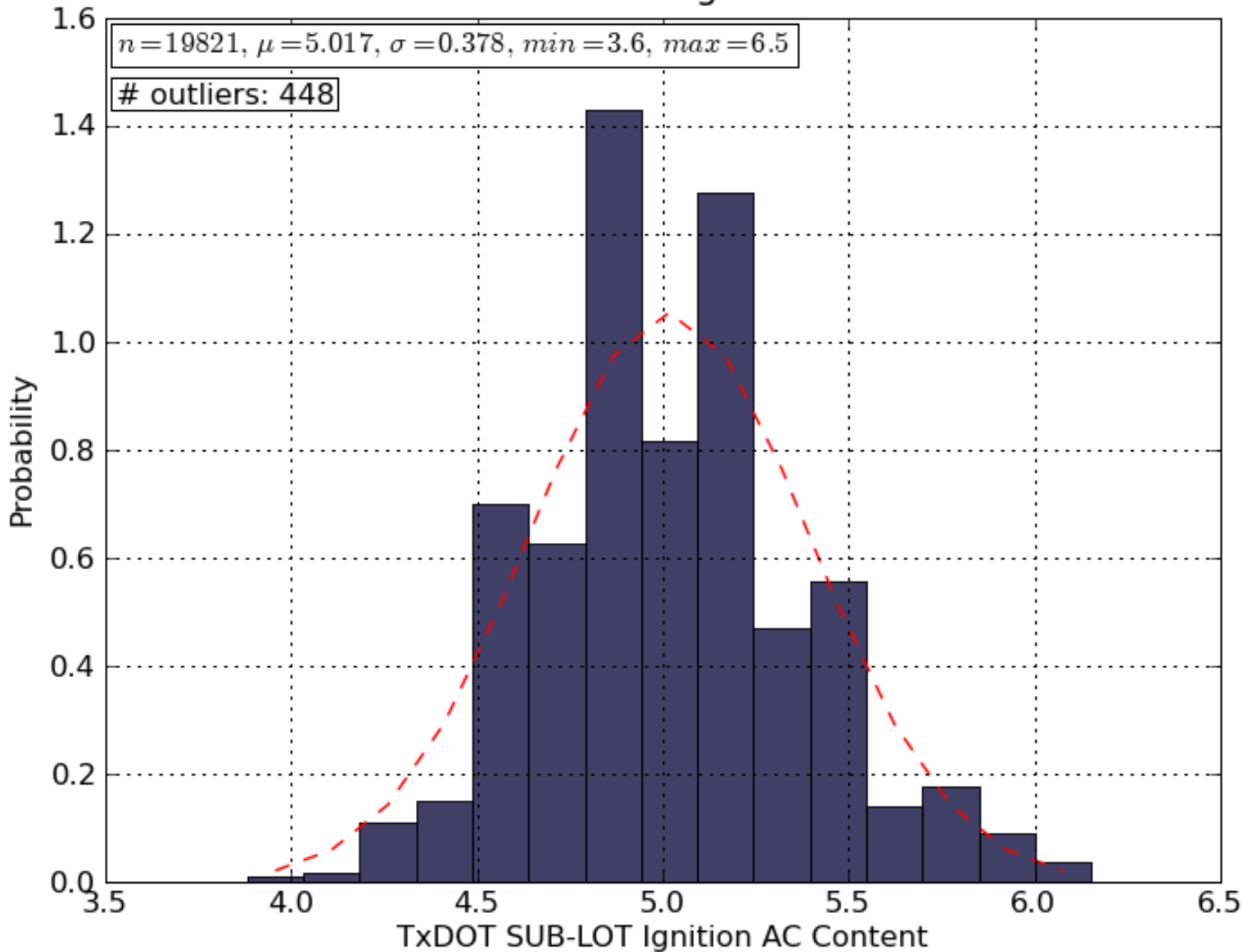
# JMF AC Contents

Mix Type	N	Mean	SE Mean	StDev	Variance	Minimum	Maximum
A	3077	3.975	0.005	0.294	0.087	3.200	4.900
B	7172	4.414	0.005	0.427	0.182	3.100	6.400
C	12148	4.581	0.003	0.303	0.092	3.400	5.900
D	9173	5.012	0.004	0.400	0.160	4.200	8.000
F	116	5.878	0.059	0.636	0.405	4.900	8.500

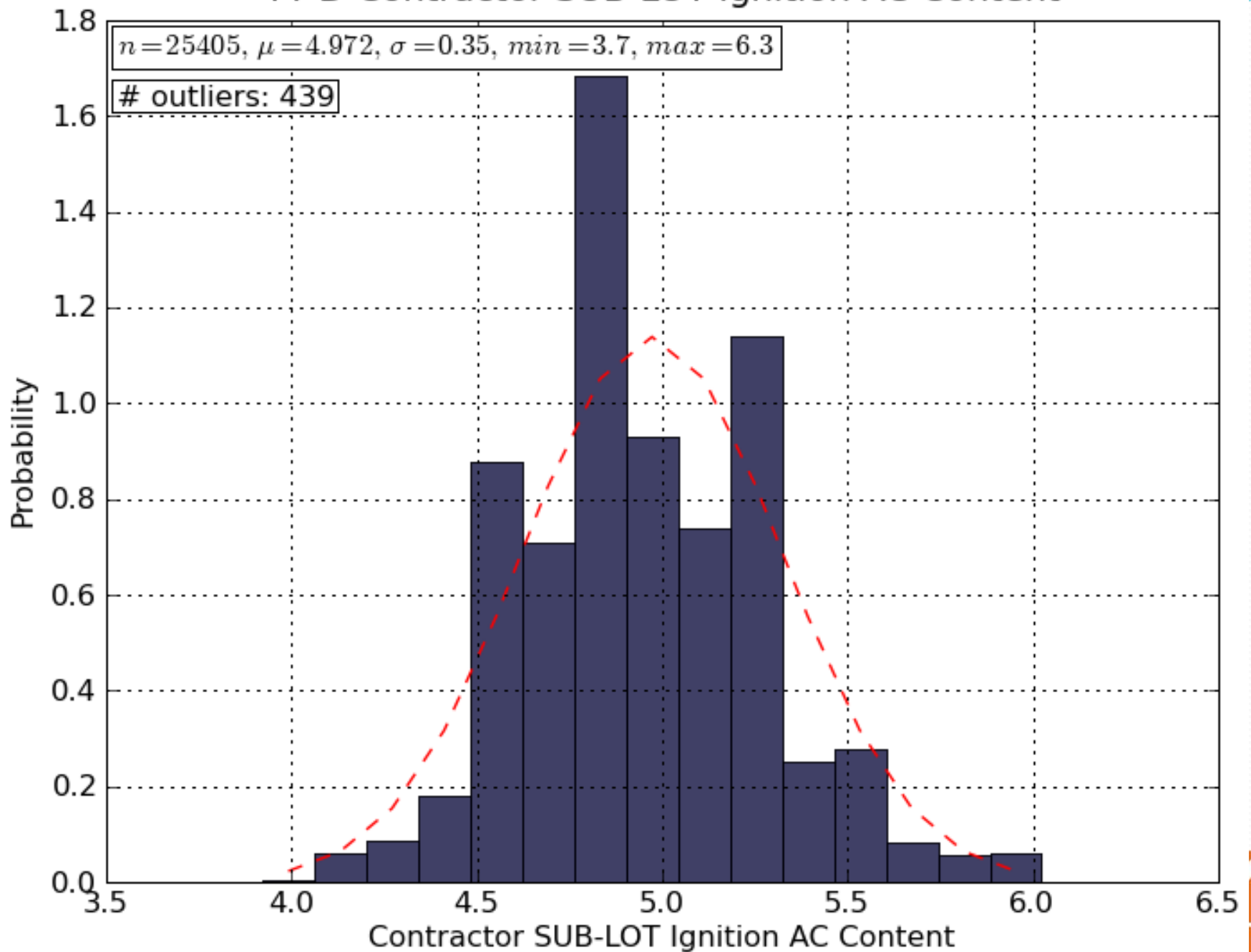
# Type D JMF AC

<b>Binder Grade</b>	<b>N</b>	<b>Mean</b>	<b>Stdev</b>
<b>PG 64-22</b>	1376	5.02	0.48
<b>PG 64-28</b>	20	4.95	0.05
<b>PG 70-22</b>	1655	4.96	0.31
<b>PG 70-28</b>	895	5.28	0.54
<b>PG 76-16</b>	17	5.45	0.19
<b>PG 76-22</b>	3816	4.98	0.35
<b>PG 76-28</b>	269	5.13	0.39

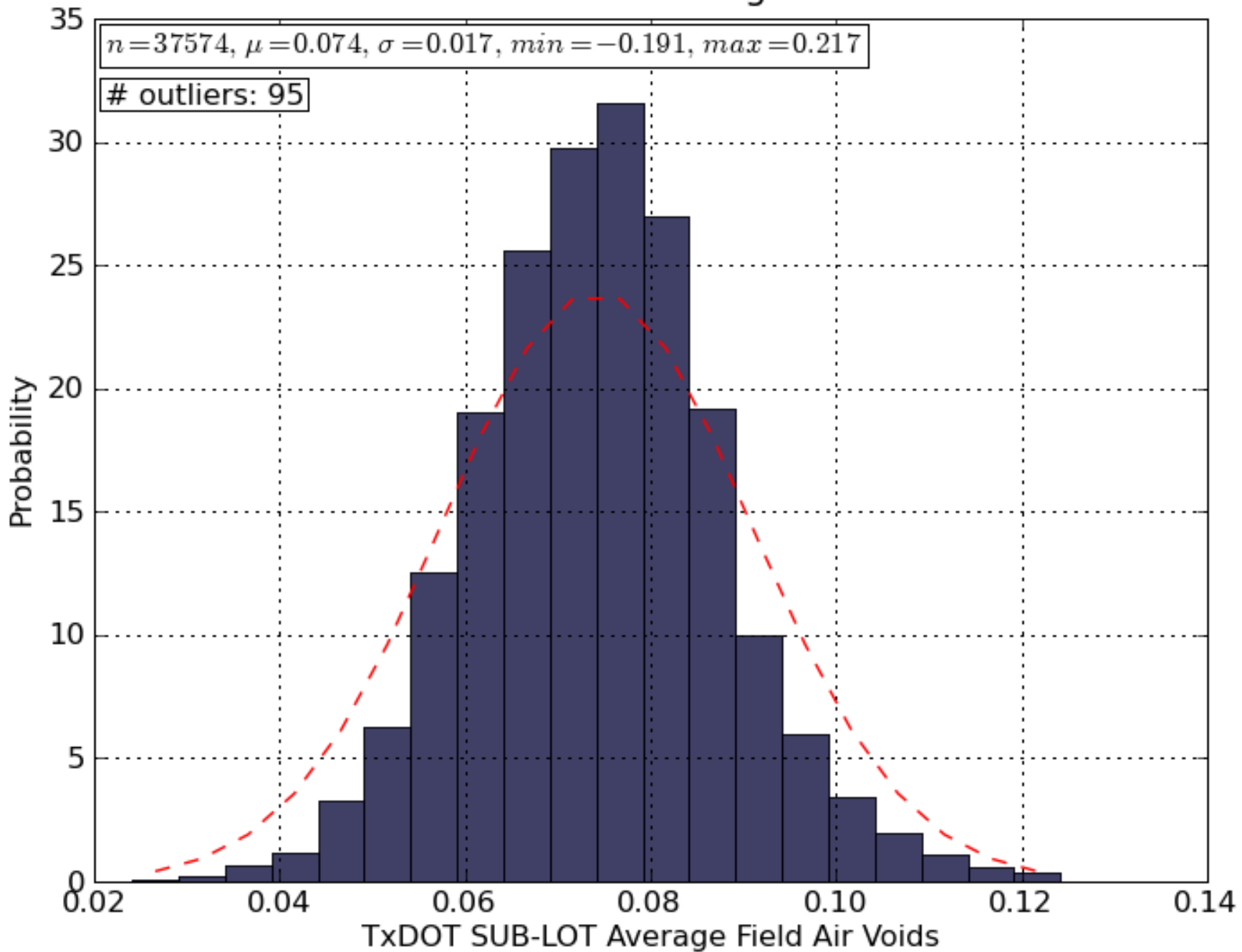
# TY D TxDOT SUB-LOT Ignition AC Content



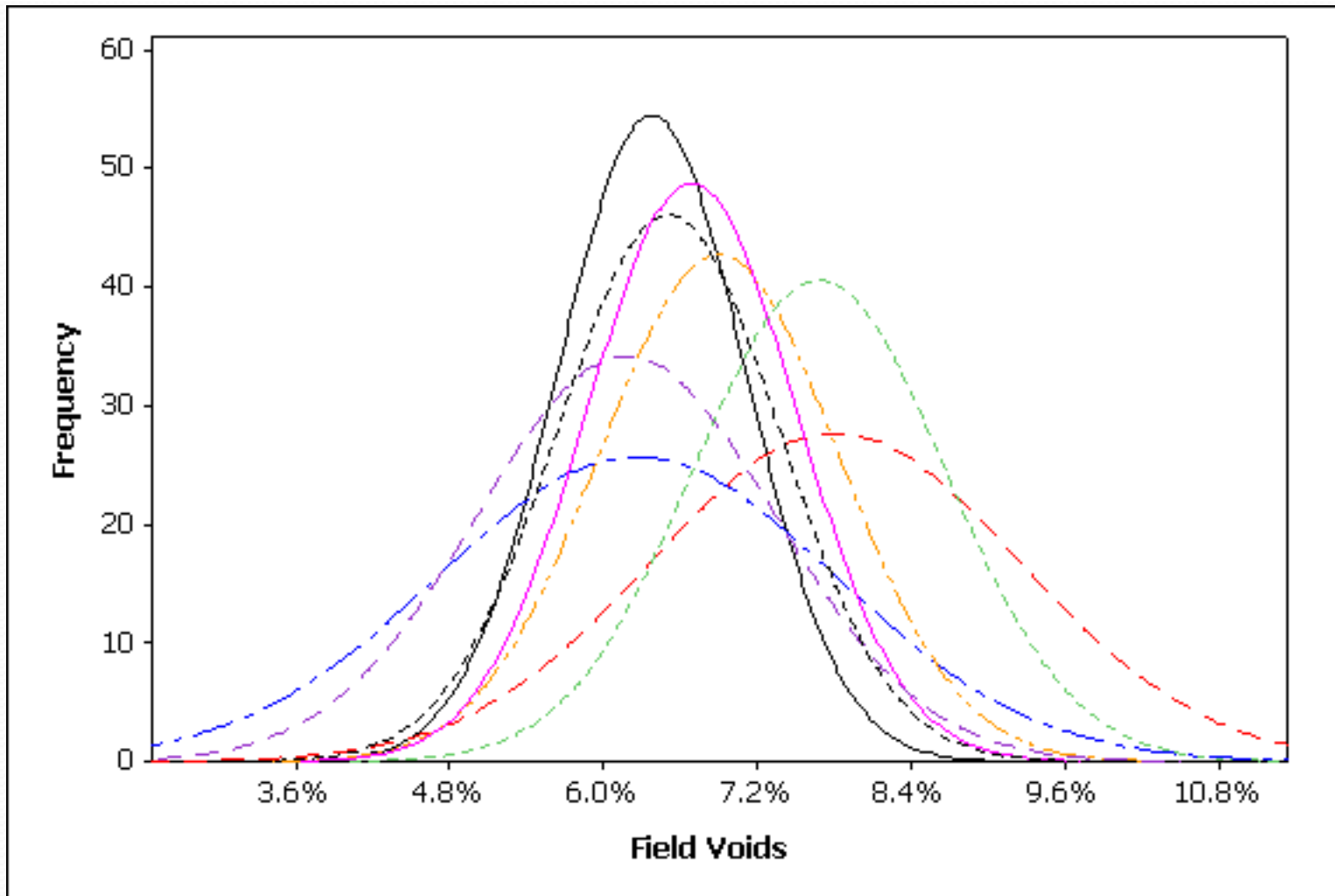
# TY D Contractor SUB-LOT Ignition AC Content



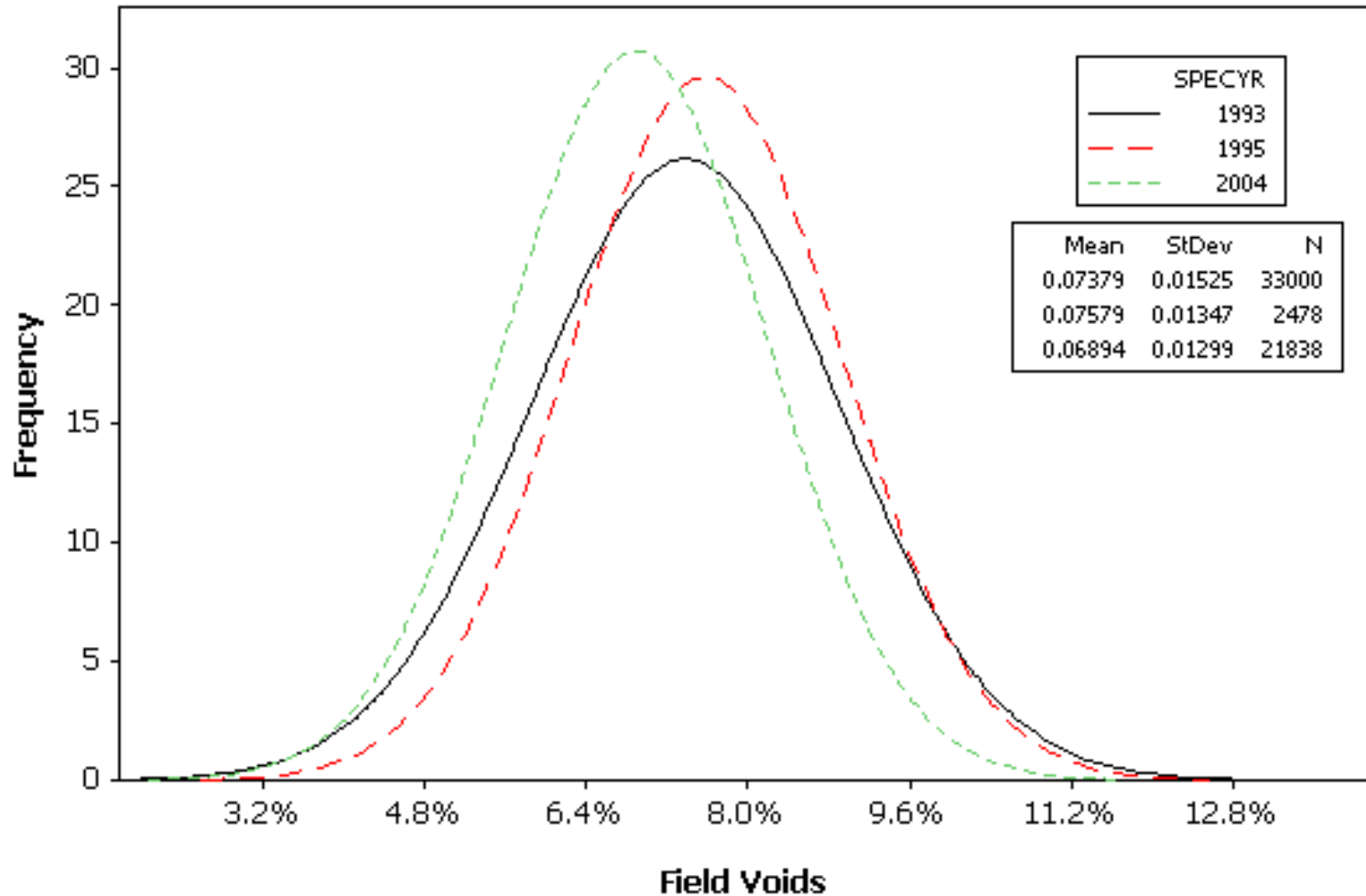
# TY D TxDOT SUB-LOT Average Field Air Voids



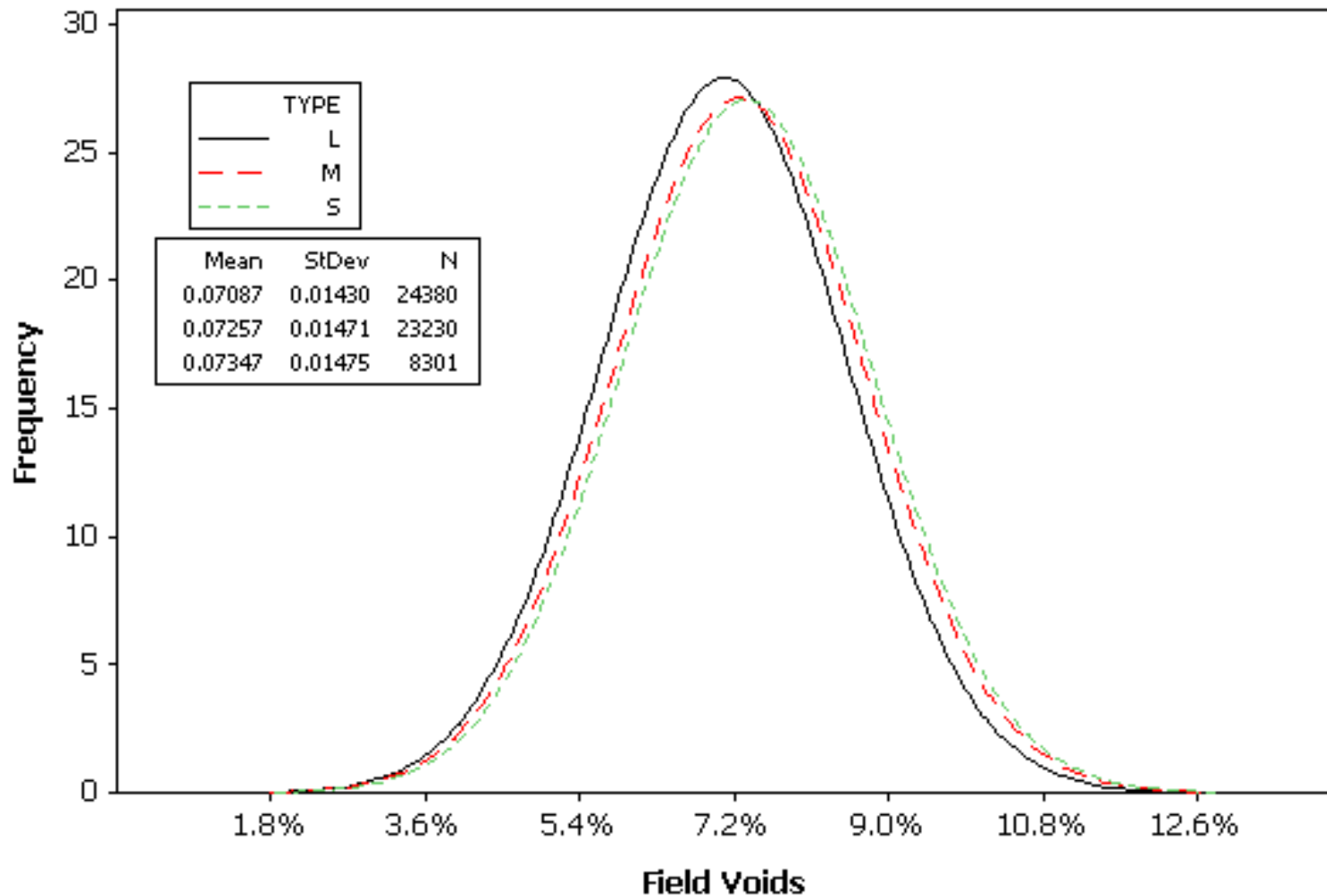
# Distribution of Sub-lot Field Voids for Type C Mixes from Different Producers



# Distribution of Sub-lot Field Air Voids for Type C Mixes in Different Specification Years



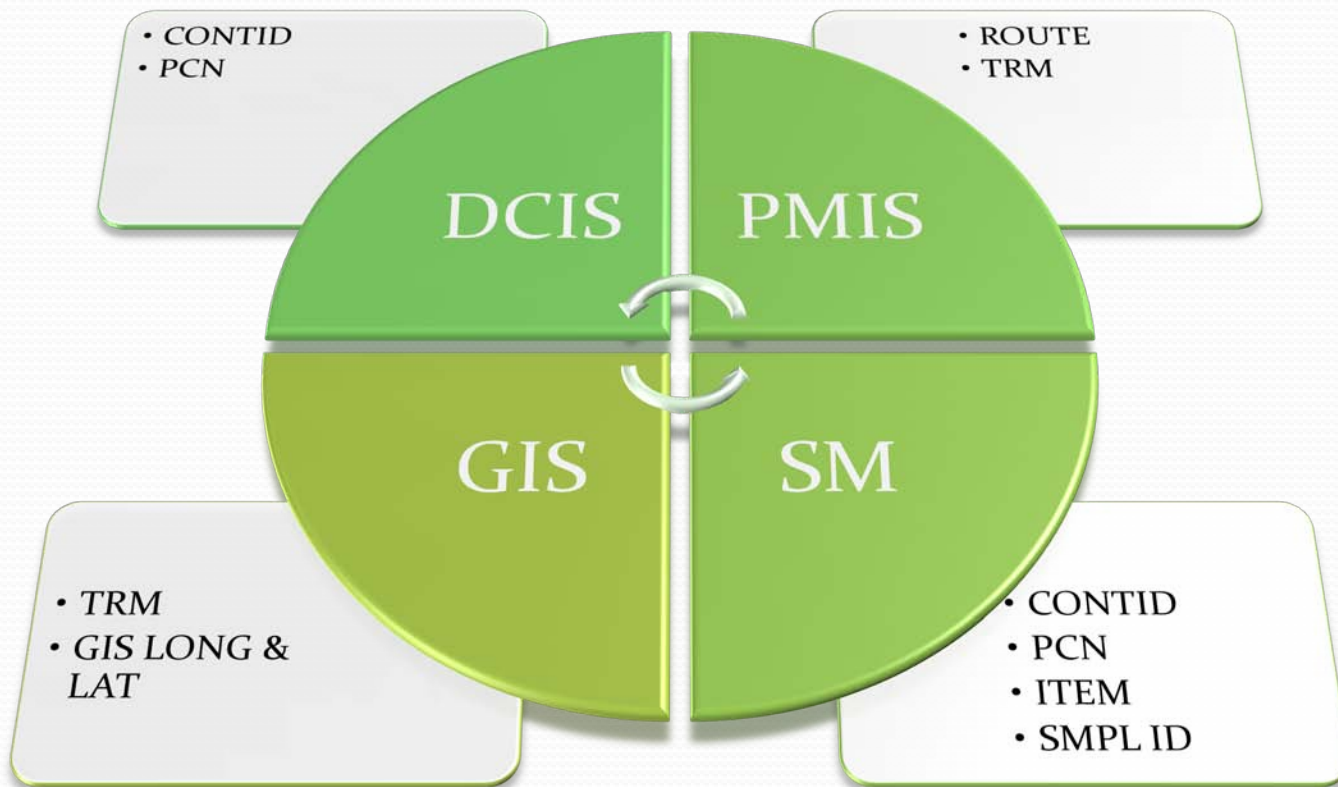
# Field Voids Variation of Type C Mixes Related to Project Quantities



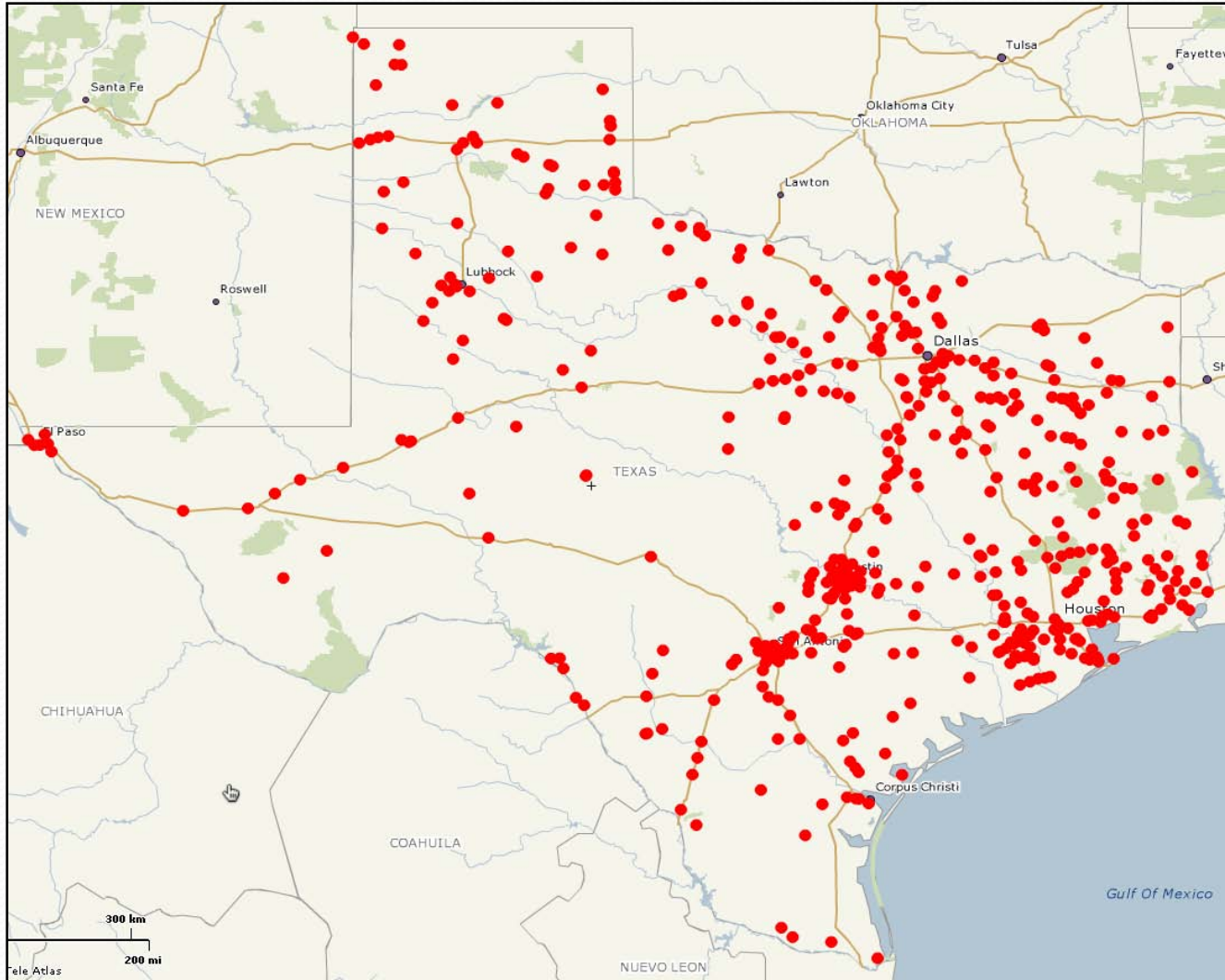
# PathFinder (Network level)

- Web-based RIA
- Geographical Information System
- Originally developed to track the performance of Superpave in Texas
- Expanded to track the performance of all HMA in Texas

# Database Integration



# GIS Location of HMA Projects



# Section Info

007608022 ✕

### Section Info

<b>Mix:</b> TY C	<b>District:</b> SAN ANGELO
<b>Grade:</b> PG 70-22	<b>County:</b> REAGAN
<b>Constructed in:</b> 2004	<b>Route:</b> US67
<b>Length (miles):</b> 18.594	<b>Climate:</b> DRYWARM
<b>Quantity (ton):</b> 2400	<b>Price (\$/ton):</b> 58.64
<b>Roadway:</b> Undivided Mainlanes	

<b>Design AC:</b> 4.5	<b>Field Density:</b> 93.1
<b>Lab Density:</b> 95.9	<b>VMA:</b> 14.5
+ <b>Average core thickness, in:</b> 1.9	

**Plot end point marker**

**Performance Info Table**

**Performance Info Chart**

**Performance Trend Analysis**

**Design QC/QA Data**

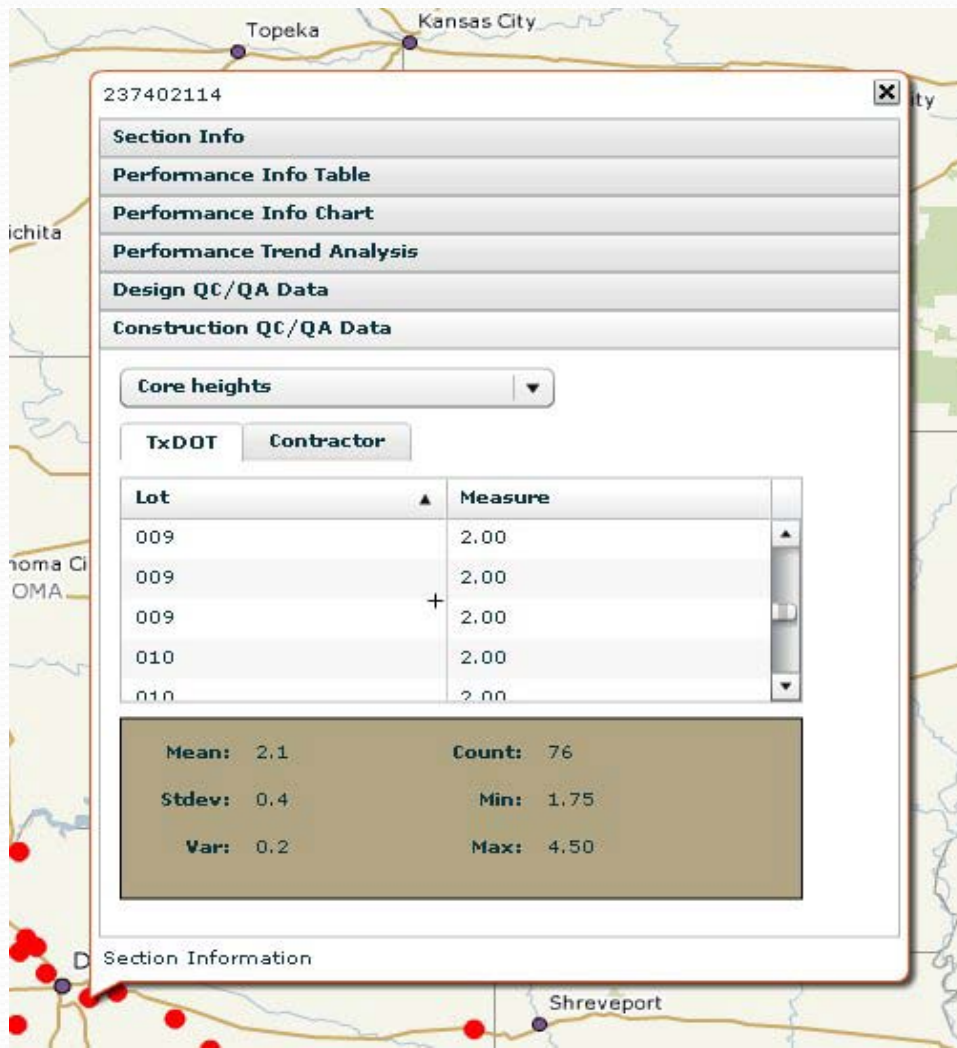
**Construction QC/QA Data**

Section Information





# QCQA Data



# Statistical Function

Statistics

Indicate Mix Types to include in analysis

CMHB-C    SMA-D    SP-C    TY-C  
 CMHB-F    SMA-F    SP-D    TY-D  
TY-C    TY-F

Indicate Climates to include in analysis

Dry Cold    Dry Warm    Mixed  
 Wet Cold    Wet Warm  
Mixed

Indicate Facility Types to include in analysis

IH    US    SH    FM  
FM

Indicate High Temp Grade to include in analysis

PG 76-\*\*    PG 70-\*\*    PG 64-\*\*  
Select Reference High Temp Grade

Indicate Low Temp Grade to include in analysis

PG \*\*-28    PG \*\*-22  
Select Reference Low Temp Grade

Other variables

Design AC Content    Field Density  
 Lab Density    Lab VMA  
 Thickness    ESALs  
 AADT    Speed Limit

Performance Response to Rearess

# Regression Analysis

The screenshot shows a software window titled "Statistics" with a map background. It features a "Performance Response to Regress" dropdown menu set to "Average IRI". To the right, there are checkboxes for "Thickness", "ESALs", "AADT", and "Speed Limit". Below these is a "Color coding:" section with "Analysis variables" in green, "Reference variables" in red, and "Not included" in black. At the bottom, a table displays regression results for 11,550 observations across 10 variables.

**Performance Response to Regress**  
Average IRI

Thickness     ESALs  
 AADT         Speed Limit

**Color coding:**  
Analysis variables  
Reference variables  
Not included

# Observations : 11550  
# Variables : 10

Variable	Coefficient	Std. Error	t-Statistic	Probability
Constant	85.881	1.055	81.414	0.0
TY-D	-6.307	0.708	-8.907	0.0
CMHB-C	-7.914	1.15	-6.884	0.0
Wet-Cold	15.109	1.1	13.732	0.0
Wet-Warm	3.667	0.926	3.959	0.0
Dry-Cold	-0.558	1.032	-0.54	0.589
Dry-Warm	-1.49	1.038	-1.436	0.151
IH	-14.678	0.996	-14.741	0.0
US	-18.998	0.923	-20.584	0.0
SH	-13.743	0.938	-14.645	0.0

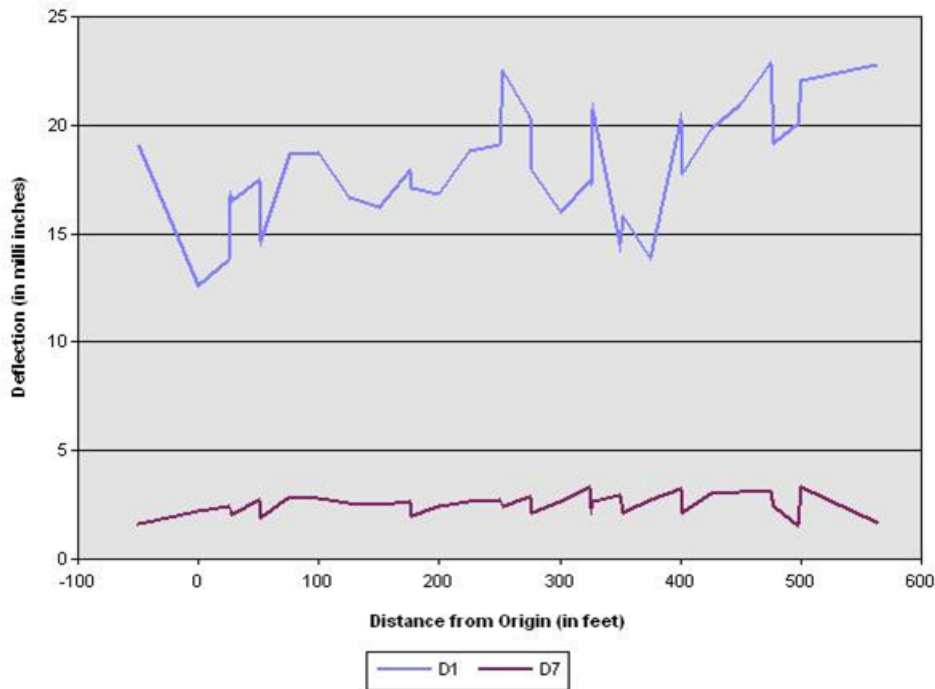
# TxFlex/FPD (Project Level)

- Experimental Design
  - 3 Pavement Types
  - 5 Environmental zones
  - 2 Traffic Volumes
  - Replication
- Scope
  - 50 LTPP Sections
  - 100 Texas Sections (over 5 years)
- Data
  - Level 1 MEPDG
  - TxMEPDG

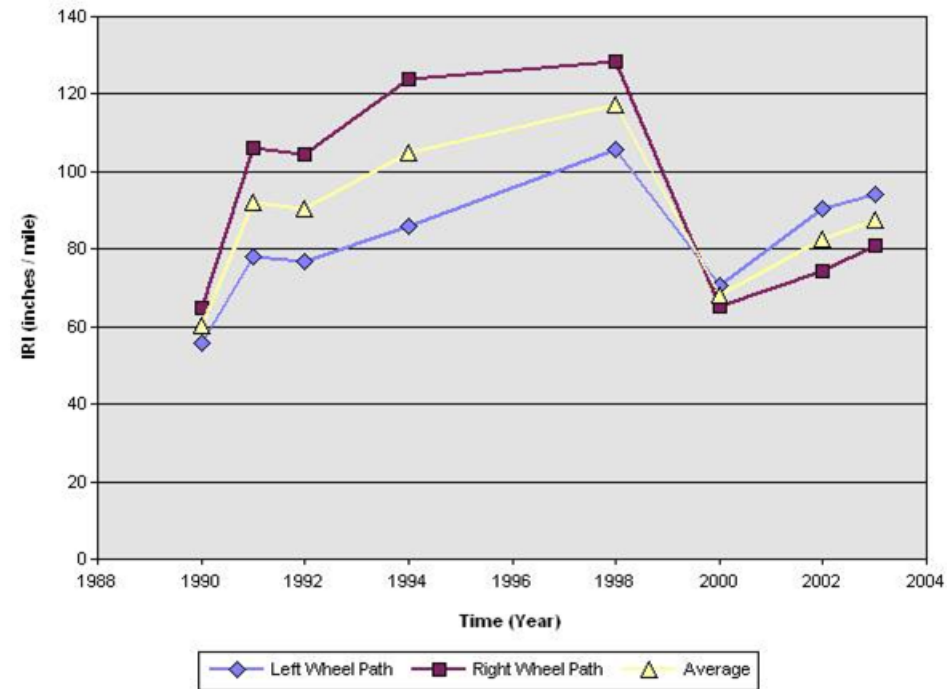


# Data Visualization

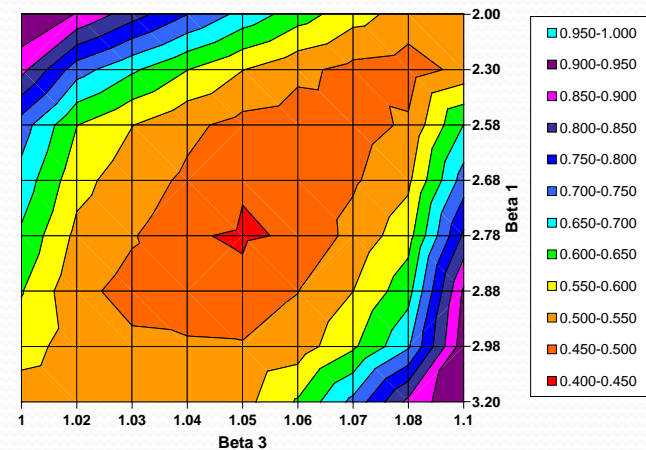
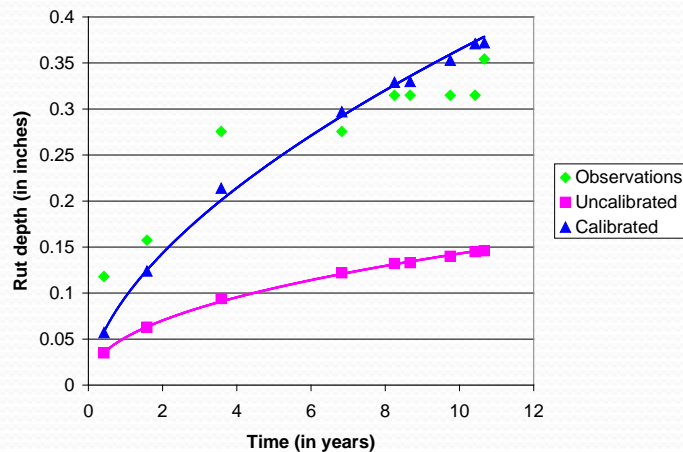
FWD Results



International Roughness Index

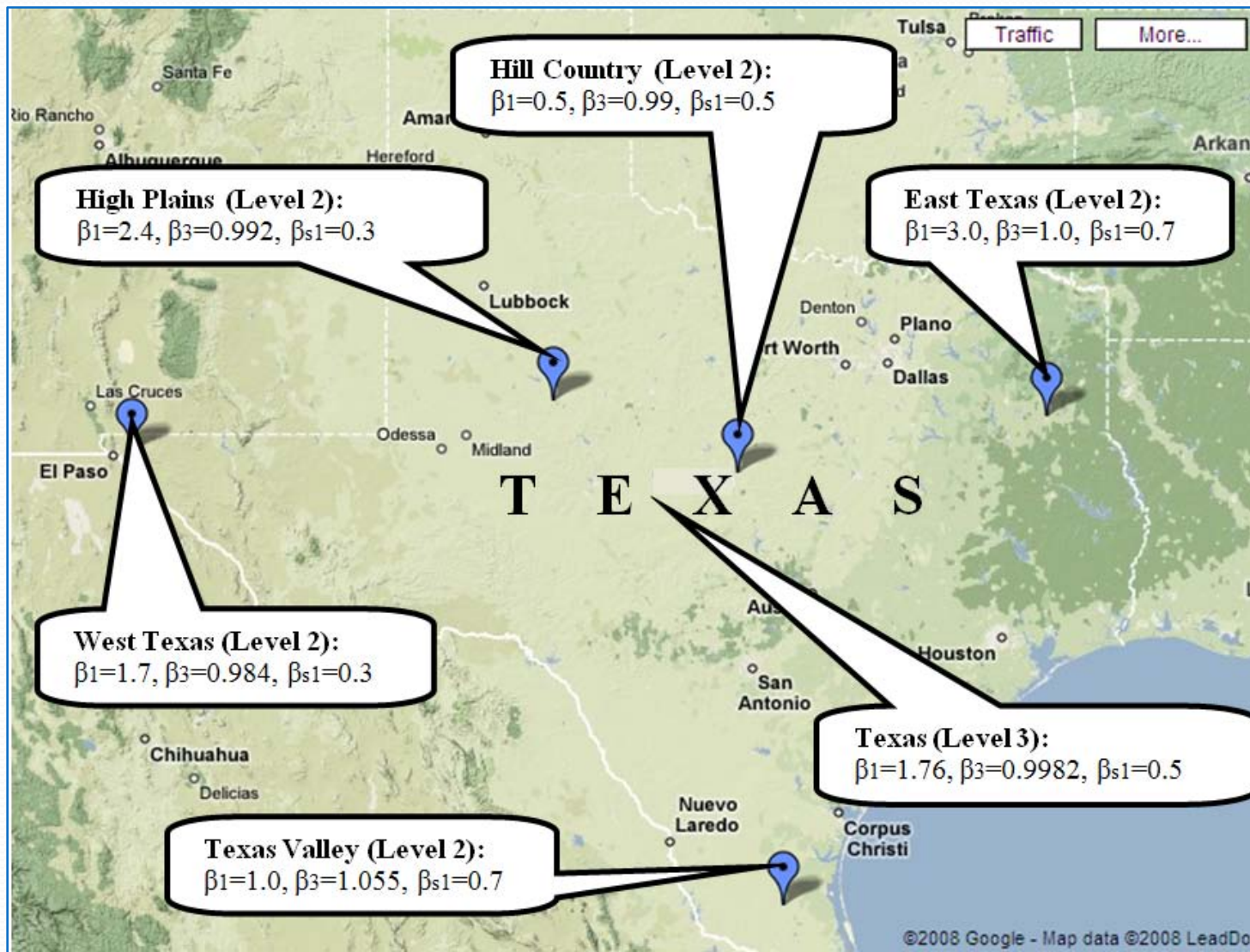


# MEPDG Calibration Approach



- Initialize with all betas = 1.0
- Calculate SSE (observations vs. un-calibrated)
- Modify the betas and recalculate SSE
- Continue until SSE is minimized

# Texas MEPDG calibration



# The future - TxCIT



# In Summary

- Growth in database applications
- Overcoming obstacles towards integration
- Sustainability is the key
- Future – GIS web-based infrastructure
  
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# IRI – PMIS vs. TxFLEx

