A Critical Assessment of Jointed Plain Concrete Pavement (JPCP) Using Sensing Technology – A Case Study on I-285

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Acknowledgement

US DOT National Demonstration Project entitled, “Remote Sensing and GIS-enabled Asset Management (RS-GAM)” sponsored by **USDOT** RITA (Research and Innovative Technology Administration) and **the Georgia Department of Transportation** to develop an intelligent roadway asset inventory and management system using emerging 2D imaging, lasers, 3D LiDAR, UAV, and GPS/GIS technologies

Outline

- Background
- Objective
- JPCP Condition Assessment and Decision-making using Sensing Data
- Case Study on I-285
    - Condition assessment
    - Spatial distribution of broken slabs
    - Growth of broken slabs
    - Monitoring of single slab deterioration
- Conclusions and Recommendations

Background – New Challenge for State DOT

- Majority of Jointed Plain Concrete Pavements (JPCPs) in Georgia are more than 40 years old and are now in need of rehabilitation, such as broken slab replacement, or reconstruction.
- Based on traditional operation, it requires reconstruction on the I-285 section. However, there is NO money for reconstruction of these JPCPs. Full and partial slab replacement is the option based on money available .
- However, the current slab replacement plan development and cost estimation are:
  - Time-consuming
  - Tedious
  - Dangerous under heavy traffic (e.g., I-285)
  - Difficult to obtain an accurate quantity estimate (e.g., on the inside lanes).

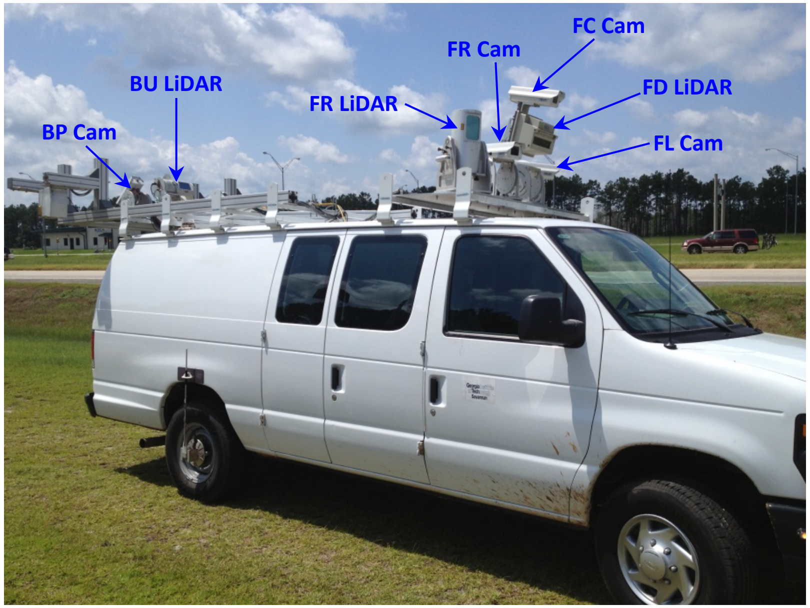
Background – New Challenge for State DOT (Cont'd)

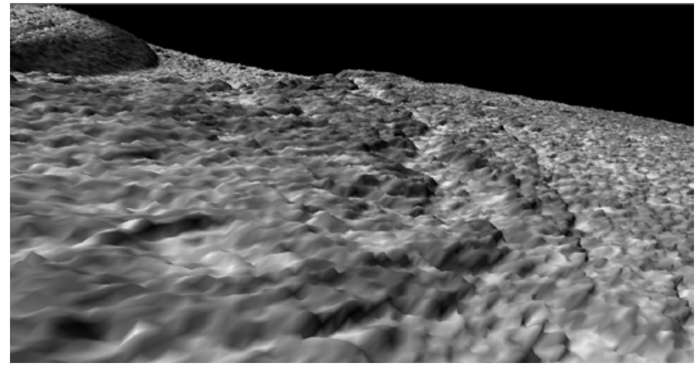
- It requires us to think out of box to explore innovative means to conduct concrete pavement maintenance, rehabilitation and reconstruction (MR&R).
  - By leveraging the strength of emerging sensing technology and automatic distress detection and classification methods.
  - For developing new infrastructure asset management practices.

Objective

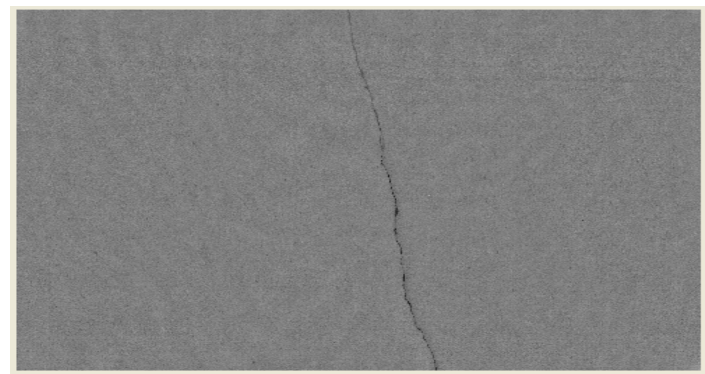
- To explore innovative ways to cost effectively evaluating JPCP conditions at slab level in support of slab replacement plan development and quantity estimation
  - Detailed, location-referenced distress data
  - Safe and rapid data collection
  - More accurate and efficient quantity estimate
  - Slab-based deterioration.
- Ultimately, an innovative and cost-effective JPCP pavement maintenance, rehabilitation, and management methodologies, technologies, and practices will be developed to intelligently and cost-effectively sustain our pavement assets.

High-resolution 3D Pavement Surface Data

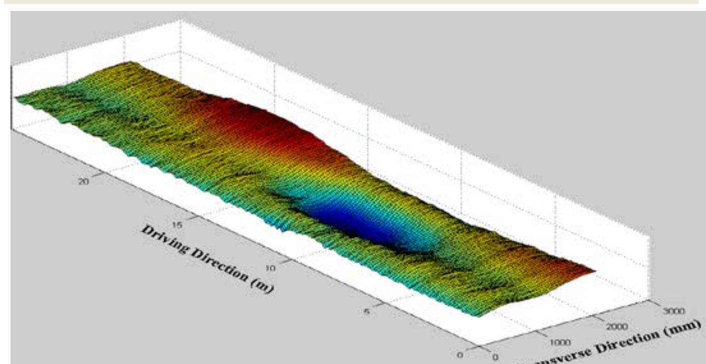




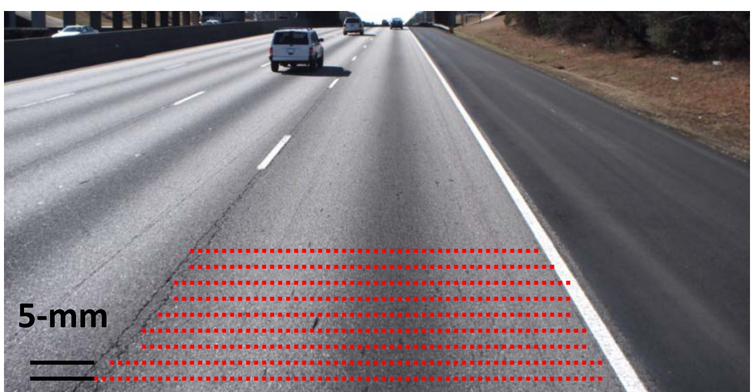
Texture/
faulting



Crack



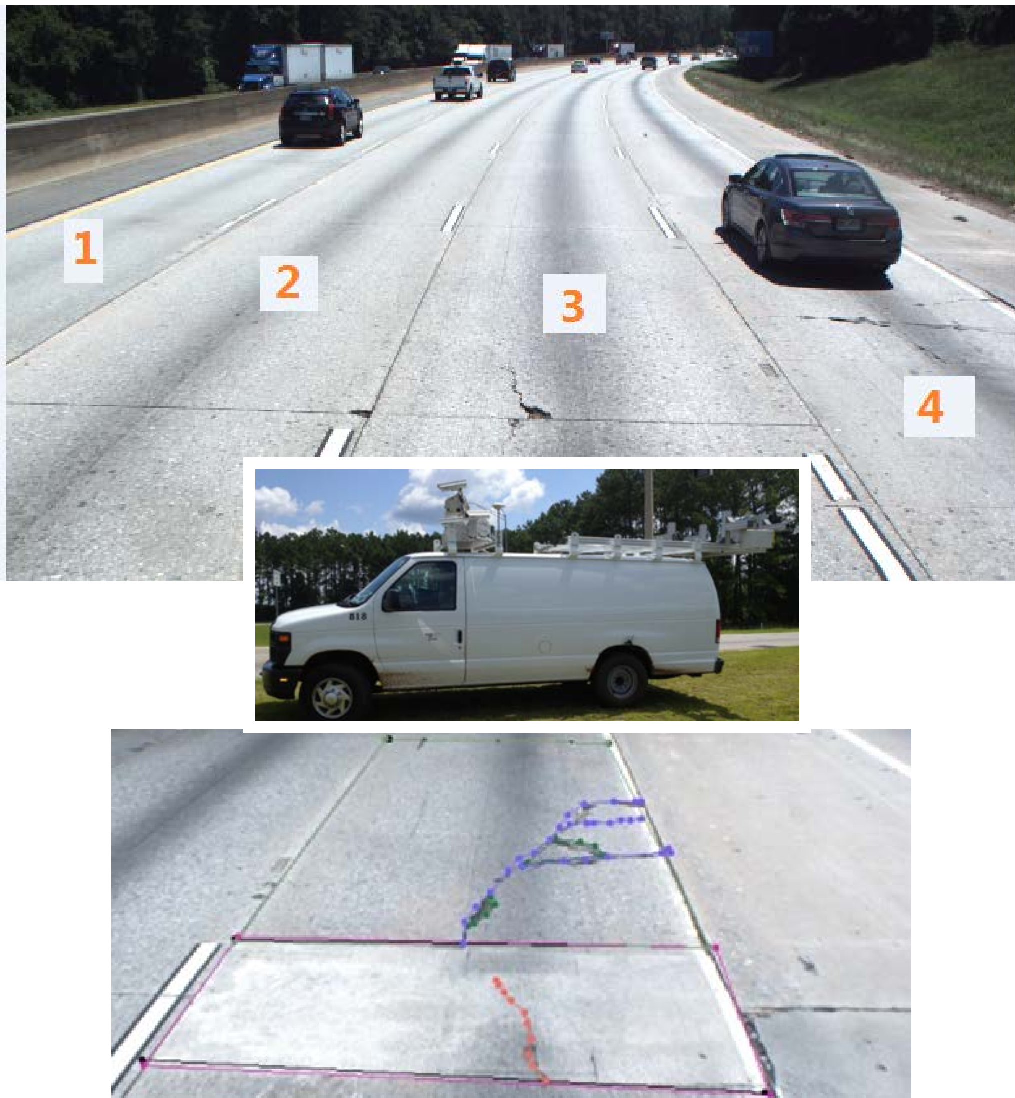
Rutting



1-mm

@ 100 km/hr:

JPCP Condition Assessment and Decision-making using Sensing Data



Data Collection

↓

Data Processing
(Joint, Faulting, Cracking, Spalling, etc.)

↓

Condition at Slab-level

↓

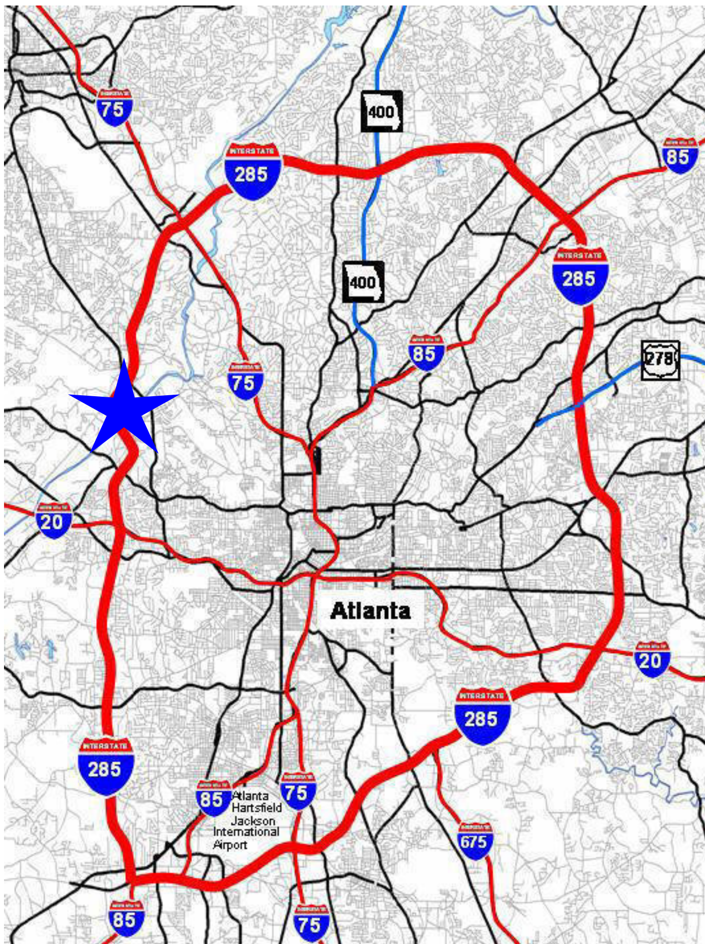
Condition Assessment

Slab Replacement Plan

Quantity Estimate

Deterioration Behavior

Case Study on I-285 in Atlanta



I-285 WB MP 12-13

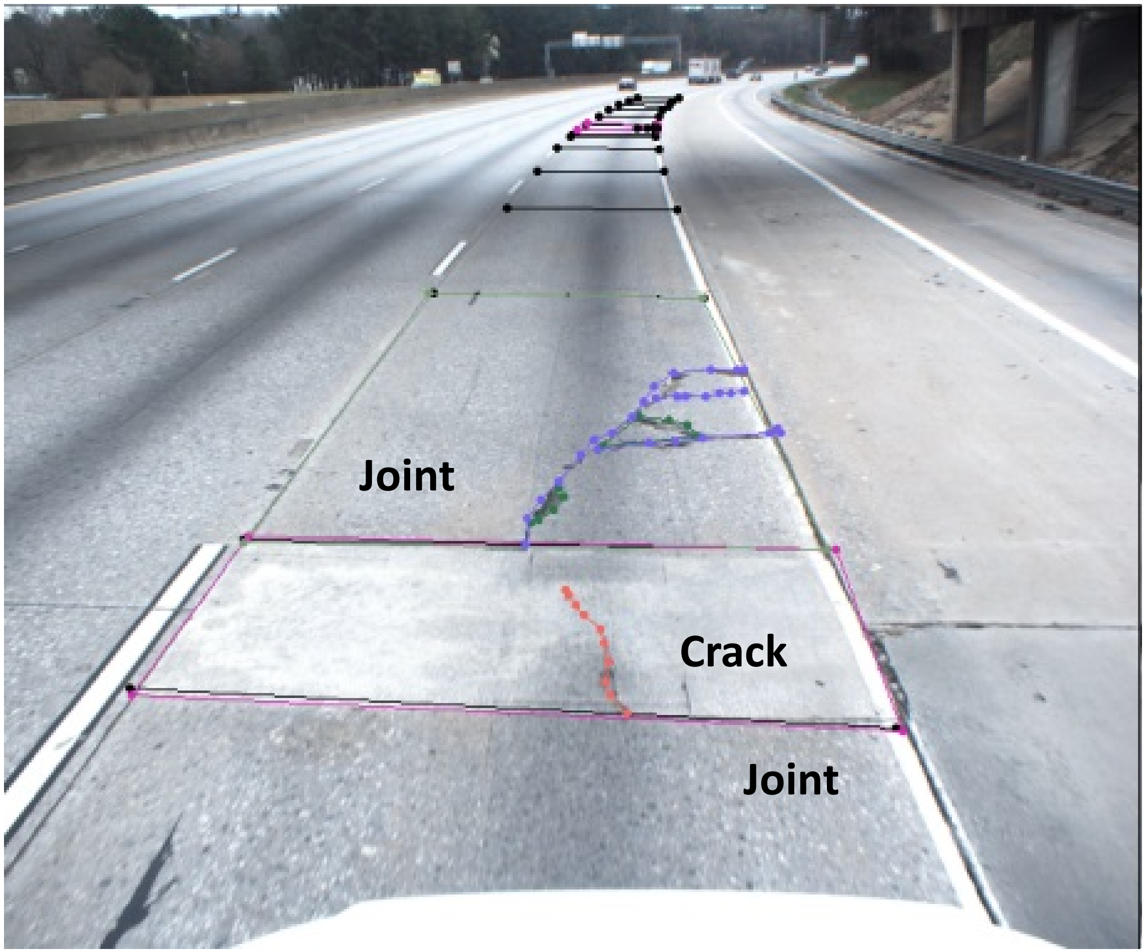
- Constructed in 1968
- In service for more than 40 years
- 10-in thickness
- No dowel
- 30-ft joint spacing
- 12-ft wide
- Asphalt shoulder

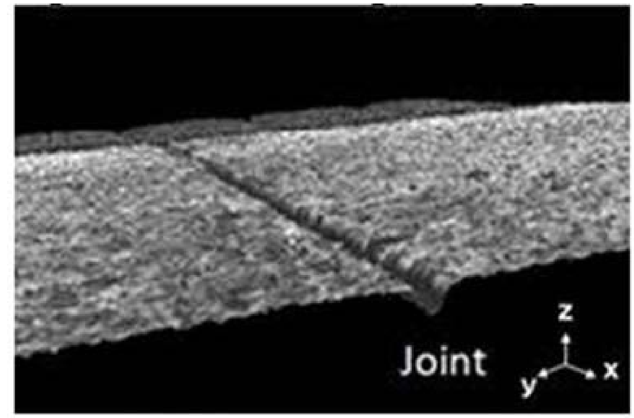
Traffic on I-285

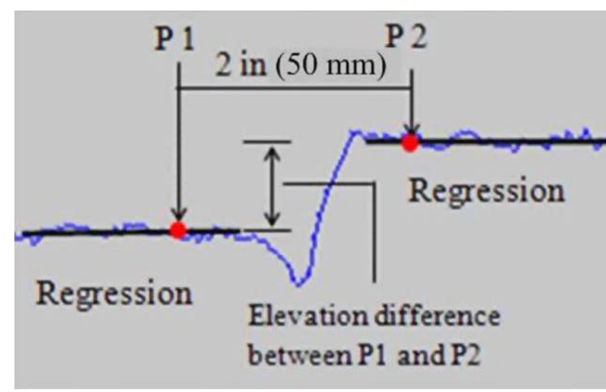
- 150,000^{+} AADT
- 20,000^{+} AADTT

Year	Annual Average Daily Traffic	Annual Average Daily Truck Traffic	% Trucks
2014	154913	23650	15.27
2013	154576		
2012	151240	21582	14.27
2011	154100	16920	10.98
2010	151320	21351	14.11
2009	154680	22289	14.41
2008	159730	25685	16.08

Rapid and Accurate Detailed Level Distress Data Collection at Slab-level







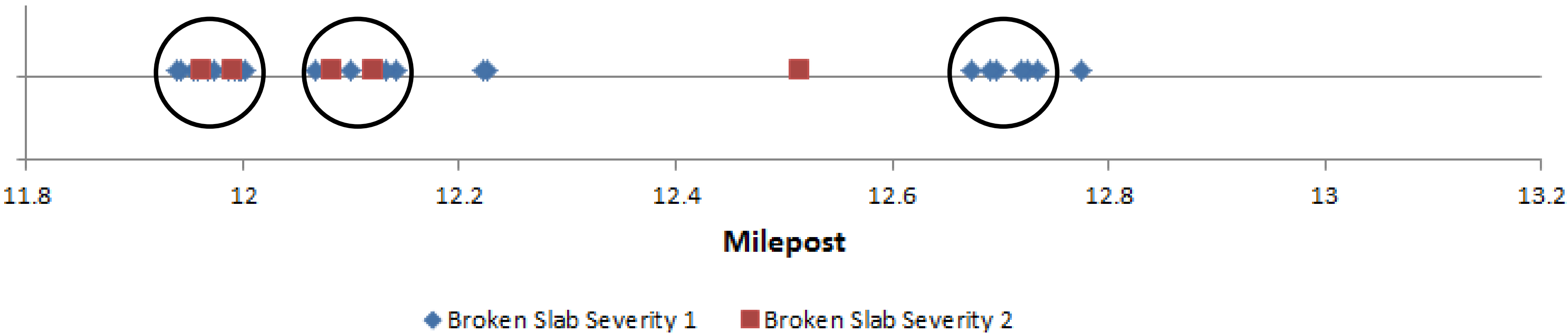
Extract detailed, location-referenced distresses on each slab

Aggregated Condition on 1 Mile

	May 2013
# Slabs	327
# Broken Slabs Severity Level 1	24
# Broken Slabs Severity Level 2	5
Total # of Broken Slabs	29

	May 2013
Total Number of Longitudinal Cracks	50
Total Longitudinal Crack Length (m)	83
Total Number of Transverse Cracks (>6ft)	49
Total Number of Corner Cracks	39
Total Number of Spalls	38

Spatial Distribution of Broken Slabs



- Identify clustered broken slabs
- Investigate the causes

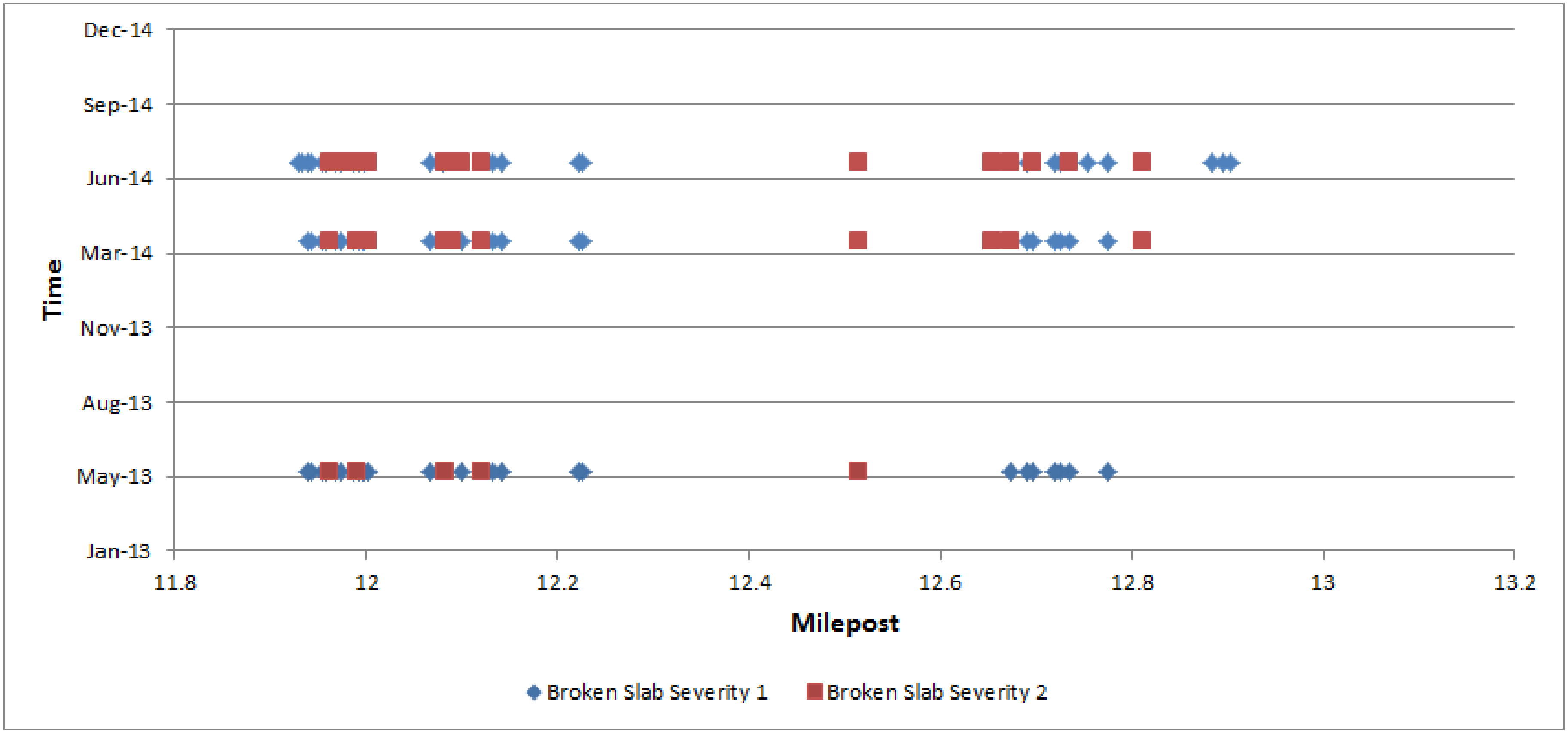
Aggregated Growth of Broken Slabs on 1-Mile

	May 2013	March 2014	July 2014
# Broken Slabs Severity Level 1	24	22	25
# Broken Slabs Severity Level 2	5	10	16
Total # of Broken Slabs	29	32	41

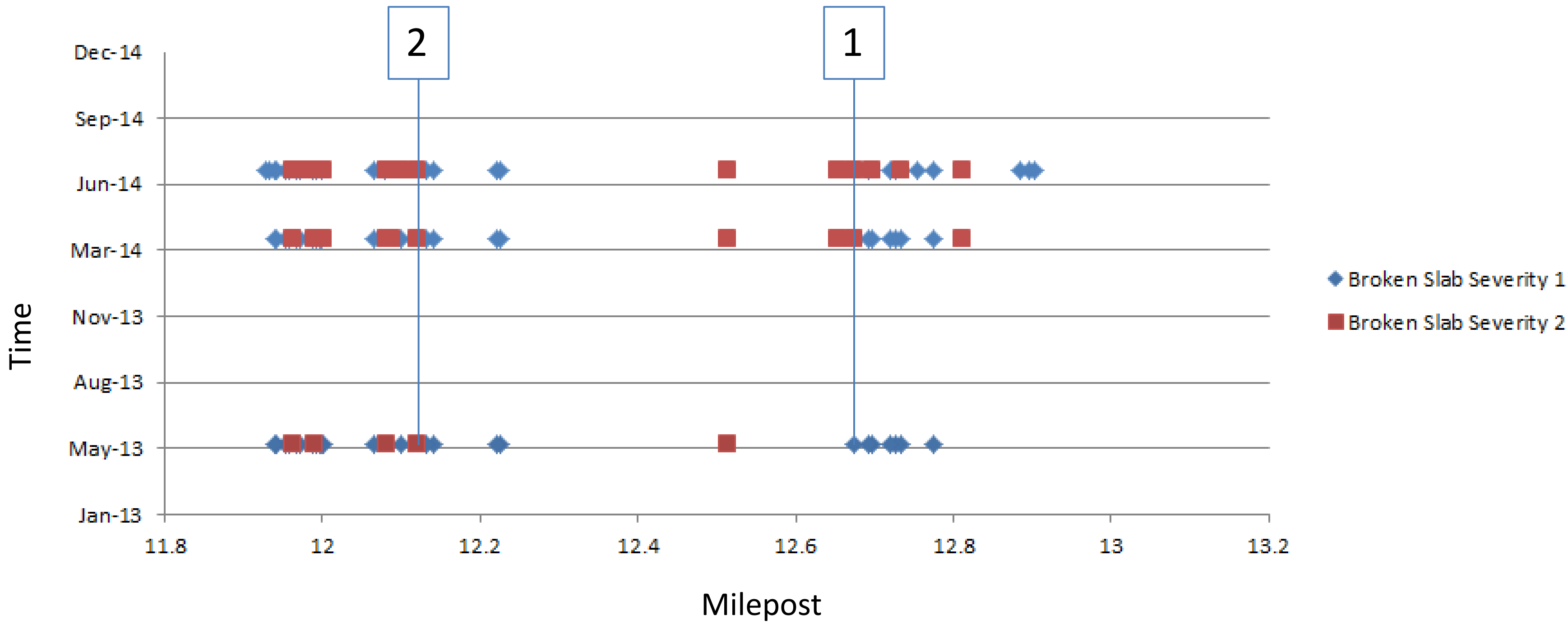
More than 28% broken slab increase / yr

	May 2013	March 2014	July 2014
Total Number of Longitudinal Cracks	50	50	72
Total Longitudinal Crack Length (m)	83.40	96.51	124.03
Total Number of Transverse Cracks (>6ft)	49	55	61
Total Number of Corner Cracks	39	41	55
Total Number of Spalls	38	43	46

Growth of Broken Slabs

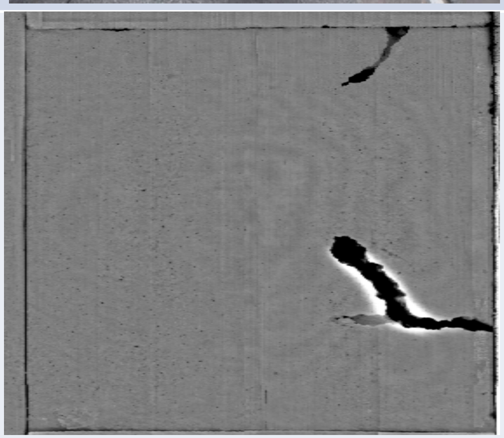


Monitoring of A Single Slab Deterioration



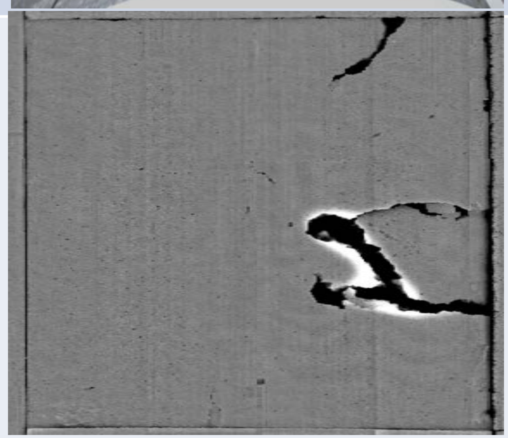
Monitoring of Single Slab Deterioration (Location 1)

May 2013



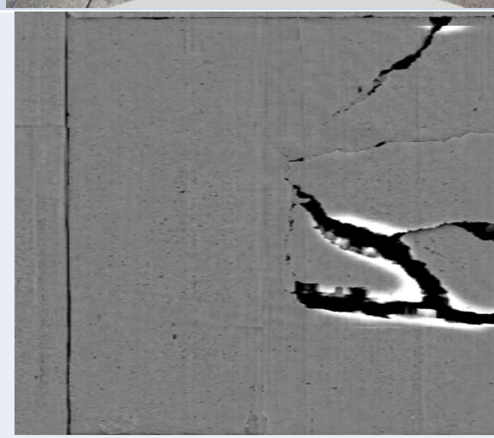
Transverse Crack Level 2
Length: 7.4 ft
Max. Width: 138 mm
Max. Depth: 47 mm

March 2014



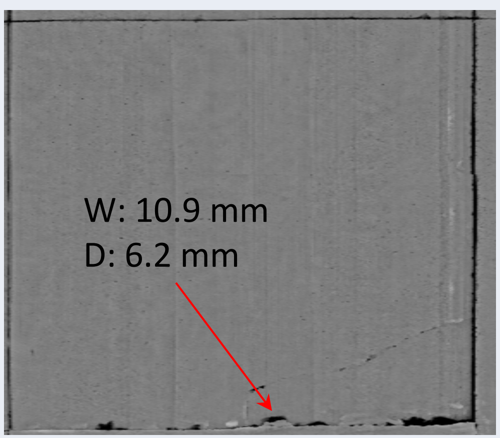
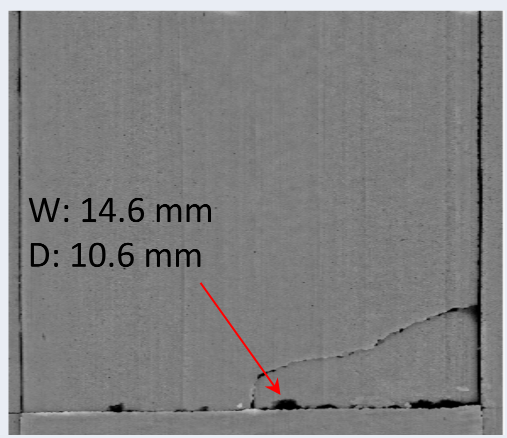
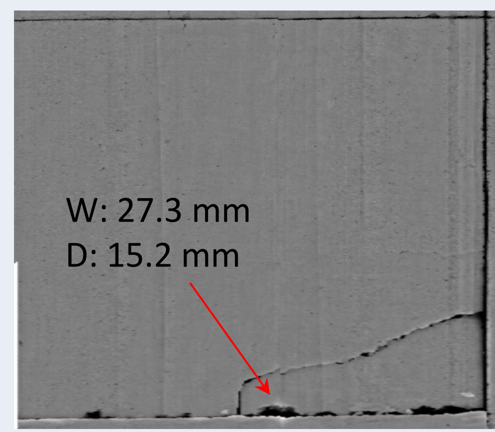
Transverse Crack Level 2
Length: 15.6 ft
Max. Width: 140 mm
Max. Depth: 50 mm

July 2014



Transverse Crack Level 2
Length: 33 ft
Max. Width: 159 mm
Max. Depth: 51 mm

Monitoring of Single Slab Deterioration (Location 2)

May 2013	March 2014	July 2014
		
		

Efficient and Accurate/Reliable Quantity Estimate

1. Identify the slab (8 f.)
2. Consider dowel bar (10 ft.)
3. Consider remaining slab length (15 ft.)

Conclusions

- Because of the funding shortage, state DOTs are forced to explore innovative solutions to address their challenges (funding shortage)
- An innovative method using 3D and GPS/GIS technologies with automatic distress detection and analysis is developed to assist in GDOT's condition assessment and slab replacement plan development and quality estimation.. The case on I-285 has demonstrated the strength of utilizing the proposed method.
  - Safety and accurate condition evaluation
  - Less traffic interference
  - Slab replacement plan can be effectively developed with improved accuracy using the detailed slab-level distress data.
- The proposed method can also analyze the deterioration of JPCP at lab level.

Recommendations

- Test the proposed method on to a larger section.
- Identify and predict the slab with potential safety concern based on their deterioration trend.

Q/A