Non-Destructive Testing Devices

Patrick Icenogle

What is a NDT Device

- Device capable of measuring in-place pavement properties without damaging the pavement
- Some of the measured properties include:
  - Smoothness
  - Thickness
  - Modulus/Stiffness

NDT Devices

- Surface Data Collection Systems
- Ground Penetrating Radars
- Falling Weight Deflectometers
- Seismic Technologies

Advantages

- No damage to pavements
- Move toward performance based specs
- Increased sampling frequency
  - Some are continuous
- Reduced coring
- Less lab work
- Many tests are computer aided

Uses

- Quality Tools (QC/QA)
  - Actual roadway properties in actual roadway conditions
  - Increased sampling frequency with no damage to pavements
- Pavement Performance
  - Same points can be tested multiple times during a pavement's lifetime

NDT Devices

- International Roughness Index (IRI)
  - Smoothness/Roughness measure
  - Longitudinal surface profile
  - Continuous measurement collection at roadway speeds
  - Ratio of accumulated suspension motion to distance traveled
  - Smoother roads have lower IRI values
- Louisiana working towards IRI specification for concrete pavements

NDT Devices

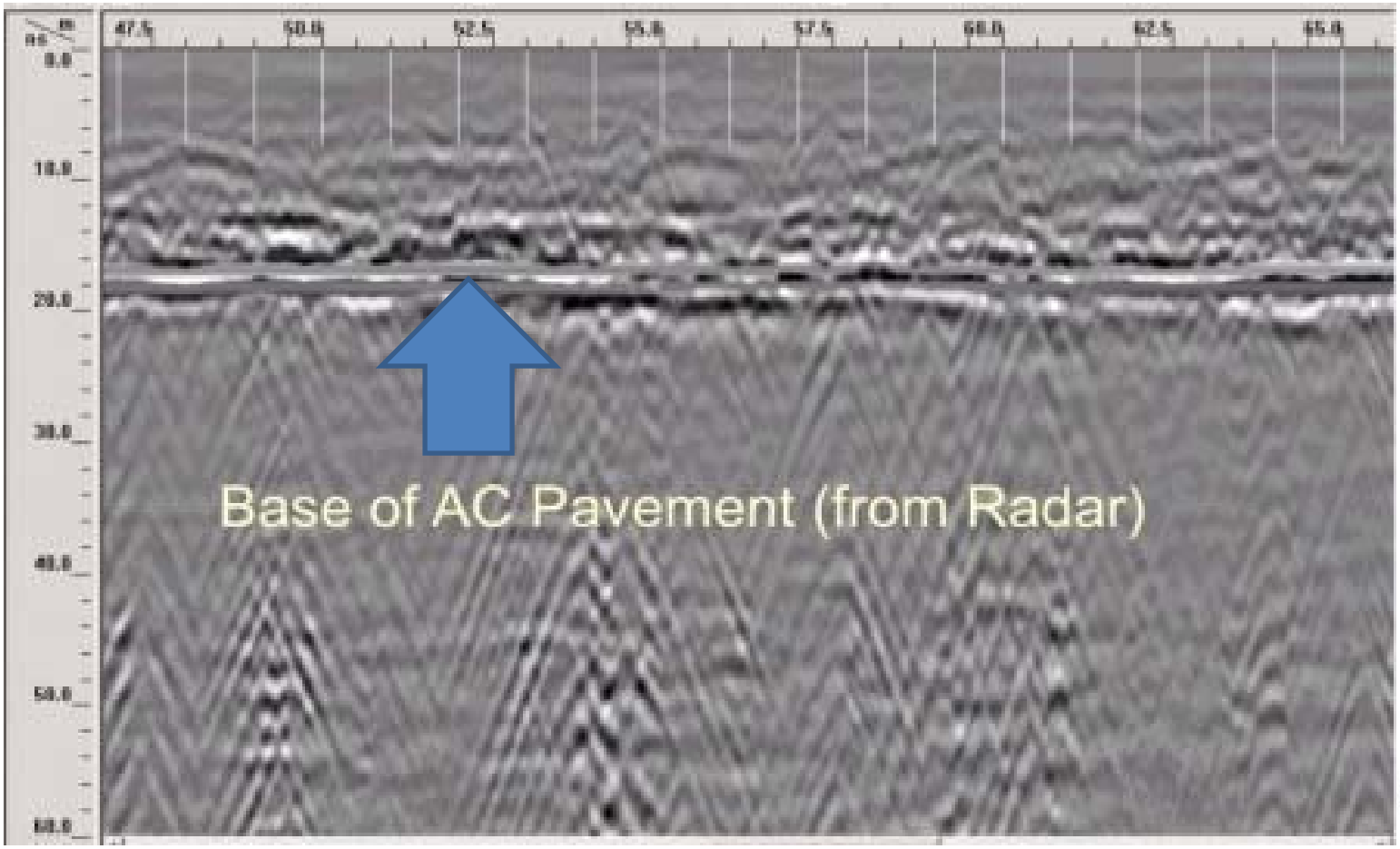
- Ground Penetrating Radar (GPR)
  - Thickness measurement
  - Depth of reinforcement

NDT Devices

- Ground Penetrating Radar (GPR)
  - Transmits high frequency electromagnetic or radio waves into the pavement
  - Waves moving from one material to another causes variations in the signal
  - Receives reflected signal and determines depth of variations in the signal
  - Continuous measurement collection at roadway speeds

NDT Devices

- Ground Penetrating Radar (GPR)



NDT Devices

- Falling Weight Deflectometer (FWD)
  - Deflection measurement
  - Modulus/Stiffness backcalculation of multiple layers of the pavement structure

NDT Devices

- Falling Weight Deflectometer (FWD)
  - Impact load applied to loading plate
  - Surface deflections are measured by geophones at various distances from the center of impact
  - Using reverse of the design process, a modulus value can be back calculated from the deflections
  - Stop and go testing, but test intervals are short

NDT Devices

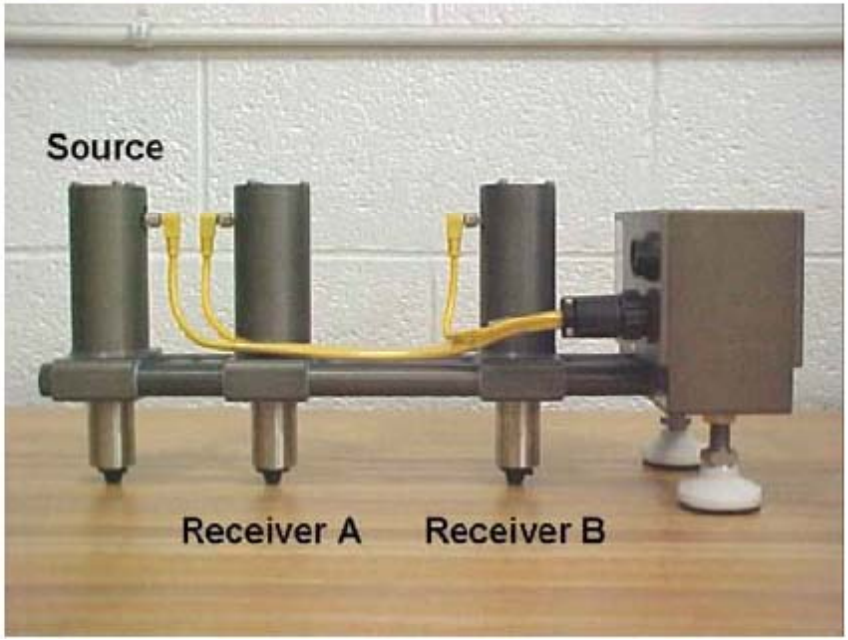
- Light Weight Deflectometer (LWD)
  - Deflection measurement
  - Modulus/Stiffness backcalculation of multiple layers of the pavement structure

NDT Devices

- Light Weight Deflectometer (LWD)
  - Portable version of the FWD, based on same principles
  - Designed for unbound and base materials, however, current research is looking at uses for flexible pavements

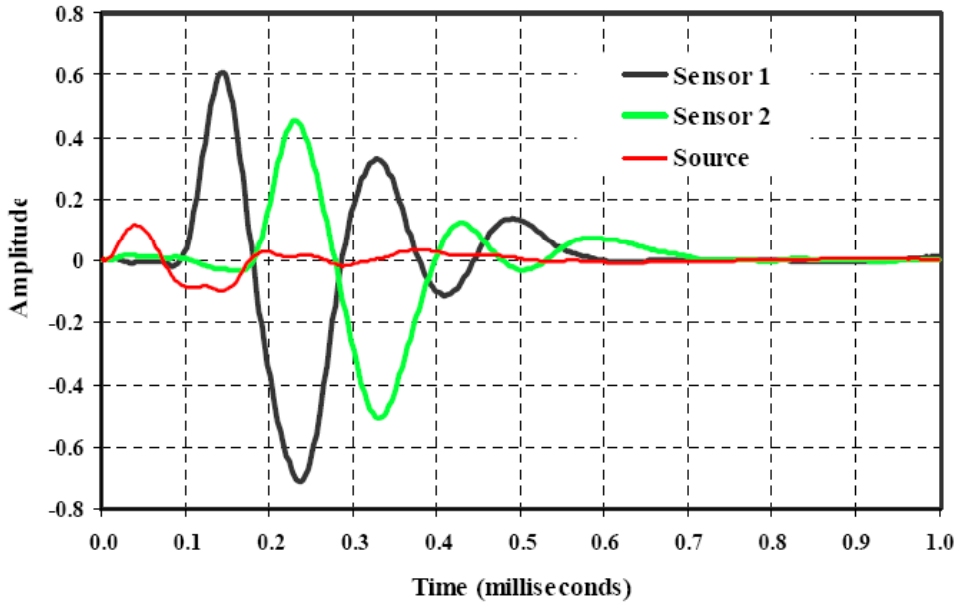
NDT Devices

- Portable Seismic Pavement Analyzer (PSPA)
  - Modulus/Stiffness measurement of surface layer



NDT Devices

- Portable Seismic Pavement Analyzer (PSPA)
  - Source generates stress waves at regular intervals
  - Receivers records wavelengths and arrival times
  - Phase velocity is computed and related to modulus



LTRC PROJECT NO. 09-5C

Evaluation of Non-Destructive Technologies for Construction Quality Control of HMA and PCC Pavements in Louisiana

PI:
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and
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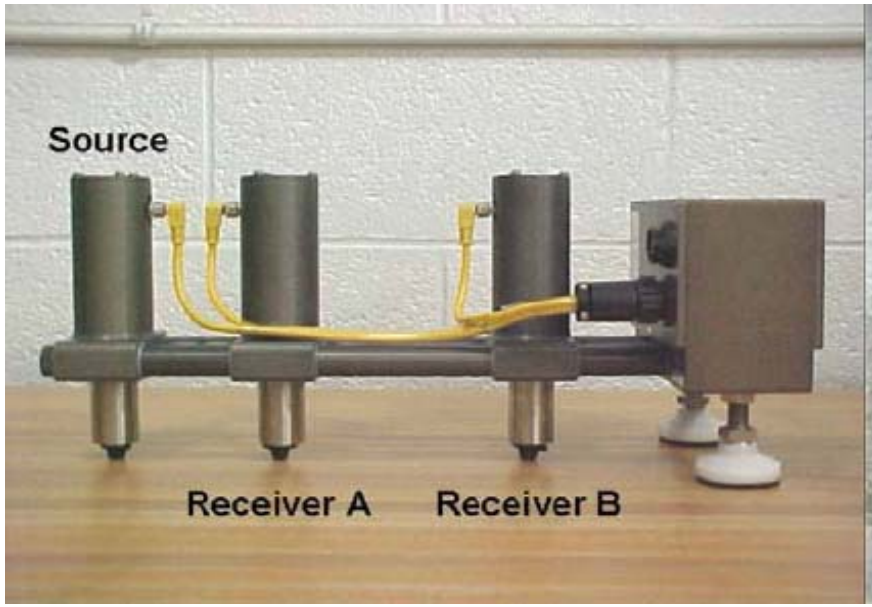
LTRC 09-5C

PSPA

Portable Seismic Pavement Analyzer



LWD

Light Weight Deflectometer

LTRC 09-5C Objectives

- Develop procedures for operating the LWD and PSPA devices as QC/QA tools
- Perform a ruggedness test on the devices
- Compare lab properties obtained from cores and cylinders to field properties obtained from the LWD and PSPA devices

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- LWD and PSPA measure the modulus of the surface layer of a pavement
- Modulus values can be used as a standalone measure or correlated to other properties
- LWD center deflections can be used as a standalone measure representative of the pavement structure

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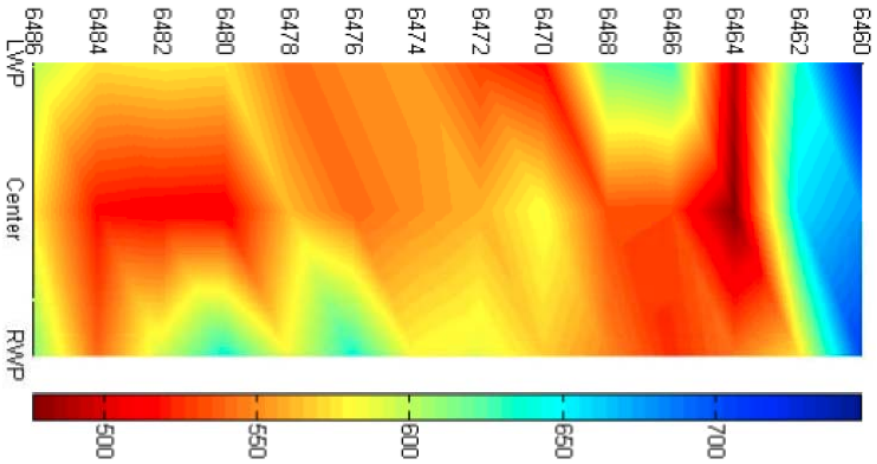
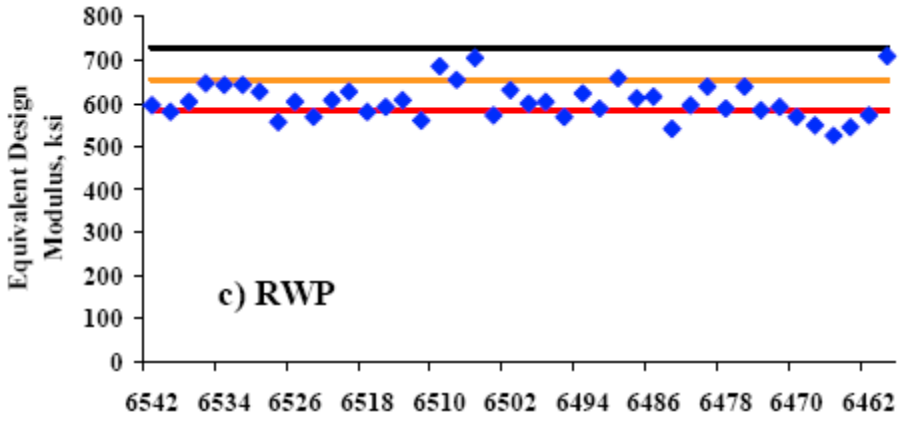
- Ruggedness Testing
  - Presence of water
  - Presence of nearby vehicles/construction
  - Presence of small cracks
  - Orientation of receivers
  - Distance from joint

Research by Others

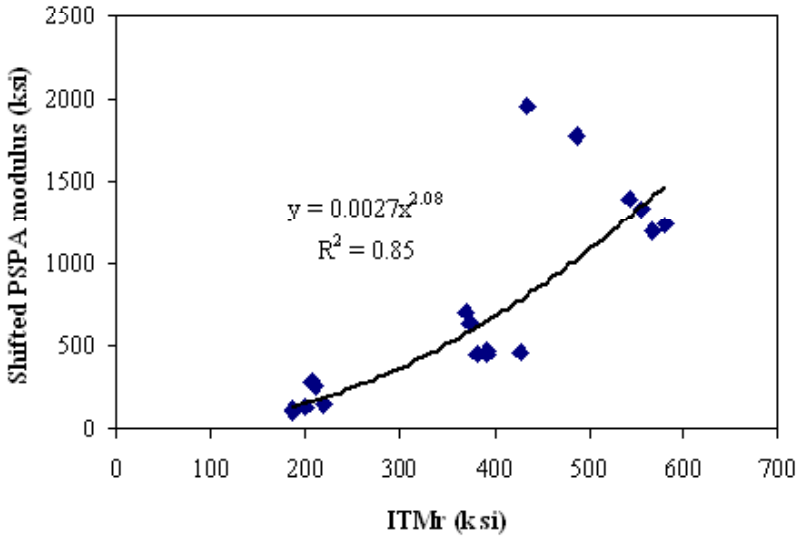
- AZDOT
  - "Use of NDT Equipment for Construction Quality Control of Hot Mix Asphalt Pavements"
  - PSPA values correlated well with modulus values from cores
  - Concluded that contractors should be able to get within 85% of target design modulus from the lab





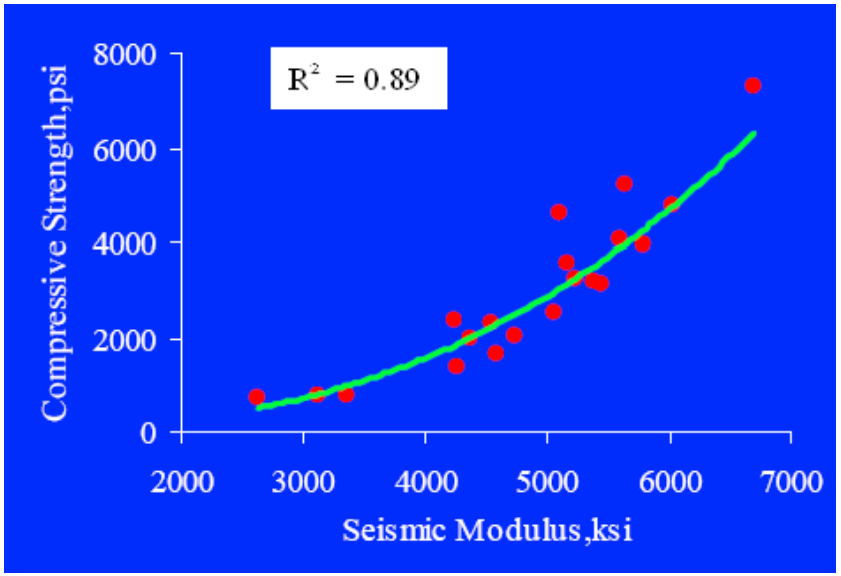
Research by Others

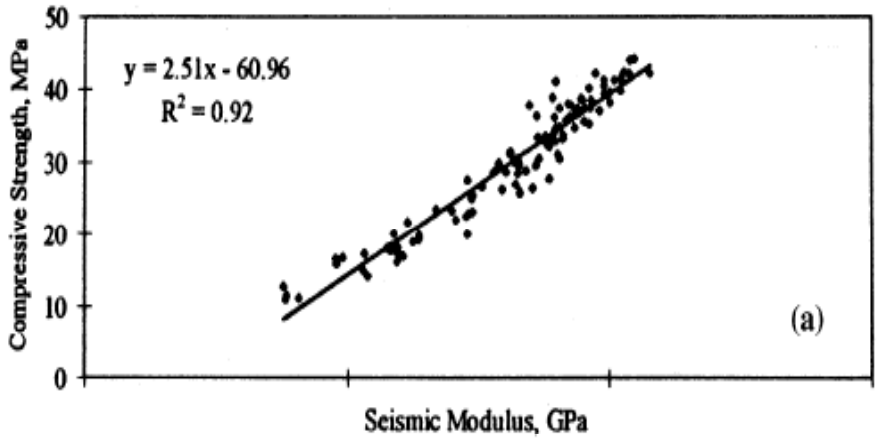
- LTRC Project 02-3B
  - Compares Physical and Mechanical Properties of HMA Mixture and Field vs. Laboratory
  - PSPA had lower variability than FWD and LWD
  - PSPA correlated well with ITMr



Research by Others

- Univ. of Texas, El Paso and TxDOT
  - Good relationship between compressive strength and lab seismic modulus





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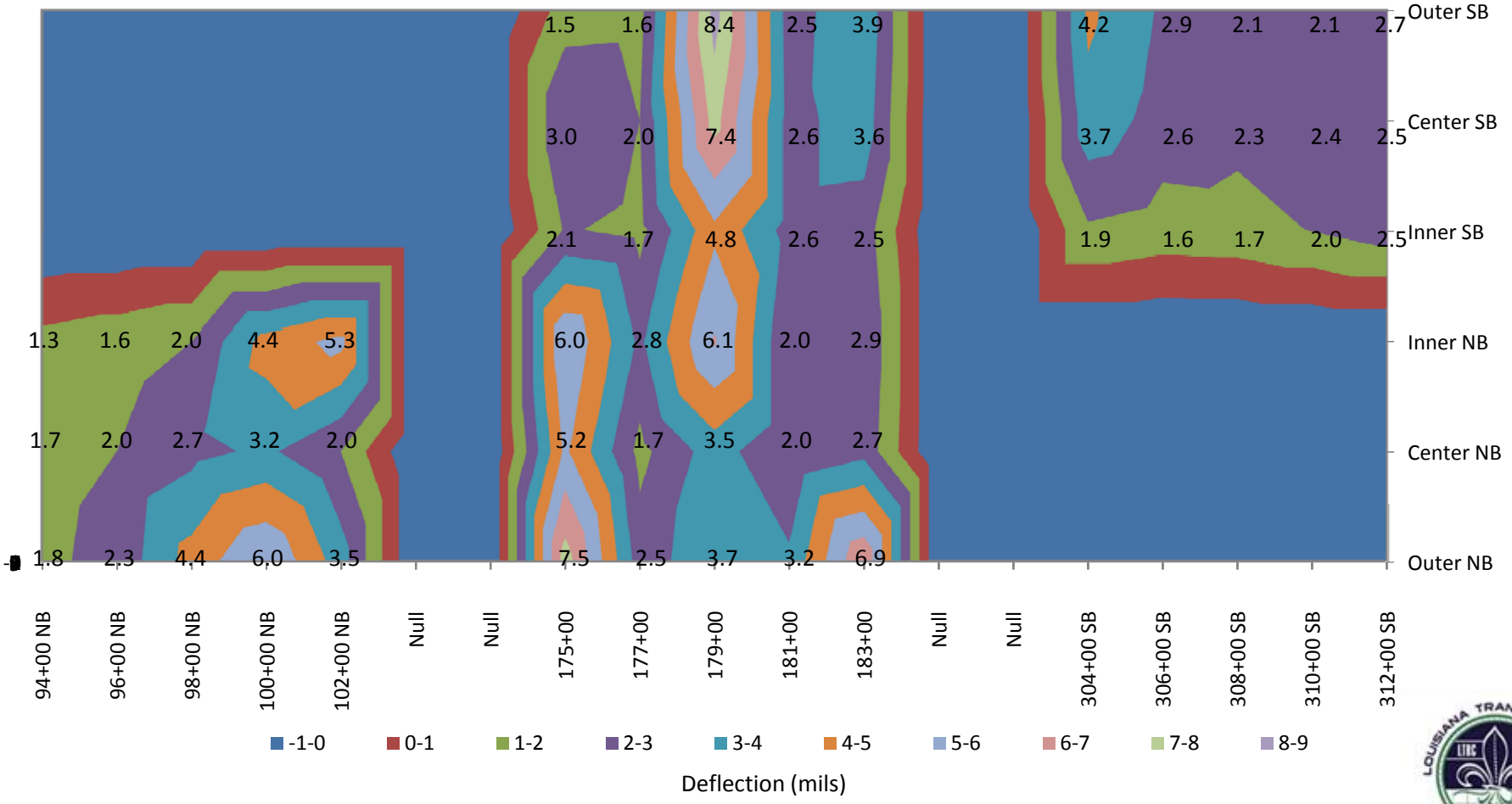
Asphalt Deflections Contour



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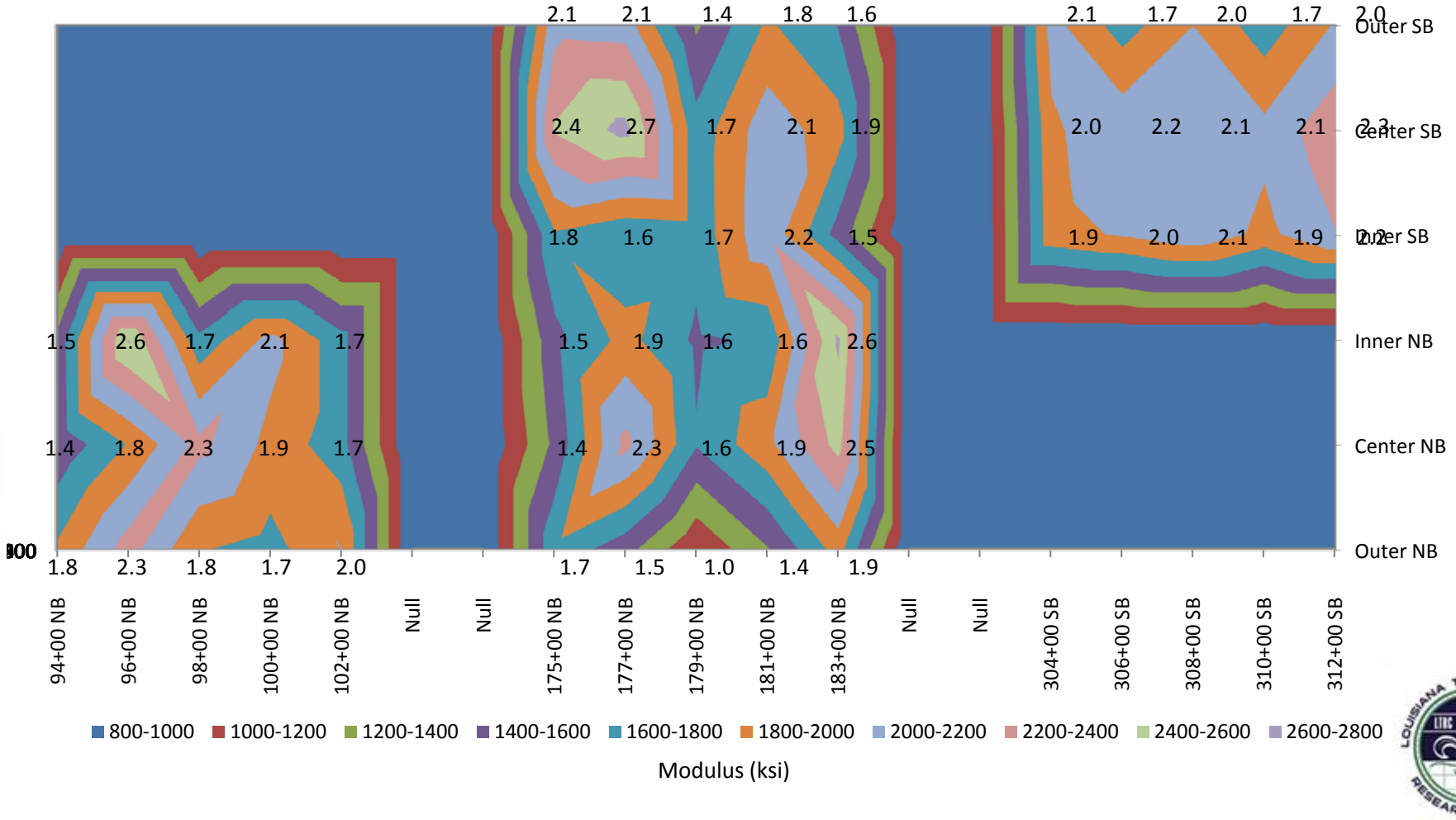
PSPA Temp Corrected Modulus Contour



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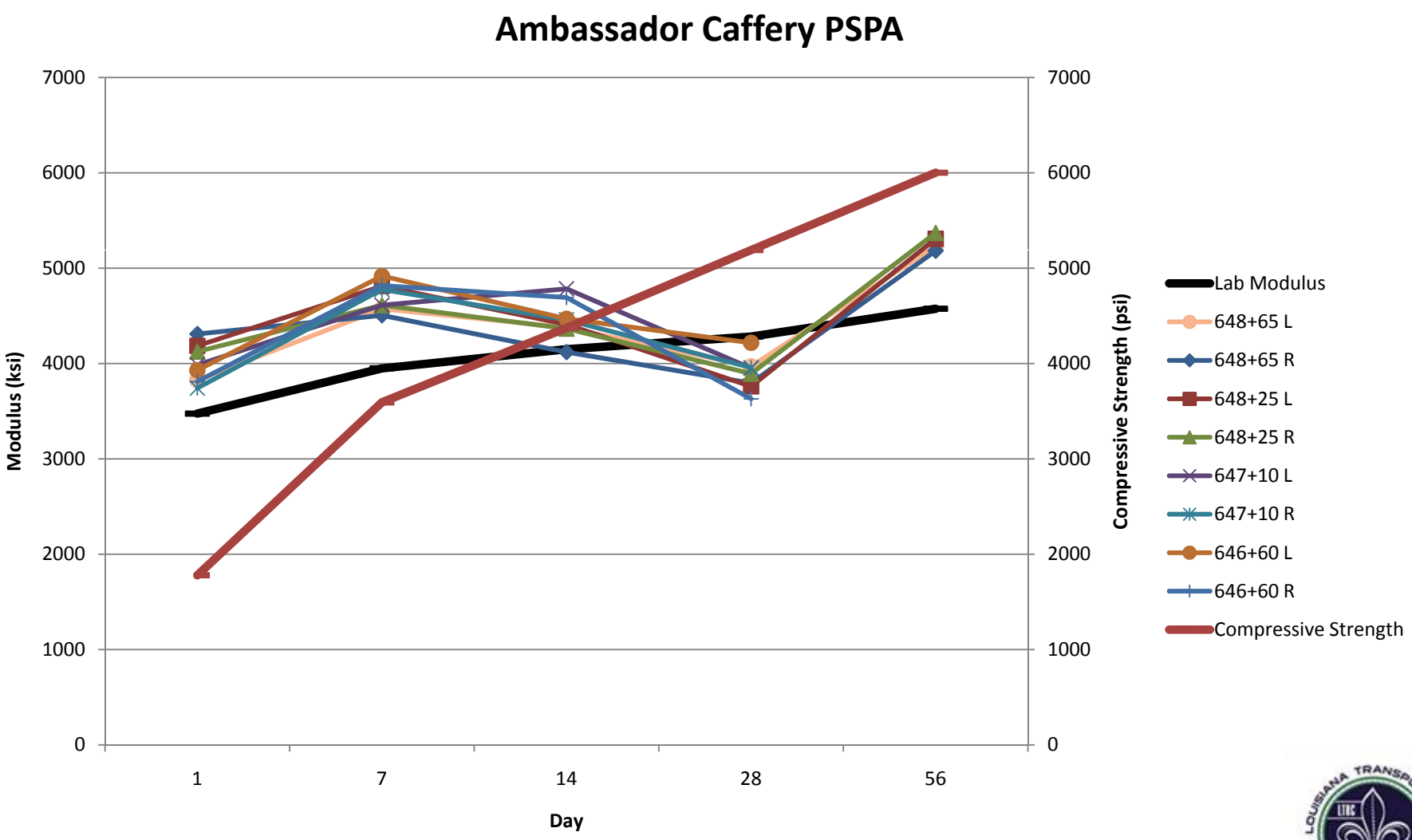
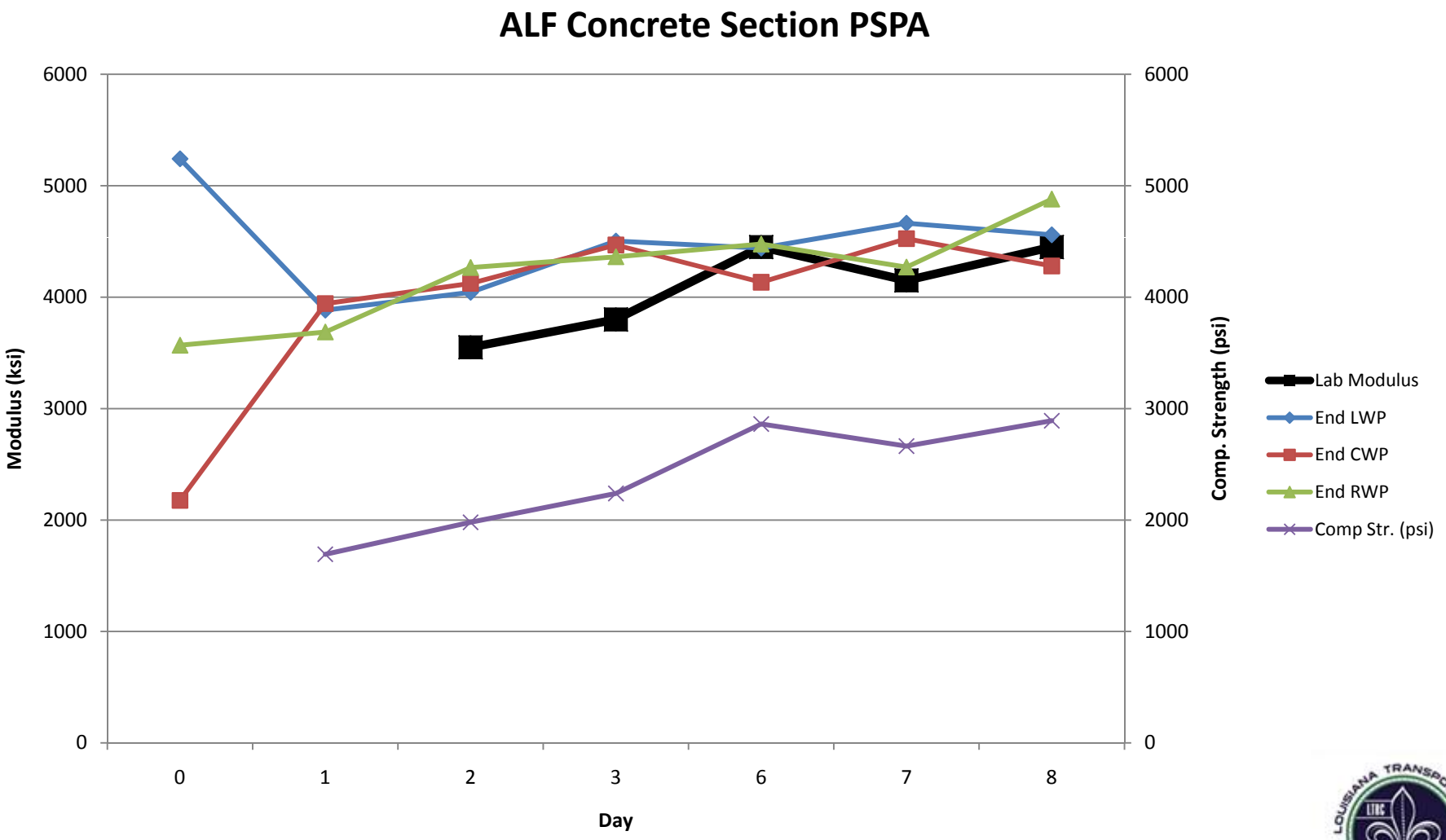

Ambassador Caffery PSPA
Modulus (ksi)
Compressive Strength (psi)
Day
0
1000
2000
3000
4000
5000
6000
7000
1
7
14
28
56
Lab Modulus
648+65 L
648+65 R
648+25 L
648+25 R
647+10 L
647+10 R
646+60 L
646+60 R
Compressive Strength

LTRC 09-5C


ALF Concrete Section PSPA
Modulus (ksi)
Comp. Strength (psi)
6000
5000
4000
3000
2000
1000
0
0
1
2
3
6
7
8
Day
Lab Modulus
End LWP
End CWP
End RWP
Comp Str. (psi)

References

1. Celaya, Manuel; Nazarian, Soheil; Zea Manuel; and Tandon, Vivek. "Use of NDT Equipment for Construction Quality Control of Hot Mix Asphalt Pavements". Arizona Department of Transportation, 2006.

2. Mohammad, Louay; Saadeh, Shadi; Zhang, Chenggang; and Rhagavendra, Amar. "Comparison of the In-situ Strength and Laboratory Mechanical Properties of Asphalt Concrete Mixtures". Louisiana Department of Transportation, 2006.

3. Yuan, D. and Nazarian, S. "A Nondestructive Methodology for Optimizing Opening of PCC Pavements to Traffic". Project Summary Report 0-4188-S1. Center for Transportation Infrastructure System, University of Texas at El Paso. 2003.

4. Nazarian, Soheil; Yuan, Deren; Weissinger, Eric; and McDaniel, Mark. "Comprehensive Quality Control of Portland Cement Concrete with Seismic Methods". Texas Department of Transportation, 1997.

5. Von Quintus, Harold; Minchin, Jr., Robert; Nazarian, Soheil; Maser, Kenneth; Prowel, Brian. "NDT Technology for Quality Assurance of HMA Pavement Construction". NCHRP Report 626. Transportation Research Board, Washington D.C. 2009.