Ground Penetrating Radar for Evaluation of Asphalt Density

by

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Roanoke, VA

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Background and Objectives

- Background
  - Density of new asphalt is critical for future pavement performance
  - Current QA methods can only address a small number of random points
  - GPR has the capability to conduct a 100% scan of the new pavement and identify density deficiencies
- Objectives
  - Develop survey methodology
  - Conduct field evaluations and correlate GPR and core data

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Technical Background

- Horn antenna GPR can measure pavement surface layer dielectric by measuring the reflection amplitude from the pavement surface

- Pavement dielectric is directly related to density, assuming material composition is uniform

- This relationship has been confirmed in previous studies

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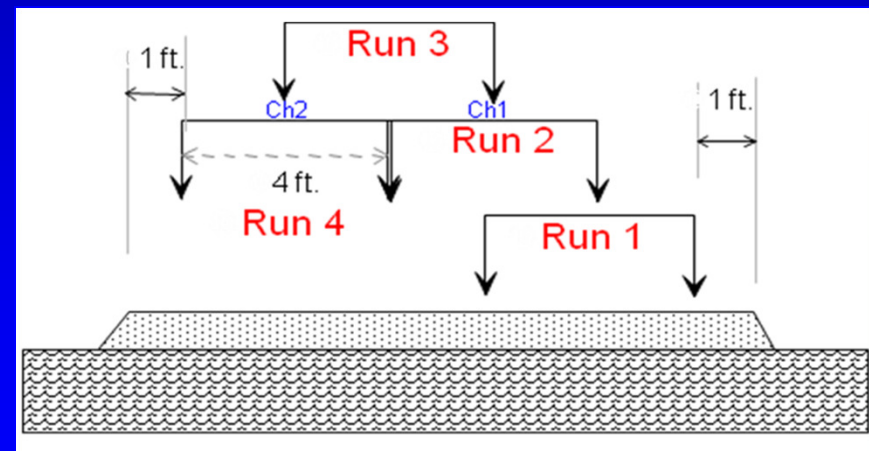
GPR System and Specifications

- Dual 2-GHz horn antenna system operated by the Florida DOT

- The system was evaluated for the following parameters:
  - Time Range of the GPR Scan
  - Data Rate
  - Sample Rate

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Test Equipment and Protocol

Data collection protocol
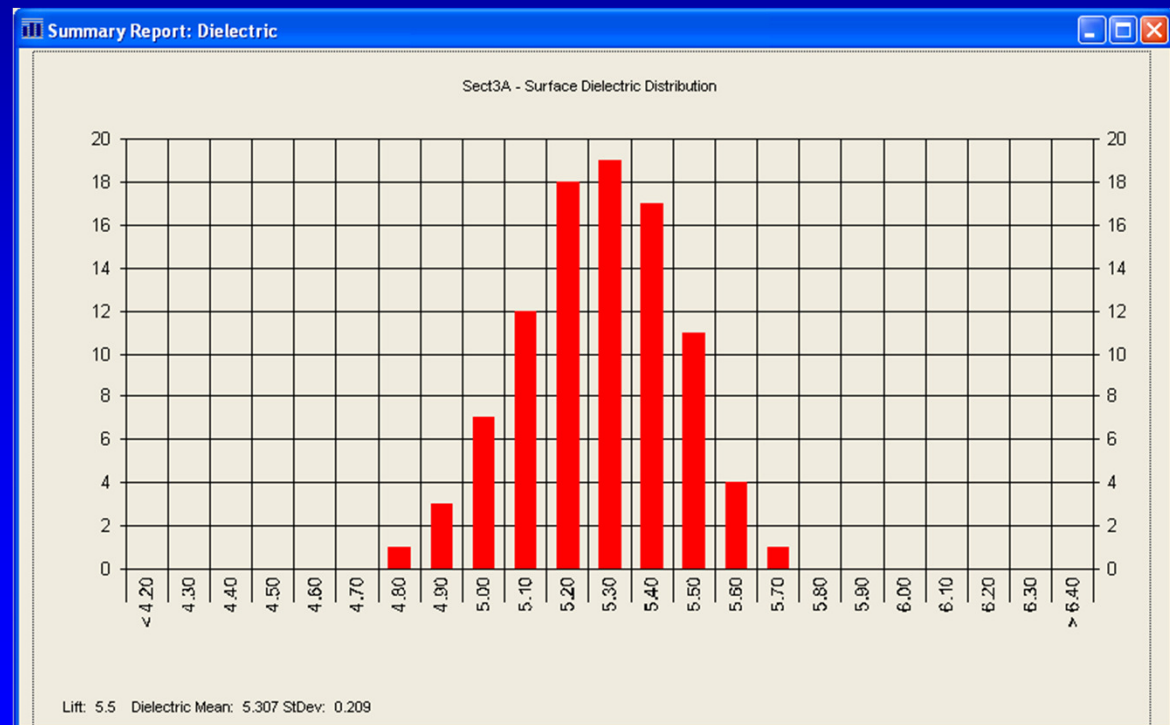
Automated Data Analysis (GPRQA)

- Dielectric constant for given survey layout is automatically calculated.

- Results presented graphically as contour plots and histograms for the entire pavement section

- Analysis process takes about 20 minutes – user obtains immediate feedback for locating cores

- Core data is used to calibrate the dielectric values with core density measurements

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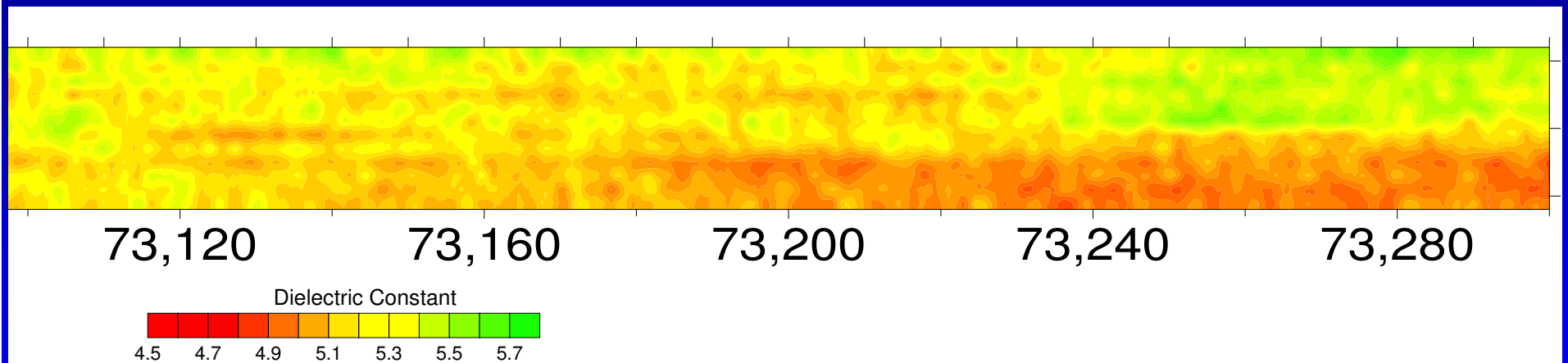
GPRQA Analysis

Raw Output

TextStation	Offset	Thickness	Dielectric
71600.25	-11	3.054632	4.840155
71600.25	-9	1.803153	5.210477
71600.25	-7	2.931722	5.120124
71600.25	-5	2.566721	5.270694
71600.25	-3	2.783084	5.285629
71600.25	-1	2.80098	5.22176
71600.25	1	3.306938	5.239645
71600.25	3	2.914933	4.959617
71600.25	5	2.285716	5.088805
71600.25	7	3.086261	5.18236
71600.25	9	3.9823	5.012023
71600.25	11	2.957405	5.083148
71600.5	-11	2.944654	5.254775
71600.5	-9	1.749252	5.170932
71600.5	-7	2.931722	5.120124
71600.5	-5	2.566721	5.270694
71600.5	-3	1.804893	5.308926
71600.5	-1	2.823227	5.336705
71600.5	1	3.306938	5.239645
71600.5	3	2.914933	4.959617
71600.5	5	1.801444	5.036787
71600.5	7	3.037751	5.002033
71600.5	9	3.9823	5.012023

Histogram Output

Summary Report: Dielectric

Sect3A - Surface Dielectric Distribution

Lift: 5.5   Dielectric Mean: 5.307   StDev: 0.209

GPRQA Contour Plotted Output

73,120   73,160   73,200   73,240   73,280

Dielectric Constant

4.5   4.7   4.9   5.1   5.3   5.5   5.7

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Location Reference for Data Collection: Laser Trigger System

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# Field Validation Testing

- Field Validation Trials were completed on three different construction projects.

  - New Construction Projects:
    - State Road 20 (Town of Interlaken)
    - State Road 23 (Duval County)

  - Asphalt Resurfacing Project:
    - State Road 222 (City of Gainesville)

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# SR 20 Survey Results Highlights

Dielectric value vs pavement core density (G_{mb}):

Trial Sections	Section Length (ft.)	(R^2)
Section 1	600	0.81
Section 2	700	0.80
Section 3 – Hot Survey	800	0.86
Section 3 – Cold Survey	800	0.98
Section 4	800	0.83
Section 5 (in area of Section 3)	7000	0.84
Section 5 (in area of Section 4)	7000	0.97

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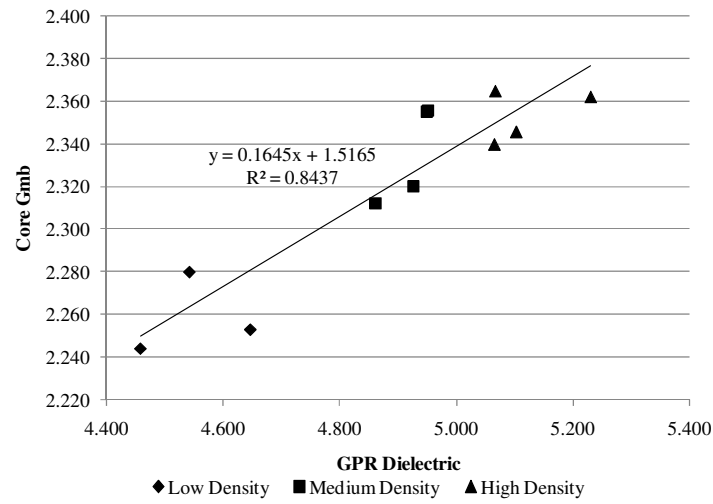# Overall Density Correlation for 3 Projects
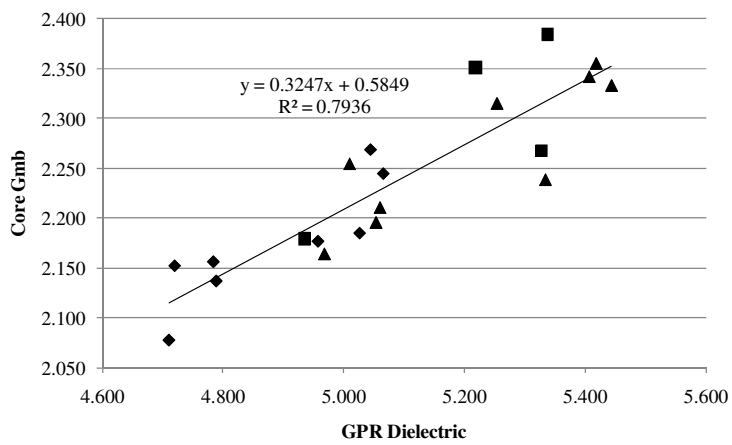
SR 20 Results
$R^2 = 0.79$
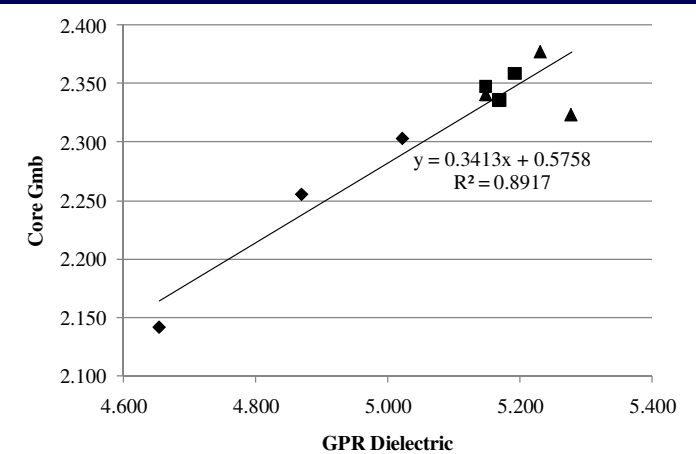
SR 23 Results
$R^2 = 0.89$

SR 222 Results
$R^2 = 0.84$

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Summary of Findings

- GPR dielectrics contours shows overall density variation.

- Dielectric data is used to 'target' the core locations

- Method provides significantly more data than traditional density tests

- Calibrated GPR dielectric values correlate better with core density values than standard nuclear and non-nuclear density gages.

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