#### **GPR Applications-Florida Practices**

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Non-Destructive Evaluation (NDE) Technologies for Evaluating Asphalt Pavement-Virtual User-Group Peer Exchange

September 28-29, 2021



#### **Overview**

GPR Applications
 Air-Launched GPR
 Ground-Coupled GPR

PaveScan

≻Mini XT

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#### FDOT GPR Program

- ➢ 30 Years in Production
  - 26,000 Lane Miles
  - **2,000** Projects
- Statewide Predesign Evaluation of In-Service Roadways
  - Thickness of Pavement Layers
- Pavement Forensic Investigations
  - Premature Failure / Distress
  - Sink holes / Voids





#### **SharePoint Pre-Design Request**

#### BROWSE



SharePoint List Pavement Pavement Condition

Pre-Design District Contacts

Pavement Marking Mgt

Pavement Performance

Pavement Research

Quick Links Department Contacts Department Resources Public Notices Technology Resources

Pavement Performance Workspace

Documents

Friction

Mobile Retroreflectivity

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Pre-Design

Other Resources

	One-Time Special F	Projects I	High Friction Surf	ace Treatment	Pre	-Design									
l	PRE-DESIGN														
	Submit New Project(s)	District 1	District 2	District 3	District 4	District 5	District 6	District 7	Turnpike	Statewide					
	Mutiple Projects	Pending	Pending	Pending	Pending	Pending	Pending	Pending	Pending	Pending					
	Single Project	Reported Las 90 Days	Reported Last 90 Days	Reported Las 90 Days											
	Email	All Projects	All Projects	All Projects	All Projects	All Projects	All Projects	All Projects	All Projects	All Projects					



#### **Example of Pre-Design Thickness Report**

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### Air Launched GPR



- High frequency (1GHz or 2GHz) antennas for pavement surveys
- Operate at highway speed, no traffic restrictions required
- Estimate existing pavement thickness "continuously" and nondestructively
- "Engineered Coring Plan
  - Minimize coring to reduce costs
  - Core verification
  - Isolate areas

#### **GPR vs Coring**

	GPR	Coring
Operating speed	Highway speed	Stationary
Traffic restrictions	None	Lane closure
Thickness accuracy	Approximation	Exact
Number of thickness data per lane per mile	52 to 5280	1 to 3



### **GPR Precision Study**

- Seven sites selected for pavement thickness accuracy and repeatability studies
- Four different pavement types used:
  - Flexible (HMA)
  - Rigid (PCC)
  - HMA overlaid PCC
  - PCC overlaid HMA
- Varying pavement thickness



## Data Collection (GPR/Core)

# Stationary GPR data collected and locations marked for coring







#### **Accuracy of Air Launched GPR**



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#### **Repeatability of Air Launched GPR**

Repeatability in terms of COV within 10 %



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### **Case-I-75 in Marion County**

- 6 lane resurfacing
- Lanes L1 and R1 were constructed at different dates
- GPR survey requested to assist in the engineering coring plan
- Safety issue to core in middle passing lane





#### **GPR Profiles per Lane**



- Similar thickness profiles between L2, R2 and L3, R3
- Thickness Variability
- District decided NOT to core lanes L2 and R2
- Reduced MOT and Total savings = \$ 4,000

L2: Original pavement



**Thickness Variability** 





#### Follow Up, GPR vs Cores



→ GPR Thickness Prediction → Core Thickness



### **Ground-Coupled GPR**

- Antennas of various frequencies (100 MHz to 900 MHz)
- Used for pavement surveys and forensics
- Handheld, requires traffic restrictions
- Lower frequency antennas offer greater penetration depths but lower resolution
- Higher frequency antennas offer greater resolution but lower penetration depths





#### **Ground-Coupled GPR Applications**

#### **Underground Utilities**



#### Sinkhole Investigations



![](_page_15_Figure_5.jpeg)

#### **Pavement Depressions/High Moisture**

![](_page_15_Picture_7.jpeg)

![](_page_15_Figure_8.jpeg)

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# SR 24/Waldo Road, Alachua County, FL

# Removing steel plate over pavement depression

![](_page_16_Picture_2.jpeg)

# Pavement depression after steel plate was removed

![](_page_16_Picture_4.jpeg)

![](_page_16_Picture_5.jpeg)

## **GPR** Test Layout

![](_page_17_Picture_1.jpeg)

![](_page_17_Picture_2.jpeg)

#### **GPR testing directly over the Pavement Depression**

![](_page_18_Picture_1.jpeg)

![](_page_18_Picture_2.jpeg)

#### **GPR Results**

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Longitudinal GPR pass 10 indicate potential shifting soils and void around pavement depression

![](_page_19_Figure_2.jpeg)

# Transverse GPR pass 6 indicate potential shifting soils and void around pavement depression

![](_page_19_Figure_4.jpeg)

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# **On-Site Voids Confirmation**

• Maintenance breaking out center of Pavement Depression for visual access

![](_page_20_Picture_2.jpeg)

• Void revealed when pavement was removed

![](_page_20_Picture_4.jpeg)

![](_page_20_Picture_5.jpeg)

#### South Bound Roosevelt Bridge Approach Slab in Stuart, Florida

![](_page_21_Picture_1.jpeg)

![](_page_21_Picture_2.jpeg)

#### **Testing Schematic**

![](_page_22_Figure_1.jpeg)

![](_page_22_Picture_2.jpeg)

# Bridge Approach Slap Voids-3D Rendering

![](_page_23_Figure_1.jpeg)

![](_page_23_Picture_2.jpeg)

# **PaveScan Applications**

- PaveScan device used to determine relative density of asphaltic layer
- Quality assurance/quality control of new pavements
- Real-time dielectric measurements that correlate to density
- Allows for on-site continuous evaluation of relative compaction effectiveness

![](_page_24_Picture_5.jpeg)

#### **PaveScan Applications: Static/Vibratory Compaction Experiment**

SMO Test Strip

![](_page_25_Picture_2.jpeg)

![](_page_25_Picture_3.jpeg)

### Static/Vibratory Compaction

![](_page_26_Figure_1.jpeg)

![](_page_26_Picture_2.jpeg)

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#### **Static/Roller Compaction Results**

Plot of % Density (Cores) and GPR Dielectric Values

![](_page_27_Figure_2.jpeg)

#### **PaveScan Applications- Temperature Study**

![](_page_28_Figure_1.jpeg)

![](_page_28_Picture_2.jpeg)

#### PaveScan Applications-SMO APT Lane 5

#### **GPR** Dielectric Values and Thermal Imaging Profile

![](_page_29_Figure_2.jpeg)

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#### PaveScan Applications: RoadWorms-SR 26, Alachua, FL

![](_page_30_Picture_1.jpeg)

![](_page_30_Picture_2.jpeg)

#### PaveScan Applications-Florida Concrete Test Road-US 301

 52 Test Sections Distributed Into 3 Experimental Groups: Structural (20 Test sections), Drainage (16 Test sections), and Calibration (16Test sections),

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oint Spacing(ft)	15	15	15	15	13	12	13	13	12	13	13	13	13	15	15	12	13	6	13	6
Edge Drain	Ý	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Ň	Y

#### PaveScan Applications-Florida Concrete Test Road-US 301

• Propose Using PaveScan to Measure Concrete Slab Curing Rate

![](_page_32_Picture_2.jpeg)

![](_page_32_Picture_3.jpeg)

#### PaveScan Applications-Florida Concrete Test Road-US 301

#### Dielectric Values vs Concrete Curing Time

![](_page_33_Figure_2.jpeg)

#### StructureScan Mini XT

- Antenna Frequency 2.7 GHZ
- Mainly for locating reinforcements in concrete

![](_page_34_Picture_3.jpeg)

![](_page_34_Picture_4.jpeg)

#### **Transverse and Longitudinal Reinforcement Bar Spacing**

![](_page_35_Picture_1.jpeg)

![](_page_35_Figure_2.jpeg)

![](_page_35_Picture_3.jpeg)

#### Transverse and Longitudinal Reinforcement Bar Spacing

![](_page_36_Figure_1.jpeg)

## **Challenges on GPR Applications**

- Bridge Deck Corrosions
- Delamination in Asphalt Layers
- Limited to the Localized Survey
- MOT Support

![](_page_37_Picture_5.jpeg)

## **Moving Forward-New GPR Technology**

- 3D Radar
- High Speed Mobile
- 21 Antenna Array/6 ft wide
- Step Frequency

   ✓ 100 MHZ to 3 GHz
- Continuous
- Up to 6 ft depth

![](_page_38_Picture_7.jpeg)

![](_page_38_Picture_8.jpeg)

![](_page_38_Figure_9.jpeg)

![](_page_38_Picture_10.jpeg)

![](_page_39_Picture_0.jpeg)

![](_page_39_Picture_1.jpeg)