



## Cross-Slope and Other Pre-Design Tools



June 13, 2013  
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### ***Today's Presentation***

- ◆ Discuss the latest Pre-Design tools/services available at the SMO
- ◆ Discuss the Statewide benefits of such services
- ◆ Provide information of how to request/monitor projects



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## Pavement Materials

- ◆ Located in Gainesville, FL
- ◆ Role - Statewide Pavement support related to:
  - ✓ District Pre-Design
  - ✓ Research
  - ✓ Safety
  - ✓ Acceptance
  - ✓ Network Surveys



## Challenges with Traditional Pre-Design Surveys

- ◆ Manual (thickness, cross slope & rut depth)
- ◆ Destructive
- ◆ Slow and labor intensive
- ◆ Expose crew to hazardous conditions
- ◆ Require traffic control
- ◆ Inconvenience to public
- ◆ Costly
- ◆ Difficult to meet design production goals



## ***Evolution of Technology***

- ◆ Help improve Pre-Design Collection Process
  - ✓ High Speed Non-Contact Technology (laser based)
  - ✓ High speed computers
  - ✓ Automated/Continuous Survey Methods
  - ✓ Safe (reduced traffic control required)
  - ✓ Cost-Effective (Manual vs. Automated)
  - ✓ Easier to interpret results



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## ***Examples of New Technology***



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## 2012 Plans Preparation Manual Changes

- ◆ Require mobile cross-slope evaluations on resurfacing projects [Pages from PPM 2012Volume1-2.pdf](#)
- ◆ Followed up by DTM for specific areas
- ◆ Impact of PPM
  - ✓ How to build infrastructure to handle testing (In-house Production)
  - ✓ 5.3% of system assessed annually = 2,300 miles



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## Multi-Purpose Survey Vehicle (MPSV)

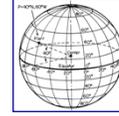
- ◆ Automated Cross-Slope (10 ft)
- ◆ Inertial Profiling System
  - ✓ Rut
  - ✓ Ride
  - ✓ Faulting
- ◆ Imaging System
  - ✓ Cracking
  - ✓ Front
  - ✓ Downward



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## Critical Components for Cross-Slope

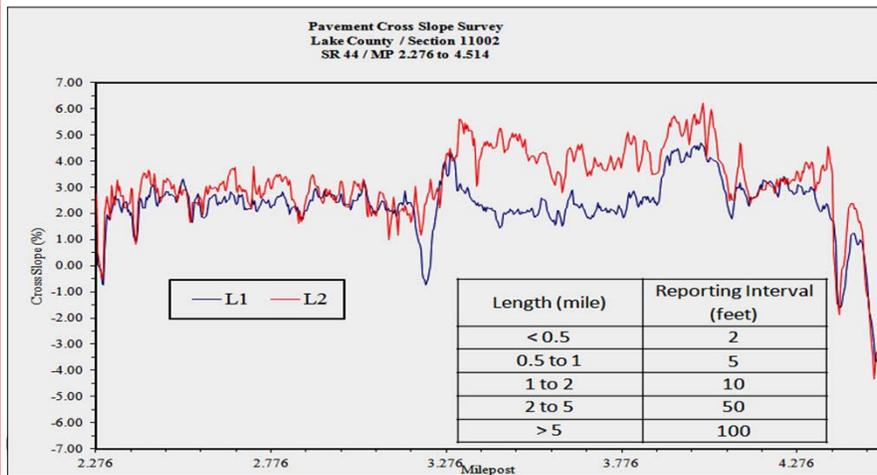
- ◆ Cross-Slope Components
  - ✓ Differential Global Positioning System (DGPS)
  - ✓ Inertial Measurement Unit (IMU)
  - ✓ Position Orientation System (POS)
  - ✓ Inertial Lasers



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## Cross-Slope Reporting

- ◆ Excel-Based
- ◆ Interval-Flexible



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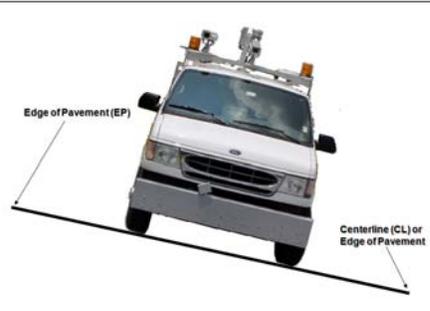
## ***Is the MPSV Cross-Slope Reliable?***



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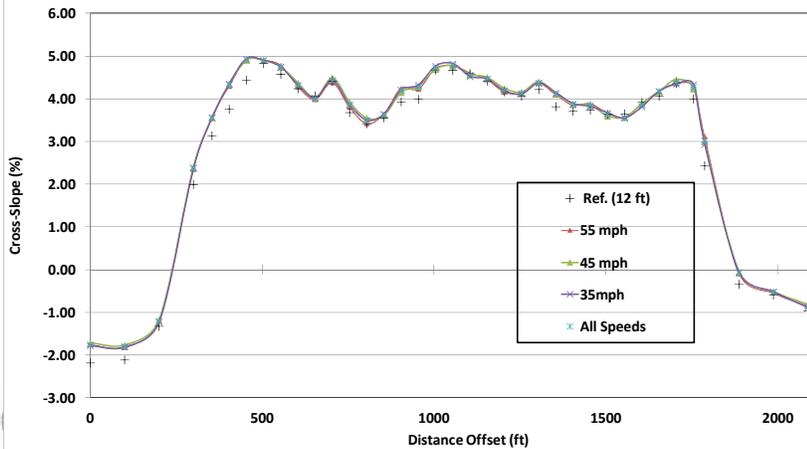
## ***Field Validation Study***

- ◆ 35/45/55 mph (repeatability)
- ◆ Compare to manual survey
- ◆ Repeatable/Reproducible



## Survey vs. MPSV (Precision Results)

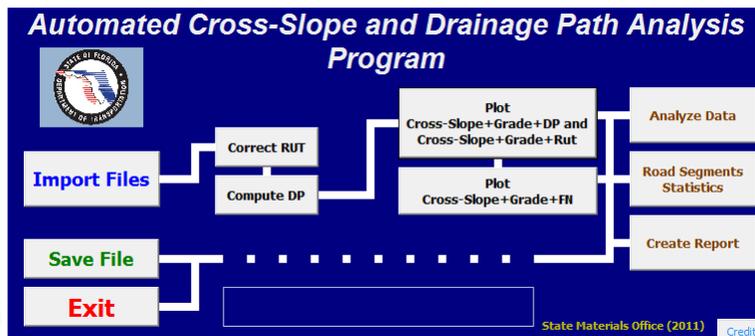
- ◆ Repeatability at the 95% C.I. (low variability): 0.009%
- ◆ Accuracy at the 95% C.I., (bias range): 0.13% to 0.23%
- ◆ Accuracy is comparable to survey tolerances: 0.20%



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## Automated Cross-Slope and Drainage Path Analysis– Excel Based

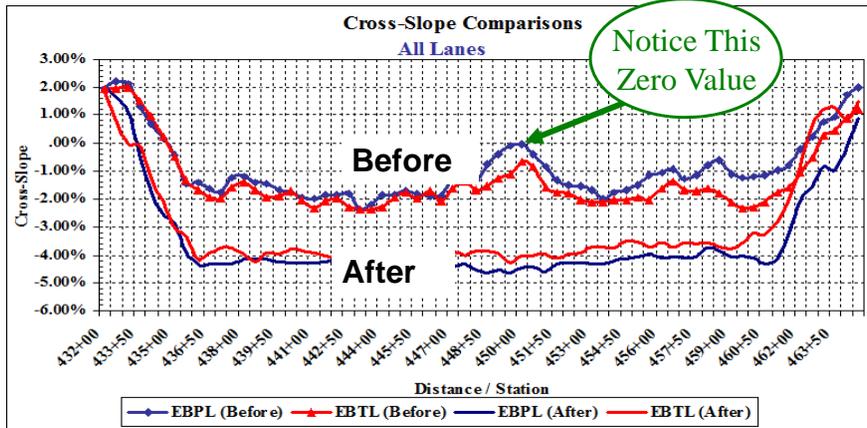
- ◆ Imports MPSV data (cross-slope, grade, rutting, distance)
- ◆ Identifies poorly draining areas using drainage path length
- ◆ Generates outputs (tabular and graphical)



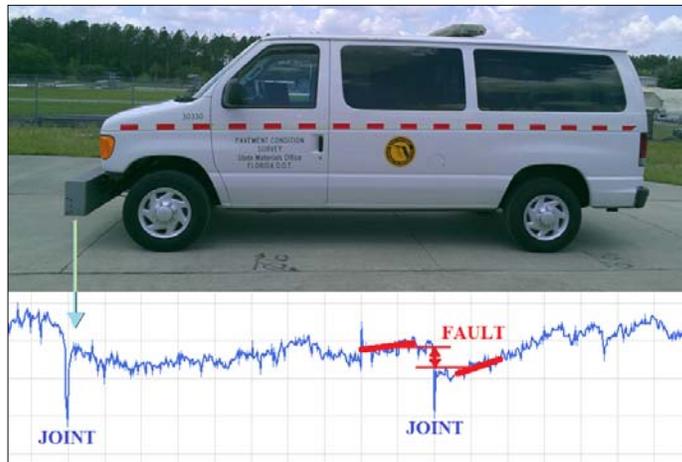
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## Pre/Post Evaluations

- ◆ Identifies areas of poor drainage



## Automated Faulting



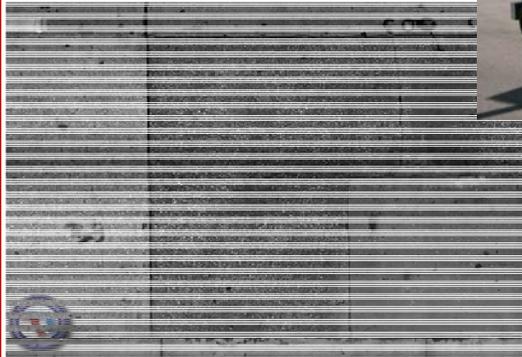
- ◆ Rigid Faulting (FDOT Developed, AASHTO R-36 Test Method)
- ◆ Nationally Recognized through FHWA



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## High Speed Imaging

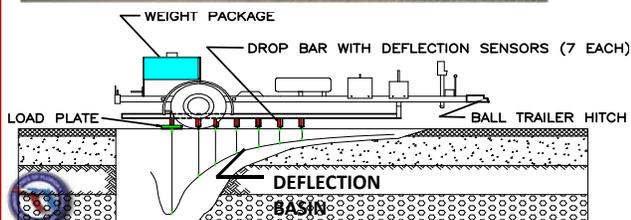
- ◆ Special Projects
- ◆ Rigid Defect Rating
- ◆ High Risk Areas



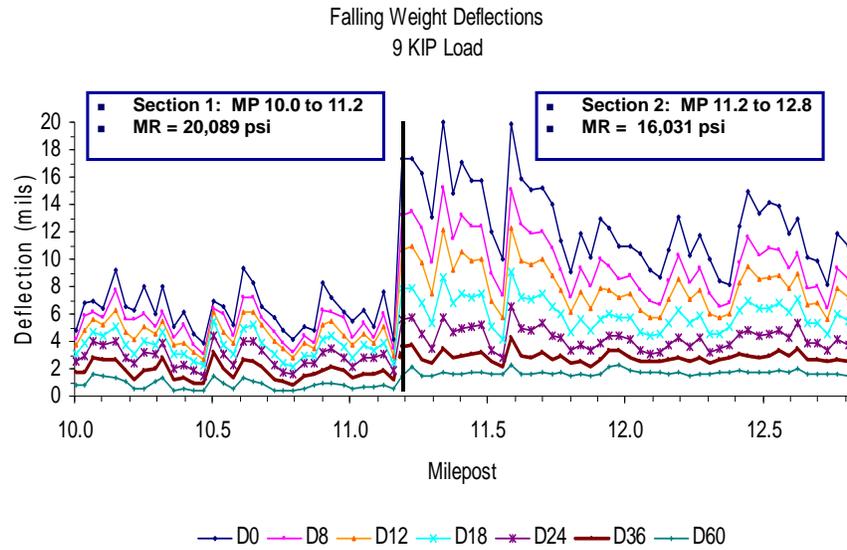
## Falling Weight Deflectometer (FWD)



- ◆ Statewide Resilient Modulus Testing
- ◆ Mainly used for Pre-Design pavement evaluation & forensic investigations
- ◆ Advantages
  - ✓ Nondestructive
- ◆ Disadvantages
  - ✓ Requires Maintenance of Traffic (MOT)



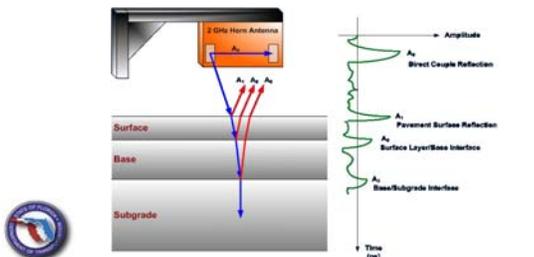
## Typical FWD Plot



## Ground Penetrating Radar (GPR)



- ◆ Non-Destructive Pavement Thickness Survey
- ◆ SMO-Statewide Testing Services
- ◆ Operate at highway speed, no traffic restrictions required
- ◆ Continuous (2 ft resolution)
- ◆ “Engineered Coring Plan”
  - ✓ Minimize coring
  - ✓ Isolate areas
  - ✓ Core verification
  - ✓ Reduce core costs



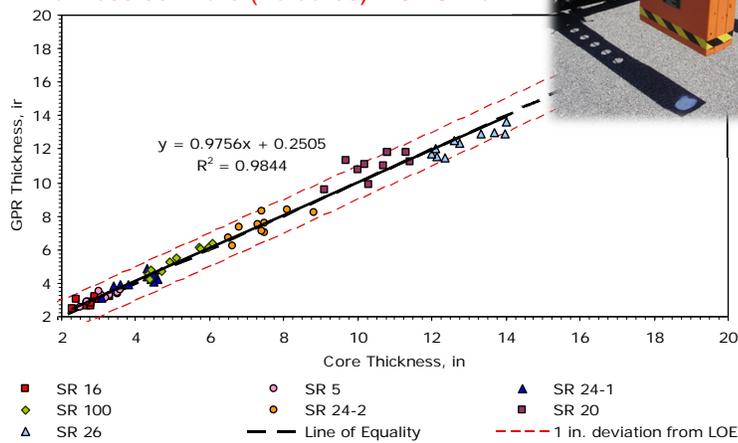
## Is the GPR Reliable?



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## Accuracy of GPR

Thickness estimate (with cores) = 0.4 inch  
Thickness estimate (no cores) = 0.75 inch



## Integration of Technology

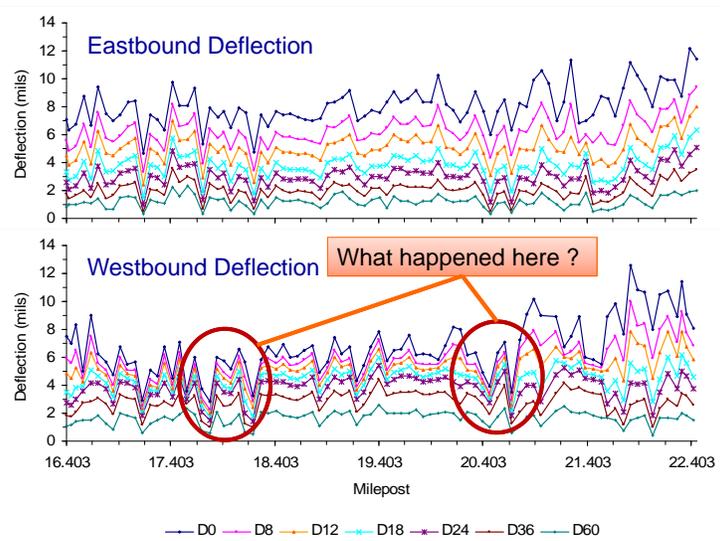


FWD

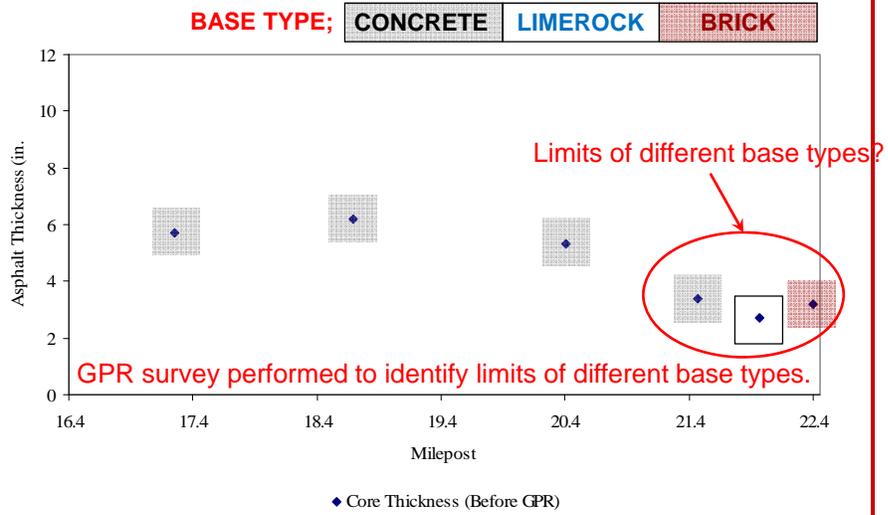
GPR



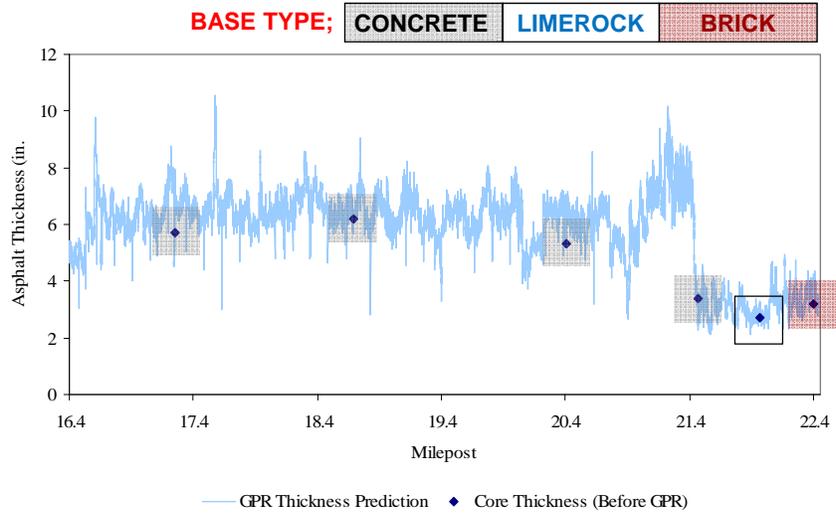
## SR 600 in Polk County - FWD



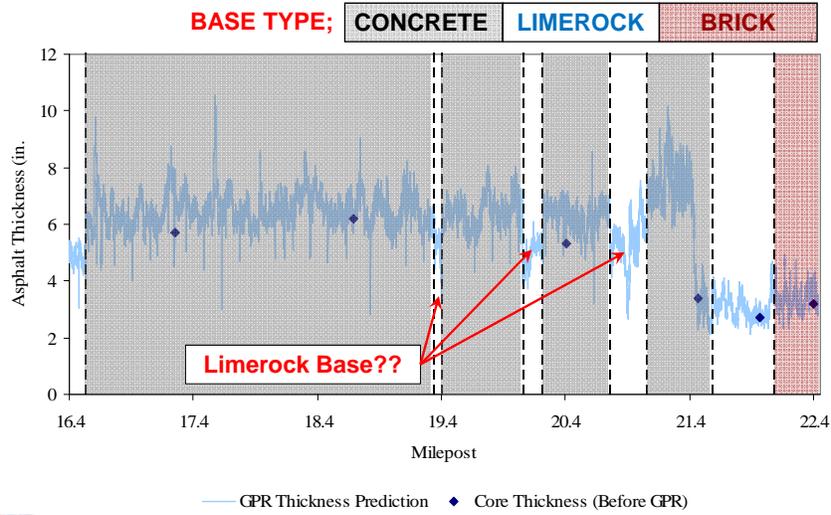
## Initial Cores - Westbound



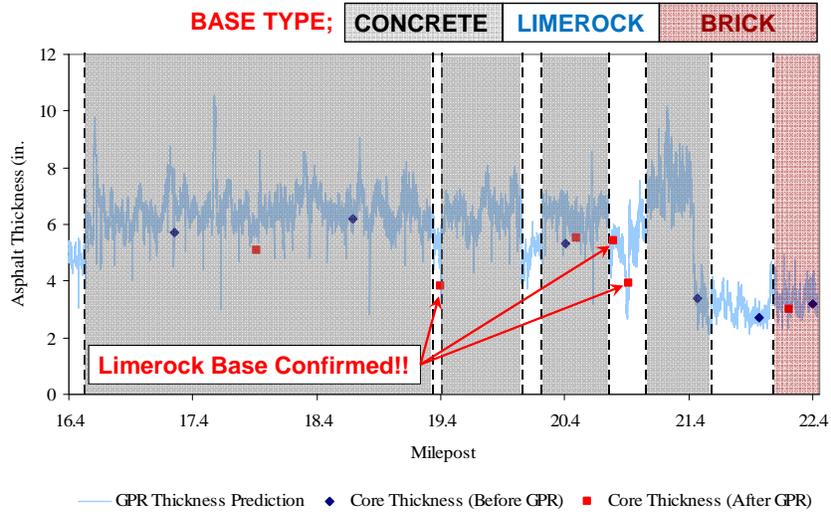
## GPR Thickness Profile



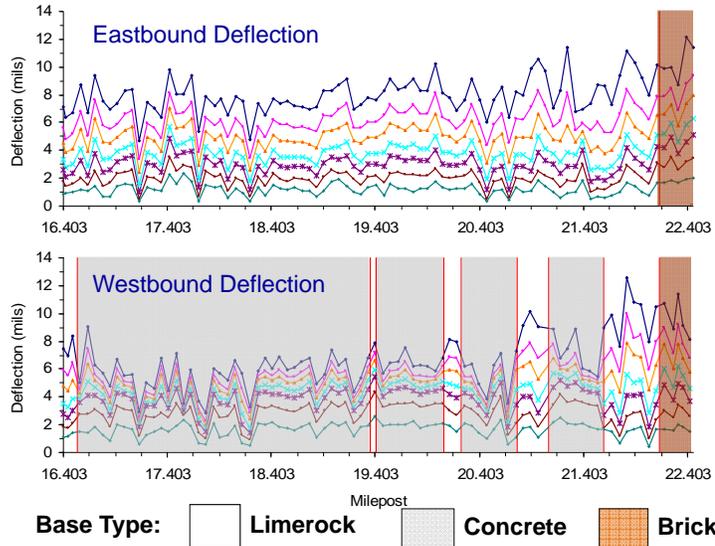
## Base Types Identified



## Additional Verification Cores



## SR 600 in Polk County - FWD



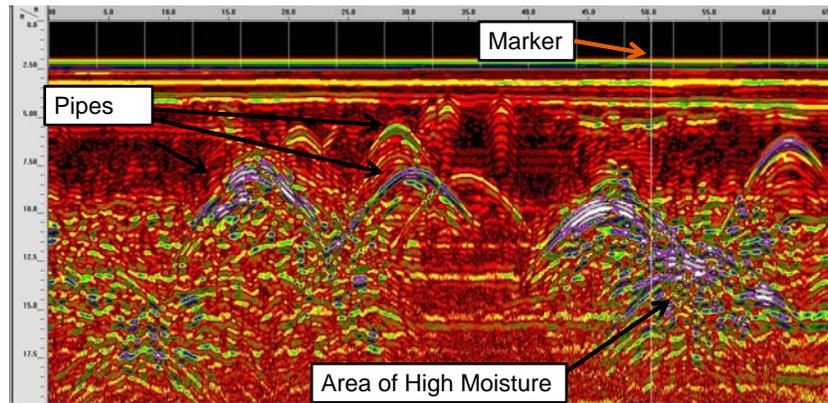
## Site Specific GPR

- ◆ Forensics:
  - ✓ Depressions
  - ✓ Sink holes
  - ✓ Utilities
  - ✓ Moisture
  - ✓ Variable depth
  - ✓ Distress Mapping



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## Ground Coupled GPR Amplitude Display



## Automated Dynamic Cone Penetrometer (ADCP)



- ◆ Correlate soil stiffness from penetration resistance
- ◆ Estimate layer thickness
- ◆ Used to estimate in-situ Limerock Bearing Ratio (LBR)
- ◆ D3 Using ADCP for shoulder widening design

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## Friction/Texture Based Technology

- ◆ Statewide Testing
- ◆ Measure Friction/Texture
  - ✓ High speed
  - ✓ Site specific
- ◆ Friction/Texture Relationships
- ◆ Support District Safety/Materials

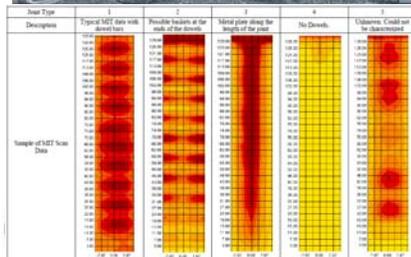


a) Florida DOT Locked-Wheel Friction Test Unit.

b) 64kHz Laser Mounted on Truck.

## MIT-Scan

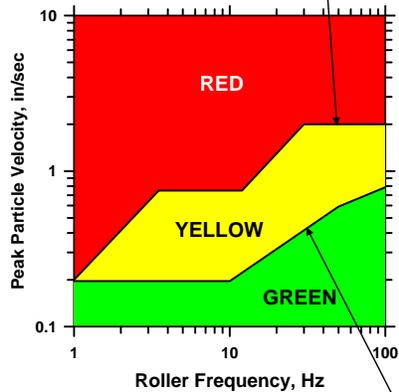
- ◆ Uses magnetic signal to measure dowel/tie bar alignments and cover depth



# Vibration Calculator

## ◆ Pre-Design for Vibration Sensitive Zones

### US OSM Blast Criteria

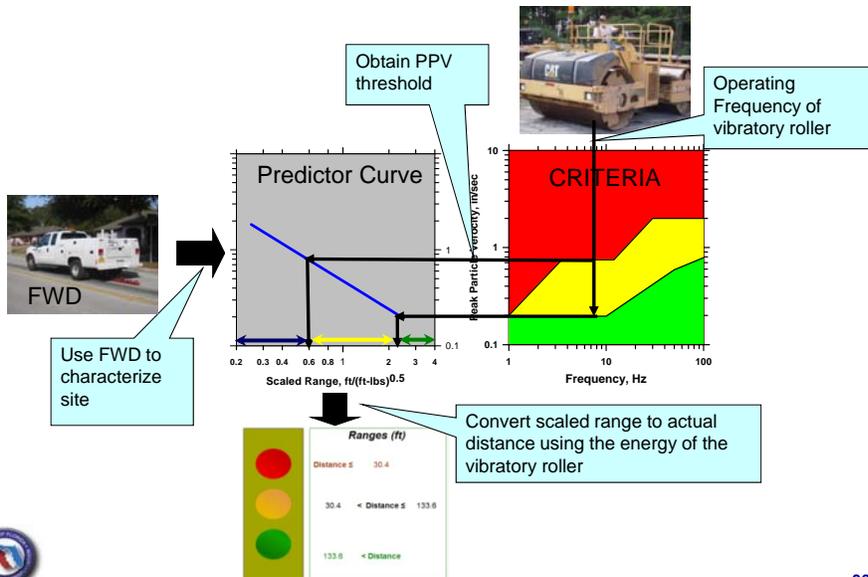


- ◆ Red – Architectural damage possible
- ◆ Yellow – People may be annoyed, but architectural damage unlikely
- ◆ Green - People may perceive vibration, but annoyance is unlikely

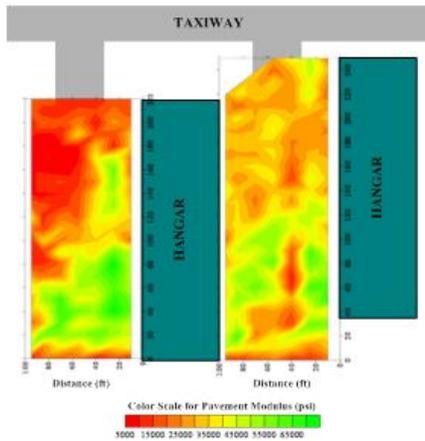
### German DIN 4150 Vibration Criteria



# Vibration Calculator



## Enhanced Pavement Test Data Analysis Methodology



- ◆ Contour Plotting of multiple 2-D Pavement Data
- ◆ Bird's Eye View
- ◆ Easy to Understand for Non-Engineer
- ◆ Support Litigation
- ◆ Commercial Software



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## FDOT's Mobile Retroreflectivity Unit (MRU)



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## ***Under Development, Noise Trailer***



- ◆ New tool to:
  - ✓ Collect High Speed Noise Data
  - ✓ Better information for Noise Wall Design
  - ✓ Predict Wayside measurements
  - ✓ Quantify Noise:
    - Pavement Type
    - Mix Design
    - Aggregates



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## ***Future of Tracking Pre-Design Projects***



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### Statewide Pre-Design Projects

*Embankment Modulus (FWD), Pavement Thickness (GPR), and Roadway Cross Slope (MPSV)*

Submit New Project(s)		District 1	District 2	District 3	District 4	District 5	District 6	District 7	Turnpike	Statewide
Single Project	Multiple Projects	Pending								
		Reported								
	Submit via Email	Last 90 Days								
		All Projects								

- ◆ <http://smsharepoint.sm.dot.state.fl.us/sites/SMO/pavement/performance/Lists/PreDesign/DistrictRequests.aspx>
- ◆ Sharepoint System
- ◆ SQL Database
- ◆ District Coordinators
- ◆ Project Tracking

Office	Contact Name	Phone	Email
State Materials Office	William "Thad" Bryant	352-955-6331	<a href="mailto:william.bryant@dot.state.fl.us">william.bryant@dot.state.fl.us</a>
	Joseph Reber	352-955-6315	<a href="mailto:joseph.reber@dot.state.fl.us">joseph.reber@dot.state.fl.us</a>
District 1	Debra Childs	863-519-5846	<a href="mailto:debra.childs@dot.state.fl.us">debra.childs@dot.state.fl.us</a>
	Marlene Hebert	863-519-4267	<a href="mailto:marlene.hebert@dot.state.fl.us">marlene.hebert@dot.state.fl.us</a>
District 2	Chad Townsend	386-961-7844	<a href="mailto:chad.townsend@dot.state.fl.us">chad.townsend@dot.state.fl.us</a>
	Belgis MaBoor	386-961-7444	<a href="mailto:belgis.maboer@dot.state.fl.us">belgis.maboer@dot.state.fl.us</a>
District 3	Samuel Weede	850-330-1621	<a href="mailto:samuel.weede@dot.state.fl.us">samuel.weede@dot.state.fl.us</a>
District 4	Eva Campello	954-777-4458	<a href="mailto:eva.campello@dot.state.fl.us">eva.campello@dot.state.fl.us</a>
District 5	Tim Keefe	386-740-3512	<a href="mailto:timothy.keefe@dot.state.fl.us">timothy.keefe@dot.state.fl.us</a>
District 6	Cathy Margoshes	305-470-5258	<a href="mailto:cathy.margoshes@dot.state.fl.us">cathy.margoshes@dot.state.fl.us</a>
District 7	Pedro Lopez	813-975-6789	<a href="mailto:pedro.lopez@dot.state.fl.us">pedro.lopez@dot.state.fl.us</a>
Turnpike	Christopher NeSmith	407-264-3482	<a href="mailto:christopher.nesmith@dot.state.fl.us">christopher.nesmith@dot.state.fl.us</a>
	Eduardo Hernandez	954-444-4571	<a href="mailto:eduardo.hernandez@dot.state.fl.us">eduardo.hernandez@dot.state.fl.us</a>



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### Submitting Pre-Design Requests

#### Statewide Pre-Design Projects

*Embankment Modulus (FWD), Pavement Thickness (GPR), and Roadway Cross Slope (MPSV)*

Submit New Project(s)		District 1	District 2	District 3	District 4	District 5	District 6	District 7	Turnpike	Statewide
Single Project	Multiple Projects	Pending								
		Reported								
	Submit via Email	Last 90 Days								
		All Projects								

- ◆ District Coordinators will:
  - ✓ Link to Submit Single/Multiple Projects
  - ✓ Use Standard Template
  - ✓ Coordinators or Project Managers can monitor progress



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## ***Pavement Materials Contacts***

### **Unit Manager**

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### **Pavement Condition**

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### **Pavement Performance**

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Patrick (Pat) Upshaw, P.E.  
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## ***Questions?***

