
Most Promising Technologies: Evaluation Plan

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PRELIMINARY FINDINGS – SUBJECT TO UPDATES

Factors Considered in Final Ranking of Promising Technologies:

- **Numerous Needs identified in DOT surveys**
 - **Pavements (20+)**
 - **Bridges (15+)**
 - **Tunnels**
 - **Earthworks**
 - **Other structures**

Factors Considered in Final Ranking of Promising Technologies:

- **Success/Failure of current NDT technologies to address DOT needs**
- **Expert panel assembled to provide state-of-the-art assessment of existing and emerging technologies**
- **R06 research team prioritized needs and proposed plan for SHRP 2 implementation and development**

Types of Projects Proposed:

- **Demonstration projects**
 - **Technology transfer of implemented NDT techniques**
- **Focused development projects**
 - **Promising technology where more development is needed**
- **Experimental research projects**
 - **DOT need identified and several technologies can be used to address need**
- **Unfulfilled needs**
 - **No currently successful NDT technique**

PRELIMINARY FINDINGS – SUBJECT TO UPDATES

Recommended Demonstration Projects

- D1 Infrared and GPR for Uniformity
Measurements on New HMA Layers
- D2 Inertial Profilers for Construction
Acceptance Testing of Smoothness
- D3 Field Demonstration of Resistivity Mapping
- D4 Monitoring Changes in Tunnel Profiles

Recommended Focused Development Projects

- F1 Using Field Spectroscopy devices to Fingerprint Construction Materials
- F2 Development of Continuous Deflection Sensors
- F3 Implementation Program for Intelligent Compaction
- F4 Real-Time Smoothness Measurements on PCC Pavements During Construction

Demonstration Project

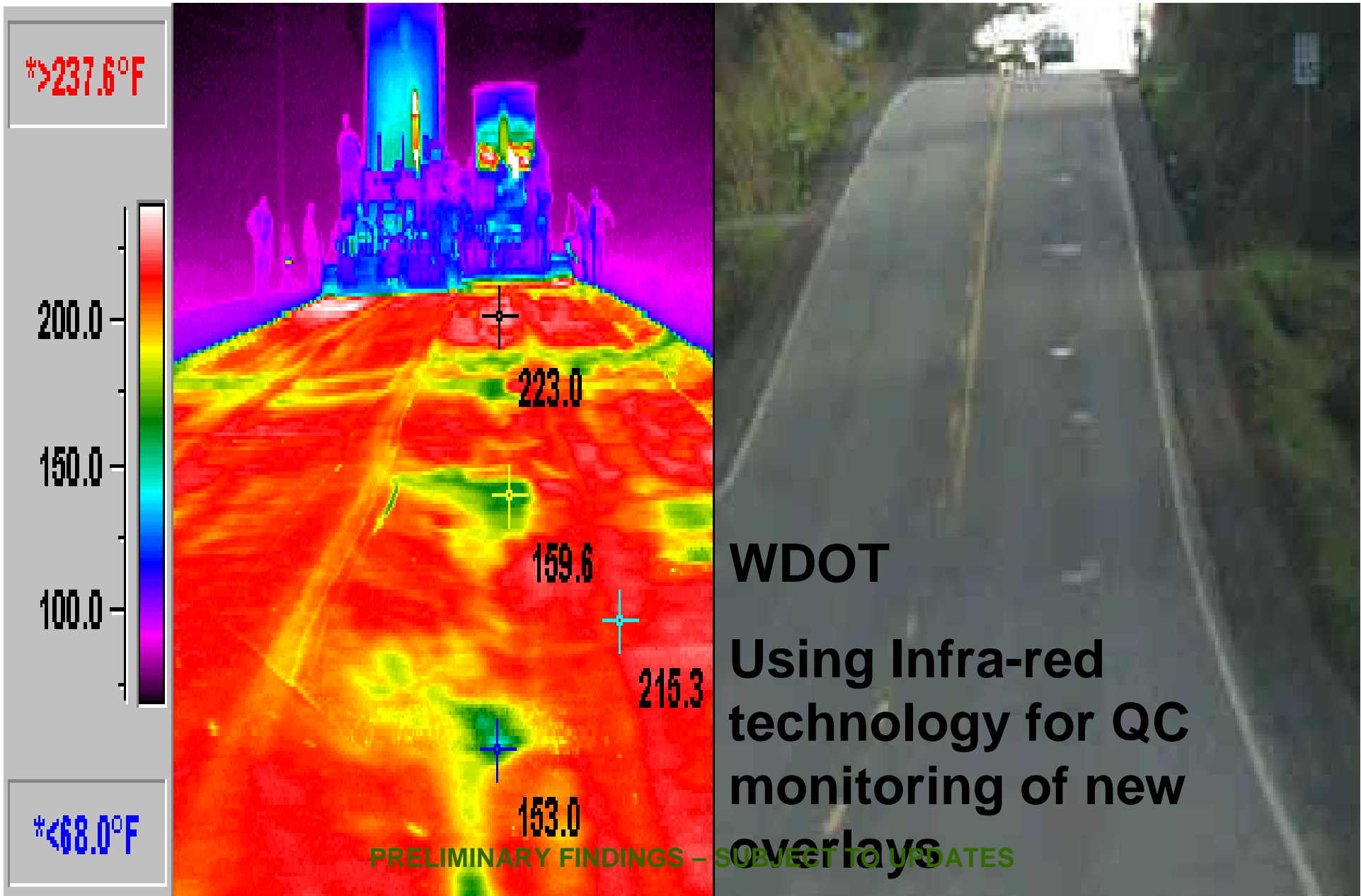
D1: Infrared and GPR for Uniformity Measurements on New HMA Layers

Problem Statement

- Mix segregation a continuing problem
- Increasing priority because
 - Many overlays placed at night
 - fewer inspectors
 - Concerns about stiffer mixes
- Traditional methods are point specific
 - Need for 100% coverage
- Lead agencies at implementation
 - Washington DOT (IR)
 - FinRA (GPR)

PRELIMINARY FINDINGS – SUBJECT TO UPDATES

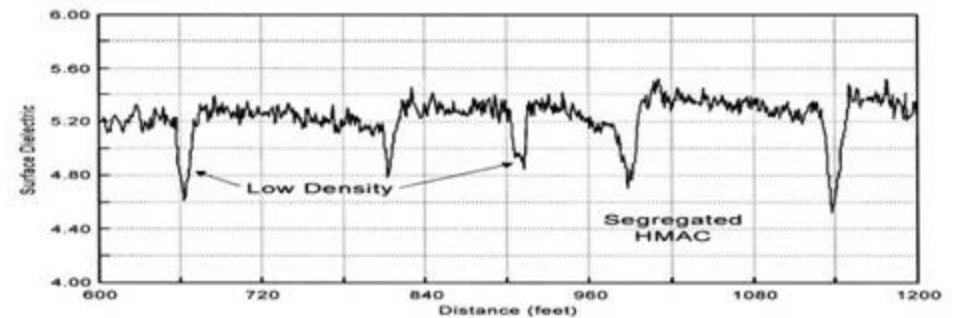
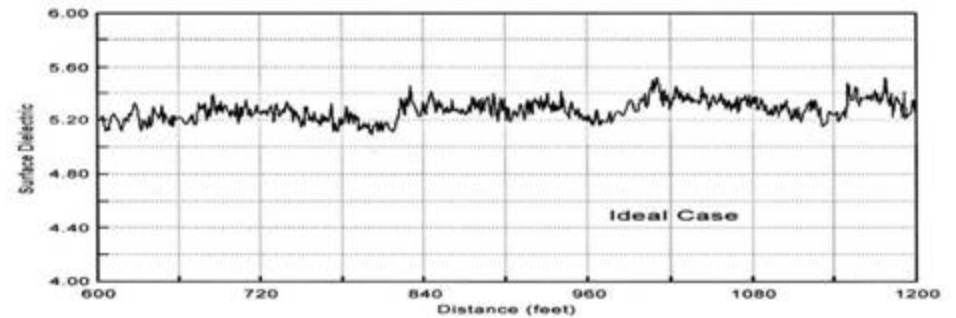




GPR Systems in Finland



GPR Detection of HMA Segregation
Surface Dielectric Plots



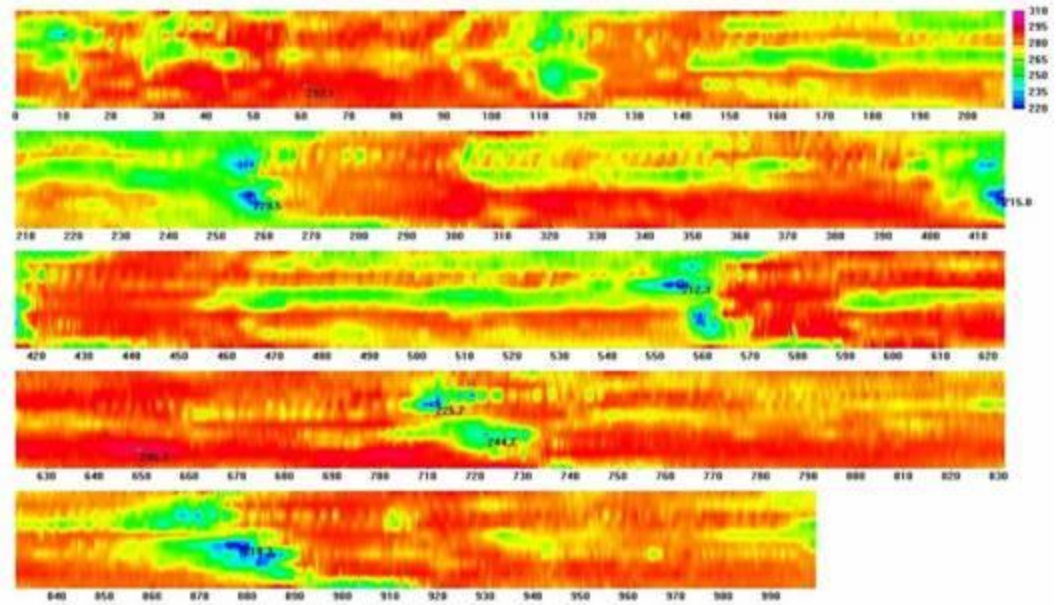
Finnish Standard 2000; PANK 4122

GPR is an option for evaluating in place density

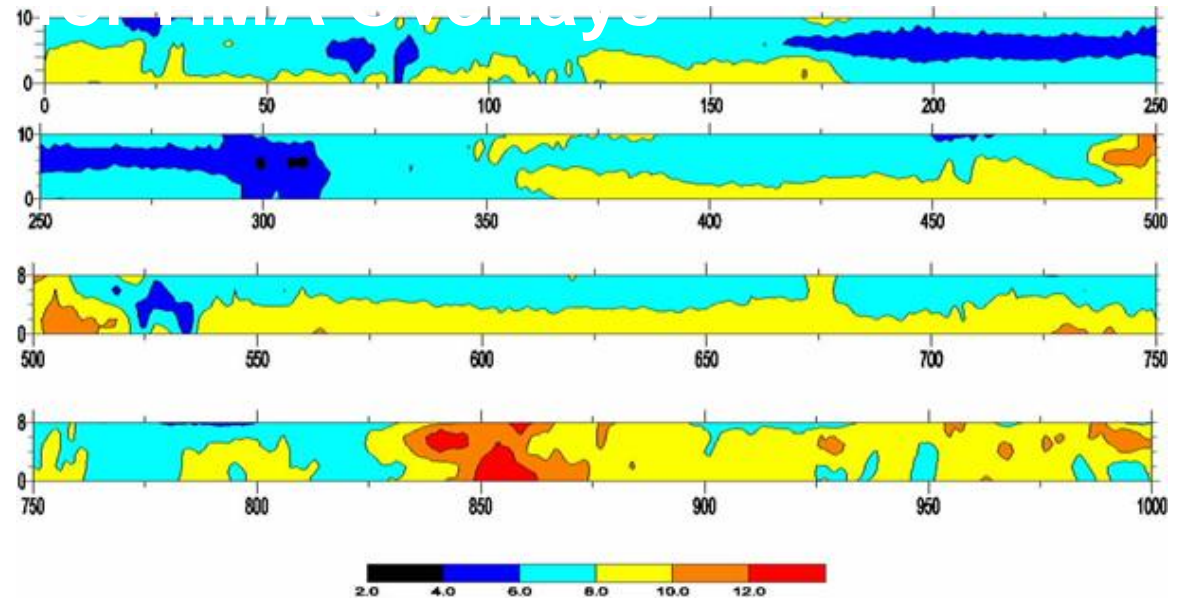
Project specific calibration

Surface Dielectric vs Core density

PRELIMINARY FINDINGS – SUBJECT TO UPDATES



100% Coverage Devices for QC/QA testing of new HMA layers



PRELIMINARY FINDINGS – SUBJECT TO UPDATES

D1: Infrared and GPR for Uniformity Measurements on New HMA Layers

Study Objectives

Demonstrate Technologies to DOT's

Develop and Field test prototype specifications

Work Plan

- Phase 1 Assemble equipment, develop training materials, demonstrate technology in one DOT, perform validation coring, phase 1 report

- Phase 2
 - Demonstrate approach in additional DOT's
 - Provide Training
 - Propose Draft Specifications
 - Operator and Equipment certification recommendations

PRELIMINARY FINDINGS – SUBJECT TO UPDATES

D1: Infrared and GPR for Uniformity Measurements on New HMA Layers

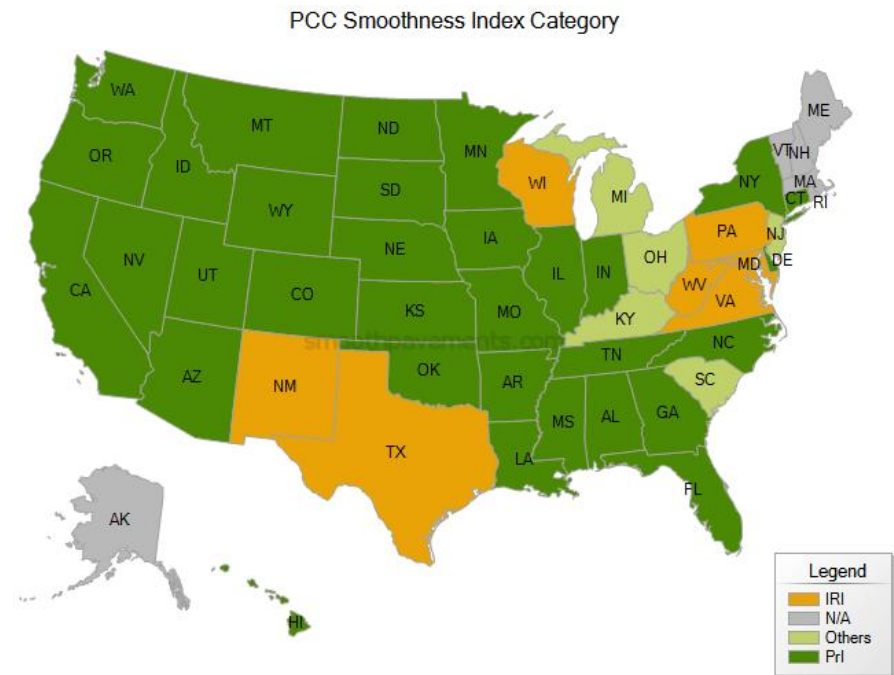
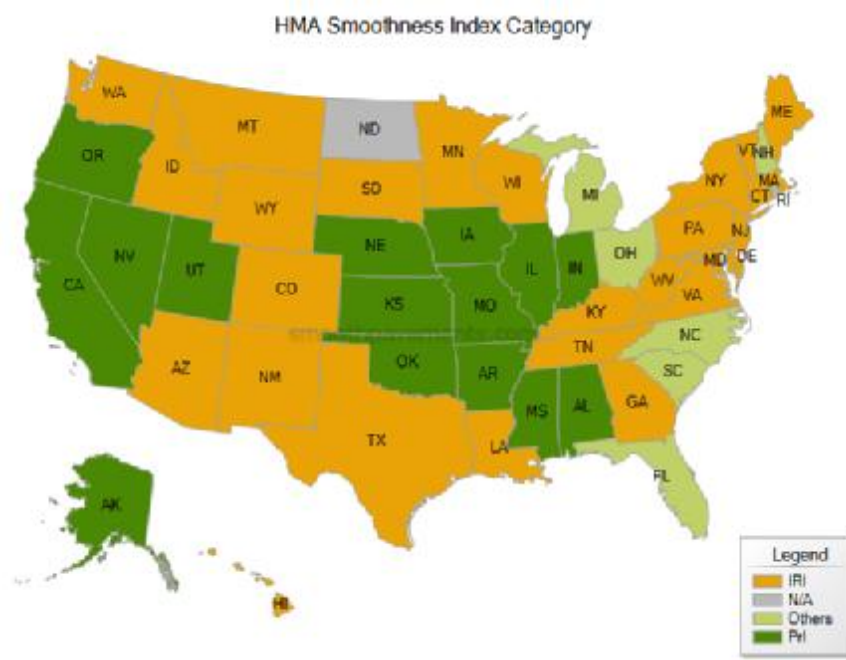
Anticipated Results

- Demonstration of new technologies in several DOT's
- Accelerate the development of new 100% coverage systems
- Develop equipment and test procedure recommendations
- Develop prototype construction specifications

D2: Inertial Profilers for Construction Testing of Pavement Smoothness

Background

- Current Practice



PRELIMINARY FINDINGS – SUBJECT TO UPDATES

D2: Inertial Profilers for Construction Testing of Pavement Smoothness

Background

- Keys to implementation
 - Senior management champion
 - Industry buy-in
 - Smoothness specification
 - Process for determining corrective action
 - Equipment and operator certification program
 - Training DOT personnel

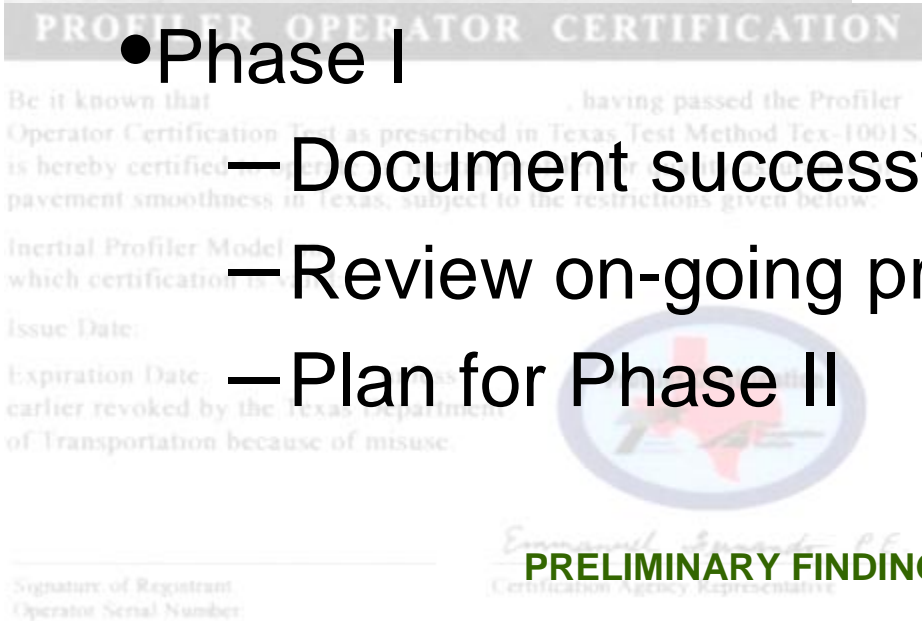
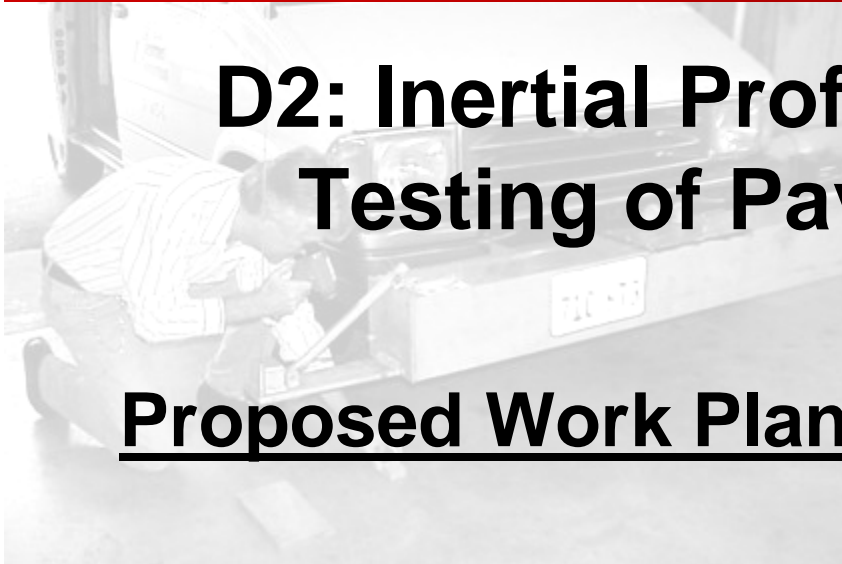
PRELIMINARY FINDINGS – SUBJECT TO UPDATES

D2: Inertial Profilers for Construction Testing of Pavement Smoothness

Proposed Work Plan

•Phase I

- Document successful DOT implementation
- Review on-going projects
- Plan for Phase II



PRELIMINARY FINDINGS – SUBJECT TO UPDATES

D2: Inertial Profilers for Construction Testing of Pavement Smoothness

Proposed Work Plan

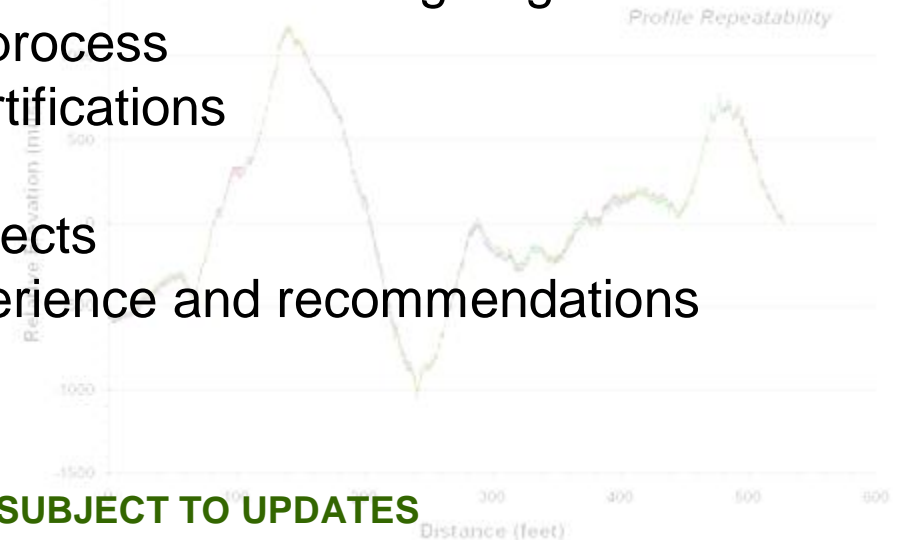
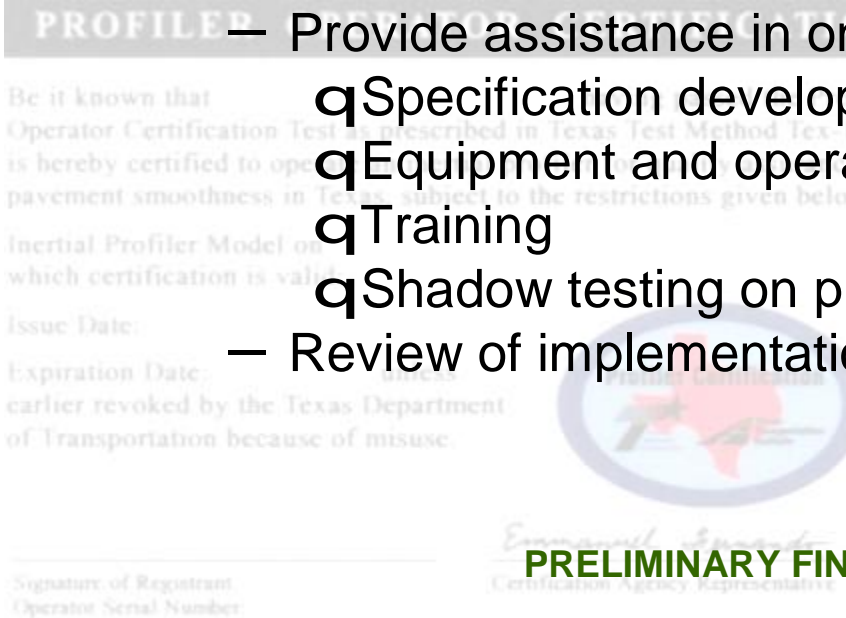
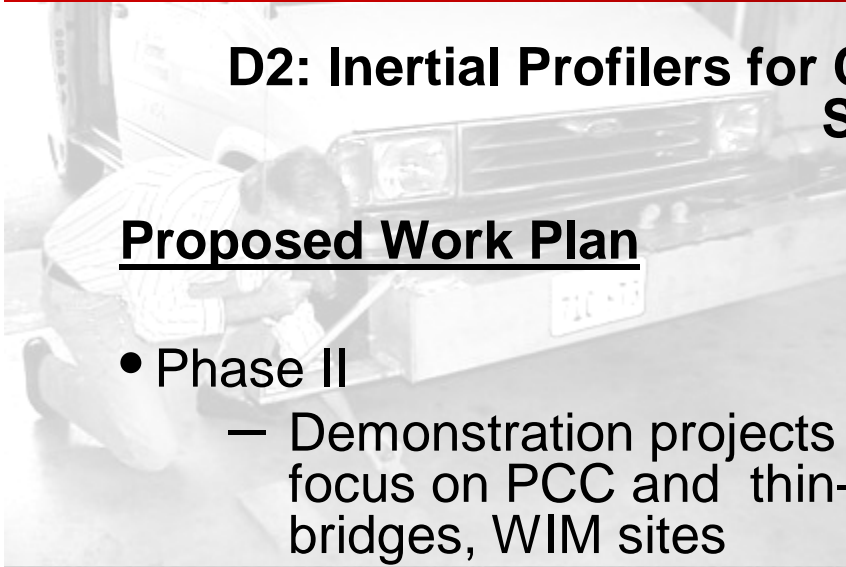
- Phase II

- Demonstration projects to implement smoothness specs with focus on PCC and thin-surfaced roads on flexible base, bridges, WIM sites

- Provide assistance in one or more of the following target areas:

- q Specification development process
- q Equipment and operator certifications
- q Training
- q Shadow testing on pilot projects

- Review of implementation experience and recommendations



PRELIMINARY FINDINGS – SUBJECT TO UPDATES

D2: Inertial Profilers for Construction Testing of Pavement Smoothness

Anticipated Products

Demonstration projects to expand use of inertial profilers for construction smoothness testing

- Specification development
- Equipment and operator certification
- Training program



PRELIMINARY FINDINGS – SUBJECT TO UPDATES

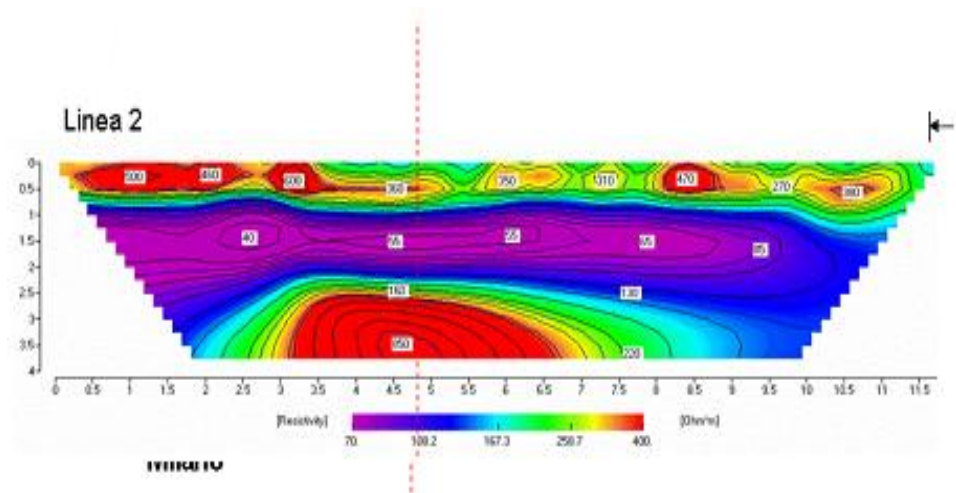
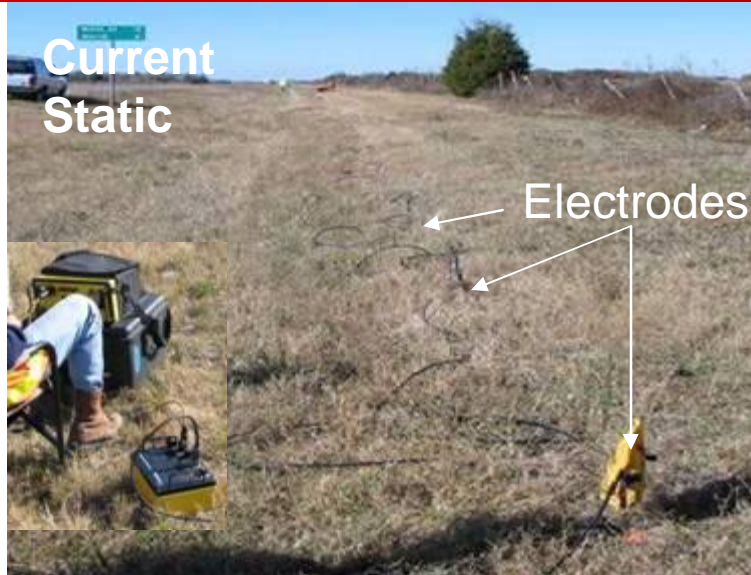
D3: Resistivity Mapping

Problem Statement

- Resistivity Systems show promise in subsurface mapping
 - Continuous mapping of soil profile
 - Interpolation between boreholes
 - Locating problem soil deposits and possible sinkholes
- Equipment, Interpretation software and training available
 - Not widely used in highways
- Research underway to develop mobile resistivity systems
- Lead agencies at implementation
 - Minnesota and Florida
 - European Agencies

PRELIMINARY FINDINGS – SUBJECT TO UPDATES

Soil Resistivity Testing



Signals (colors) primarily influenced by moisture content

D3: Resistivity Mapping

Study Objectives

- Introduce technology to DOT's
- Identify cost effective applications

Proposed Work Plan

- Phase 1 Study
 - Evaluate existing commercial systems (Hardware and software)
 - Demonstrate on highway project under design in one DOT
 - Develop training materials and State of the Art report
 - Identify DOT's willing to participate in Phase 2
- Phase 2 Study
 - Demonstrate recommended system in several DOT's
 - Develop an Implementation plan
 - Operator and Equipment certification

PRELIMINARY FINDINGS – SUBJECT TO UPDATES

D4: Monitoring Change in Tunnel Profiles

Problem Statement

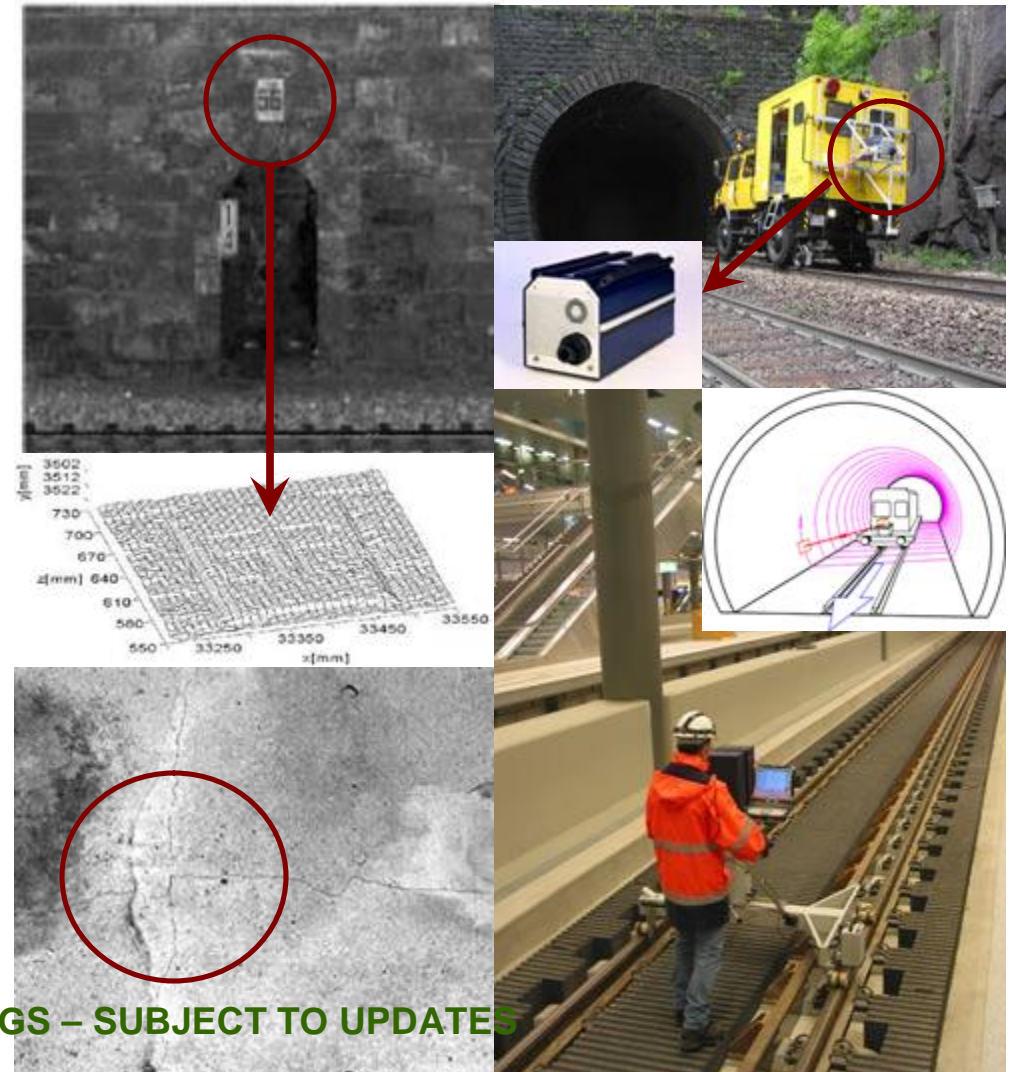
- Timely detection and remediation of problems important for road user safety
- Monitoring tunnel condition key to determining needs
- NDE techniques should provide 100% coverage and minimize user delays
- Laser scanning appears a promising nondestructive tool for monitoring tunnel condition
- Technology has been used for tunnel inspections during construction, for acceptance, and to monitor performance
- Recommend demonstration projects to check implementation readiness
- Lead states: Minnesota, California

PRELIMINARY FINDINGS – SUBJECT TO UPDATES

D4: Monitoring Change in Tunnel Profiles

Proposed Work Plan

- Phase I
 - Review state-of-practice
 - European experience
 - Japanese experience
 - Plan demonstration
 - q Products to evaluate
 - q Establish test criteria
 - q Propose test program
 - Conduct demonstrations
 - Document test results
 - Recommendations



PRELIMINARY FINDINGS – SUBJECT TO UPDATES

D4: Monitoring Change in Tunnel Profiles

Proposed Work Plan

- Phase II
 - Additional development work, if needed
 - Possible enhancements to customize applications
 - Verification testing of enhanced or modified tunnel laser scanning techniques
 - Funding separate from Phase I

- Phase III
 - Process for technology implementation of validated tunnel scanning systems

PRELIMINARY FINDINGS – SUBJECT TO UPDATES

D4: Monitoring Change in Tunnel Profiles

Anticipated Products

- Validated NDE techniques for condition assessment and monitoring of tunnel linings
- Application guidelines
- Process for technology implementation

PRELIMINARY FINDINGS – SUBJECT TO UPDATES

Recommended Focused Development Projects

- F1 Using Field Spectroscopy devices to Fingerprint Construction Materials
- F2 Development of Continuous Deflection Sensors
- F3 Implementation Program for Intelligent Compaction
- F4 Real-Time Smoothness Measurements on PCC Pavements During Construction

Focused Development Project

**F1 Using Field Spectroscopy Devices to Fingerprint Construction
Materials**

Problem Statement

- Agencies reporting problems with material variability (AC, Emulsions)
Current validation tests take too long
- Need for rapid field test to determine of Organics/Sulfates contents
- New technologies have not been widely investigated
- Field units have point and shoot capabilities
- FHWA taking the lead with FTIR evaluation
- FTIR only one tool others may be better
- Exciting new technology many potential applications

PRELIMINARY FINDINGS – SUBJECT TO UPDATES

Field Spectroscopy Devices

XRF, FTIR, Raman



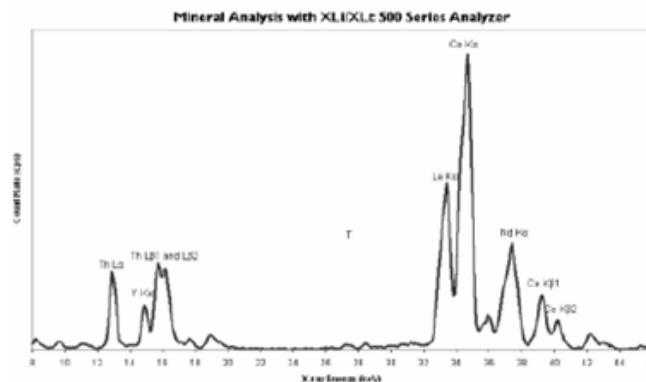
XRF x-rays
at atomic
level



Raman
(Laser
Excitation of
Molecules)



FTIR



INTENSITY COMPARED TO STANDARDS

PRELIMINARY FINDINGS – SUBJECT TO UPDATES

F1 Using Field Spectroscopy Devices to Fingerprint Construction Materials

Study Objectives

- Determine what these devices can do with paving materials
- Identify practical applications (for example)
 - polymer content of asphalt
 - quality and uniformity of lime and cements
 - uniformity of asphalt emulsions
 - sulfate content of soils
- Introduce technologies to DOT's
- Develop draft test protocols and equipment specifications

PRELIMINARY FINDINGS – SUBJECT TO UPDATES

Focused Development Project F1:
Using Field Spectroscopy Devices to Fingerprint Construction Materials

Proposed Work Plan

- Phase 1 Lab Study
 - Evaluate existing commercial systems in laboratory
 - Identify promising applications
- Phase 2 Initial Field Study
 - Demonstrate most promising applications in field
 - Recommendations on how to implement technology
 - Develop implementation plan and training materials
- Phase 3 Implementation in DOT's
 - Purchase equipment for DOT use
 - Training program

PRELIMINARY FINDINGS – SUBJECT TO UPDATES

Focused Development Project:

F2 Development of Continuous Deflection Sensors

Problem Statement

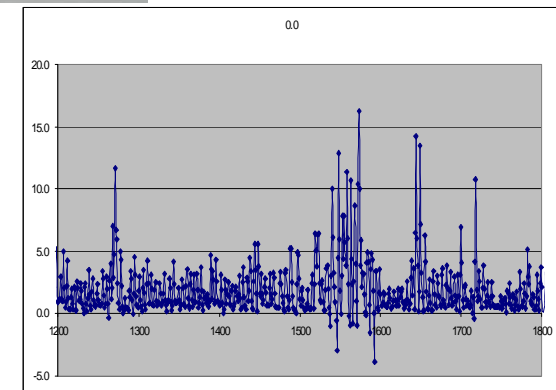
- Large investment in Europe and USA in high speed non contact I
- Laser based systems target network level analysis
- Major needs exists at project level especially with JCP
 - Provide deflection every 1 foot of travel
 - Need 2 sensors to determine LTE
- Most DOT's say selecting rehab for JCP is a big problem
- Rolling contact sensors (geophones) developed and shown to work well, but current system is slow
- Several devices available to put dynamic loads on pavements
- Need for new sensor systems
- Lead Agency Texas, Europe

PRELIMINARY FINDINGS – SUBJECT TO UPDATES

Rolling Dynamic Deflectometer (Project level only)



**Vibrosis
Equipment**



PRELIMINARY FINDINGS – SUBJECT TO UPDATES

F2: Development of Continuous Deflection Sensors



- **Devices available to put vibratory loads on pavements**
- **Need for sensors and software to**
 - a) Measure pavement deflections**
 - b) Remove surface noise from signal**
 - c) Measure movement on either side of joint**

F2 Development of Continuous Deflection Sensors

Study Objectives

To develop a rolling sensor system for measuring concrete pavement deflections under vibratory loads

Work Plan

Phase 1

- Sensor evaluation
- Develop prototype systems
- Field test on vibratory pneumatic roller

Phase 2

- Demonstrate in Several DOT's

Focused Development Project F3: Implementation Program for Intelligent Compaction

Problem Statement

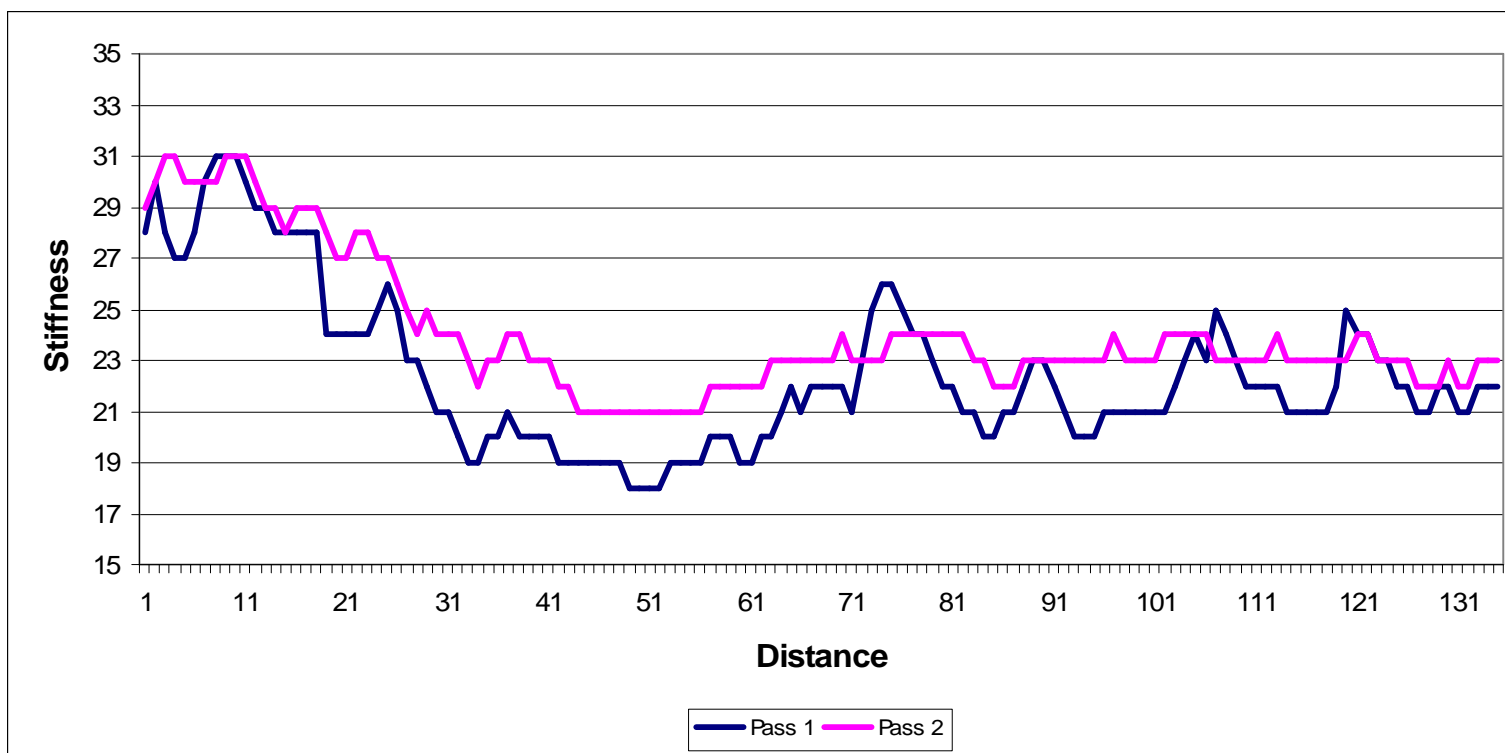
- Literature indicates large potential
- Early work in Europe in 1970's
- Slow to gain acceptance in USA

- FHWA taking lead at implementation
- Activity/Interest in many states
 - Minnesota, Iowa, Texas, others



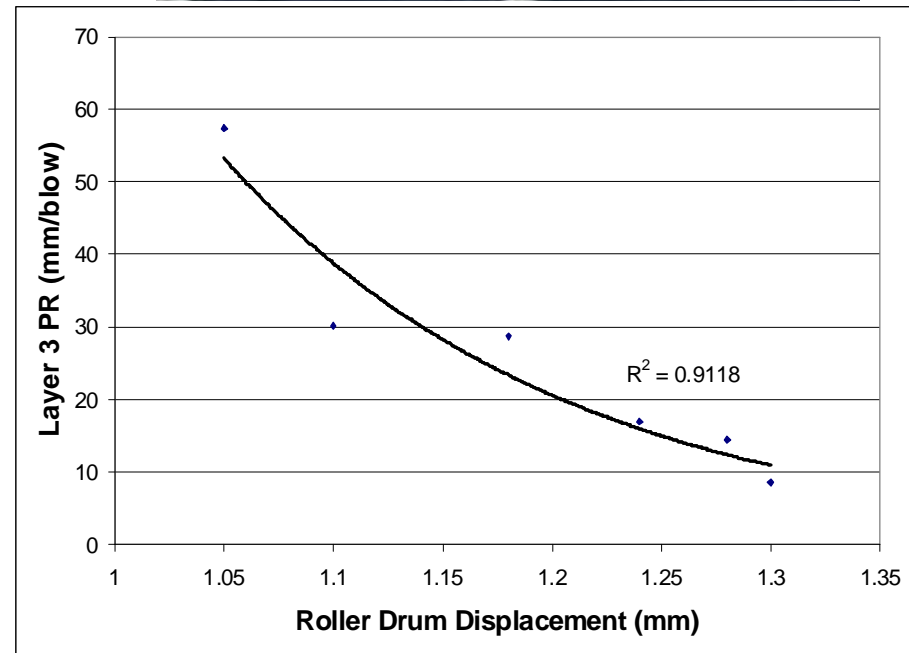
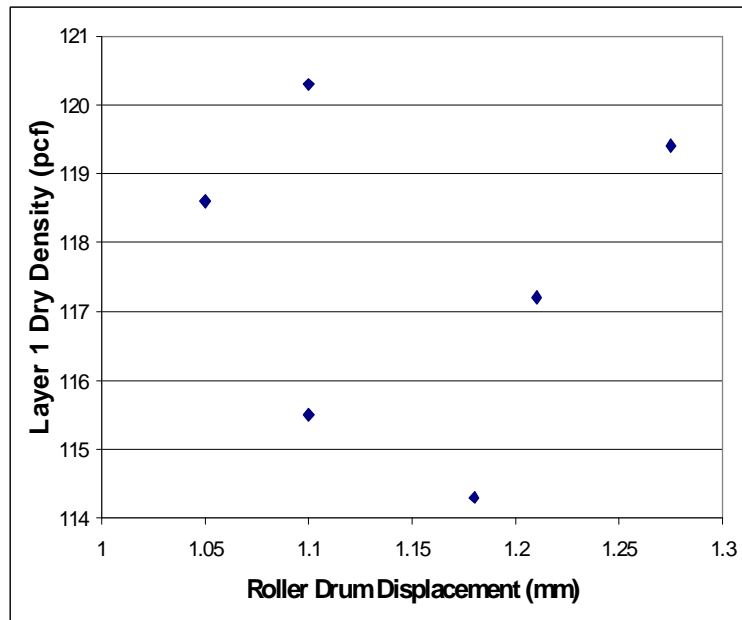
IC Systems for Bases

- Proprietary
- Applications
 - Monitor compaction
 - Finding weak spots
 - Compaction control



PRELIMINARY FINDINGS – SUBJECT TO UPDATES

What is the roller measuring ?



PRELIMINARY FINDINGS – SUBJECT TO UPDATES

Focused Development Project F3:

Implementation Program for Intelligent Compaction

Issue that need to be addressed

- Most current QC/QA use nuclear density techniques on upper layer
- Roller measures layer stiffness of entire section
 - These do not appear to be well correlated
 - Contractors currently not responsible for weak spots deep in subgrade
- What is best use of this technology
 - a) when to stop rolling, b) find weakest spot c) feedback compaction control
 - a) soils/foundation layers, b) Bases, C) HMA
- Equipment availability and Proprietary concerns
 - Every vendor uses different terminology
- No national standards
 - No consensus on how to establish target values ??
 - How to certify equipment and operators?
- How can stiffness measurement be incorporated into specifications
- How does roller stiffness relate to design stiffness
- What is advantage over proof rolling

PRELIMINARY FINDINGS – SUBJECT TO UPDATES

Focused Development Project F3:
Implementation Program for Intelligent Compaction

• **Research Proposed**

- Need to learn from European experience
- Coordinate with National Pooled Fund study
kick off Jan 23/24th Dallas Texas

F4: Real-Time Smoothness Measurements during PCC Pavement Construction

Problem Statement

- Acceptance testing of concrete pavement smoothness after curing entails corrective work to remove defects
- Diamond grinding costly & leaves permanent scar on pavement
- Quality control to detect defects during placement can minimize need for grinding to improve ride

F4: Real-Time Smoothness Measurements during PCC Pavement Construction

Proposed Work Plan

- Technology review
- Test existing technology
 - q Identify methods to test
 - q Plan test program
 - q Conduct tests
 - q Identify additional development needs
- Perform development work
- Test improved methods
- Document development work
- Implementation recommendations



PRELIMINARY FINDINGS – SUBJECT TO UPDATES

F4: Real-Time Smoothness Measurements during PCC Pavement Construction

Anticipated Products

- Validated quality control tool for smoothness measurements during concrete placement
- Application guidelines
- Process for technology implementation