SHRP2
STRATEGIC HIGHWAY RESEARCH PROGRAM

Pavement Evaluation 2010

October 24-26, Roanoke, VA

Use of Continuous Deflection Measurements for Network Level Pavement Analysis

SHRP 2 R06(F)

October 24, 2010

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TRL

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Virginia Transportation Research Council

Virginia Sustainable Pavement Research Consortium (VA-SPARC)

VirginiaTech TRANSPORTATION INSTITUTE

Contents

- **Introduction**
  - Background & SHRP 2 Project Objectives
- **Survey of Practice & Expectations**
  - Follow-up Interviews
- **Available Equipment**
  - Example Applications
- **Final Remarks**

Background

- **Existing pavement structural capacity is a critical input for structural analysis of in service pavements**

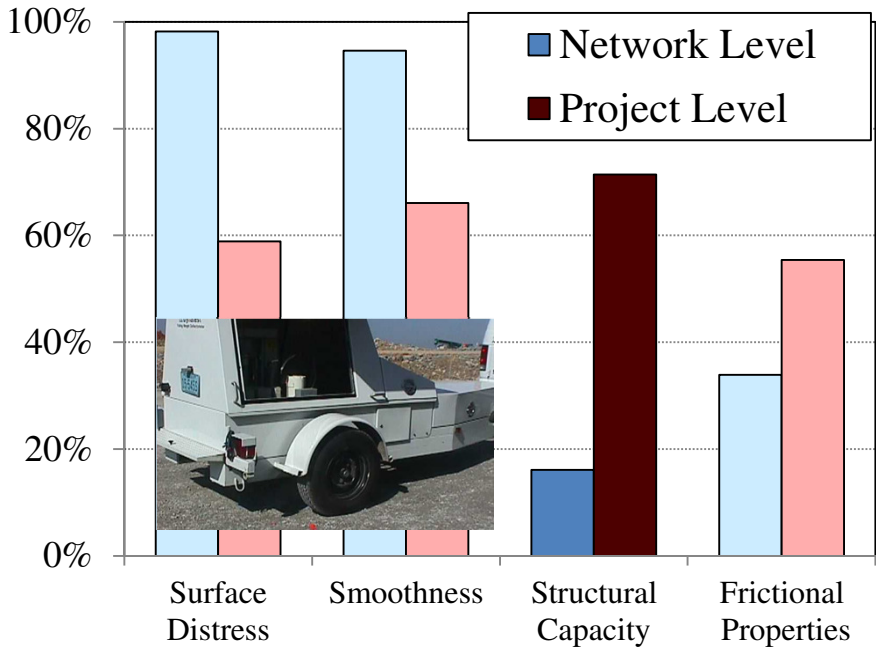
Project-level:

- **Design of pavement renewal/ rehabilitation treatments**

Network-level:

- **Identification of sections with structural capacity deficiencies**
- **Support preservation vs. Renewal decisions**

What pavement condition data does your agency collect?



Background (cont.)

- **FWD technology only allow stationary measurements at discrete points along the pavement sections**
  - **Disturbs traffic and requires traffic control $\Rightarrow$ limits productivity**
- **Continuous deflection measuring devices --that in some cases operate at traffic speed-- allows a better spatial coverage with less negative impact on mobility.**

SHRP 2 R06(F) Project Objectives

- Critical and unbiased assessment of the potential of existing continuous deflection devices as practical and cost-effective tools for use in the development of optimum pavement rehabilitation strategies on rapid renewal projects
- Explore their capability for screening structural deficient sections and scoping their needs at the network level

Proposed Outcomes/ Products

- Catalogue of existing technologies and equipment for continuously measuring pavement deflections
- Survey of the user needs in terms of pavement deflection measurement at the project and network level

Completed

- Evaluation of the identified current and emerging technologies presented in a practical and easy to use format
- Dissemination and implementation plan
- Training materials

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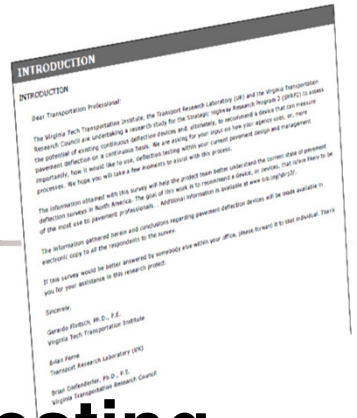
User Need Survey


INTRODUCTION

INTRODUCTION

Dear Transportation Professional

The Virginia Tech Transportation Institute, the Transport Research Laboratory (UK) and the Virginia Transportation Research Council are undertaking a research study for the Strategic Highway Research Program 2 (SHRP2) to assess the potential of existing continuous deflection devices and, ultimately, to recommend a device that can measure pavement deflection on a continuous basis. We are asking for your input on how you, agency-wide, or, more importantly, how it would like to use, deflection testing within your current pavement design and management processes. We hope you will take a few moments to assist with this process.

The information obtained with this survey will help the project team better understand the current state of pavement deflection surveys in North America. The goal of this work is to recommend a device, or devices, that is/are likely to be of the most use to pavement professionals. Additional information is available at www.ccg.org/Sr2p2.

The information gathered herein and conclusions regarding pavement deflection devices will be made available in electronic copy to all the respondents to the survey.

If this survey would be better answered by somebody else within your office, please forward it to that individual. Thank you for your assistance in this research project.

Sincerely,

Gerardo Flintsch, Ph.D., P.E.
Virginia Tech Transportation Institute

Brian Ferne
Transport Research Laboratory (UK)

Brian Diefenderfer, Ph.D., P.E.
Virginia Transportation Research Council

- **Stage I – Web survey**
  - **Practices and uses of deflection testing**
  - **Pavement rehabilitation design applications**
  - **Pavement management applications**
- **Stage II – Follow up Interviews**
  - **Desired uses and capabilities**
  - **Current PMS uses**
  - **Experience with existing continuous deflection measuring equipment**

User Need Survey Results

- 37 survey respondents (84%) use pavement deflection testing.
- 5 agencies (of 38 resp.) use deflections in their PMS
  - Average current cost for network-level data ~ $167/mile (estimate)
- 34 agencies (85%) incorporate deflection testing into their pavement rehabilitation design procedure

Follow-up Interviews:

- Arizona (AZ)
- Florida (FL)
- Indiana (IN)
- Kansas (KS)
- Virginia (VA)
- Montana (MT)
- New Hampshire (NH)
- New Mexico (NM)
- Oregon (OR)

States that use network-level deflection testing in their PMS

States that have some experience with a continuous deflection device, mainly the RWD

Follow-up Interviews
Primary desired applications:

- Help identify "weak" (or structurally deficient) areas that can be then investigated further at the project-level
- Differentiate sections that may be good candidates for preservation from those that would likely require a heavier treatment
- Provide network-level data to calculate a "structural health index" that can be incorporated into a PMS

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Deflection Measurement

- **Static Measurement Devices**

- **Moving Measurement Vehicles with Stationary Measurement Apparatus**

- **Moving Measurement Vehicles with Non-Stationary Measurement Apparatus**

Continuous Deflection Measurement

Static Measurement Devices

Moving Measurement Vehicles with Stationary Measurement Apparatus

Moving Measurement Vehicles with Non-Stationary Measurement Apparatus

Principle	Denomination	Picture	Speed (km/h)	Status
Vibrating mass loading	Portancemetre		3-6	Production model
	Moving FWD		30	Decommissioned prototype
	Measuring Ball		5	Decommissioned prototype
	Rolling Dynamic Deflectometer (RDD)		5	Prototype
Rolling wheel load	Airfield Rolling Weight Deflectometer (ARWD)		35	Decommissioned prototype
	Road Deflection Tester (RDT)		70	Prototype
	Rolling Wheel Deflectometer (RWD)		Up to 80	Prototype
	Traffic Speed Deflectometer (TSD)		60 to 80	Production model
Image-based	No official acronym as yet		4	Early prototype

nt Analysis

Devices that met (or were close to meet) **the network-level operational requirements:**

"Traffic" Speed

RWD

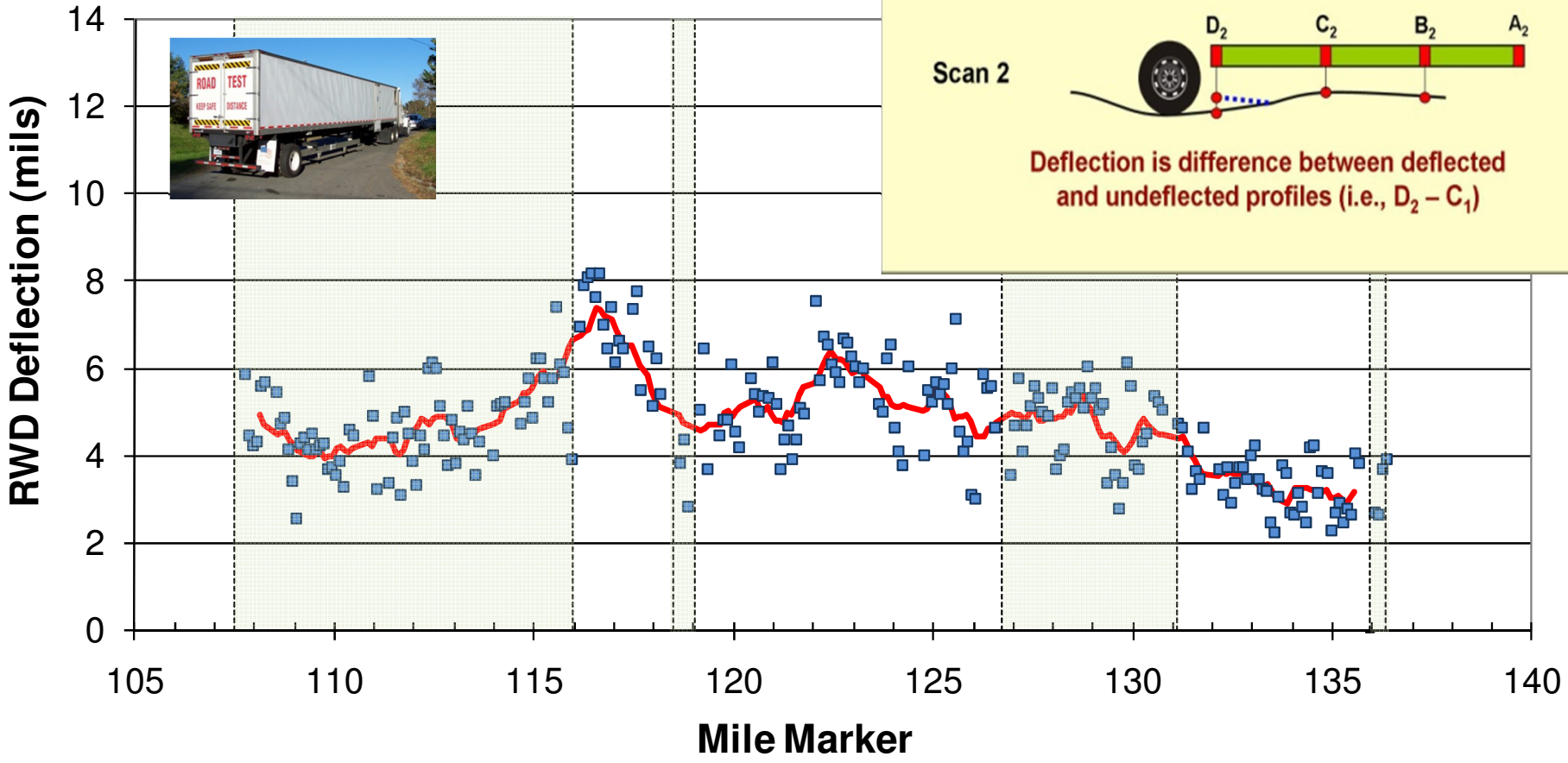
TSDs

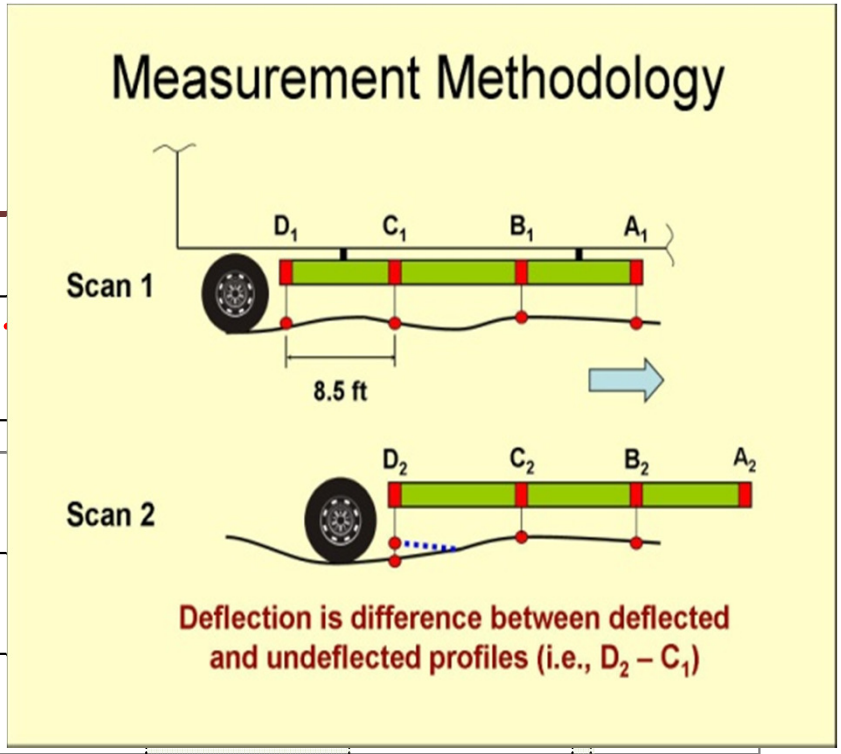
Slower Speed

RDD

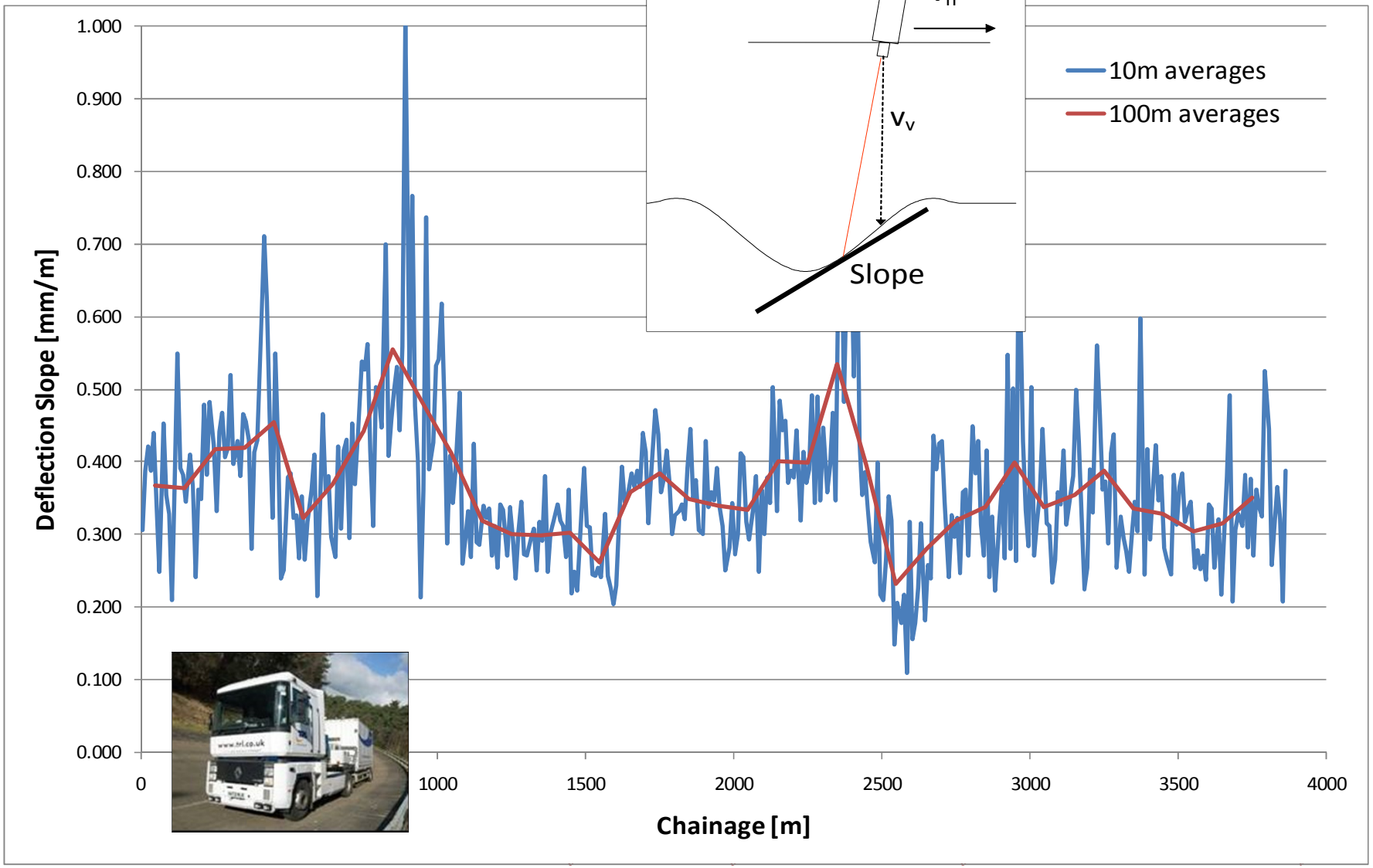
Definition: "*deflection measuring device constantly moving that can collect data at intervals of approximately 300 mm (1 ft) or smaller using load levels typical of truck loading (i.e., 40-50 kN (9-11 kips) per wheel or load assembly).*"

RWD


RWD Deflection (0.1 mile avegrage)
Sectioning (based on last resurfacing)
RWD Deflection (mils)
0
2
4
6
8
10
12
14
105
110
115
120
125
130
135
140
Mile Marker
ROAD TEST
KEEP SAFE DISTANCE

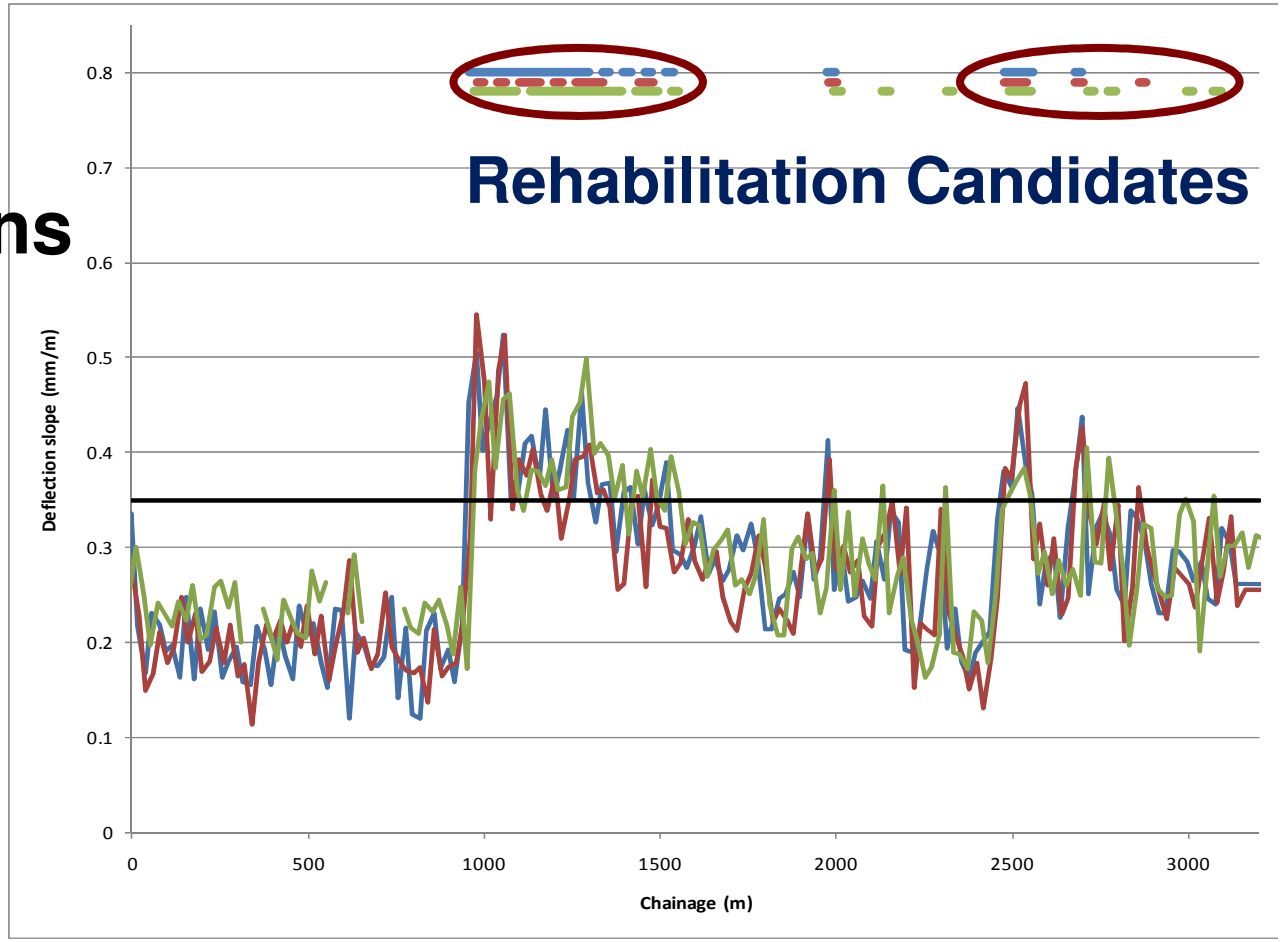

Measurement Methodology
Scan 1
D1
C1
B1
A1
8.5 ft
Scan 2
D2
C2
B2
A2
Deflection is difference between deflected and undeflected profiles (i.e., D2 – C1)

TSD


Slope = V_v/V_h
V_h
V_v
Slope
10m averages
100m averages
Deflection Slope [mm/m]
1.000
0.900
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
0
1000
1500
2000
2500
3000
3500
4000
Chainage [m]

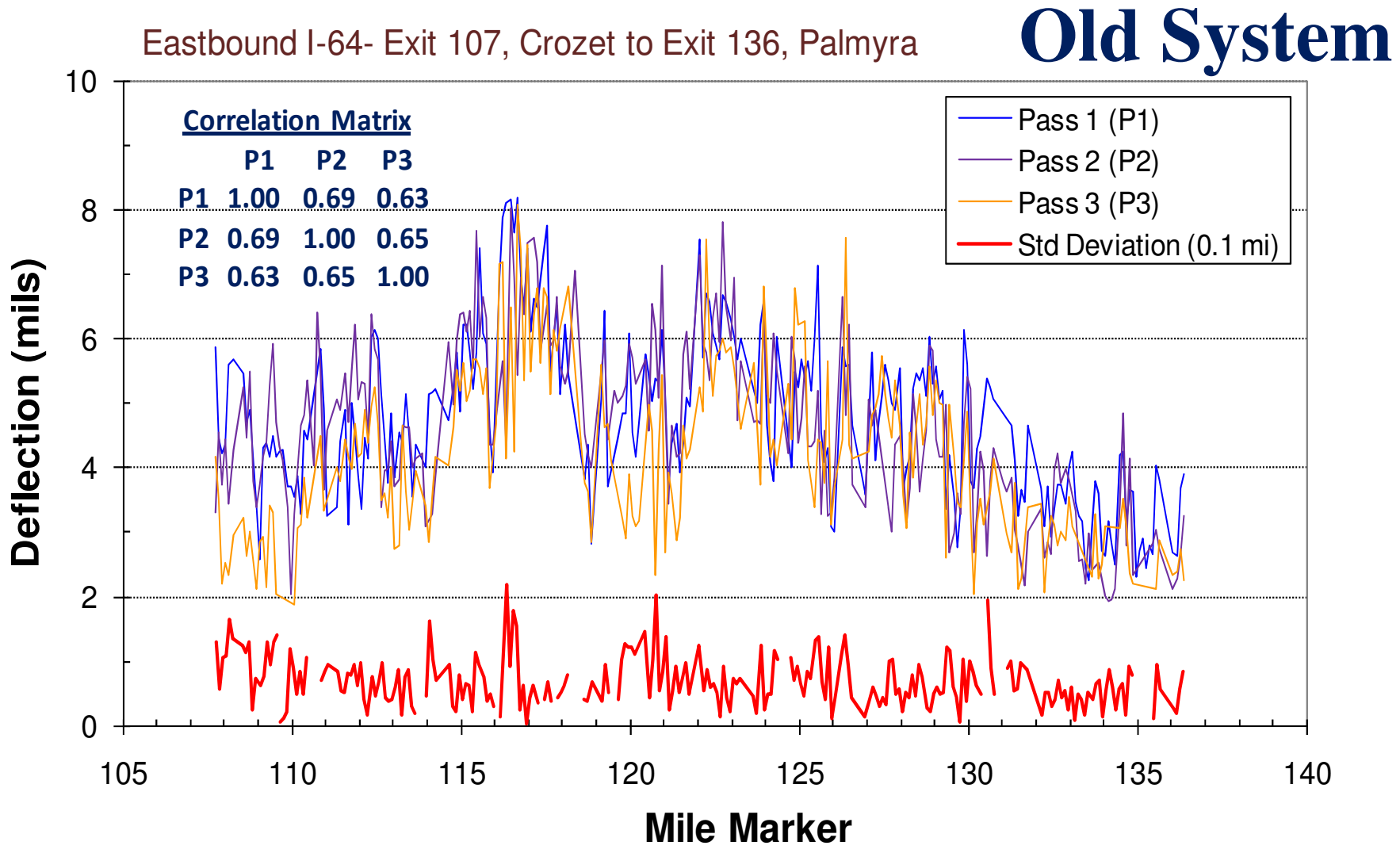
Example Network-level Application

- **Detection of structurally weak sections**

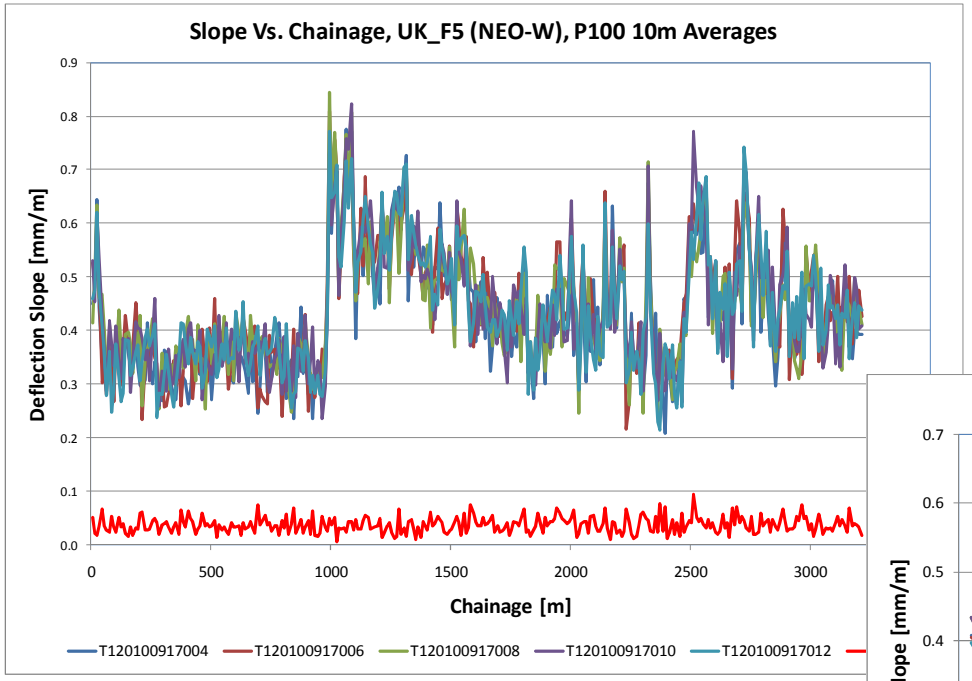


- **Calculation of a structural "health index"?**

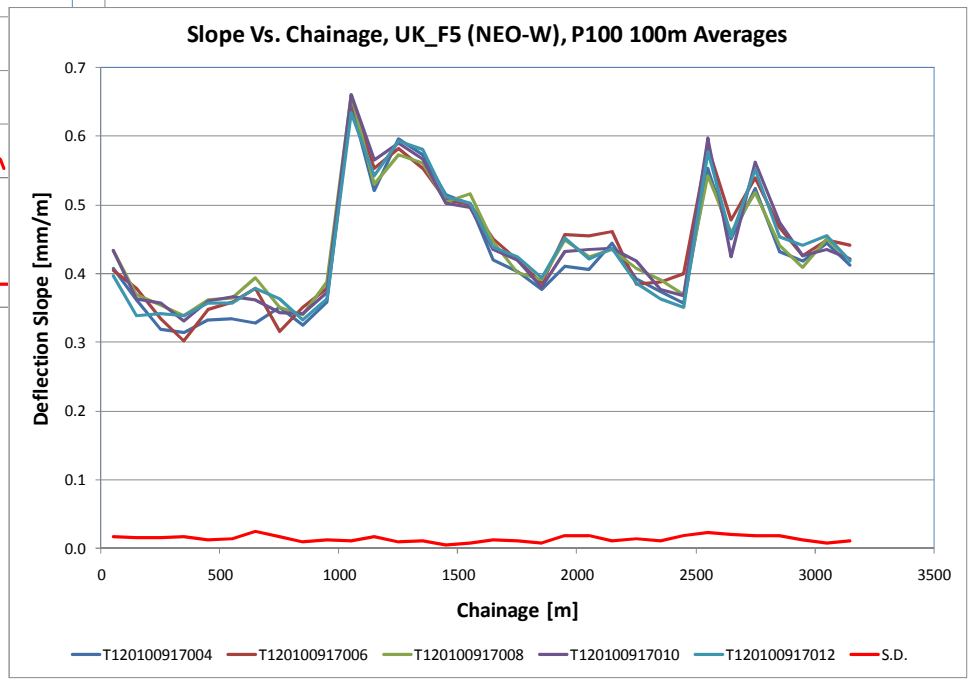
Example Analysis – RWD Repeatability



TSD Repeatability

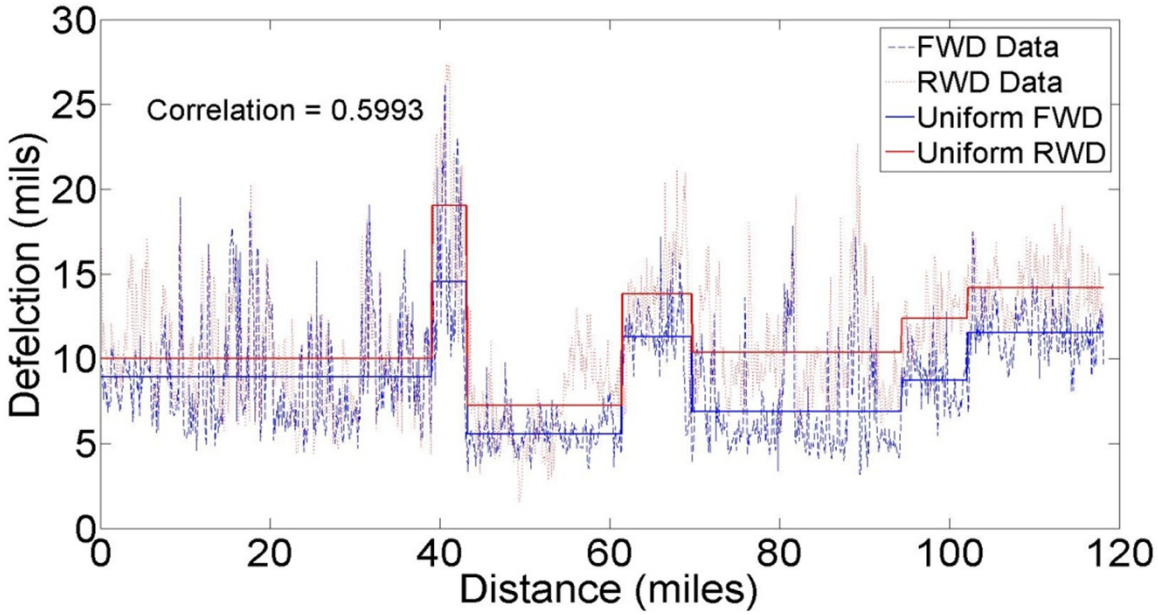


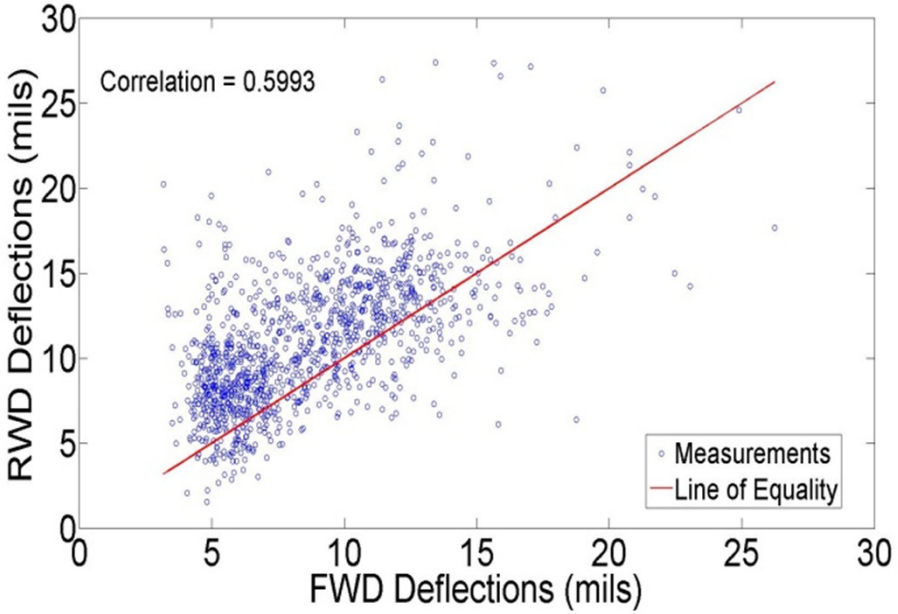
10 m Averaging



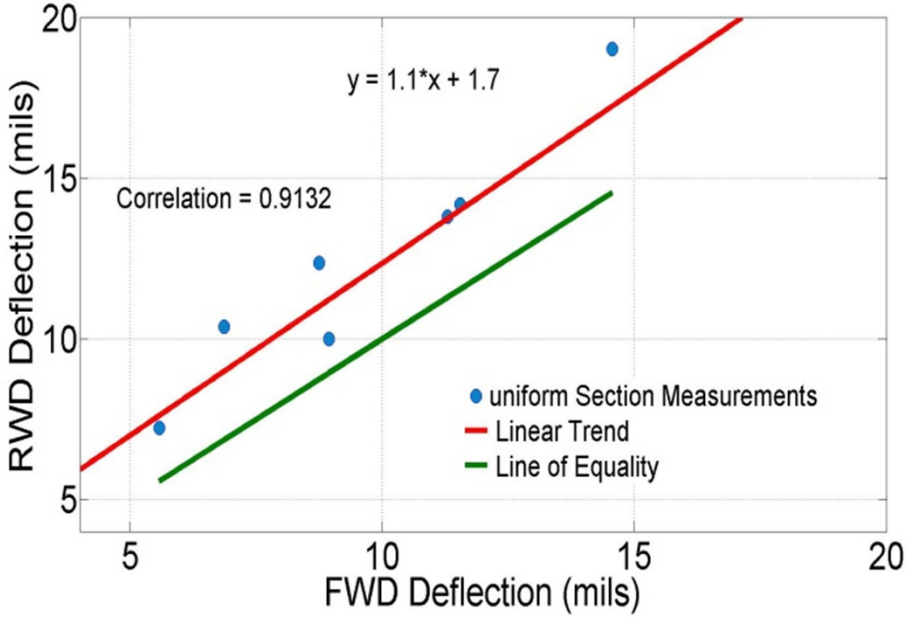
100 m Averaging

Comparisons with FWD
(NM Data)





Individual 0.1 mi segment comparisons



Homogeneous section comparisons

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Final Remarks

- There seems to be a need for network-level pavement deflection data
  - Identify weak sections
  - Compute health indices (related to RSL?)
  - Support preservation vs. renewal decisions
- Preliminary analysis suggest that:
  - Continuous Deflection measurements may be able to provide level of "accuracy" and repeatability necessary for this level of analysis
  - Despite of the high acquisition cost, available technology appear to be cost effective

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