TPF-5(282)

Demonstration of Network Level Pavement Structural Evaluation with Traffic Speed Deflectometer

Third Meeting of the Technical Advisory Committee

May 22, 2015
The Westin Alexandria - Banneker Room
400 Courthouse Square, Alexandria, VA 22314

Flexible Agenda

8:00 - 8:05	Opening Remarks (Siva)
8:05 – 8:30	Findings from of FHWA research project (Siva/Senthil)
8:30- 9:30	Results of first round of testing (Samer Katicha/Gerardo Flintsch) ✓ TSD data ✓ Auxiliary data ✓ Analysis
9:30 – 10:00	TSD device and data analysis update (Jørgen Krarup/Greenwood Engineering)
10:00 – 10:30	Update on UK use of TSD (Brian Ferne)
10:30 - 10:45	Break
10:45 – 11:15	Idaho Transportation Department District 6 "Subsurface Pavement Evaluation East Idaho Corridor Loop" (Ken Maser/Shawn Enright)
11:15 - 12:00	Feedback from pooled fund SHA members and second round of testing logistics
12:00 - 1:00	Lunch Break
1:00 - 2:00	Implementation of measurements into pavement management system (discussion)

Web/Teleconference for those wishing to attend remotely:

Webinar URL: https://connectdot.connectsolutions.com/siva
Call-in numbers: 1-877-848-7030 (toll free) or 1-404-443-2170 (toll paid)
Access Code: 8995445
(audio will also be available through the computer speaker/microphone)

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Pavement Structural Evaluation at the Network Level

FHWA Project No. DTFH61-12-C-00031

U.S. Department of Transportation
Federal Highway Administration

Outline

- Goal & Objective
- Field Trials
- Device Accuracy & Precision
- Deflection Indices
- Network-Level PMS Application
- Conclusions

Project Goal & Objectives

- Goal:
  - Establish reliable measure of pavement structural condition based on traffic speed deflection-related measurements
- Objectives:
  - Assess and evaluate capability of traffic speed deflection-related devices for pavement structural evaluation at network level
  - Develop methodologies for enabling use of devices in pavement management

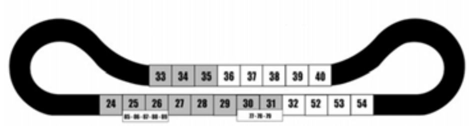
FIELD TRIALS

Devices

Sites

MnROAD Facility

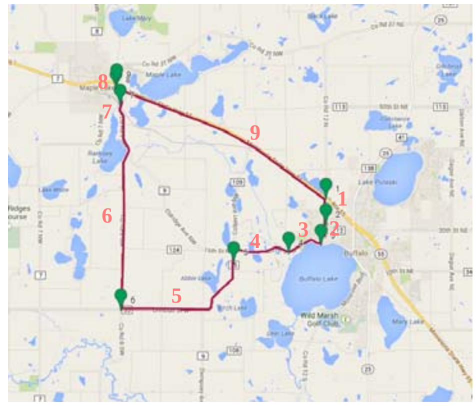
- **3.5-mile mainline roadway**
  45 sections, each 500 ft long and varying pavement types
- **2.5-mile closed-loop low volume roadway**
  28 sections, each 500 ft long and varying pavement types



Sites

18-mile loop in-service road in Wright County, MN

- Longer test sections
- Tight turns
- Rolling hills

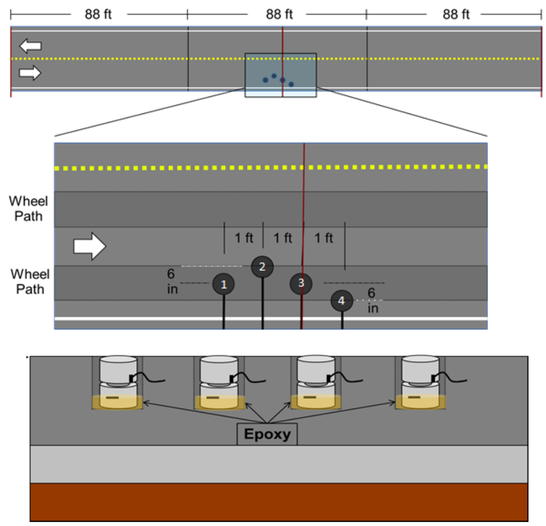


MnROAD Accuracy Cells

Cell 3	Cell 19	Cell 34	Cell 72
3 in. HMA	5 in. HMA	4 in. HMA	9 in. PCC
6 in. Full Depth Reclaimed with Engineered Emulsion Base	12 in. Unbound Aggregate Base	12 in. Unbound Aggregate Base	8 in. Unbound Aggregate Base
4 in. Base	12 in. Subbase 1		
33 in. Subbase 1	7 in. Subbase 2		
Clay	Clay	Clay	Clay

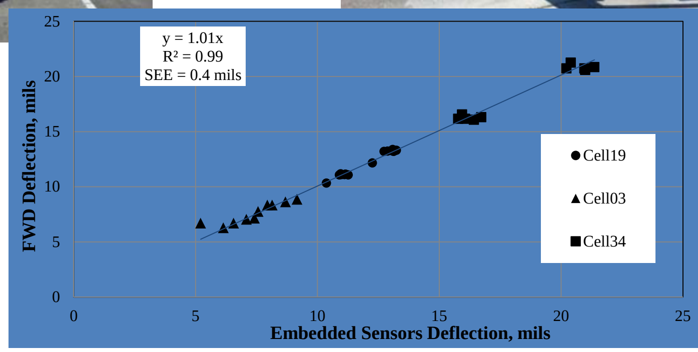
Sensors

4 geophones & 1 accelerometer per section

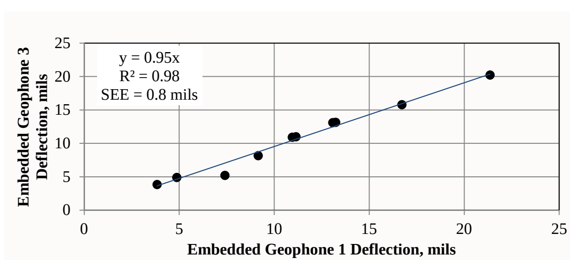


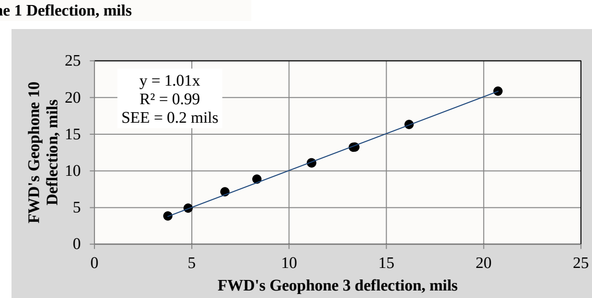
Sensor Placement

Sensor Evaluation



Sensor Evaluation

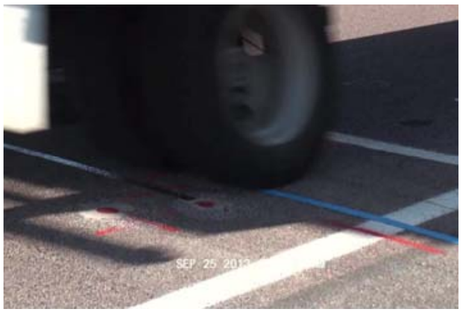




Wheel Location

ARA RWD

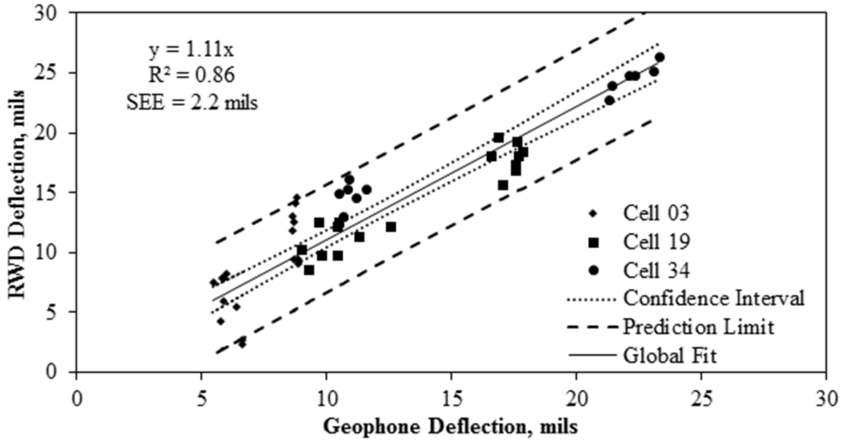
Greenwood TSD



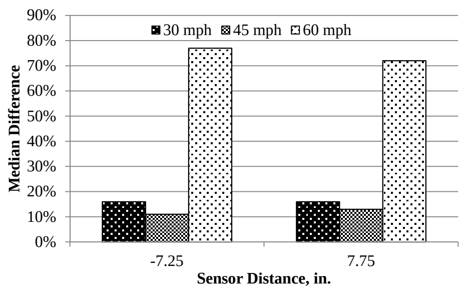
Average Difference and St. Dev. of Difference

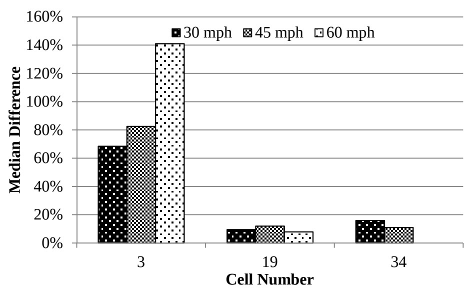
TSD			RWD		
Sensor Distance (in.)	Average Difference	Standard Deviation of Difference	Sensor Distance (in.)	Average Difference	Standard Deviation of Difference
4	12%	5%	-7.25	11%	3%
8	4%	3%	7.75	11%	10%
12	6%	7%			
24	11%	8%			

Overall RWD Accuracy Results

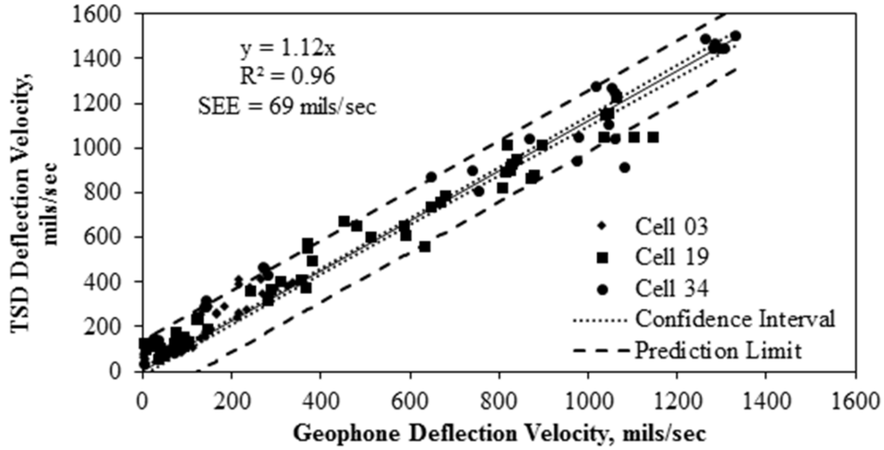


RWD Accuracy Results

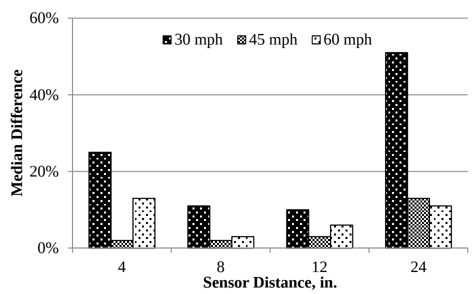


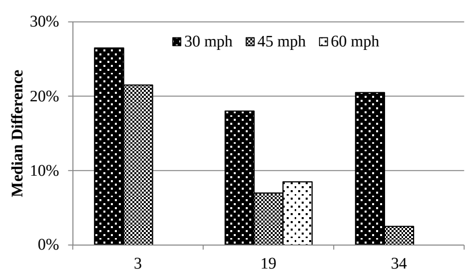


Overall TSD Accuracy Results



TSD Accuracy Results

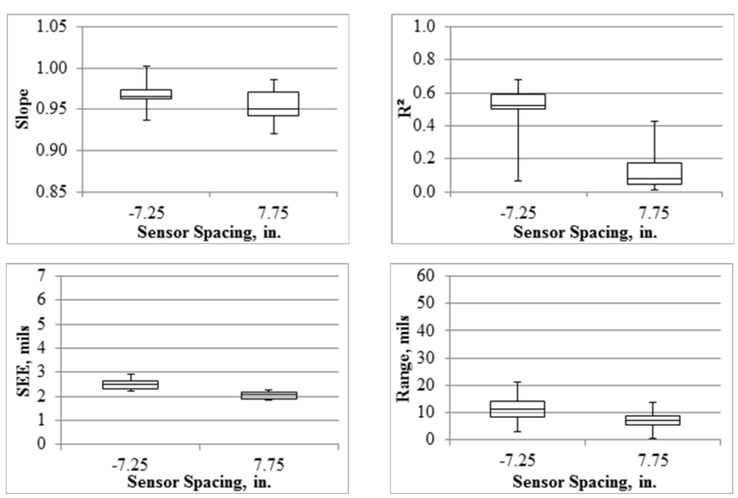




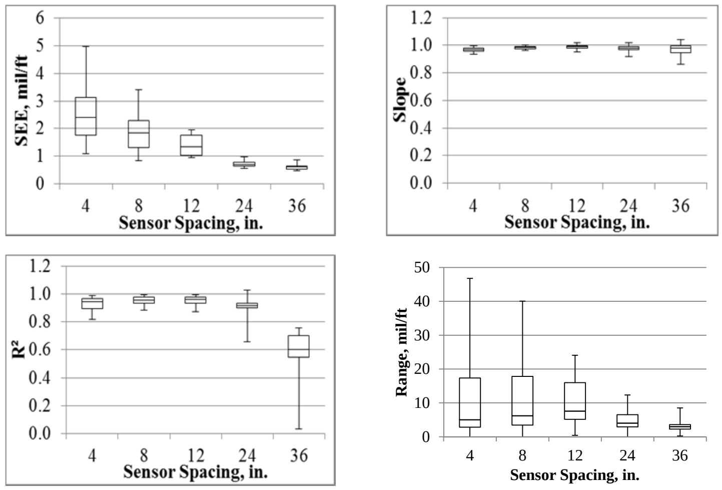
Precision

- Included almost all MnROAD cells and 18-mile Wright County loop
  - Different pavement structures, horizontal curves, vertical curves, etc.
- Tested at different speeds and times of day
- Average and COV of deflection parameters for each sensor from replicate passes calculated for each reported test point

Precision Comparison -RWD



Precision Comparison - TSD



DEFLECTION INDICES

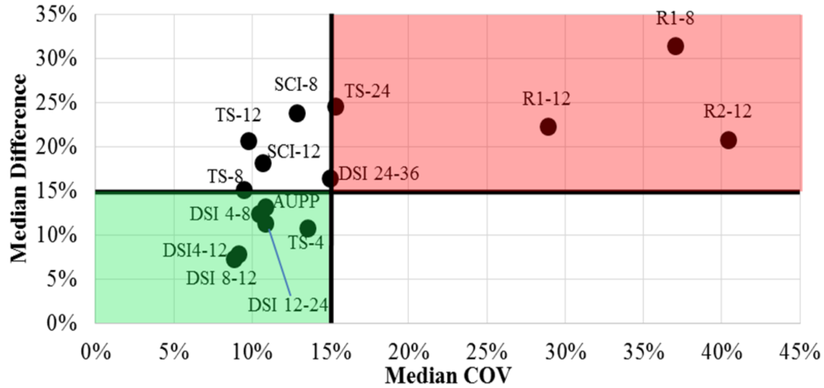
3D-Move Program

- Estimates dynamic pavement responses at given point within pavement structure using continuum-based finite-layer approach
- Calibrated for use in development of methodology for incorporating TSDD measurements into network-level PMS applications
- Key element was simulating pavement deflections using numerical models with focus on understanding parameters that affect TSDD measurements

JULEA Simulations

- To confirm the adequacy, applicability and validity of the best indices, Monte Carlo simulations were conducted
- JULEA-generated database of 15,000 pavement structures
  - Covered a wide range of layer moduli and thicknesses
  - Deflections and horizontal strains at bottom of HMA layer computed for each simulated pavement structure

Overall Field Performance

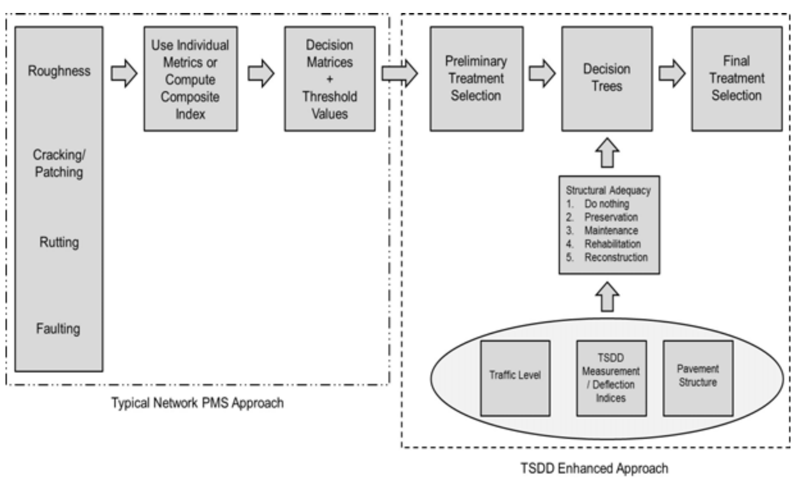


Recommended Index

- Deflection slope index $DSI_{4\text{-}12}$ (difference between deflections at 4 and 12 inches from applied load)
  - Most appropriate index and recommended for use in network-level PMS applications
- Surface curvature index SCI_{12} (difference between deflections at 0 and 12 inches from applied load)
  - Performed nearly as well as $DSI_{4\text{-}12}$, and hence could also be considered

NETWORK LEVEL PMS APPLICATIONS

Implementation of Findings



Incorporating into Network Level PMS

1. Calculating representative indices for estimating structural condition of pavement
2. Estimating horizontal strains at bottom of HMA layer
3. Adjusting estimated strains to standard temperature
4. Establishing structural adequacy of pavements using temperature corrected strain

CONCLUSIONS

Conclusions and Recommendations

- Implementation steps need to be taken from concept to full development
- Validation and/or calibration of recommended deflection indices as well as implementation procedures need to be done using field data collected on highway agency networks

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Thank you!

U.S. Department of Transportation
Federal Highway Administration

Network Level Structural Evaluation with the TSD Device

Samer W. Katicha, PhD
Senior Research Associate, Virginia Tech Transportation Institute

May 22nd 2015

VirginiaTech
Transportation Institute

Pooled Fund Team

- Pooled Fund Effort (9 State + FHWA)
  - FHWA (lead)
  - CALTRANS, GDOT, IDOT, NDOT, NYDOT, PennDOT, SCDOT
  - Two new members: Idaho, VDOT
- Project Team
  - Engineering & Software Consultants, Inc. (ESCINC)
    - Project management
  - Virginia Tech Transportation Institute (VTTI)
    - Lead research team
  - Transport Research Laboratory (TRL): Brian Ferne
    - Expert advice and consulting support
  - Greenwood Engineering
    - Testing

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Project Objective

- Demonstration of Network Level Structural Evaluation with the Traffic Speed Deflectometer
- Incorporating TSD Measurements into the PMS
  - Appropriate Indices
  - Supporting data

Project Tasks

- Demonstrate the use of the TSD
- Assess methods to incorporate TSD structural information in a PMS
- Conduct exploratory data analysis
- Use results of "Pavement Structural Evaluation at the Network Level"

TSD testing

- Two rounds of testing (2 years)
- Each round of testing consists of two days
- First day
  - Device calibration (if needed): morning
  - 30 to 50 miles: afternoon
- Second day:
  - Up to 250 miles

Project Status

- First round of testing completed in all participating agencies
- Obtaining auxiliary pavement data
  - e.g. pavement thickness, condition, FWD testing…
- Data analysis: processing, Deflections, SCI, SNeff, Backcalculation
- Upcoming year
  - Second round of data collection
  - Select possible indices
  - Implementation

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TSD
What does it measure?

TSD

What does it measure

- Deflection slope NOT deflection
  - 100, 200, 300, 600, 900, and 1500 mm
- What can we get from it:
  - Deflections (integrate)
  - Surface Curvature Index (SCI): difference in deflection
  - Area Under Pavement Profile (AUPP)
  - Effective Structural Number (SN): need pavement thickness
- Data is collected at 1,000 Hz (20 mm) and summarized at 10 m

Exploratory Data Analysis

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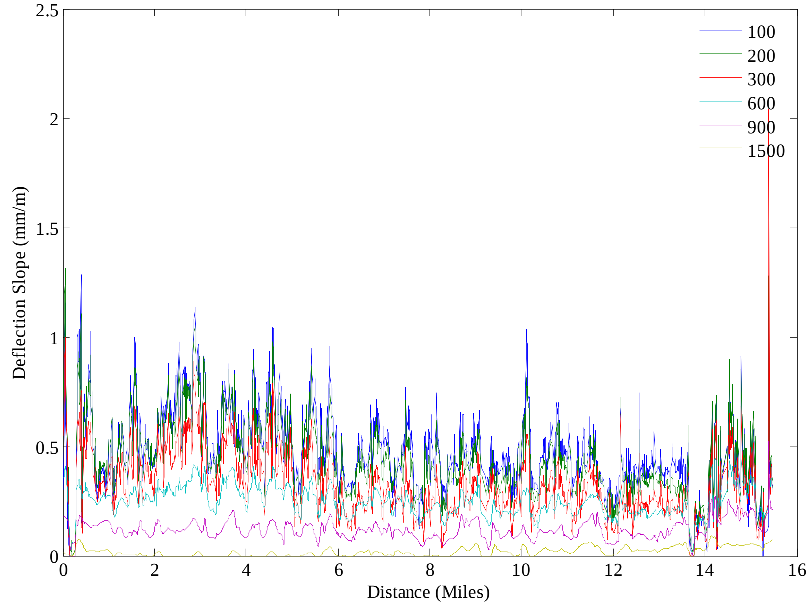
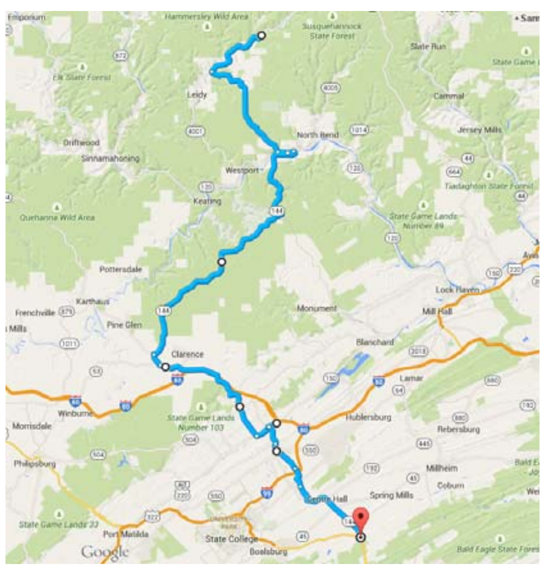
What the data looks like



Test Site Map



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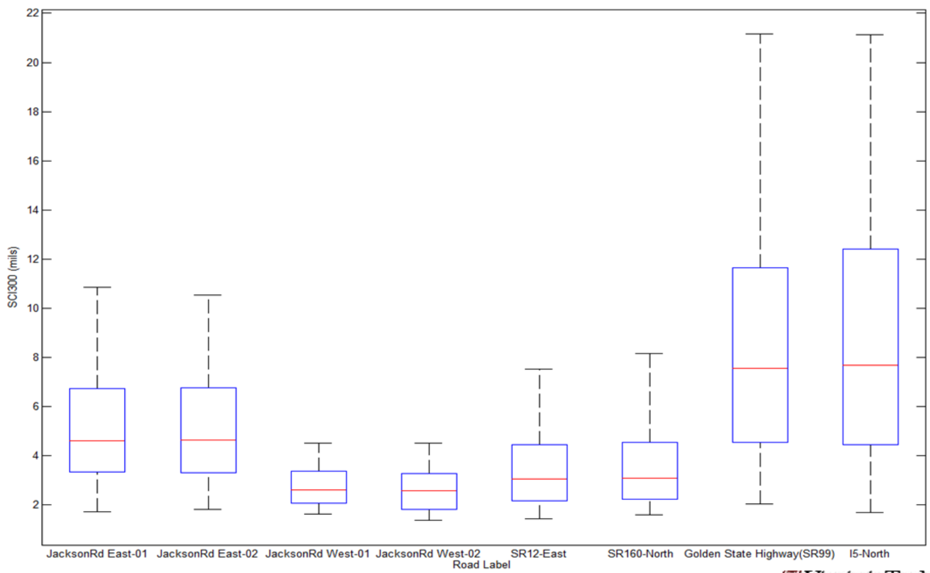
SCI 300 of Tested Sections (California)



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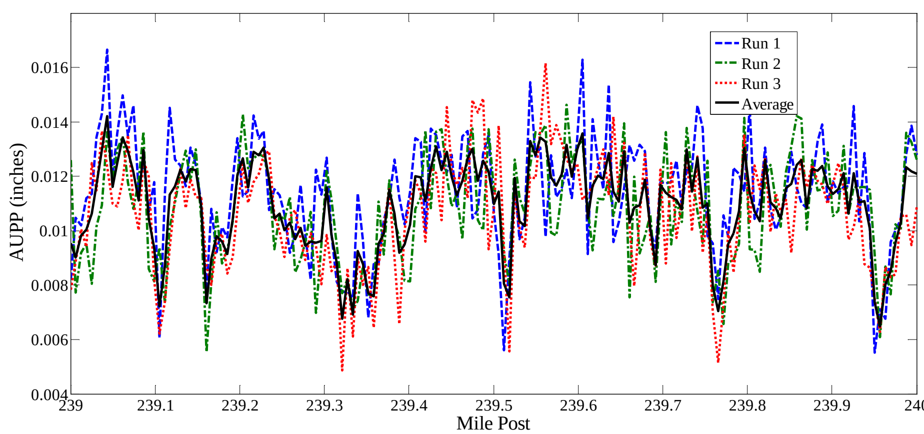
Evaluating Repeatability (standard deviation)

- AUPP: 1.4462 mils; Deflection Slope: 0.4116 mils/ft (0.035 mm/m)



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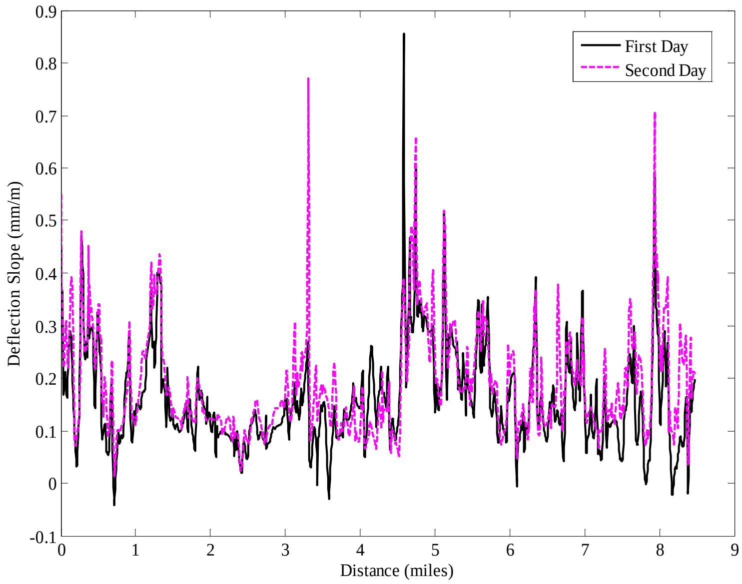
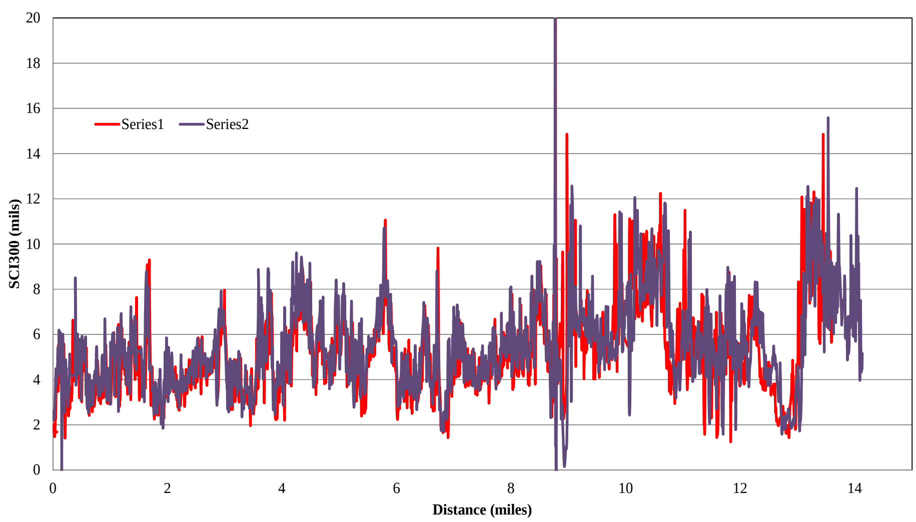
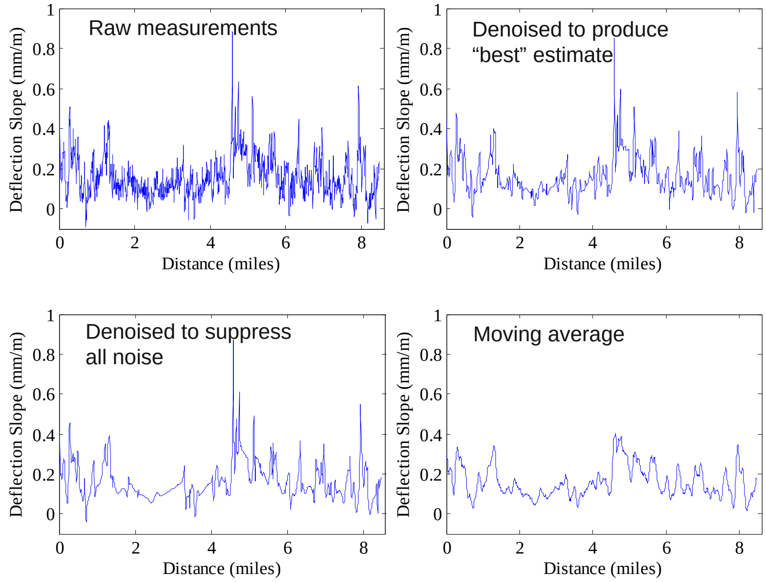
Repeatability (New York)



Repeatability (California)

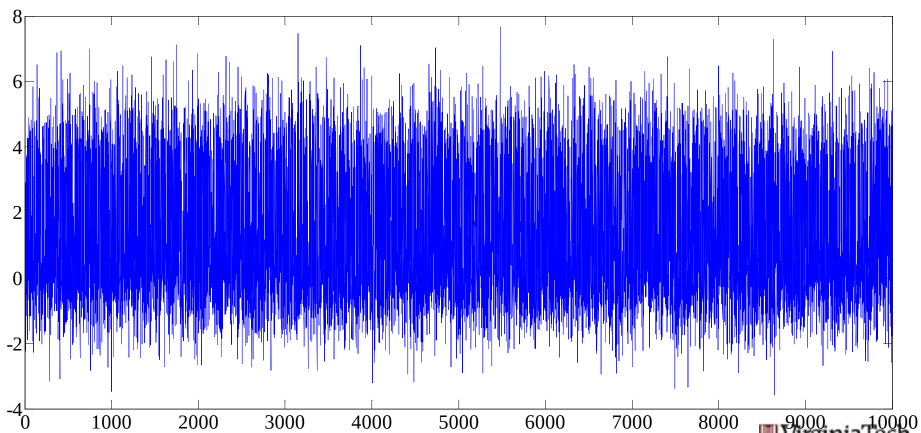


Filtering/Denoising



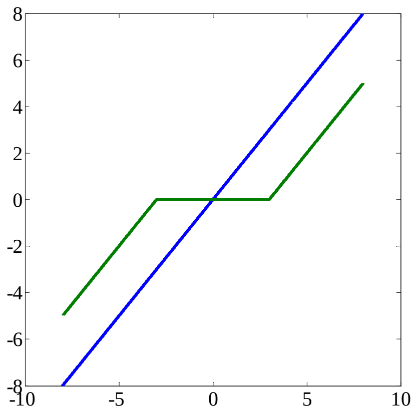
Stein Unbiased Risk Estimate (SURE)

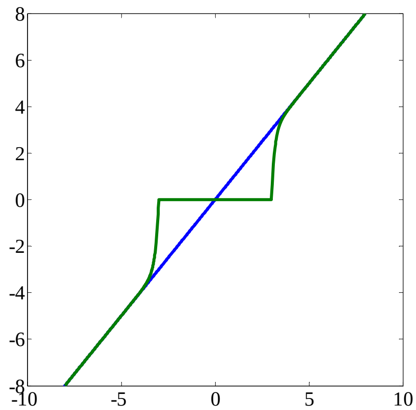
- 10,000 measurements
- Error std = 1
- Ground truth: 3,000 = 4; 7,000 = 0



Thresholding Function

- Set low measurements to zero





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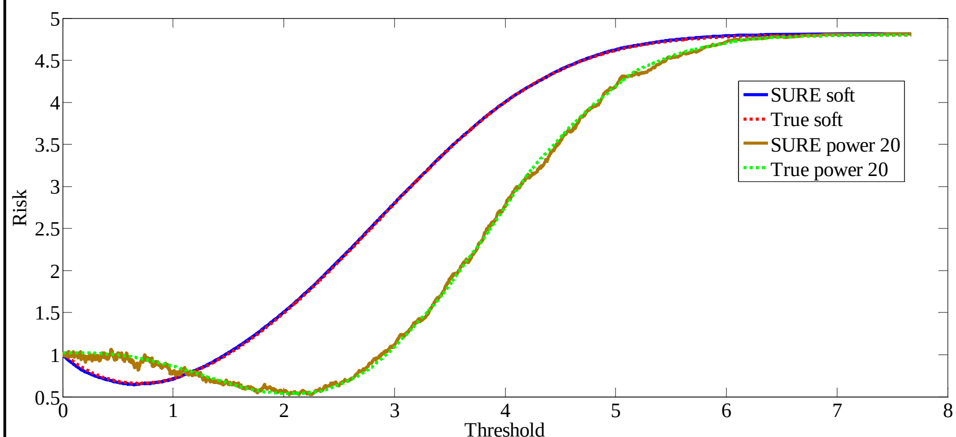
SURE



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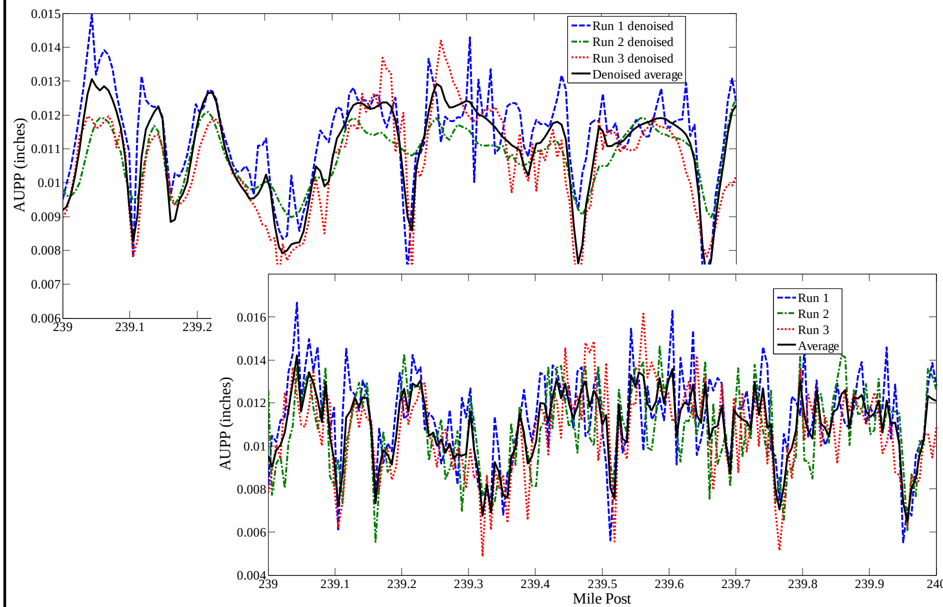
Why Filter?



1. Structural Health Index

- Effective Structural Number

$$SN_{eff} = k_1 SIP^{k_2} H_p^{k_3}$$

Rhode et al. (1994)

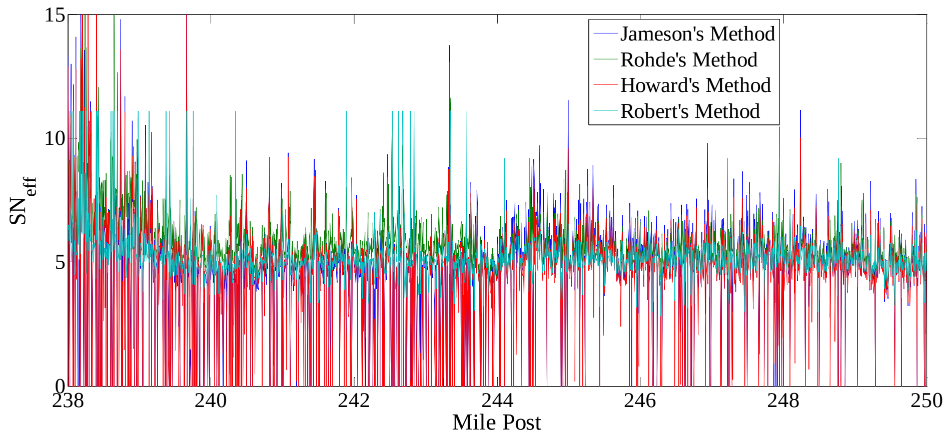
$$SIP = D_0 - D_{1.5H_P}$$

Where:

D_0 = peak deflection under the 9,000 lb load (microns)

$D_{1.5Hp}$ = deflection at 1.5 times the pavement depth (microns)

Structural Number (Original)



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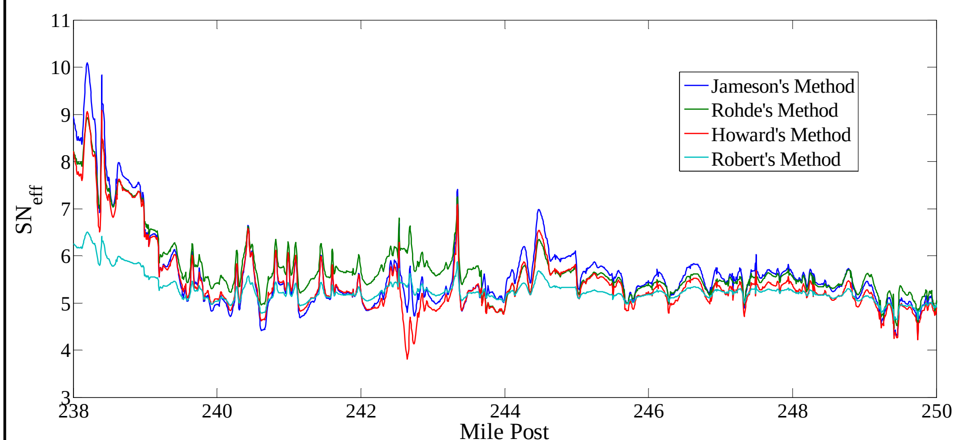
Structural Number (Denoised)



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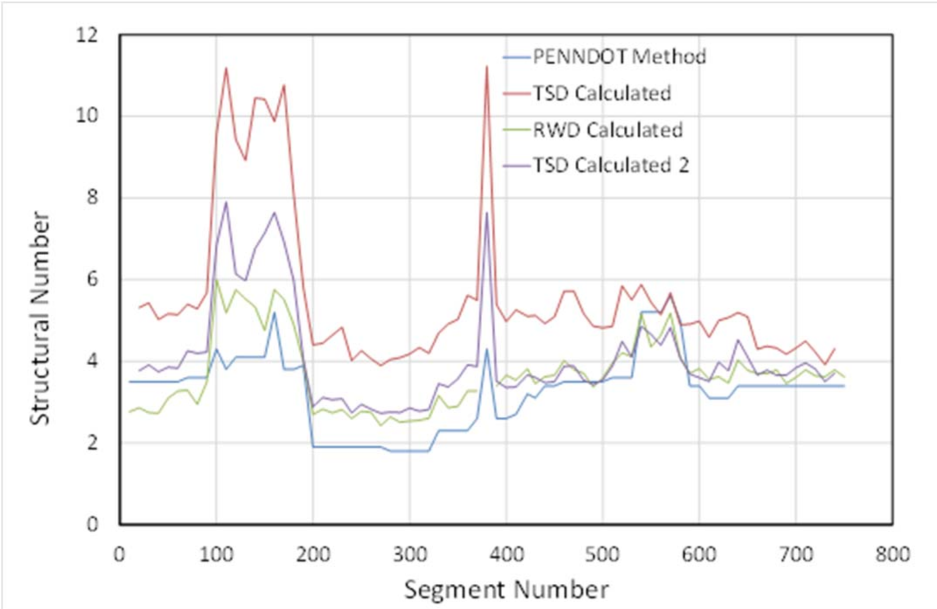
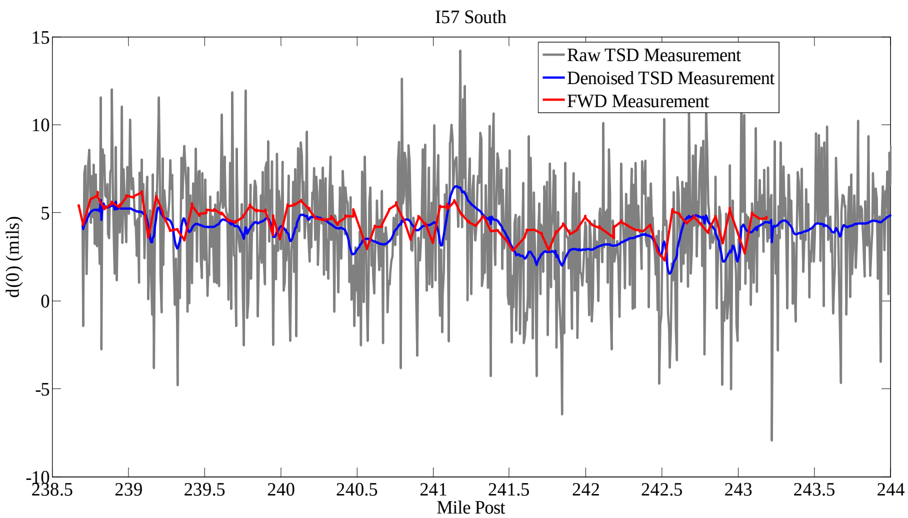
Structural Number Comparison Pennsylvania



Comparison with FWD (D_0)



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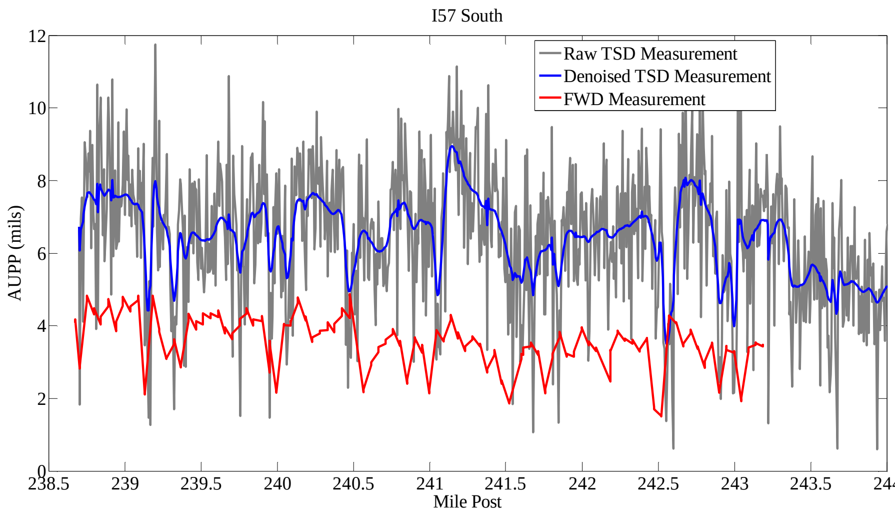
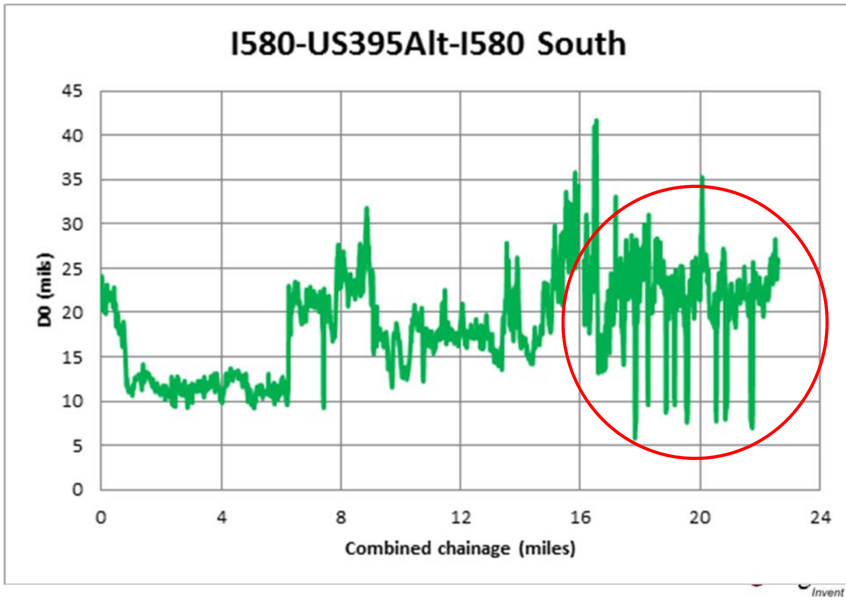
Comparison with FWD (AUPP)



Testing (Nevada)

Identification of Features (Nevada)



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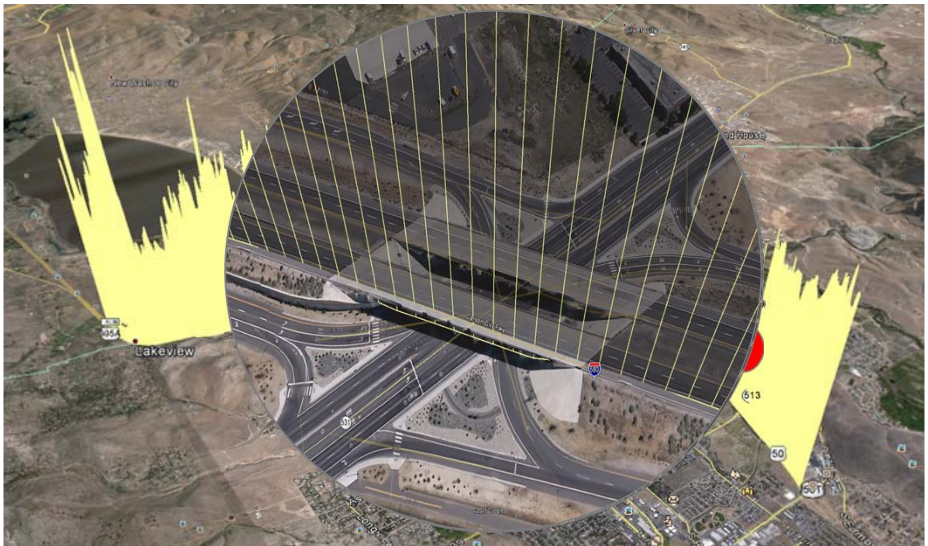
Identification of Features (Nevada)



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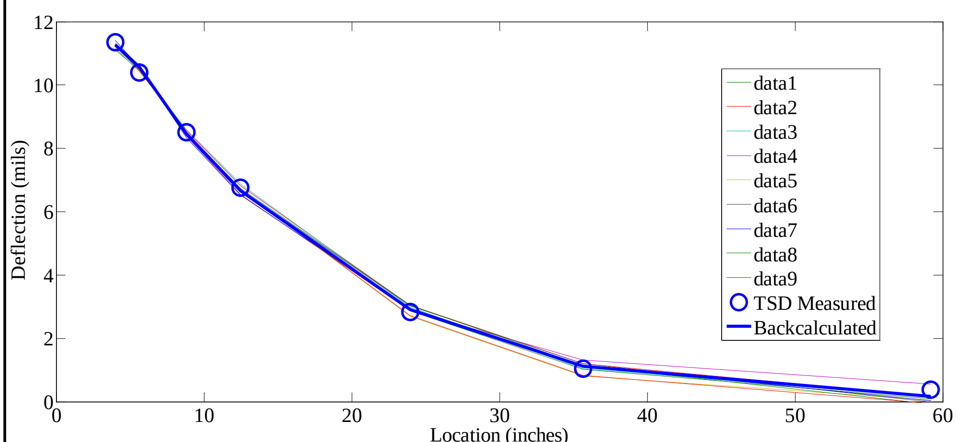
Backcalculation

Pennsylvania



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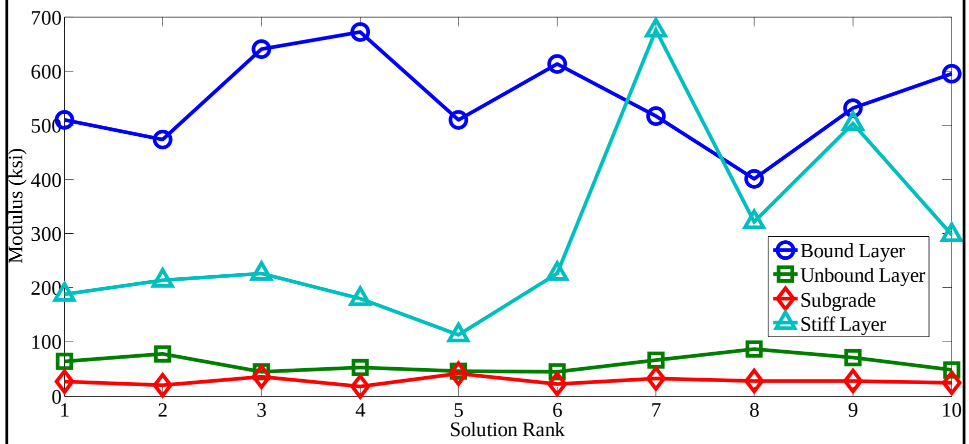
Pennsylvania (Moduli)



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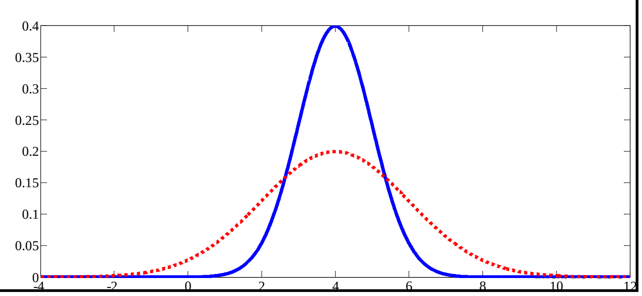
Data Quality vs Quantity

- FWD Accurate but sparse data: 1 measurement/mile
- TSD Less accurate but dense data: 160 measurement/mile
- Error FWD = 1
- Error TSD = 0.16 (6 times better) also gives variability of section
- Equivalent FWD measurements: 40



Back to Main Objective

- Incorporate TSD test results into PMS
  - Select the appropriate index(es)
    - FHWA project "Pavement Structural Evaluation at the Network Level"
    - Input from DOTs
    - SN, remaining service life, SCI, strain in asphalt layer
- Incorporate into PMS
  - Structural condition is one of many indicators
  - Good Decisions consider many (independent) measures

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Thank you… Questions?

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TPF-5(282)

Third Meeting of the Technical Advisory Committee

May 22, 2015 Alexandria, VA

Greenwood TSD

TSD/Device and Data Analysis Update

Louis Pedersen
Jørgen Krarup

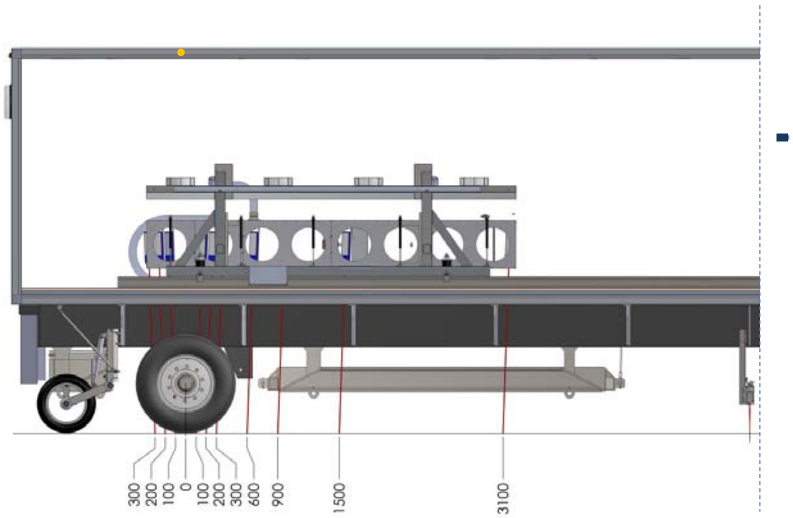
Greenwood Engineering A/S

H.J.Holst Vej 3-5C, Brøndby

Measuring Systems for Infrastructure
For Roads and for Railroads

Inside TSD Semi-trailer

GREENWOOD ENGINEERING



GREENWOOD ENGINEERING

GREENWOOD ENGINEERING

USA

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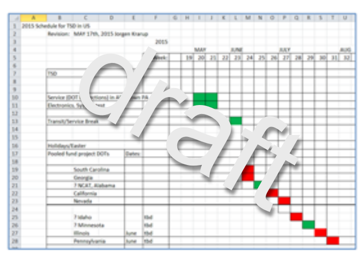
Greenwood Task:

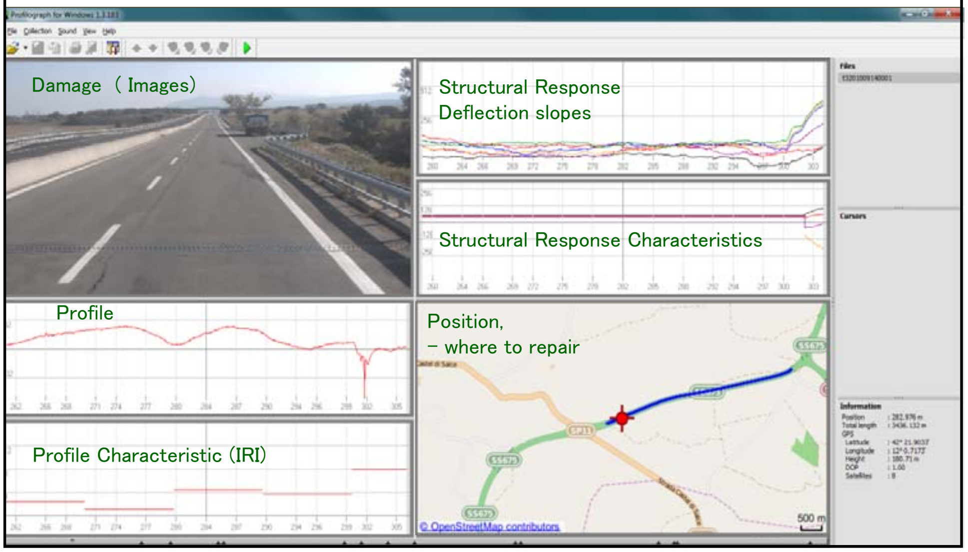
TSD recordings 1-2 days in each project member network



GREENWOOD ENGINEERING

GREENWOOD ENGINEERING

What are we looking for ?



GREENWOOD ENGINEERING

What are we looking for ?

1: Relate SCI300 to horizontal strain at bottom of flexible layer: $\log \varepsilon_h = 0.481 + 0.881 \log(SCI_{300})$

2: Estimate relative number of ESALs to failure? $\varepsilon_h = -0{,}000250 \times (N/10^6)^{-0{,}191}$

Poland

Pomiary TSD na drogach ZDW w Katowicach

Zarząd Dróg Wojewódzkich w Katowicach

Wyniki w podziale na odcinki diagnostyczne

KLASSE	NUMMER	BUCHSTABE	LAGE	FS	VNK	NNK	VST	BST	DATUM	UHRZEIT	AVG_D0	STD_D0	AVG_SCI300	STD_SCI300	TJ	TP
W	408		R	1	5736002	5736004	300	400	30-wrz-13	09:00:07	135.8687	75.96843	77.73314	41.40445	4.97711	6.84257
W	408		R	1	5736002	5736004	400	500	30-wrz-13	09:00:14	149.4319	84.07422	76.11578	45.95568	5.23562	6.81933
W	408		R	1	5736002	5736004	500	600	30-wrz-13	09:00:21	176.9237	114.08047	89.34696	64.34692	5.03112	6.86976
W	408		R	1	5736002	5736004	600	700	30-wrz-13	09:00:28	171.8448	106.3911	66.15414	44.60727	5.41681	6.86194
W	408		R	1	5736002	5736004	700	800	30-wrz-13	09:00:35	158.2001	101.4295	76.0046	56.43734	5.74964	6.89961
W	408		R	1	5736002	5736004	800	900	30-wrz-13	09:00:42	111.9021	63.88513	55.26619	34.98738	5.8279	6.91575
W	408		R	1	5736002	5736004	900	1000	30-wrz-13	09:00:49	128.6151	95.76961	64.95246	44.5142	4.83742	6.9006
W	408		R	1	5736002	5736004	1000	1100	30-wrz-13	09:00:58	202.8632	352.26432	98.6924	118.2863	4.65279	6.9108
W	408		R	1	5736002	5736004	1100	1200	30-wrz-13	09:01:05	106.4551	63.1146	42.25903	26.04249	5.50185	6.91639
W	408		R	1	5736002	5736004	1200	1300	30-wrz-13	09:01:11	161.4647	83.84301	73.99478	37.37332	4.40192	6.91616
W	408		R	1	5736002	5736004	1300	1400	30-wrz-13	09:01:18	151.5539	94.50182	79.37208	41.64606	4.41028	6.93652
W	408		R	1	5736002	5736004	1400	1500	30-wrz-13	09:01:25	177.4878	87.15618	82.75701	40.65481	4.42763	6.96979
W	408		R	1	5736002	5736004	1500	1600	30-wrz-13	09:01:31	218.3558	95.87726	111.0658	44.51774	4.42168	6.95754
W	408		R	1	5736002	5736004	1600	1694	30-wrz-13	09:01:38	359.2006	118.60122	180.27295	66.2757	5.50587	6.96017
W	408		R	1	5736004	5737001	0	100	30-wrz-13	09:01:44	277.7362	187.96045	146.22009	110.26856	5.42957	6.98727
W	408		R	1	5736004	5737001	100	200	30-wrz-13	09:01:51	161.2688	98.85512	94.91976	67.88983	5.59778	6.98756
W	408		R	1	5736004	5737001	200	300	30-wrz-13	09:01:57	168.3828	80.93967	97.66041	45.48537	5.85814	7.00601
W	408		R	1	5736004	5737001	300	400	30-wrz-13	09:02:03	198.7784	93.62674	108.53344	42.11961	5.59599	7.03904
W	408		R	1	5736004	5737001	400	500	30-wrz-13	09:02:09	196.9308	103.56832	101.0816	47.84794	5.03671	7.01909
W	408		R	1	5736004	5737001	500	600	30-wrz-13	09:02:15	199.7978	82.97798	112.79953	39.14596	5.95229	7.05256
W	408		R	1	5736004	5737001	600	700	30-wrz-13	09:02:22	172.8427	99.27943	98.45673	47.15588	6.063	7.04596
W	408		R	1	5736004	5737001	700	800	30-wrz-13	09:02:29	169.2699	90.6023	90.63684	43.96795	6.07193	7.09617
W	408		R	1	5736004	5737001	800	900	30-wrz-13	09:02:36	160.2686	76.32824	84.74989	41.46023	6.05463	7.11204

Poland

Pomiary TSD na drogach ZDW w Katowicach

Zarząd Dróg Wojewódzkich w Katowicach

Wyniki w systemie „DrogaOnline”

Denmark

Network overview: Indicator levels for Pavement Structural Condition

Good **Fair** **Poor**

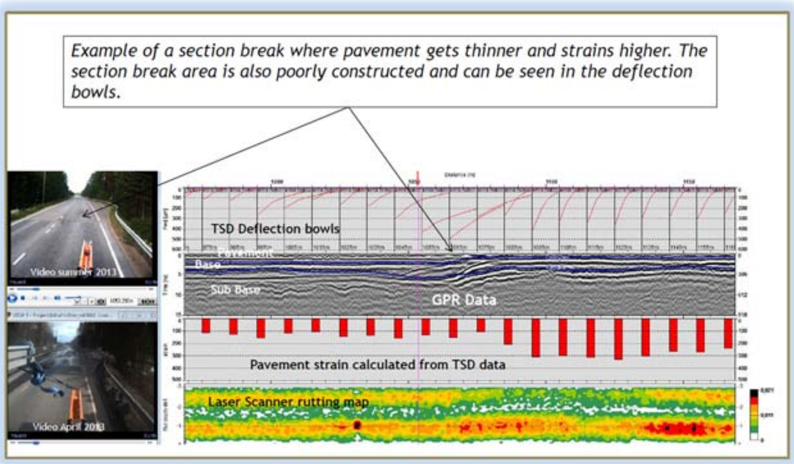
Danish State Network: 3000 lane km

Measured in 10 days

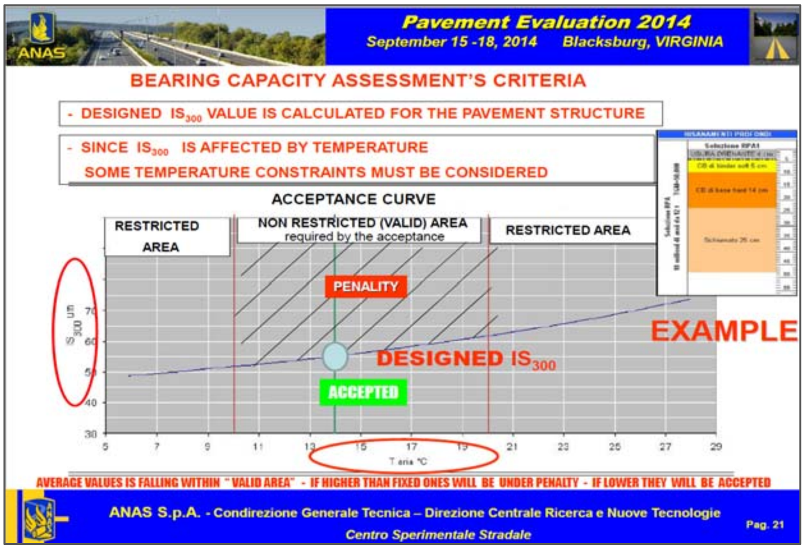
Finland

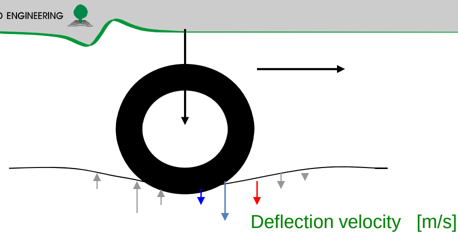
TSD data combined with GPR data

Test runs made 2013 in Finland by Roadscanners

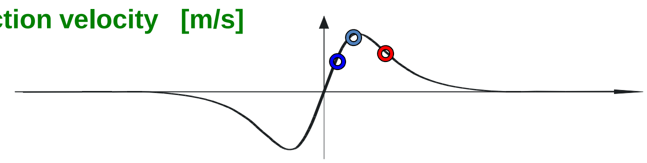


Italy

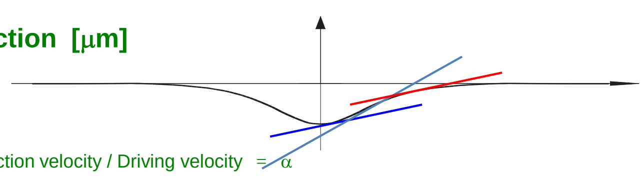




Deflection velocity [m/s]



Deflection [µm]

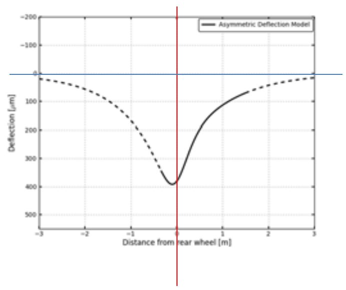


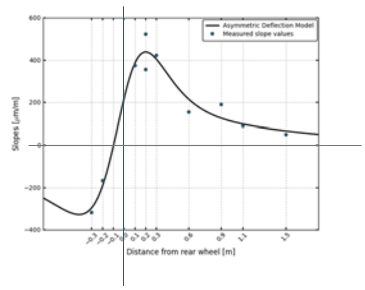
Deflection velocity / Driving velocity = α

α = Deflection slope [µm/m]

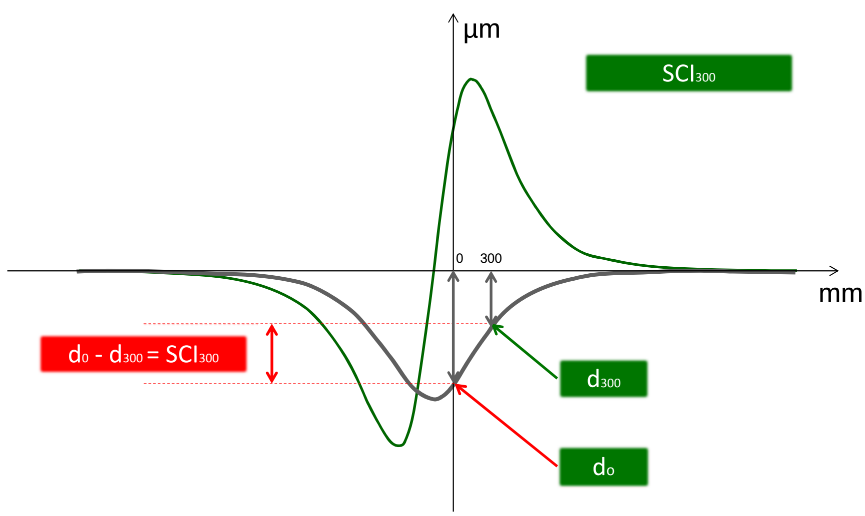
Deflection Basin

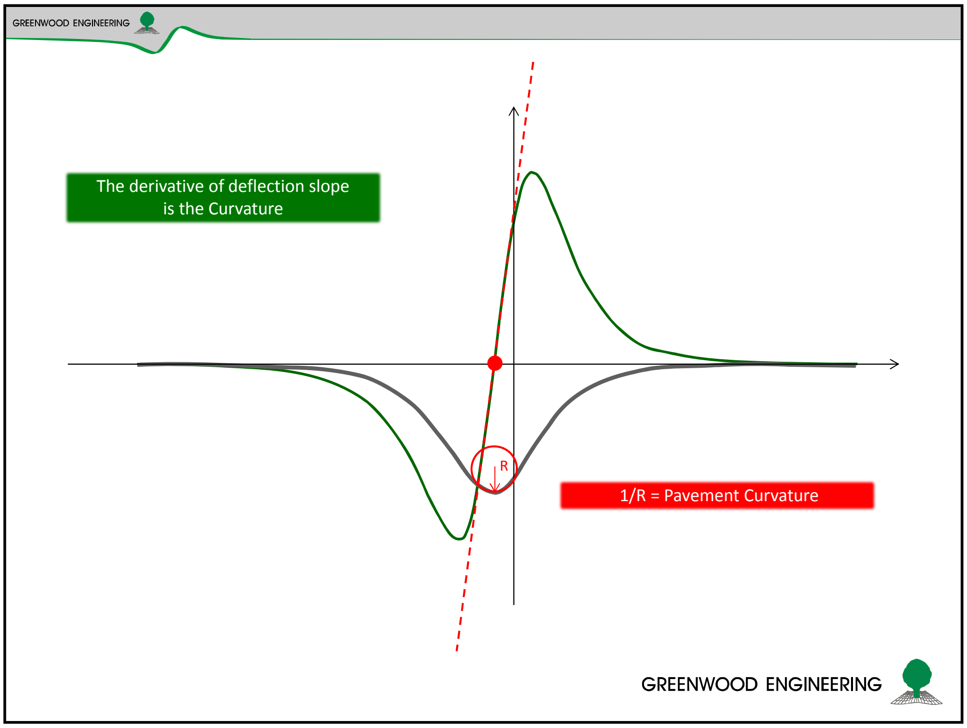
- Deflection basin based on finite element analysis simulations

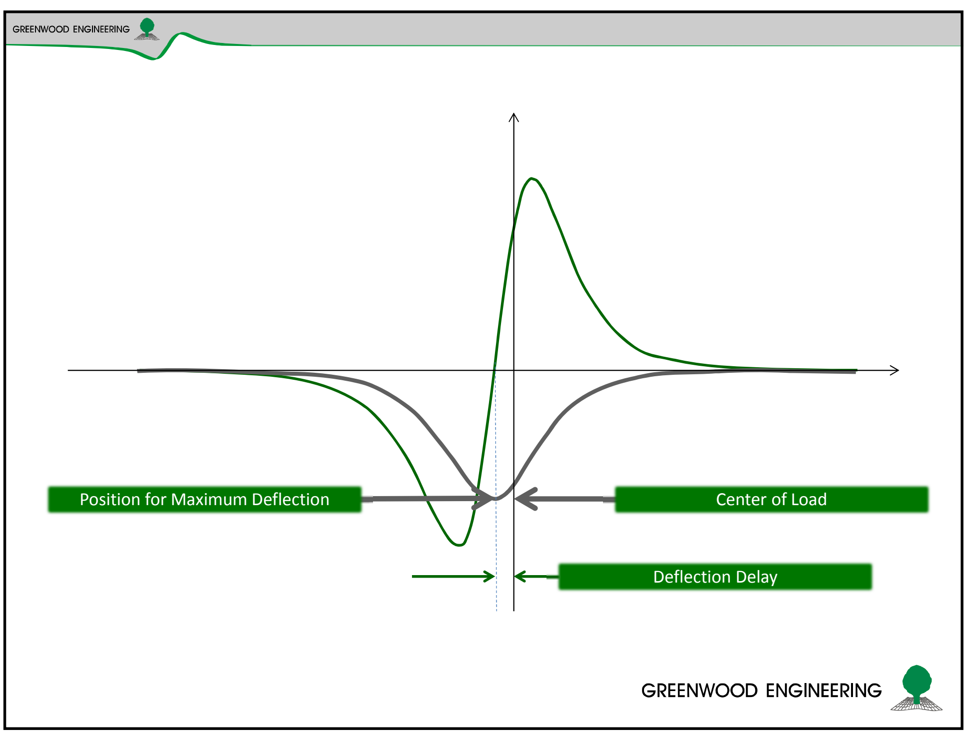




- The suggested deflection basin provides the possibility of maximum deflection occuring behind the wheel axle



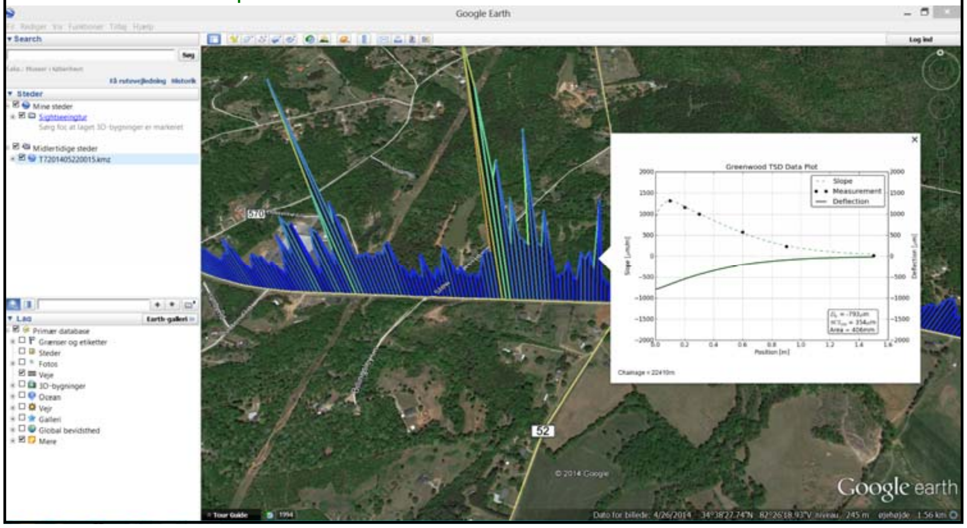

GREENWOOD ENGINEERING
The derivative of deflection slope is the Curvature
R
1/R = Pavement Curvature
GREENWOOD ENGINEERING


GREENWOOD ENGINEERING
Position for Maximum Deflection
Center of Load
Deflection Delay
GREENWOOD ENGINEERING

GREENWOOD ENGINEERING

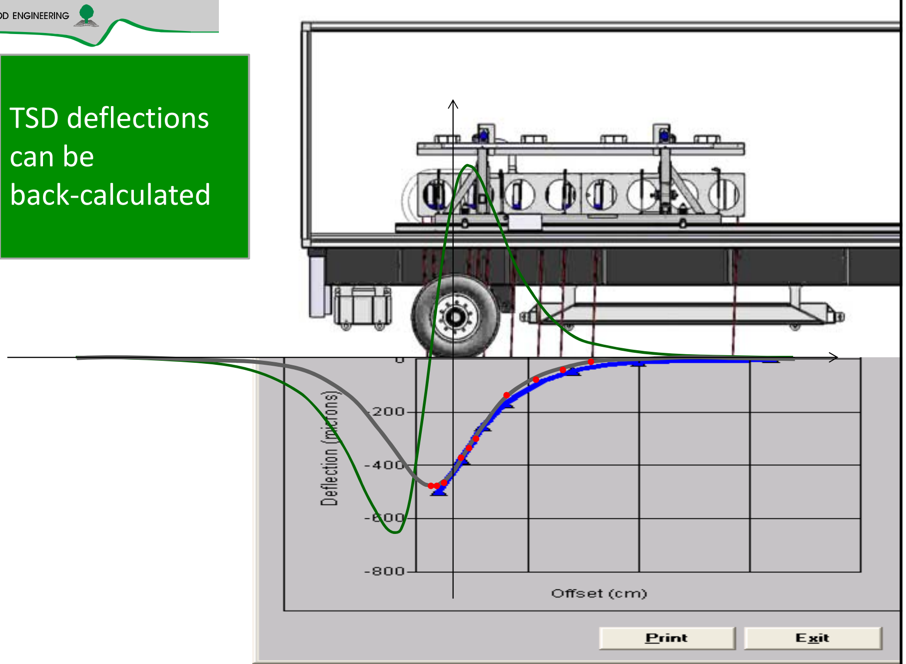
Processed data can be displayed in Google Earth.
The example below shows SCI_{300} along the route.

Click at a position and see deflection details.

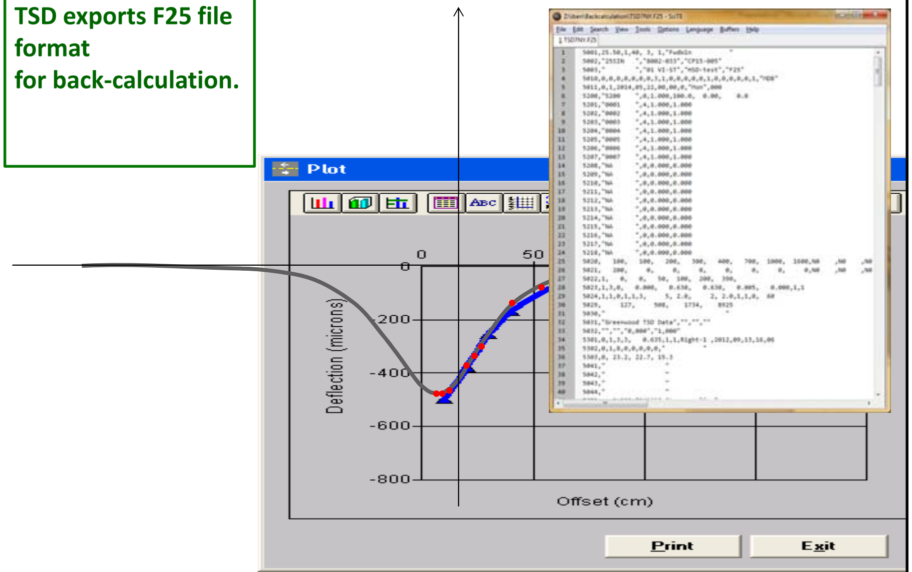


GREENWOOD ENGINEERING

TSD deflections can be back-calculated



TSD exports F25 file format for back-calculation.



GREENWOOD ENGINEERING

Field Trials: Devices

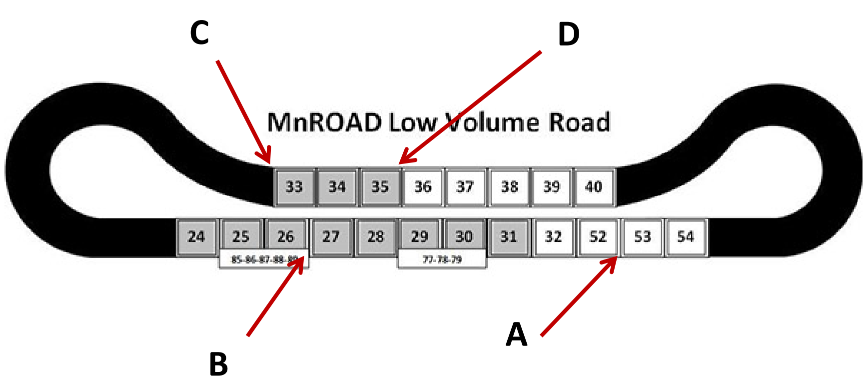
amec foster wheeler

US DOT FHWA projects in the US 2013-2015

MnRoad seen on Google maps

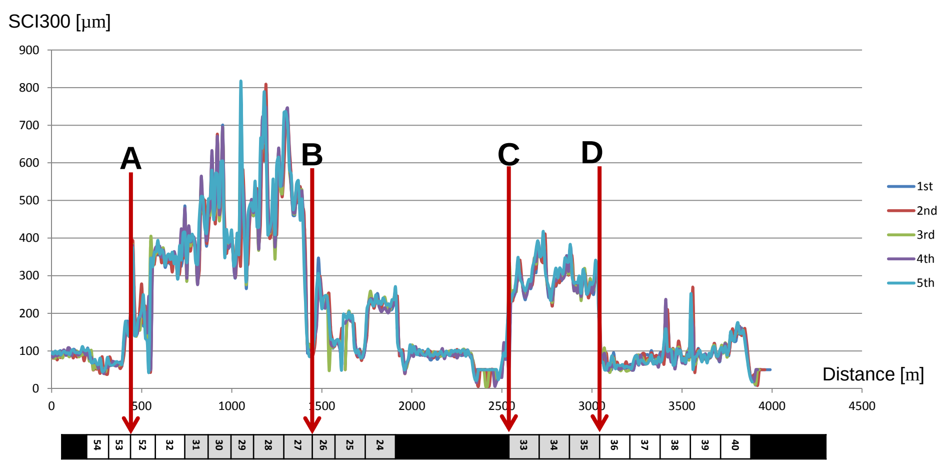
MnRoad Cell map

White cells and curve sections are rigid. Grey cells are felxible.

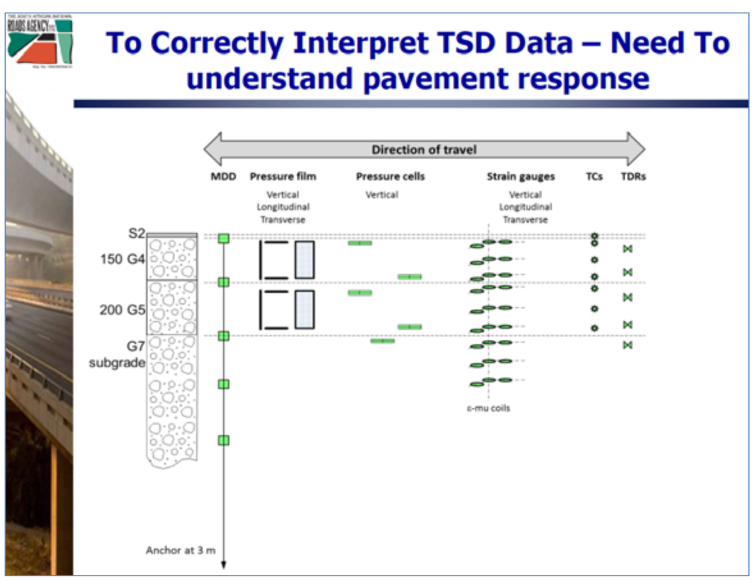


MnRoad Low Volume Road

Repeatability, 5 runs @ 30 mph



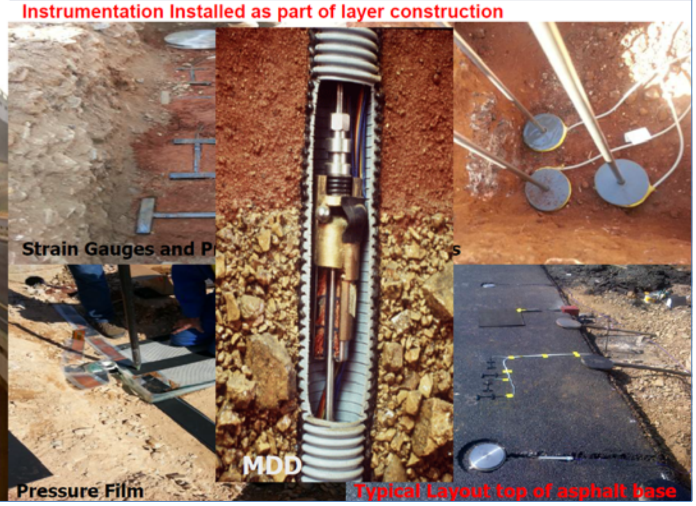
SANRAL tests in South Africa 2014



"Verification of Traffic Speed Deflectometer measurements using Instrumented Pavements in South Africa", L Kannemeyer / W Lategan / A Mckellar, Pavement Evaluation 2014

R104 Instrumented Sections - Construction

Instrumentation Installed as part of layer construction



GREENWOOD ENGINEERING

SANRAL TSD Conclusions

- TSD measurements highly repeatable.
- TSD and FWD has same pattern but not exact match for valid reasons.
- The 100mm sensor location on very flexible pavements?
- TSD Doppler Laser range focus is crucial !
- Deflection at reference sensor 3.5m is not zero, although slope is close to zero- relocate to 3.0m ?
- TSD Statistical Deflection model huge improvement over old beam model, but not 100% - Muller/Roberts PCHIP curve fit.
- TSD measures real pavement behaviour even at speeds as low as 2.5 km/h.
- TSD is not just network deflection scanning tool.

"Verification of Traffic Speed Deflectometer measurements
using Instrumented Pavements in South Africa", L Kannemeyer / W Lategan / A Mckellar, Pavement Evaluation 2014
GREENWOOD ENGINEERING


GREENWOOD TSD
Tak for opmærksomheden !
jk@greenwood.dk

Update on the UK use of the TSD

Brian Ferne, TRL

TAC3
Alexandria, VA

22 May 2015

Contents

From 1st April 2015

Highways England
has superceded
The Highways Agency

Rather than

HA's TSD
It is
HE's TSD!

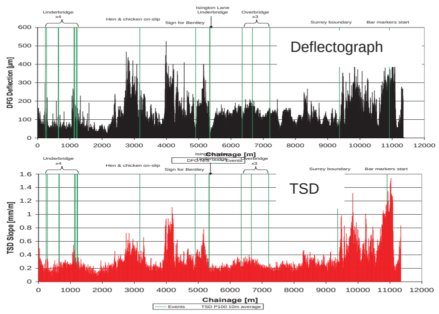
Highways England is:

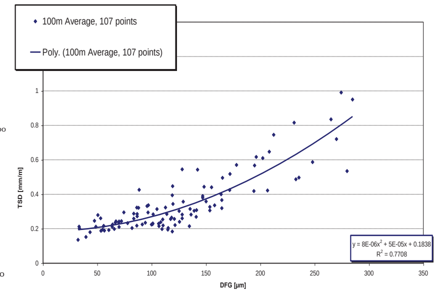
- A new government owned agency
- Moving from annularity to 5 year plans
- Capital investment of £11B over 5 years
- Additional 1300 miles of new lanes
- Additional 400 miles of SMART motorways
- £5B spend on replacing 'worn-out' roads
- HE has more freedom and flexibility than HA
- HE has the ethos of a commercial organisation

Two new bodies to hold HE to account

- Office of Rail Regulation – to monitor performance of the highways
- Transport Focus – to champion the needs of the road user

TSD Development 2006-2009

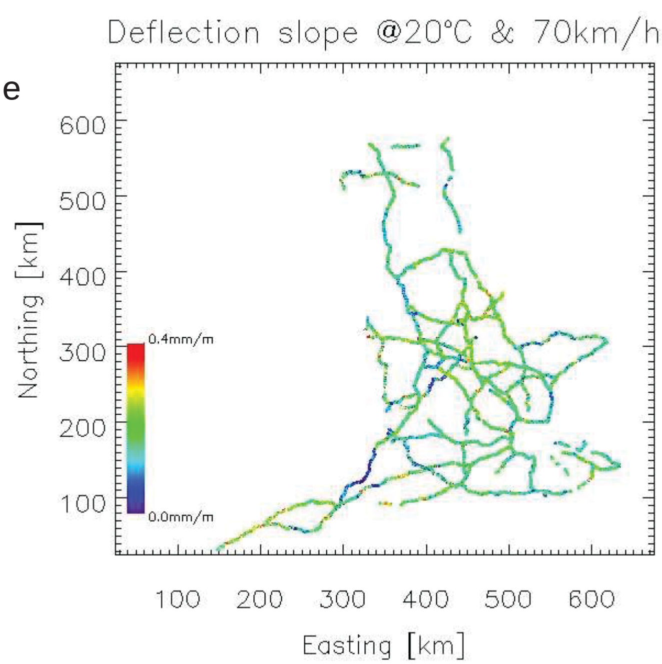




Development of prototype into fully functional research tool	Development of empirical relationship between TSD and Deflectograph	Ready for roll-out of network-level structural condition surveys as proxy for Deflectograph

TRASS1&2 Summary

- The HA TSD was successfully developed into a system capable of delivering routine network level surveys
- Over 18000km of structural condition information was collected by TRASS1 and TRASS2
- Robust QA regime established
- HA Managing Agents could be provided with indicator of network level structural condition.....



TSD Network Structural Condition categories

Category	Description
1	Flexible pavements **without any need** for structural maintenance
2	Flexible pavements **unlikely to need** structural maintenance
3	Flexible pavements **likely to need** structural maintenance
4	Flexible pavements **very likely to need** structural maintenance

- If **all** the NSC categories for a scheme are 1 or 2 then a Deflectograph survey **is only required if** there is clear additional evidence of structural deterioration (eg longitudinal wheel-track cracking, pumping or settlement).
- If a scheme has no TSD data or has any length in NSC categories of 3 or 4 then a Deflectograph survey is required for the whole scheme

TRASS3 is a 3 year + 1 + 1 contract
Awarded August 2014 to Fugro Aperio – Started September 2014

TRASS3 Objectives

- Operate and Support the TSD to Collect
  - TRASS Raw Condition Data (RCD)
  - Base Condition Data (BCD)
  - Ground Penetrating Radar (GPR) data
- Deliverables:
  - The Surveys
  - Survey Data
  - Quality Assurance records and data
  - Progress reports
- Roles:
  - Highways Agency
  - Auditor (TRL)
  - Technical Advisor (TRL)
  - Survey Consultant

Current status of TRASS3

Current and planned surveys

Main line Surveys

- Around 6000 km in 2014
- Around 3000 km plus so far in 2015
- As yet no routine GPR surveys
- Some issues over data quality revealed by QA process

Slip road surveys

- This required definition of deceleration limits
- 1 m/s/s limit embodied in validation software
- Around 500km of slip roads covered so far in 2015

Outer lane surveys

- This required official procedure for surveying and permitting undertaking
- Interim Advice Note drafted
- No surveys yet except under police guidance

Outer Lane Survey Project

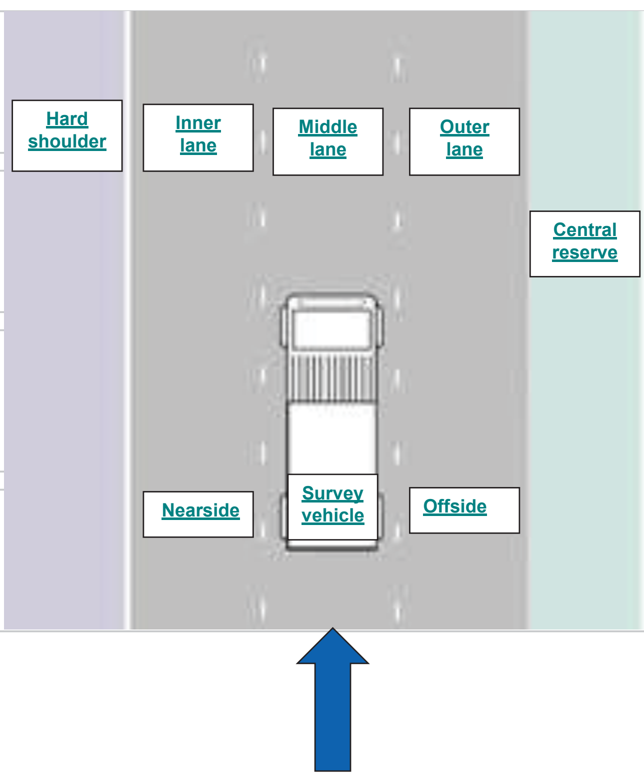
Recently completed by TRL

Survey types considered

Issues considered

Current techniques

Recommendaton



Current use of TSD data in the UK

Usage of TRASS data stored in PMS

Reducing other surveys

- Deflection slopes converted to network structural condition categories 1 to 4
- Categories used to guide scheme selection
- Categories used to guide type of further investigation
- Categories 1 and 2 suggest less need for slow speed disruptive investigations

SMART motorways

- This mainly involves conversion of hard shoulder to part-time running lane
- TSD surveys can provide guidance on strengthening need or otherwise

Surfacing Schemes

- Central decision in England to resurface 80% of HE network
- Impossible for HE engineers to directly approve all proposals
- Simplified approval process developed based on TSD structural condition categories

TRASS3 QA

- Primary
  - A 10-20km site selected by the consultant that must be surveyed every week (3 repeat runs)
  - Calculate RCD and BCD and assess against requirements.
    - Auditor can provide a tool to carry out the check.
  - These are important for monitoring ongoing consistency of the TSD
- Secondary
  - Sites located on SRN, likely to be covered during the survey
  - A set will be provided at start of the first Task
    - Number will increase with survey progress (provided by the Auditor)
  - Tool provided to extract from the survey and check against the reference
  - Results to be collated and reported weekly
- Daily
  - Undertake surveys on each day to check consistency of equipment
  - There is a process in the Scope but the consultant can propose alternative
- Repeat surveys
  - Contractor to carry out repeat runs on nominated lengths that have already been covered in that Task – max 4 routes per Task (not in Ad hoc)

V01 50m data)

Add Survey data | Remove Survey data

Ber

Site	A329m EB
Vehicle	TSD 1 V01

Visit	Date of Survey	Start time of survey	Week	Average 40mm pavement temperature	Offsets applied: Slope 100	Offsets applied: Slope 300	Offsets applied: Slope 756	Performance (% within criteria): Distance Traveled	OSGR: Section starts	OSGR: Data points	LPV 3m	LPV 10m	Normalised Slopes: Slope 100	Normalised Slopes: Slope 300	Normalised Slopes: Slope 756
					Green: <=±0.1 Amber:<=±0.2	Green: <=±0.1 Amber:<=±0.2	Green: <=±0.1 Amber:<=±0.2	± 3m or 0.1%	± 4m	± 6m	± 0.6	± 0.7	± 0.04	± 0.04	± 0.04
V01	25/06/2014	09:58	26	30.3	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
V02	12/09/2014	09:21	37	19.8	0.000	-0.076	0.042	100.0	100.0	100.0	98.7	98.7	87.0	93.0	90.3
V03	12/09/2014	10:07	37	22.0	0.014	-0.064	0.052	100.0	100.0	100.0	96.5	97.8	87.5	90.4	91.1
V04	12/09/2014	10:48	37	24.1	0.012	-0.065	0.044	100.0	100.0	100.0	95.7	98.3	90.1	93.4	95.1
V05	10/10/2014	11:41	41	20.5	-0.065	-0.085	-0.001	100.0	100.0	100.0	97.8	97.8	87.7	93.0	91.6
V06	10/11/2014	11:29	46	12.5	-0.072	-0.048	-0.025	100.0	100.0	100.0	96.6	98.3	87.5	89.7	88.8
V07	10/11/2014	11:54	46	12.7	-0.087	-0.052	-0.030	100.0	100.0	100.0	97.4	97.8	87.9	91.4	93.5
V08	10/11/2014	12:23	46	12.2	-0.097	-0.056	-0.035	100.0	100.0	100.0	97.8	97.4	86.5	91.2	94.1
V09	27/11/2014	13:07	48	20.1	-0.114	-0.098	-0.047	100.0	100.0	100.0	97.0	97.4	82.8	91.7	92.4
V10	27/11/2014	13:38	48	20.3	-0.116	-0.104	-0.047	100.0	100.0	100.0	96.6	98.3	82.3	94.4	93.6
V11	09/02/2015	14:20	7	16.8	-0.057	0.027	-0.015	100.0	100.0	100.0	97.8	97.8	86.4	90.6	89.7
V12	09/02/2015	14:42	7	16.6	-0.037	0.039	0.001	100.0	100.0	100.0	97.4	98.7	87.4	89.5	89.7
V13	27/02/2015	10:59	9	17.2	-0.082	0.037	0.065	100.0	100.0	100.0	98.1	97.7	83.1	88.7	90.1
V14	27/02/2015	11:24	9	17.7	-0.084	0.037	0.067	100.0	100.0	100.0	98.6	98.6	86.4	88.7	89.7
V15	27/02/2015	11:49	9	18.7	-0.087	0.036	0.067	100.0	100.0	100.0	99.1	99.1	81.7	87.8	91.1
V16	03/03/2015	11:06	10	18.6	-0.087	0.055	0.075	90.0	90.0	84.9	96.7	97.7	78.0	82.2	87.4
V17	04/03/2015	11:36	10	19.3	-0.105	0.043	0.064	90.0	90.0	84.9	97.2	98.6	79.4	82.7	88.3
V18	04/03/2015	12:03	10	19.2	-0.122	0.025	0.057	90.0	90.0	84.9	98.6	98.6	78.5	84.6	88.8
V19	06/04/2015	15:46	15	29.9	-0.221	-0.071	0.052	90.0	90.0	84.9	95.8	95.8	80.3	87.3	90.1
V20	06/04/2015	16:12	15	28.7	-0.218	-0.074	0.054	90.0	90.0	84.9	97.6	97.7	80.8	84.1	88.9
V21	06/04/2015	16:49	15	27.3	-0.216	-0.076	0.056	90.0	90.0	84.9	97.2	96.7	69.4	87.9	87.9
V22	11/04/2015	16:47	15	24.4	-0.188	-0.043	0.076	90.0	90.0	84.9	97.2	97.2	70.6	86.4	89.3
V23	12/04/2015	08:52	16	21.6	-0.139	-0.041	0.095	90.0	90.0	84.9	.	.	77.0	84.5	93.4
V24					.	.	.	.	.	.	.	.	.	.	.
V25					.	.	.	.	.	.	.	.	.	.	.
V26					.	.	.	.	.	.	.	.	.	.	.

Accreditation Workbook (50m data) V3.0

Add Survey data | Remove Survey data

Benchmark survey: V01

Site	A329m EB
Vehicle	TSD 1

Visit	*Date of Survey*	*Start time of survey*	*Week*	*Average 40mm pavement temperature*
V01	**25/06/2014**	**09:58**	**26**	**30.3**
V02	12/09/2014	09:21	37	19.8
V03	12/09/2014	10:07	37	22.0
V04	12/09/2014	10:48	37	24.1
V05	10/10/2014	11:41	41	20.5
V06	10/11/2014	11:29	46	12.5
V07	10/11/2014	11:54	46	12.7
V08	10/11/2014	12:23	46	12.2
V09	27/11/2014	13:07	48	20.1
V10	27/11/2014	13:38	48	20.3
V11	09/02/2015	14:20	7	16.8
V12	09/02/2015	14:42	7	16.6
V13	27/02/2015	10:59	9	17.2
V14	27/02/2015	11:24	9	17.7
V15	27/02/2015	11:49	9	18.7
V16	03/03/2015	11:06	10	18.6
V17	04/03/2015	11:36	10	19.3
V18	04/03/2015	12:03	10	19.2
V19	06/04/2015	15:46	15	29.9
V20	06/04/2015	16:12	15	28.7
V21	06/04/2015	16:49	15	27.3
V22	11/04/2015	16:47	15	24.4
V23	12/04/2015	08:52	16	21.6

Benchmark	V01	V02	V03	V04	V05	V06	V07	V08	V09	V10	V11	V12	V13	V14	V15	V16	V17	V18	V19	V20	V21	V22	V23
n/a	100.0	4.4	14.4	15.4	3.1	37.5	29.3	22.3	1.2	0.0	69.0	58.1	57.7	57.3	56.3	34.6	46.7	71.0	14.1	11.5	9.2	42.1	49.3
y	y	y	y	y	y	y	y	y	y	y	y	y	y	y	y	y	y	y	y	y	y	y	y

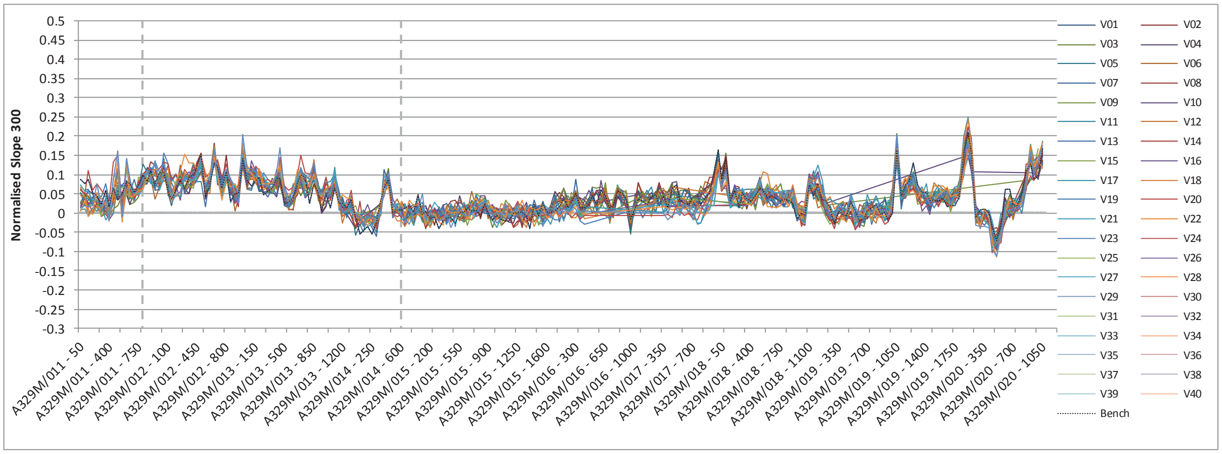
	Deflection slope 300: Counts of differences from the benchmark s																						
Bins	**V01**	**V02**	**V03**	**V04**	**V05**	**V06**	**V07**	**V08**	**V09**	**V10**	**V11**	**V12**	**V13**	**V14**	**V15**	**V16**	**V17**	**V18**	**V19**	**V20**	**V21**	**V22**	**V23**
-9999999	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-0.500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-0.200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-0.150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-0.140	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-0.130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
-0.120	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	4	2	0	0	0	0	0	0
-0.110	0	0	0	0	0	0	0	0	0	0	0	0	3	1	0	3	1	0	0	0	0	0	0
-0.100	0	0	0	0	0	0	0	0	0	0	1	2	2	2	2	9	3	1	0	0	0	0	0
-0.090	0	0	0	0	0	0	0	0	0	0	1	3	4	2	3	8	5	2	0	0	0	0	0
-0.080	0	0	0	0	0	0	0	0	0	0	2	5	3	6	5	16	12	4	0	0	0	0	0
-0.070	0	0	0	0	0	0	0	0	0	0	5	11	7	8	7	20	17	3	0	0	0	0	0
-0.060	0	0	0	0	0	0	0	0	0	0	10	25	18	15	19	33	24	11	0	0	0	0	0
-0.050	0	0	0	0	0	0	0	0	0	0	12	19	30	22	27	31	22	21	0	0	0	1	0
-0.041	0	0	0	0	0	0	0	0	0	0	33	22	23	34	30	16	27	19	0	0	0	0	0
-0.040	0	0	0	0	0	0	0	0	0	0	2	7	2	3	3	6	2	2	0	0	0	0	0
-0.030	0	0	0	0	0	0	0	0	0	0	38	36	27	42	26	30	24	32	0	0	0	1	3
-0.020	0	0	0	0	0	0	0	1	0	0	29	29	36	34	28	19	23	33	0	0	0	2	3
-0.010	0	0	0	0	0	3	1	0	0	0	26	22	25	15	29	7	14	22	1	0	0	5	7
0.000	232	0	1	0	0	2	2	0	0	0	24	17	21	17	19	5	23	22	1	1	1	7	5
0.010	0	2	2	1	0	8	6	4	0	0	18	8	8	4	8	4	13	13	3	3	1	11	10
0.020	0	1	6	4	0	11	12	2	0	0	5	2	4	6	4	3	1	15	2	4	4	20	20
0.030	0	3	6	10	2	25	18	12	1	0	4	1	0	1	2	0	0	9	4	9	5	17	22
0.040	0	4	18	20	5	38	29	14	0	0	1	0	0	0	1	0	0	4	19	7	8	27	35
0.041	0	1	5	1	1	5	9	3	0	0	2	0	0	0	0	0	0	0	0	1	0	6	3
0.050	0	16	24	22	7	36	29	21	0	2	0	0	0	1	0	0	0	1	15	18	12	24	24
0.060	0	27	41	39	15	32	44	27	4	2	0	0	0	0	0	0	0	0	31	15	22	32	34
0.070	0	38	36	40	25	32	37	25	4	1	0	0	0	0	0	0	0	0	33	38	25	26	20
0.080	0	34	34	37	32	19	24	19	4	3	0	0	0	0	0	0	0	0	28	26	38	20	12
0.090	0	39	25	22	47	9	10	7	16	9	0	0	0	0	0	0	0	0	29	30	31	8	4
0.100	0	35	17	18	40	10	9	8	14	20	0	0	0	0	0	0	0	0	17	17	27	4	6
0.110	0	15	9	9	24	2	1	2	17	15	0	0	0	0	0	0	0	0	14	21	16	1	2
0.120	0	8	3	4	16	0	1	3	12	22	0	0	0	0	0	0	0	0	9	6	6	0	1
0.130	0	4	2	0	11	0	0	0	9	9	0	0	0	0	0	0	0	0	5	7	4	0	1
0.140	0	2	0	0	2	0	0	0	1	6	0	0	0	0	0	0	0	0	0	1	5	1	0
0.150	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	1	3	0	1	0
0.200	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	1	1	0	1
0.500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

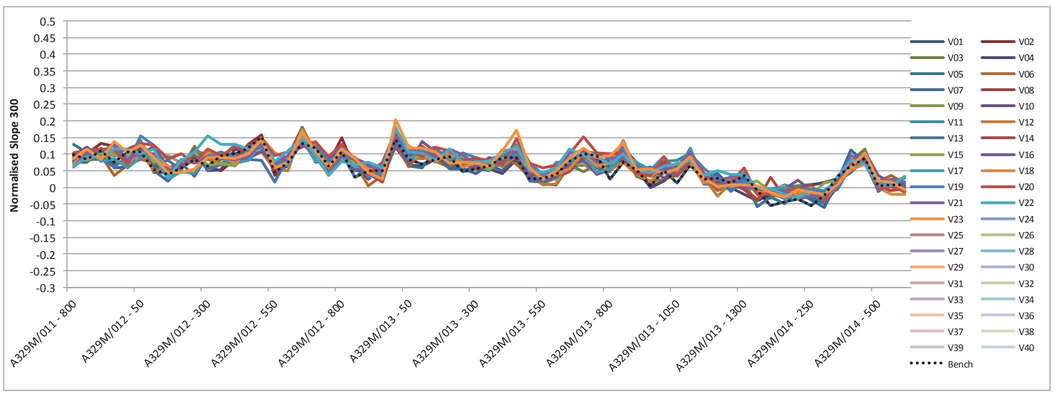
Vehicle	TSD 1

Visit	Date of Survey	Start time of survey	Week	Average 40mm pavement temperature	Offsets applied: Slope 100 (Green: <=±0.1 Amber:<=±0.2)	Offsets applied: Slope 300 (Green: <=±0.1 Amber:<=±0.2)	Offsets applied: Slope 756 (Green: <=±0.1 Amber:<=±0.2)
V01	**25/06/2014**	**09:58**	**26**	**30.3**	n/a	n/a	n/a
V02	12/09/2014	09:21	37	19.8	0.000	-0.076	0.042
V03	12/09/2014	10:07	37	22.0	0.014	-0.064	0.052
V04	12/09/2014	10:48	37	24.1	0.012	-0.065	0.044
V05	10/10/2014	11:41	41	20.5	-0.065	-0.085	-0.001
V06	10/11/2014	11:29	46	12.5	-0.072	-0.048	-0.025
V07	10/11/2014	11:54	46	12.7	-0.087	-0.052	-0.030
V08	10/11/2014	12:23	46	12.2	-0.097	-0.056	-0.035
V09	27/11/2014	13:07	48	20.1	-0.114	-0.098	-0.047
V10	27/11/2014	13:38	48	20.3	-0.116	-0.104	-0.047
V11	09/02/2015	14:20	7	16.8	-0.057	0.027	-0.015
V12	09/02/2015	14:42	7	16.6	-0.037	0.039	0.001
V13	27/02/2015	10:59	9	17.2	-0.082	0.037	0.065
V14	27/02/2015	11:24	9	17.7	-0.084	0.037	0.067
V15	27/02/2015	11:49	9	18.7	-0.087	0.036	0.067
V16	03/03/2015	11:06	10	18.6	-0.087	0.055	0.075
V17	04/03/2015	11:36	10	19.3	-0.105	0.043	0.064
V18	04/03/2015	12:03	10	19.2	-0.122	0.025	0.057
V19	06/04/2015	15:46	15	29.9	-0.221	-0.071	0.052
V20	06/04/2015	16:12	15	28.7	-0.218	-0.074	0.054
V21	06/04/2015	16:49	15	27.3	-0.216	-0.076	0.056
V22	11/04/2015	16:47	15	24.4	-0.188	-0.043	0.076
V23	12/04/2015	08:52	16	21.6	-0.139	-0.041	0.095

Normalised Deflection slope 300: Counts of differences from the be

Bins	V01	V02	V03	V04	V05	V06	V07	V08	V09	V10	V11	V12	V13	V14	V15	V16	V17	V18	V19	V20	V21	V22	V2
n/a	100.0	93.0	90.4	93.4	93.0	89.7	91.4	91.2	91.7	94.4	90.6	89.5	88.7	88.7	87.8	82.2	82.7	84.6	87.3	84.1	87.9	86.4	84
y	y	y	y	y	y	y	y	y	y	y	y	y	y	y	y	y	y	y	y	y	y	y	
-9999999	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-0.500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-0.200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-0.150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-0.140	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-0.130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-0.120	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-0.110	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-0.100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-0.090	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0
-0.080	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	1	0	1	1	0
-0.070	0	2	0	0	0	0	0	0	0	0	1	0	5	1	2	1	3	1	1	1	1	2	4
-0.060	0	1	1	1	0	2	1	0	1	0	1	2	1	3	0	4	3	3	3	4	3	1	2
-0.050	0	2	3	2	3	1	2	2	0	3	4	3	4	2	7	5	2	4	2	6	5	5	7
-0.041	0	2	6	4	8	7	7	3	4	1	4	5	3	6	4	11	8	6	4	6	4	6	5
-0.040	0	0	2	0	2	1	3	0	0	0	2	1	1	0	0	0	3	0	1	2	0	2	0
-0.030	0	15	6	16	8	13	11	9	3	1	10	11	8	10	12	6	13	18	18	12	12	15	11
-0.020	0	27	31	21	18	18	19	12	5	5	22	26	25	15	24	24	21	21	15	16	19	19	19
-0.010	0	29	26	31	33	38	36	20	13	15	33	19	30	30	31	24	22	23	31	24	22	23	24
0.000	232	37	44	36	47	41	32	28	11	18	36	35	24	33	30	32	28	36	33	36	32	31	33
0.010	0	34	31	40	37	30	46	27	16	18	29	33	36	42	27	29	28	29	28	24	35	27	27
0.020	0	40	33	31	28	35	32	22	16	15	26	30	34	33	28	27	24	26	31	28	31	28	35
0.030	0	22	24	24	21	22	23	10	11	9	21	17	17	15	20	21	15	11	15	18	21	25	19
0.040	0	9	10	13	18	10	10	7	2	4	14	16	14	11	15	13	23	17	14	15	9	15	12
0.041	0	1	3	1	0	2	1	0	0	0	0	3	1	1	0	4	1	2	2	0	1	1	1
0.050	0	6	6	5	4	7	7	4	1	1	5	5	6	4	9	5	12	8	7	4	3	6	3
0.060	0	2	3	2	0	5	1	3	1	0	2	2	4	5	3	5	7	5	5	8	4	3	6
0.070	0	0	0	0	1	0	1	0	0	0	3	1	0	1	0	1	0	3	0	1	2	1	2
0.080	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	1	1	2	0	0	1
0.090	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	1	1
0.100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.110	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
0.120	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
0.130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
0.140	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0





TSD Comparative trials

To assess relative performance of first and second generation TSD’s in terms of:

- Measured deflection response
- Short-term repeatability of measurements
- Stability of measurements, i.e. long-term repeatability
- Methods of calibration

And therefore provide guidance to the English Highways Agency (HA) on the potential benefits of upgrading their TSD

UK Comparative trials October 2013

- October 2013
  - Closed instrumented site – MIRA HA test sections
  - Two 1st generation TSD's
    - HA TSD with sensors at 100, 300 and 756mm – LH WP
    - DRD TSD with sensors at 100, 200 and 300mm – RH WP
  - One 2nd generation TSD
    - ANAS TSD with sensors at 100, 200, 300, 600, 900 and 1500mm – RH WP
  - Poor weather
  - Slow height sensor failure on UK TSD

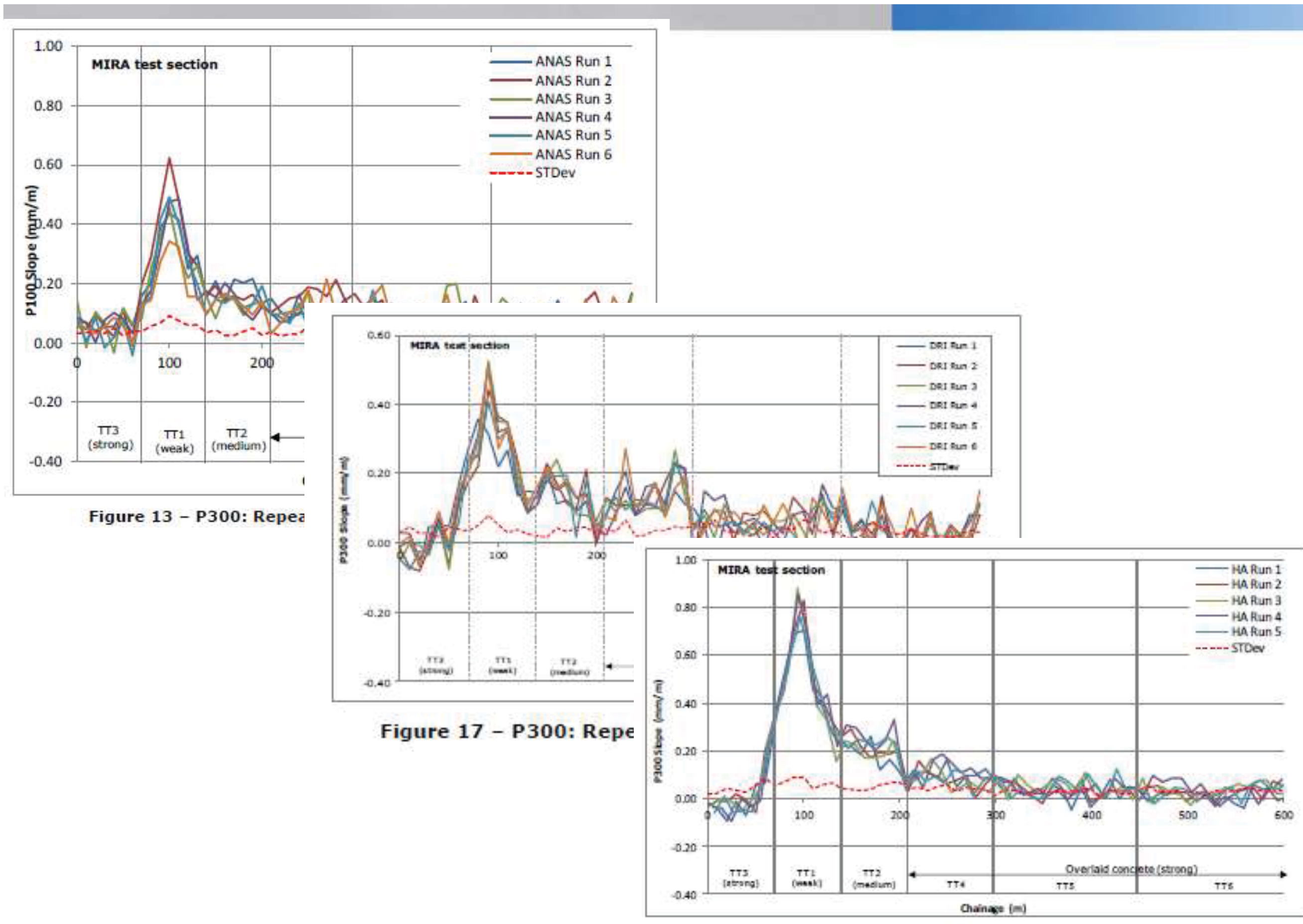


Figure 13 – P300: Repea

Figure 17 – P300: Repe

Figure 21 – P300: Repeat runs of HA TSD at 70kmph

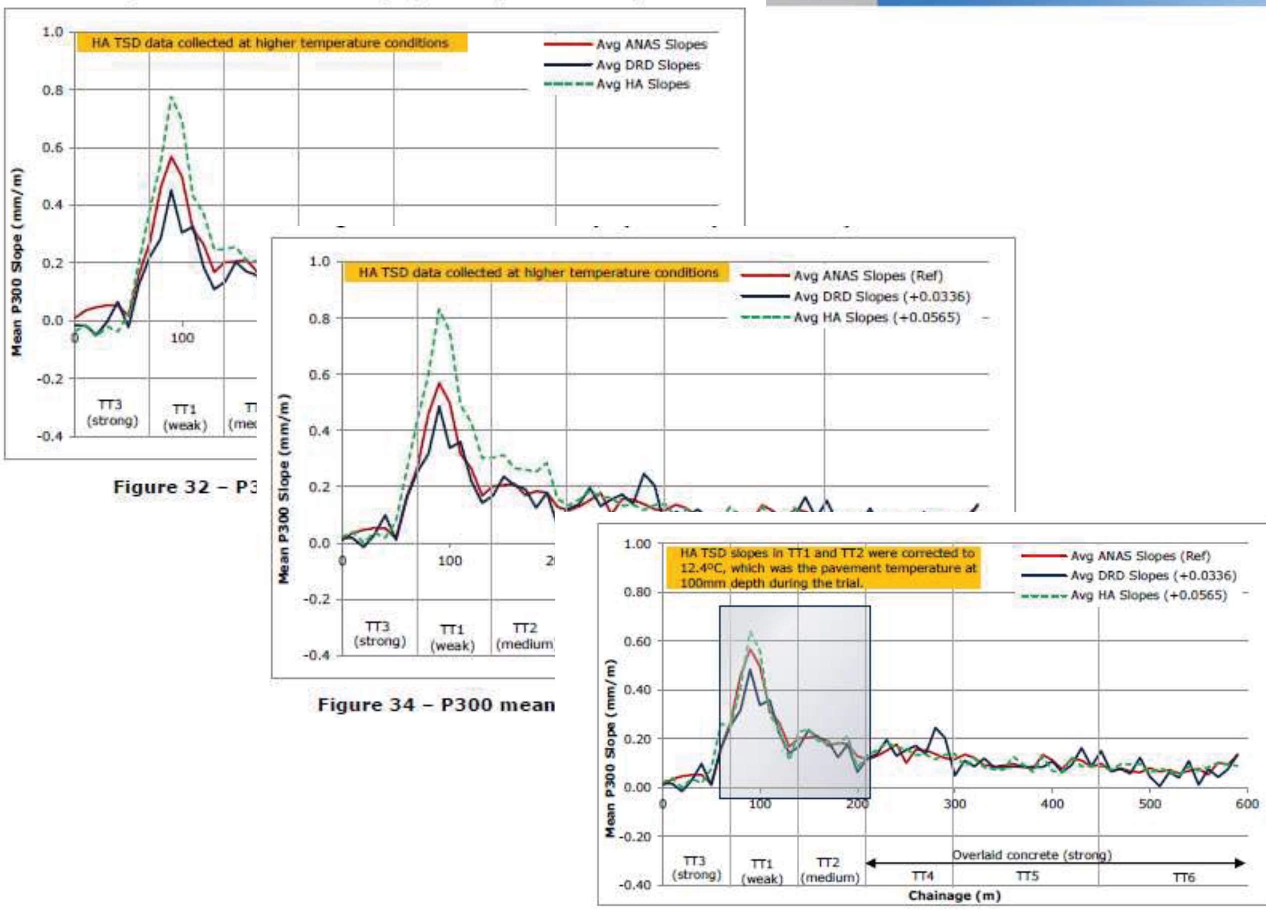


Figure 36 - P300 mean slope profiles (NSWP MIRA) with offset and HA TSD temperature corrected

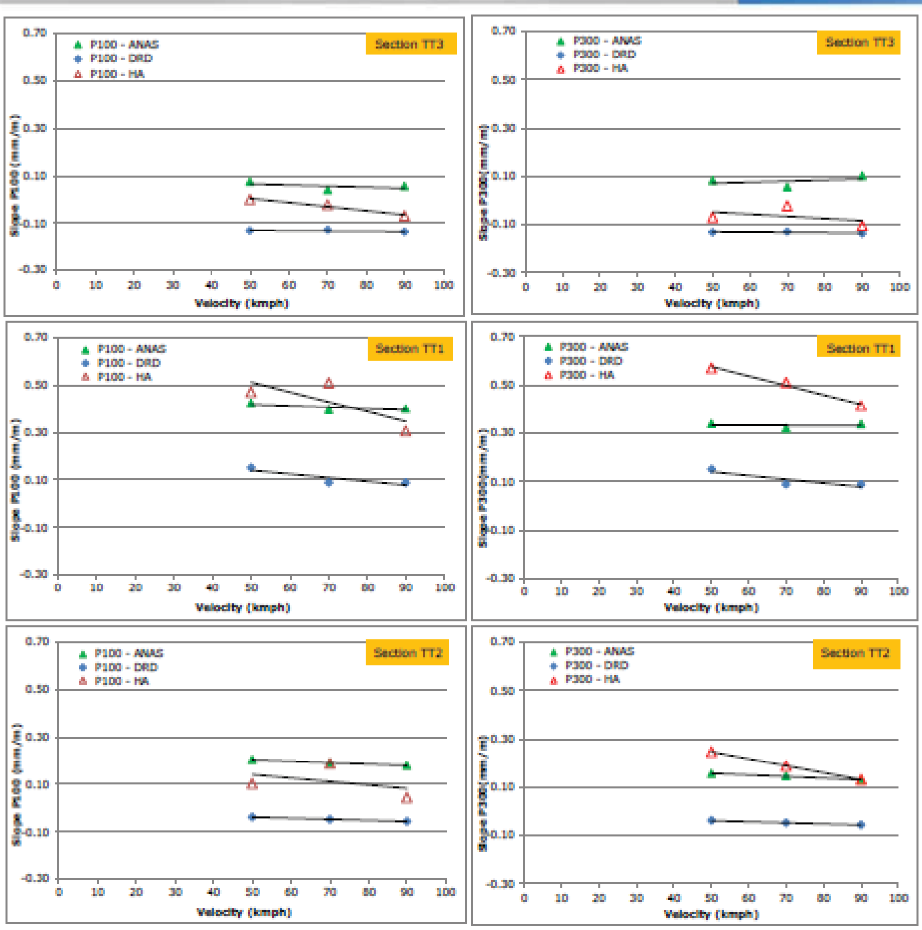


Figure 50 - Average slopes against speed (asphalt sections)

Some preliminary conclusions:

- Both 1st and 2nd generation TSDs show reasonable short term repeatability on the test track
- However, some runs showed significant offsets in level although with very similar patterns
- Comparison between machines showed some different levels but again similar patterns
- All machines ranked the test sites in the same order as the FWD and Deflectograph

HI-SPEQ –European project sponsored by CEDR

- **H**i-speed survey **SP**ecifications, **E**xplanation and **Q**uality
- Commissioned under the CEDR Ageing Infrastructure Management Call – High-speed non-destructive Condition Assessment. Managed by Ireland National Roads Authority
- 6 project partners (TRL, AIT, VTI, ZAG, COWI, Fugro). Start date 14th April 2014, Duration: 24 months
- HI-SPEQ will draw on a **Reference Group** of road owners & operators, ***survey equipment builders & users***, Data users, researchers etc.

HiSPEQ

Summary to date

Prime aim is to develop templates
- Describing high speed survey equipment
- Specifying surveys
- Specifying QA regimes
- Advising on the use of data

Cover high speed surveys of
- Surface condition
- Structural condition

To date HiSPEQ has produced three ‘Key requirements’ documents for review by Reference/Stakeholder group
- Key requirements for high speed surface condition surveys
- Key requirements for high speed structural condition surveys
- Key requirements for accreditation and quality assurance of high speed condition surveys (p64-66 summarises TSD QA)

These can be viewed on the HiSPEQ website:

www.hispeq.com

Specialist High-speed Deflection Device Groups

- DaRTS (Deflection at Road Traffic Speed)
  - International Group
  - By invitation only
  - Coordinator – Brian Ferne, TRL, UK
  - Set up by English Highways Agency and TRL in 2012
  - Meetings
    - 2012 – London, England
    - 2013 – Trondheim, Norway
    - 2014 – Blacksburg, USA
    - 2015 – Berlin, Germany
  - Specialist sub-groups
- BeCaTS (Bearing Capacity at Traffic Speed)
  - European FEHRL Working Group
  - Leader – Adam Zofka, IBDiM, Poland
  - Set up by FEHRL 2014.

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DaRTS4

BAM Federal Institute for Materials Research and Testing

International Symposium
Non-Destructive Testing in Civil Engineering (NDT-CE)
September 15 - 17, 2015, Berlin, Germany

TU berlin

One of the sessions at NDT-CE is focused on measuring deflections at road traffic speed.

- Nine abstracts on this subject have been submitted
- Seven(?) will be presented orally or as posters on the Thursday?
- DaRTS meeting on Friday 18 from 0900 to 1500
- To discuss presented papers/posters and related issues

BeCaTS

- **Bearing Capacity at Traffic Speed**
- FEHRL WG established in 2014
- To exchange and summarize specific knowledge on highway speed deflectometers, particularily TSD
- **FHWA, TRL, ARRB, DRD, BASt, and IBDiM** + IFFSTAR
- **www.becats.eu**

ROAD AND BRIDGE RESEARCH INSTITUTE (IBDiM)

24

BeCaTS

4 online meetings to date

Agreed to produce two deliverables

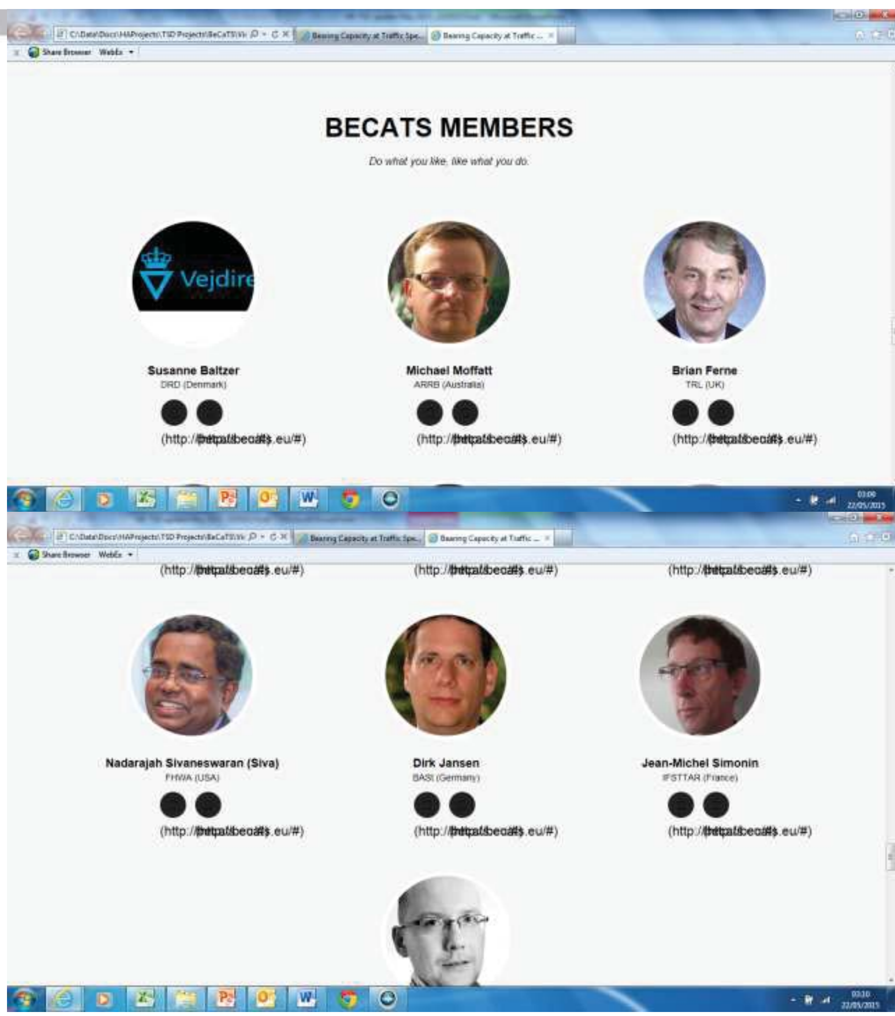
- Little Book of Pavement Structural assessment
  - This will be a published document
- Operational issues with TSDs including:
  - Calibration
  - Achieving repeatability
  - This will initially be an internal document

Website in progress:

summary of TSD's in use?

links to members

www.becats.eu



Subsurface Pavement Evaluation East Idaho Corridor Loop (EICL) (518 Miles)

Project planned by the
Idaho Transportation Department
District 6

INFRASENSE Subsurface Scanning and Mapping

AMERICAN GEO TECHNICS

NCE

IDAHO TRANSPORTATION DEPARTMENT

Elements of EICL

Corridor Segment Name	BMP	EMP	Centerline Miles
US 93	82.6	350.819	268.219
US 20	248.555	256.073	7.518
SH 33 (west)	0	78.236	78.236
SH 22	24.67	68.606	43.936
SH 28	15.15	135.645	120.495
		Total	518.404

INFRASENSE Subsurface Scanning and Mapping

AMERICAN GEO TECHNICS

NCE

IDAHO TRANSPORTATION DEPARTMENT

East Idaho Corridor Loop

(11 segments)

Project Scope and Objectives

- Continuous evaluation roadway substructure over entire 518 mile length
  - Pavement layer thickness (GPR)
  - Layer deflections/properties (TSD, with selective FWD)
  - Condition Evaluation of 42 Bridge decks (GPR & IR)
- Determine pavement structural capacity

Project Scope and Objectives (cont'd)

- Divide pavement into structurally homogeneous sections based on calculated remaining life
- Demonstrate project-level rehabilitation design for select sub-segments
- Incorporate all data into an ArcGIS geodatabase

Project Participants

- Idaho District 6 – project sponsor
- Infrasense
  - Project coordination, GPR, IR, ArcGIS database
- Nichols Consulting Engineers
  - TSD Data Analysis
  - FWD Testing and analysis
- American Geotechnics
  - Coring/boring and sample testing
  - Project-level rehab design

Background

- Two Previous Studies
  - SH75 – Stanley to Clayton (28 miles)
  - US26 – Snake River to WY State Line (29 miles)

Previous Studies: Data Collection

- Continuous GPR (asphalt and base thickness)
- FWD at 0.1 mile interval
- Cores/borings at 1 mile for AC thickness confirmation and base/subgrade properties
- Spatial coordination using GPS

Previous Studies: Data Analysis

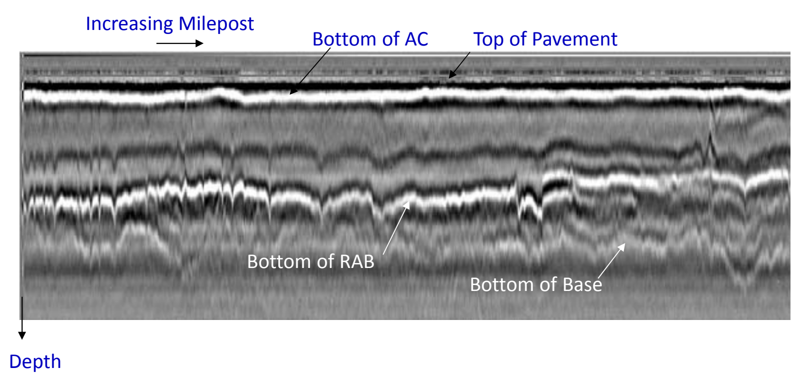
- SN calculated from FWD and GPR data @ 0.1 mi
- SN and traffic forecast used to predict remaining life
- Pavement segmented into subsections according to remaining life
- Preliminary rehab design proposed for subsections using surface condition and remaining life data
- Data incorporated into substructure geodatabase

GPR Equipment

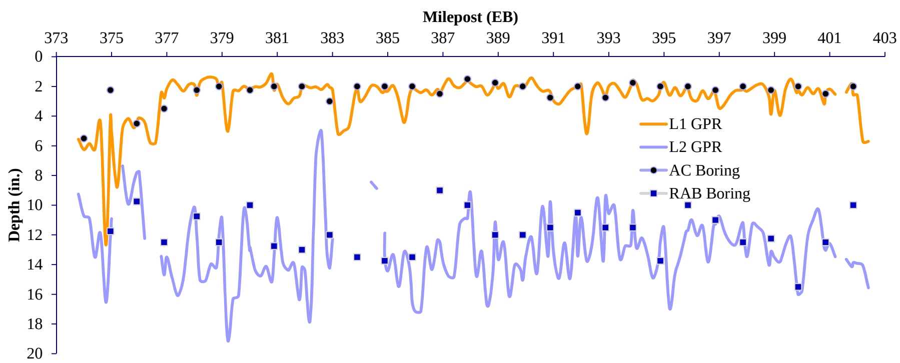
FWD/GPR Testing Equipment

Dynatest Model 8002
Truck-Mounted FWD

Sample GPR Data



US 26 GPR Data Analysis Result
Bound Layers, EB



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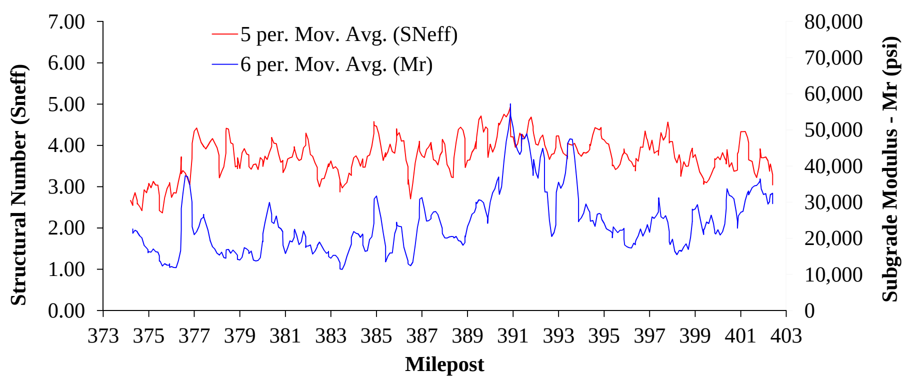
IDAHO TRANSPORTATION DEPARTMENT

US 26 Pavement Structure Properties
(from AASHTO 1993)



INFRASENSE Subsurface Scanning and Mapping

AMERICAN GEO TECHNICS

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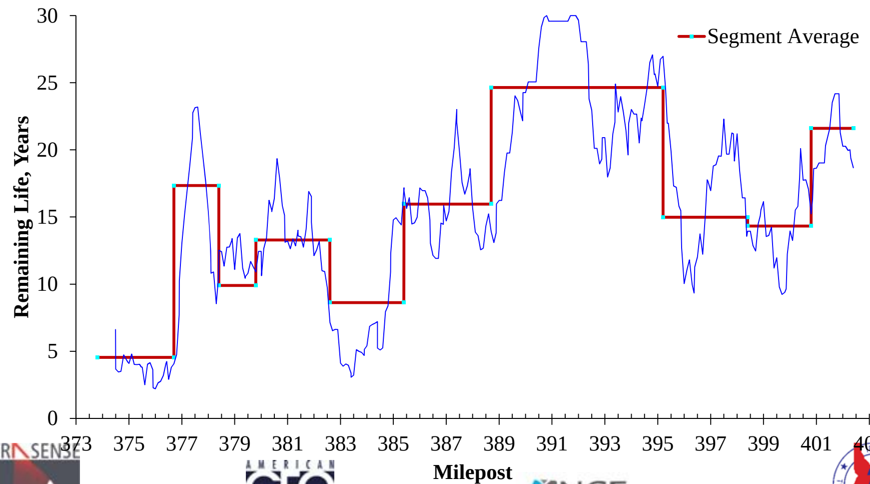
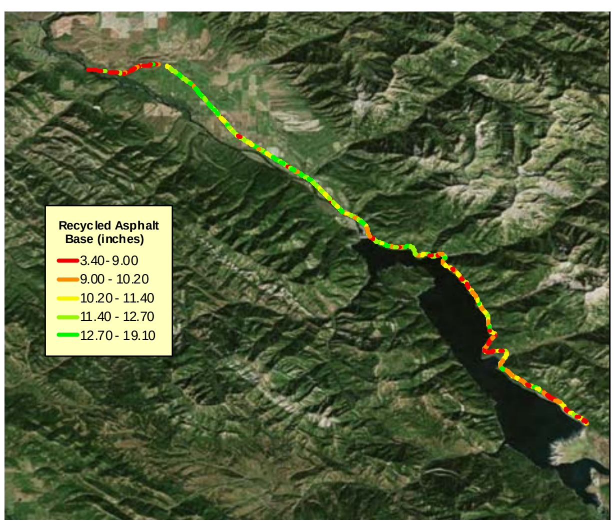
IDAHO TRANSPORTATION DEPARTMENT

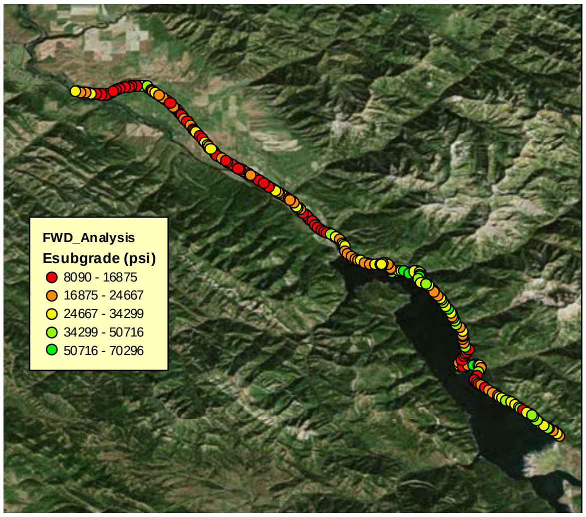
US 26 Segmentation and Remaining Life Calculation



Sample ArcGIS Data – US 26



Sample ArcGIS Data – US 26



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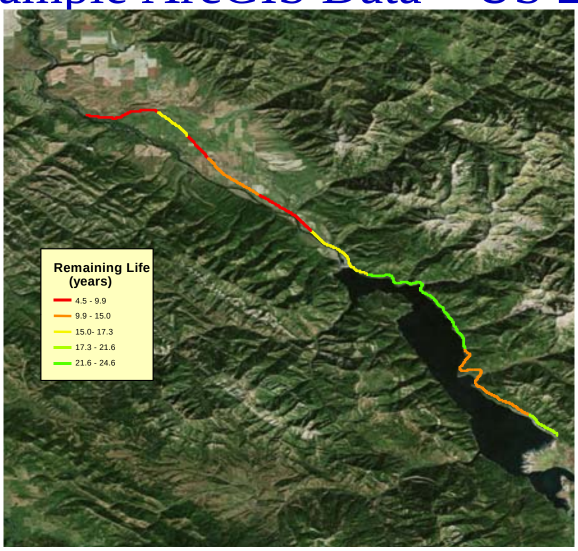
Sample ArcGIS Data – US 26



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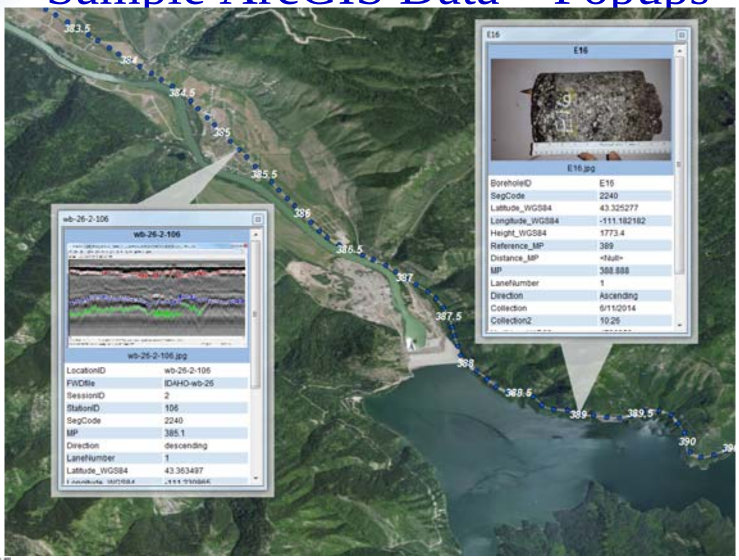
Sample ArcGIS Data – Popups



Goals for East Idaho Loop

- Extend the previous methodology to network – level evaluation
- Assess the opportunity for TSD network level pavement structure evaluation
- Extend the application of the geodatabase to various stakeholders (network, project, planning)
- Demonstrate thee use and value of network-level structure assessment for project-level rehabilitation design