THE SOUTH AFRICAN NATIONAL ROADS AGENCY SOC LTD

Reg. No.1998/009584/30

Verification of Traffic Speed Deflectometer measurements using Instrumented Pavements in South Africa

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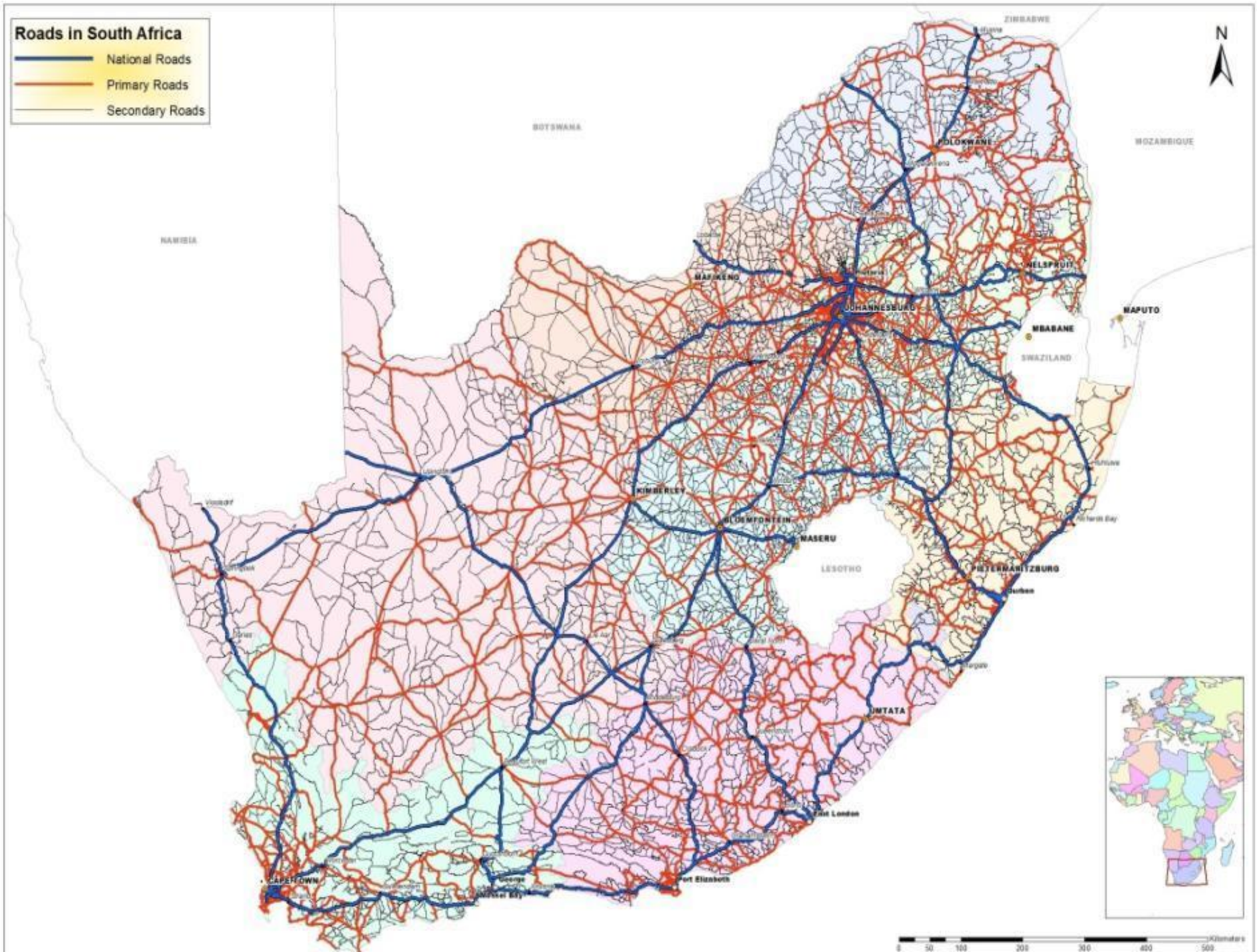
Pavement Evaluation 2014

September 15-18, 2014 ▼ Blacksburg, Virginia


Roads in South Africa
National Roads
Primary Roads
Secondary Roads
N
ZIMBABWE
BOTSWANA
MOZAMBIQUE
NAMIBIA
SWAZILAND
LESOTHO
POLOKWANE
MAFIKENG
JOHANNESBURG
NELSPRUIT
MBABANE
MAPUTO
KIMBERLEY
BLOEMFONTEIN
MASERU
PIETERMARITZBURG
Durban
UMTATA
East London
Port Elizabeth
CAPE TOWN
Kilometers

South Africa has the 10th Longest Total and 18th Longest Paved Road Network in the World

Roads Represents one of the largest public infrastructure investments in most countries

Rank	Country	Road length (km)
	World	64 285 009
1	United States	6 586 610
2	India	4 689 842
3	China	4 237 500
4	Brazil	1 751 868
5	Japan	1 210 251
6	Canada	1 042 300
7	Russia	982 000
8	France	951 200
9	Australia	823 217
10	South Africa	**750 000**
11	Spain	681 298
12	Germany	644 480
13	Sweden	572 900
14	Italy	487 700
15	Indonesia	437 759
16	Turkey	426 906
…	…	…
34	Dem Rep of Congo	**153 497**
45	Zimbabwe	**97 267**
54	Zambia	**91 440**
55	Tanzania	**91 049**
70	Madagascar	**65 663**
80	Angola	**51 429**
72	Namibia	**64 189**
98	Mozambique	**30 331**
104	Botswana	**25 798**
122	Malawi	**15 451**
148	Lesotho	**7 438**
161	Swaziland	**3 594**
173	Mauritius	**2 066**
193	Seychelles	**508**
SADC Total		**1 449 720**

South African Pavement Design

South Africa

Northern Hemisphere

Increased Number of Heavy Axles Repetitions over 20-30 year Design Life

Waterproof Layer

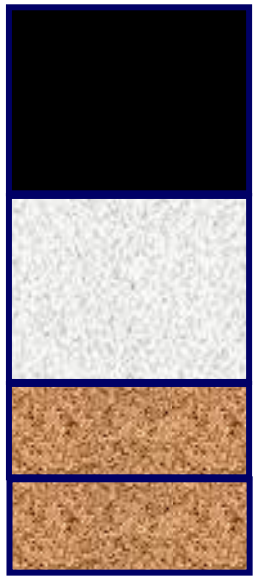
(10 to 40 mm)

(100 to 400 mm)

Local Street

Farm To Market

Water Path Length



Due to Budget Constraints, South African Pavement Design (30-40% Cheaper) is not zero maintenance design

Typical National

Interstate Road

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Asset Management System

Building Blocks/Puzzle Pieces of AMS

- **Policy/Procedures** – Principles/Rules to Guide Decisions and achieve rational outcomes – what, where, when, how.
- **Funding** – Financial resources for operation and results implementation.
- **People** - People make decisions, the rest are just to support the process.
- **Hardware** – Road Survey Equipment + IT Infrastructure.
- **Software** – Computer based data Analysis and Storage Tools.
- **Data** – Knowing what you have, its condition and performance Trend.

Asset Management System - Success

Funding

Policy/
Procedures

People

Hardware

Data

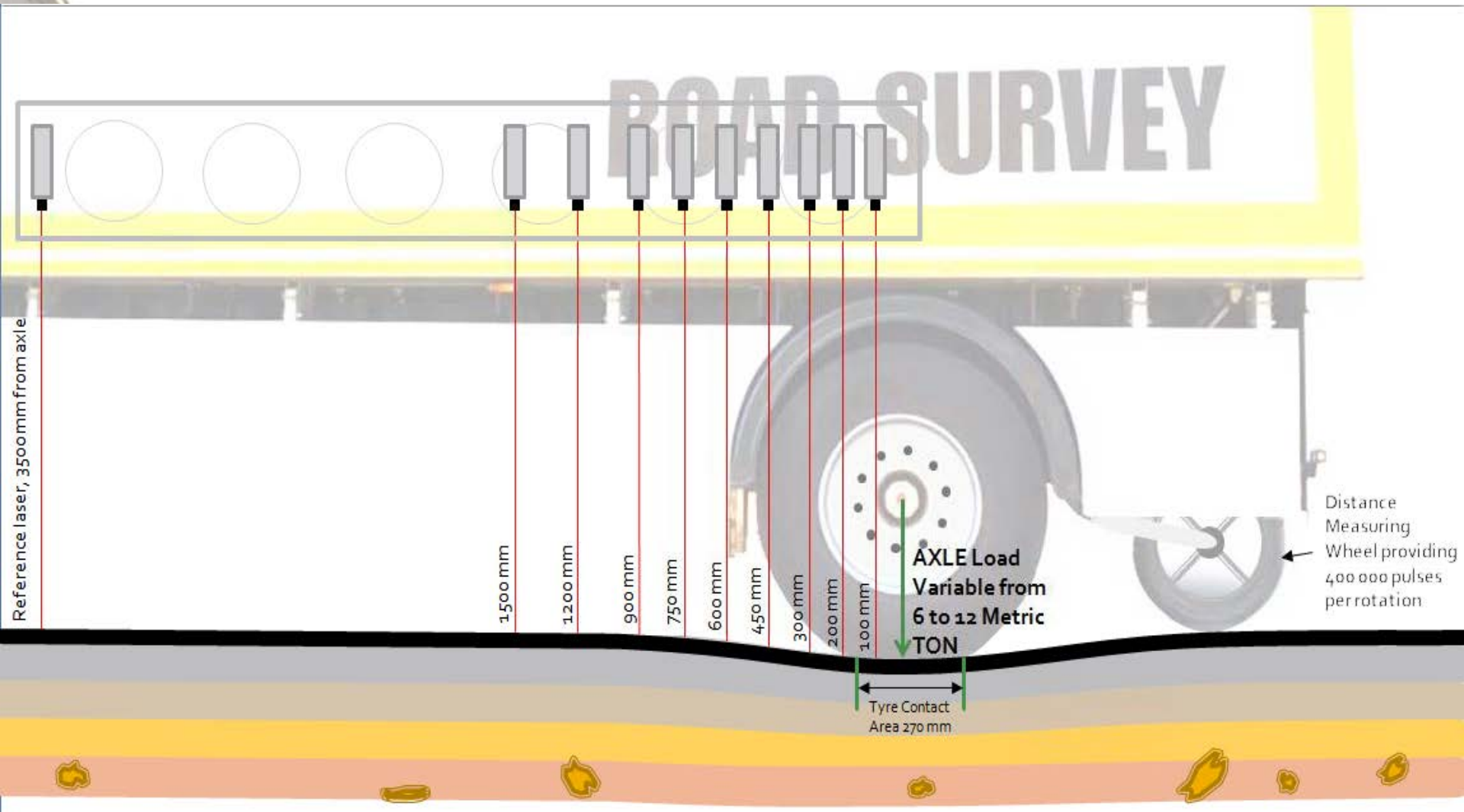
Software

- For asset management to be successful all the “pieces of the puzzle” need to be in place in a “balanced equilibrium”
- It does not help you have the most advance survey vehicle but no means to effectively store and analyse the data, or
- Have the most sophisticate software, but the quality of your data is suspect !
- Without Funding and People – Nothing will happen !!!

SANRAL TSD – Greenwood Engineering

SANRAL TSD 10 Doppler Lasers

Continuous Dynamic Load/Tire Pressure and Temperature / IRI / Macro Texture



SANRAL TSD Additional Equipment

Survey equipment such as the Trimble MX8 and Waylink PaveVision3D Ultra systems, are stored inside the trailer and can be ready for surveys within seconds with the push of a button.

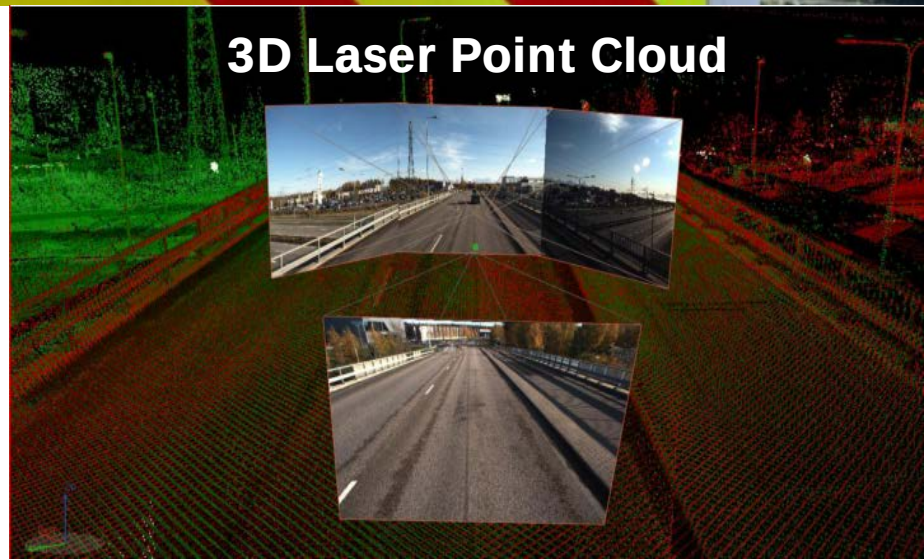
When the vehicle is not surveying, the equipment are stored again inside for safekeeping and cleaning.

Trimble MX8 Mobile LIDAR Solution

2 x REIGL Laser Scanners, 7 x 5MP Cameras, Applanix 520,Trimble DGPS

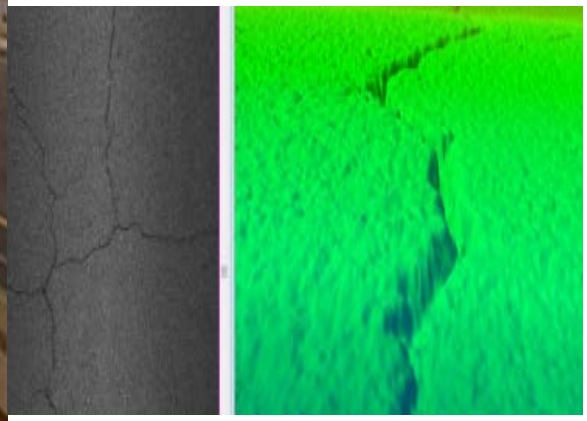
AUTOMATED EXTRACTION:

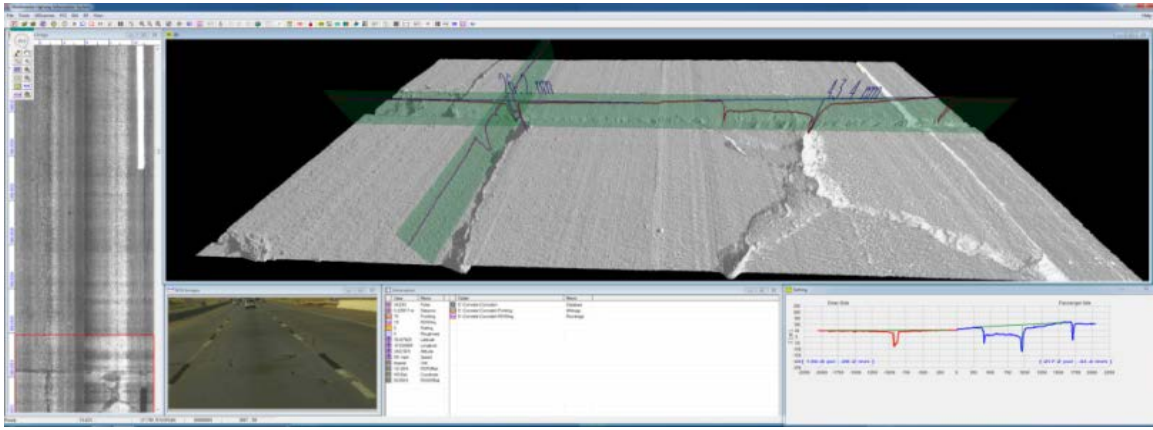
- **Pole Detection**
- **Sign Detection / Recognition**
- **Pavement Marking Detection**
- **Road Modeller (DTM, Cross Sections, Profiles)**
- **Horizontal / Vertical Line of Sight**
- **Horizontal / Vertical Clearances**



Waylink PaveVision3D Ultra

8 x 3D Range (Height) & Intensity Line Scan Cameras, Green Laser Light Source





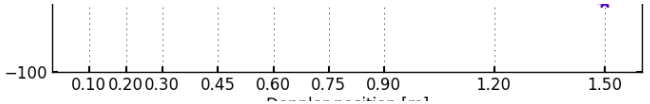
- **Using 3D Vision system we can currently automatically detect and measure:**
  - **Surface racks with a width of as little as 1.00mm;**
  - **Rutting across lane width from continues line;**
  - **Macro Texture across lane width;**
  - **Faulting on Concrete Pavements and 3D Virtual Pavement**

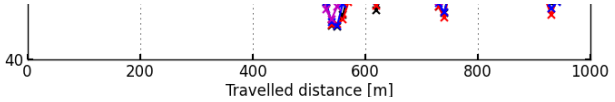
Site Acceptance Test – TSD Results

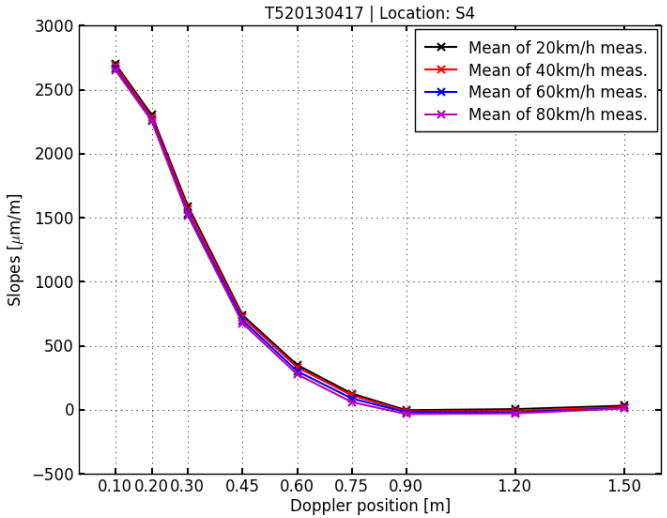
T520130414 | Location: S3

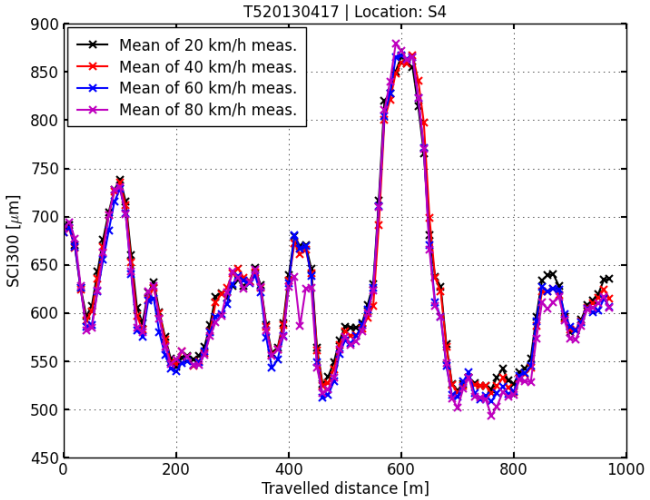
High Repeatability of results that are independent in terms of :

- Speed – 20 km/h to 80 km/h
- Roughness – IRI 0.8 to 6.0 m/km
- Deflection – D0 0.1 to 1.5 mm
- Macro Texture – MPD 0.7 to 3.0 mm



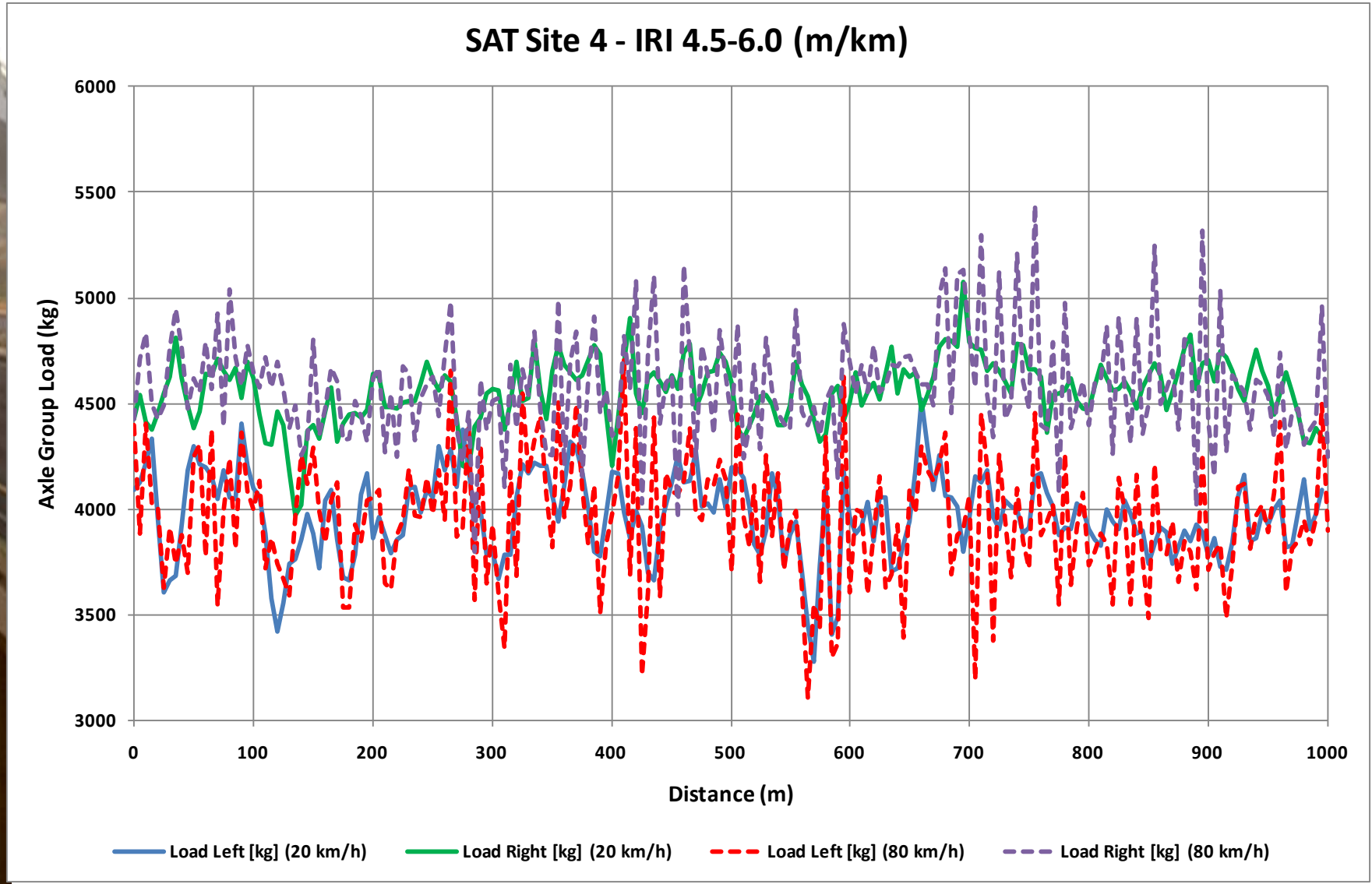






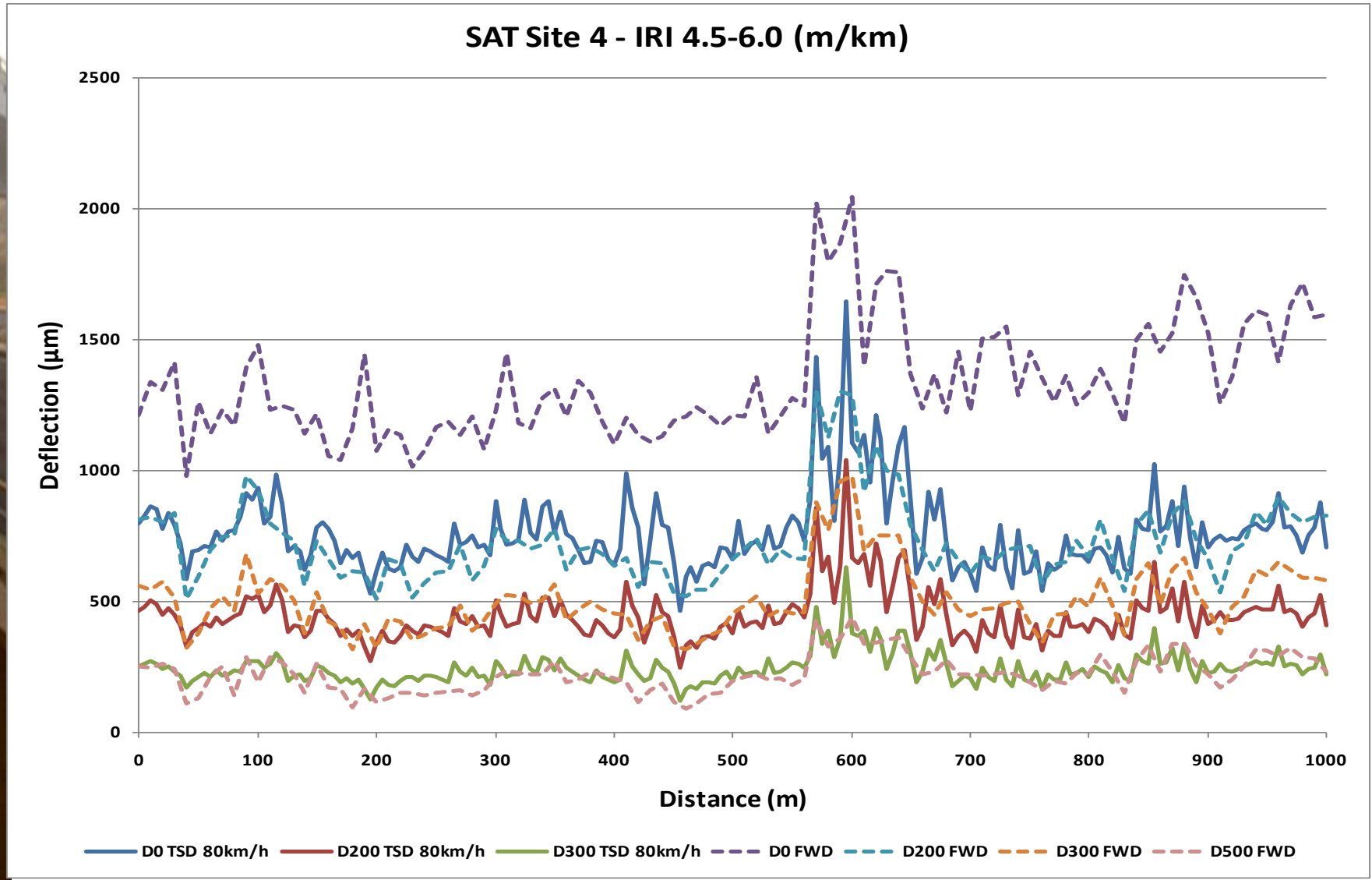
SANRAL TSD Dynamic Loading

95th Percentile Increase by ±20%



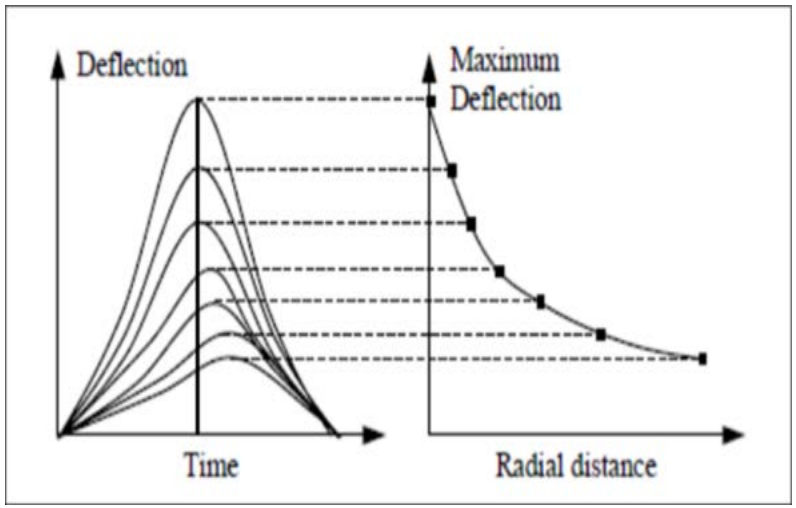
SANRAL TSD vs FWD

Same Pattern – but shift in sensor position when compared to FWD



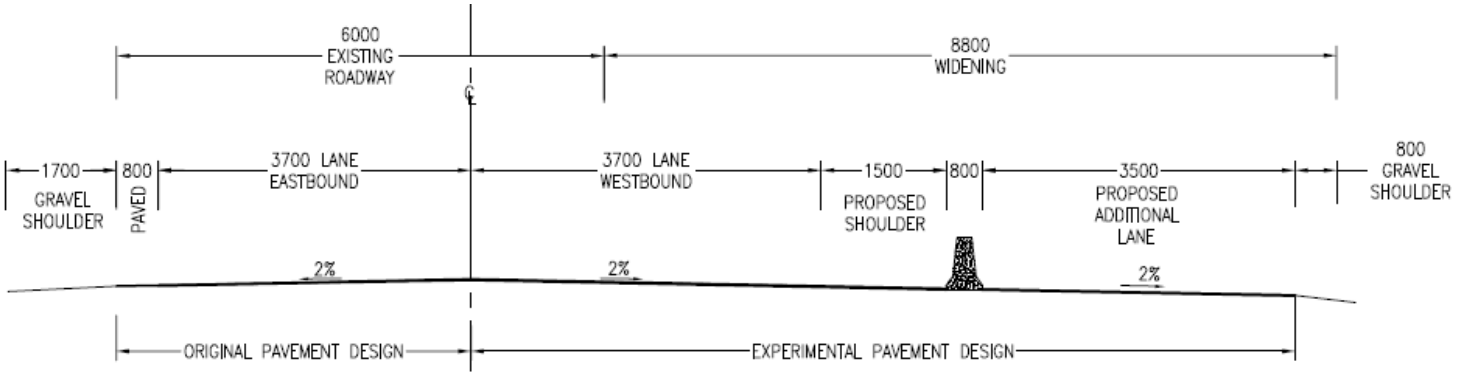
SANRAL TSD vs FWD

- Although FWD has been around for some time, cannot be used as the true reference for accepting TSD measurements:
  - **FWD Maximum Deflection versus Time History**
  - **FWD Rubber Buffer Temperature Sensitivity (Pulse Duration)**



- **R104 Instrumented Sections**

R104 Instrumented Sections - Flexible



TYPICAL CROSS SECTION AT
EXPERIMENTAL SECTION
NTS

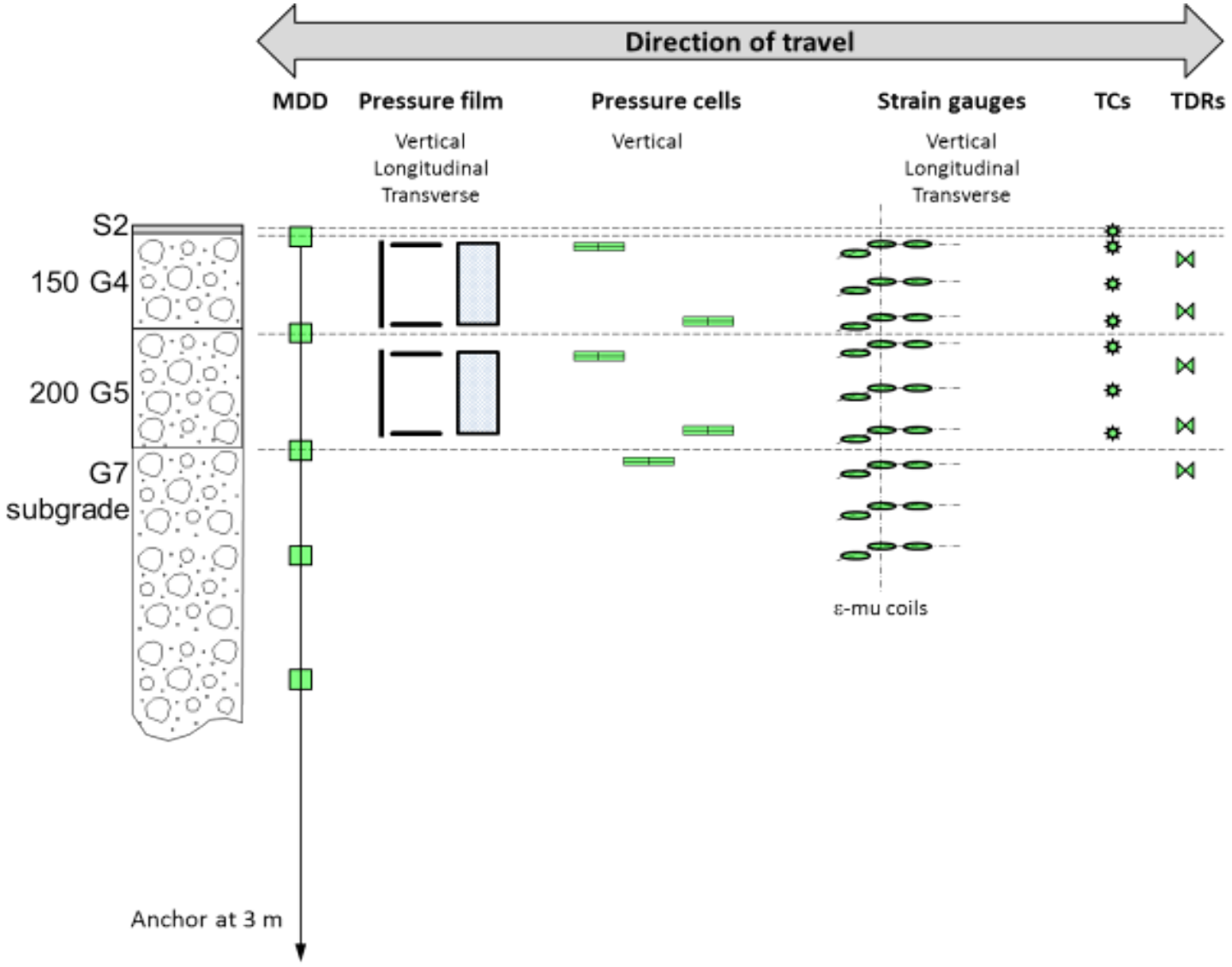
WESTBOUND

TAPER 39760 km	39610	39560		39510			39410			39310			39210			39110			39010			38910
	1		2	3			4			5			6			7						
Section No.																a			b			
Length (m)	50		50	100			100			100			100			100			100			
Finished Road Level	19/9 Double Seal (S-E1)																					
100 mm	150 G4 Donkerhoek		150 G1 Ferro Crushers	200 FTB TBC (Donkerhoek/Quicksand)			200 ETB TBC (Donkerhoek/Quicksand)			200 CTB TBC (Donkerhoek/Quicksand)			40 AC 150 BTB			40 AC 150 HMA			40 AC 100 HMA			
200 mm	200 G5 TBC (Donkerhoek/Quicksand)		200 C3 TBC (Donkerhoek/Quicksand)	150 G7 (Ex-pavement Layers)			150 G7 (Ex-pavement Layers)			150 G7 (Ex-pavement Layers)			150 C3 TBC (Donkerhoek/Quicksand)			150 C3 TBC (Donkerhoek/Quicksand)			150 C3 TBC (Donkerhoek/Quicksand)			
300 mm																						
400 mm	150 G7 (Ex-pavement Layers)		150 G7 (Ex-pavement Layers)	150 G7 (Ex-pavement Layers)			150 G7 (Ex-pavement Layers)			150 G7 (Ex-pavement Layers)			160 G7 (Ex-pavement Layers)			160 G7 (Ex-pavement Layers)			210 G7 (Ex-pavement Layers)			
600 mm Bottom of Box Cut	150 mm Road Bed Preperation																					
600 mm																						

R104 Instrumented Sections - Rigid

	38665		38820		38770		38720		38670		38620		38590		38575		38560		38545		38530		38515		38500	TAPER 38060
8				9								10														
a		b		a		b		c		d		a		b		c		d		e		f		g	
45.0		45.0		50		50		50		50		30		15		15		15		15		15		15	
150 JCP		150 JCP		70 UTCRCP		70 UTCRCP		70 UTCRCP		70 UTCRCP		55+ 25 CBP		55+ 25 CBP		55+ 25 CBP		55+ 25 CBP		55+ 25 CBP		55+ 45 CBP		55+ 45 CBP	
150 C3 TBC (Donkerhoek/Quicksand)		150 G5 TBC (Donkerhoek/Quicksand)		150 C3 TBC (Donkerhoek/Quicksand)		150 C3 TBC (Donkerhoek/Quicksand)		150 C3 TBC (Donkerhoek/Quicksand)		150 C3 TBC (Donkerhoek/Quicksand)		150 C3 TBC (Donkerhoek/Quicksand)										150 C3 TBC (Donkerhoek/Quicksand)			
200 G7 (Ex-pavement Layers)				280 G7 (Ex-pavement Layers)		280 G7 (Ex-pavement Layers)		280 G7 (Ex-pavement Layers)		280 G7 (Ex-pavement Layers)		270 G7 (Ex-pavement Layers)										250 G7 (Ex-pavement Layers)			

To Correctly Interpret TSD Data – Need To understand pavement response



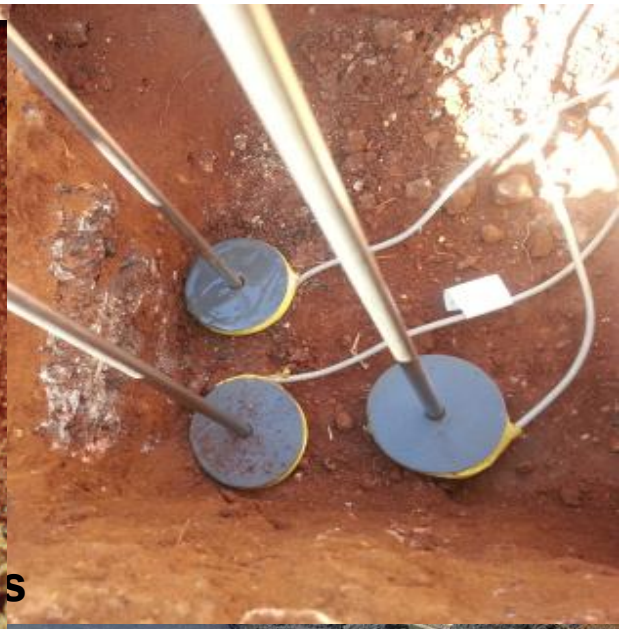
R104 Instrumented Sections - Construction

Instrumentation Installed as part of layer construction

Strain Gauges and P

s

MDD

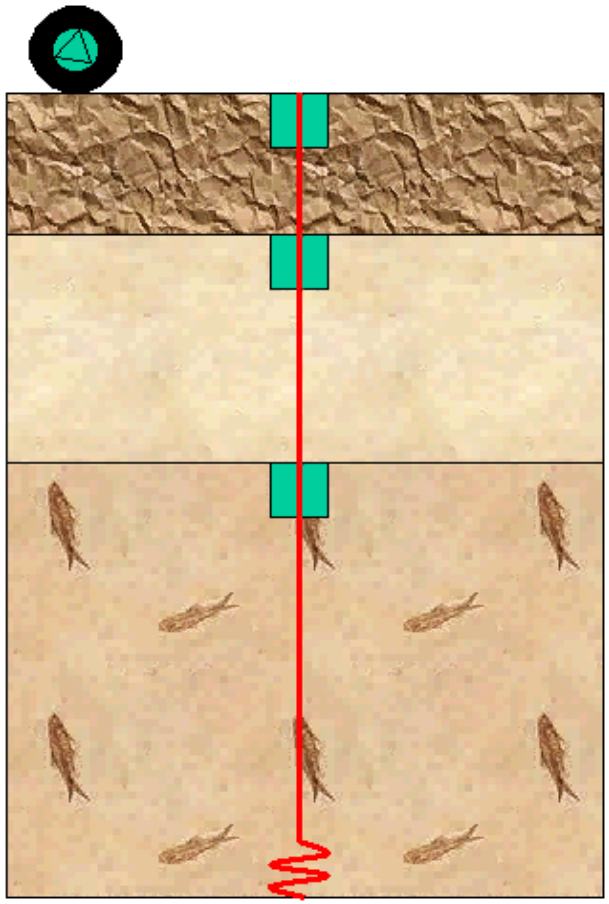


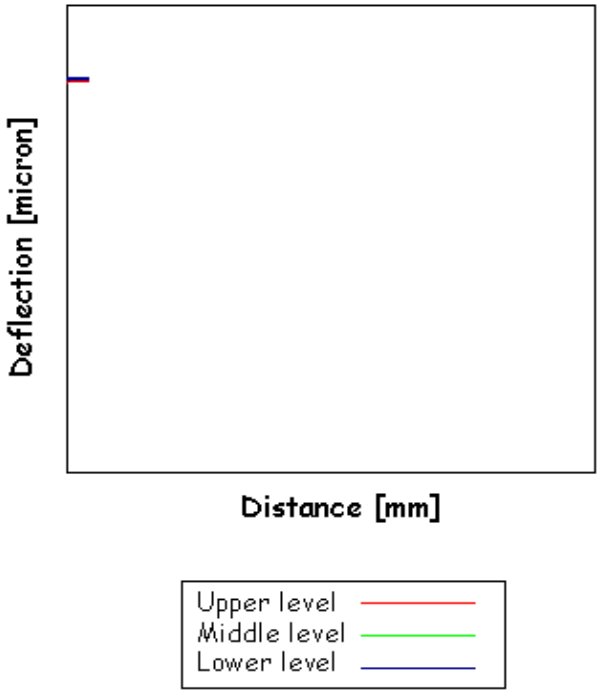
Pressure Film

Typical Layout top of asphalt base

R104 Instruments – MDD

- Multi Depth Deflectometer (MDD)

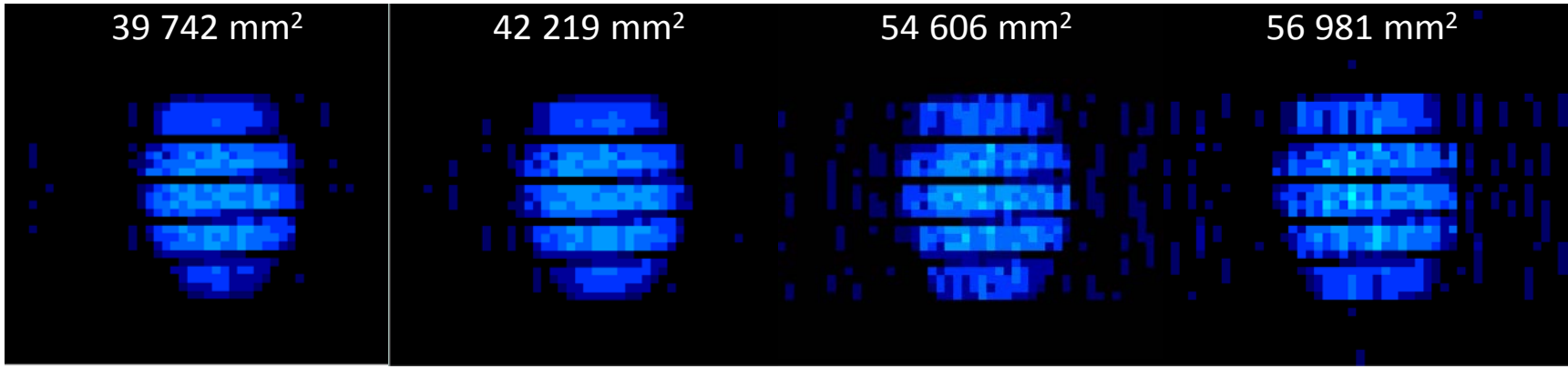




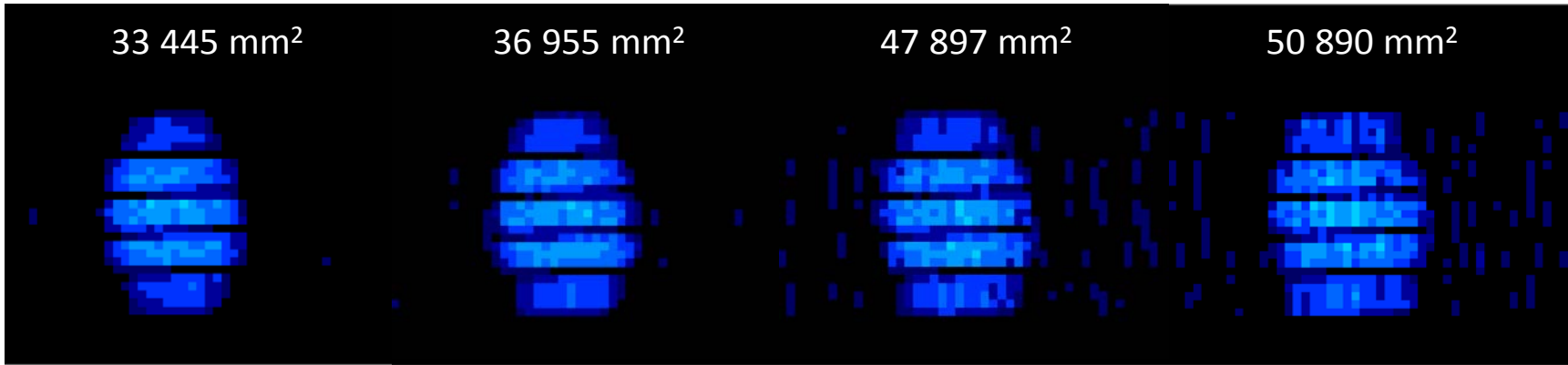
R104 Instruments – Pressure Film

- Pressure Measurement Sensors (0.2 mm)

Trail inner tyre – 31.2, 34.8, 38.3, 42



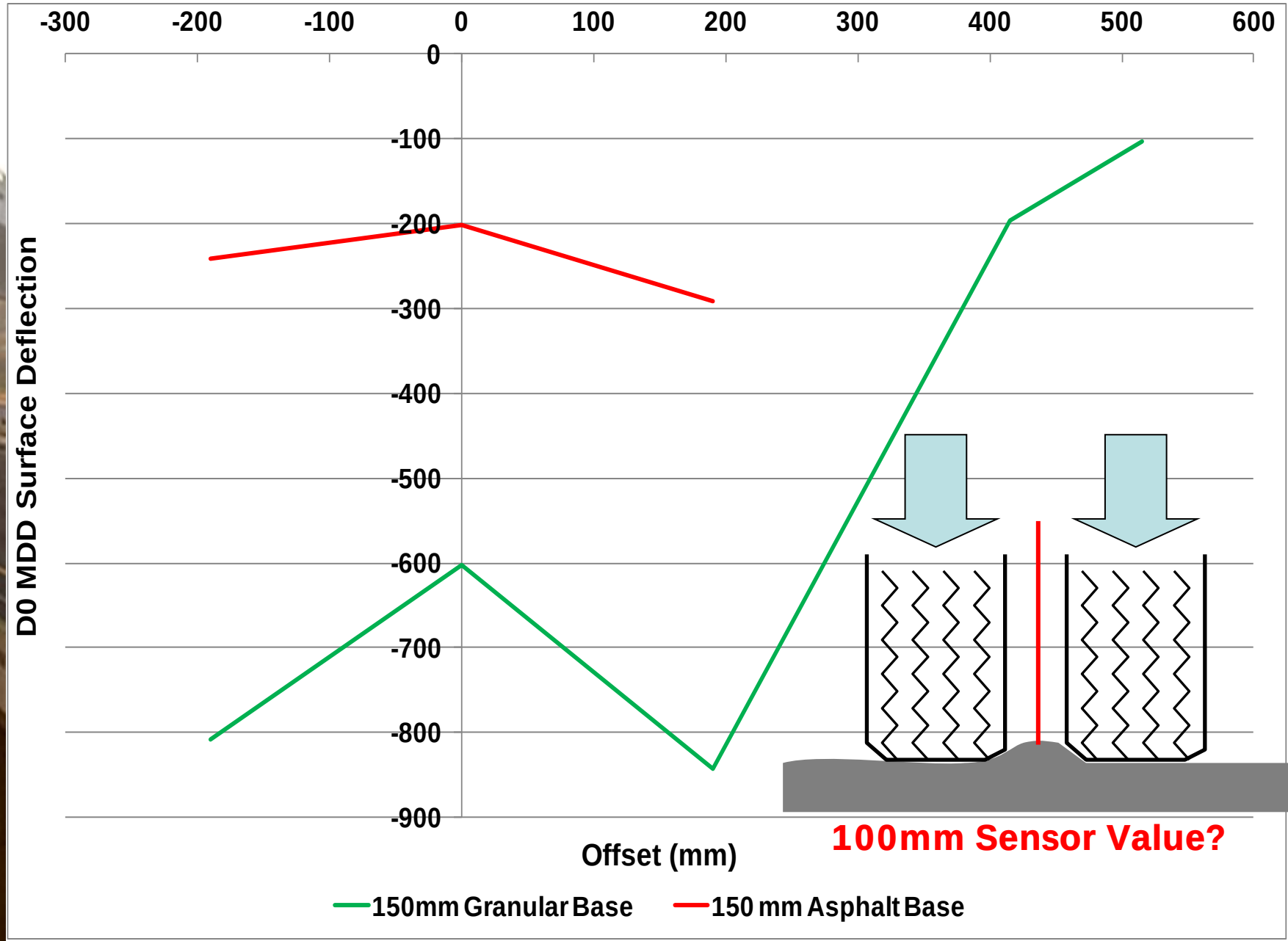
Trail outer tyre – 31.2, 34.8, 38.3, 42



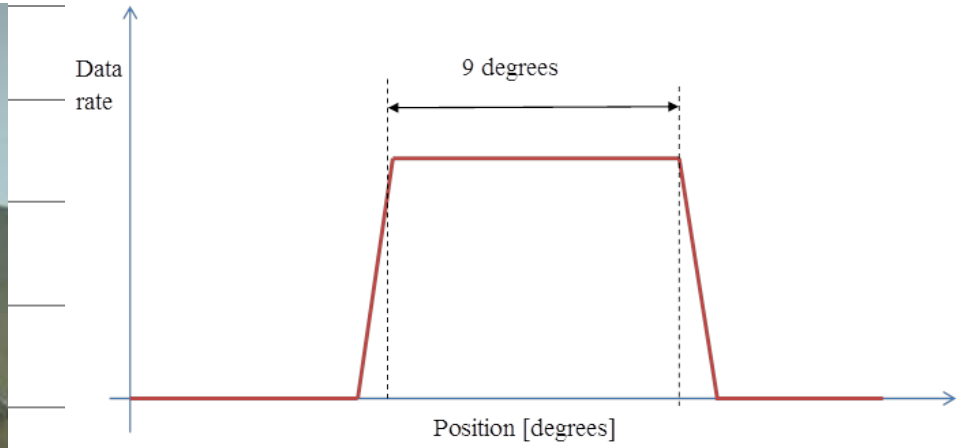
Synchronising TSD/R104 measurements

At 80km/h moving at 22.22 m/s

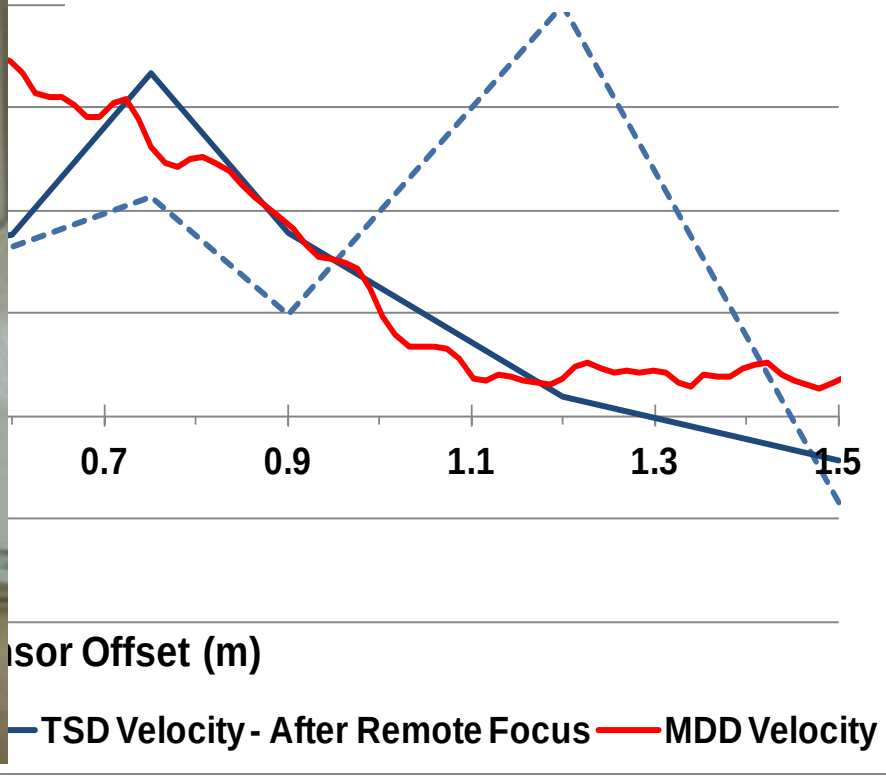
MDD Deflection Location



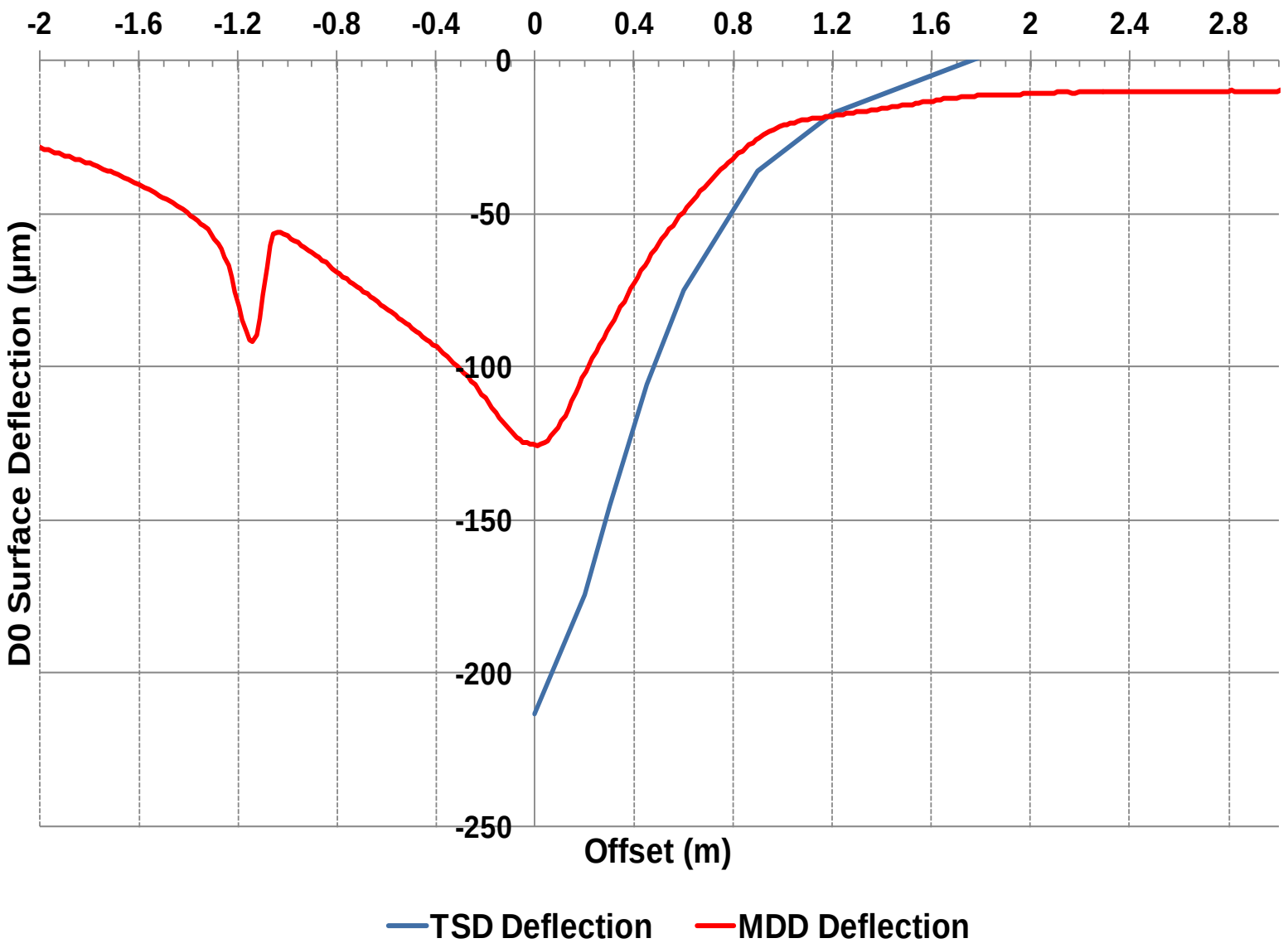
Surface Velocity (60 km/h)



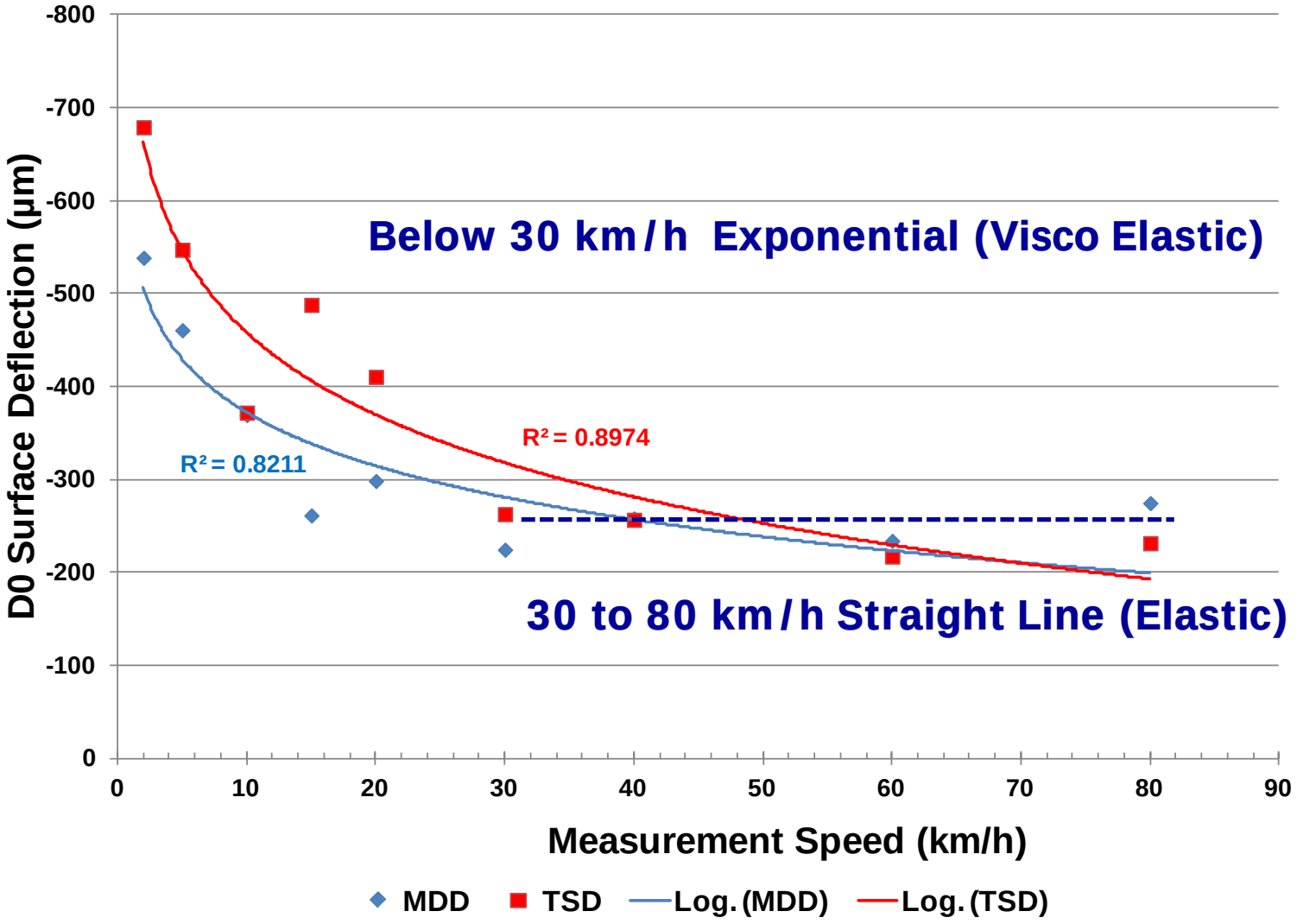
MPD > 2.5 only 4 degrees



D0 Surface Deflection (60 km/h)



D0 Deflection versus Speed



TSD measures "real" pavement response, even at low (<30 km/h) speeds

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.

Thank you!

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