arrb SYSTEMS

Usage of TSDD's at Network Level : Experiences from South Africa 2016 to 2022

BCRRA conference 2022 – Workshop
Usage of TSDDs at network level –
what do we have, what is missing
.

Simon Tetley - ARRB Systems
27 June 2022

PAVEMENT MANAGEMENT INTELLIGENCE

Content

- Background
- Road Condition Assessment in South Africa
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  - Economic Benefit of Full Spectrum Pavement Evaluation
  - Evaluation of Rigid Pavements

Background

- iPAVe 1 – 2016
- iPAVe 2 – 2021
- 74,000 Lane Kilometres of iPAVe TSDD Survey Since 2017
- KwaZulu-Natal and Free State Provinces
- Deflection Measurements, Digital Imaging, Geometry
- Riding Quality, Rut Depth, Texture and ACD
- 40,000 Deflection Points per Kilometre +/- 2,96 Billion Points ∞

Road Condition Assessment in South Africa – Status Quo

"MANUAL"

- Requires Experience
- Strenuous
- Subjective
- Time Consuming
- Dangerous

10 – 40 km/day

"SEMI – AUTOMATED"

- Improvement on Manual Methods
- Less Subjective
- Faster
- Safer

150 – 300 km/day

+

- Measures Pavement Stiffness
- Time Consuming Process
- Stationary Test - Needs Traffic Control
- Risk to Operator & Road Users

35 - 50km/day

Road Condition Assessment in South Africa – Future

Challenges

Procurement

Only One Commercial Service Provider

Until 2020/21, No Standard RAMS Tender Document – No Opportunity to Price TSDD

Draft COTO Standard Procurement Document Released 2021 – Include Both FWD and TSDD - In Use by Numerous Road Agencies

30.03	Data Collection – Road Network				
30.03 a)	Traffic Speed Deflectometer Device (TSDD)	Lane.km	-	-	-
30.03 b)	Automated Crack Detection	Lane.km	-	-	-
30.03 c)	Geometry	Lane.km	-	-	-
30.03 d)	Falling Weight Deflectometer (FWD)	Point	-	-	-
30.03 e)	Continuous Digital Imaging (Standard)	Lane.km	-	-	-
30.03 f)	Continuous Digital Imaging (Quantitative)	Lane.km	-	-	-
30.03 g)	IRI (International Roughness Index) – Class 1	Lane.km	-	-	-
30.03 h)	IRI (International Roughness Index) – Class 3	Lane.km	-	-	-
30.03 i)	Wheelpath Rutting	Lane.km	-	-	-
30.03 j)	Transverse Profile Rutting	Lane.km	-	-	-
30.03 k)	Macro Texture	Lane.km	-	-	-
30.03 l)	Surface Friction Testing (automated)	Lane.km	-	-	-
30.03 m)	Surface Friction Testing (portable)	Point	-	-	-
30.03 n)	Response Type Roughness Meter - Class 3	Lane.km	-	-	-
30.03 o)	Walking Profiler	Lane.km	-	-	-
30.03 p)	Road Safety Assessments (IRAP or Similar)	Lane.km	-	-	-
30.03 q)	Accident Statistics	Per Report	-	-	-

Challenges

Mindset

FWD is the Established Structural Testing Method at Both Project and Network Level

Public and Private Clients Reluctant to Change – Only 2 out of 9 Provinces use TSDD

Usual Question – “How do the Results Compare to FWD”

Growing Acceptance of TSDD in Past 18 Months – Particularly Private Clients

Challenges

Data Management

iPAVe 2 / TSD 18 – BIG DATA!!!

~ 4.5Gb per km at max. resolution

+ 1Gb per km for GPR

Smart Data Processing and Backup Protocols

Recent project in Free State – Collected 4500km in 5 weeks, data processed and delivered within 2 weeks.

Current Studies

Using Network Level Data at Project Level

TSDD and 2 x FWD Testing

2 x 100m Test Sections

Recent Construction and Distressed

Test Positions at 1m Spacing

AM and PM Testing

Duplicate Testing May & August 19

AM and PM Testing

TSDD at 20, 40, 60 & 80 Kph

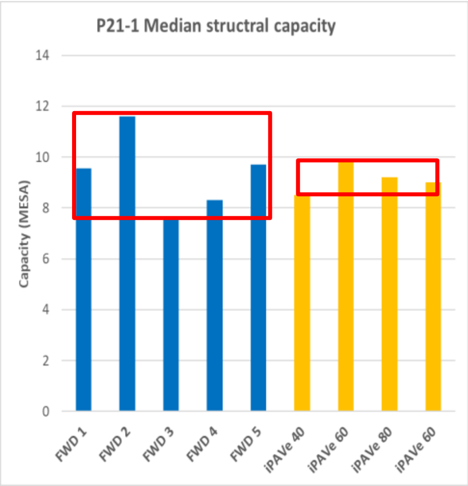
3rd Test Section = 35 Km for TSD and FWD at 50m Spacing

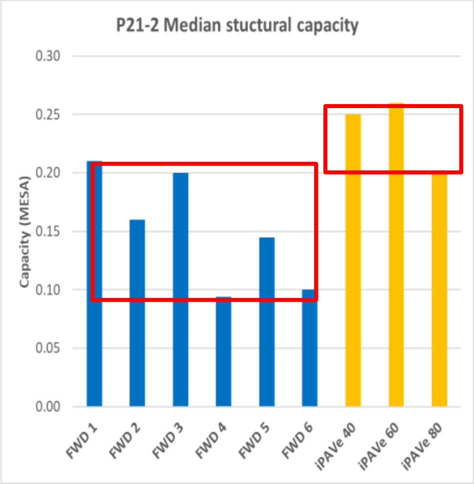
Intrusive Investigation – Cores / Test Pits

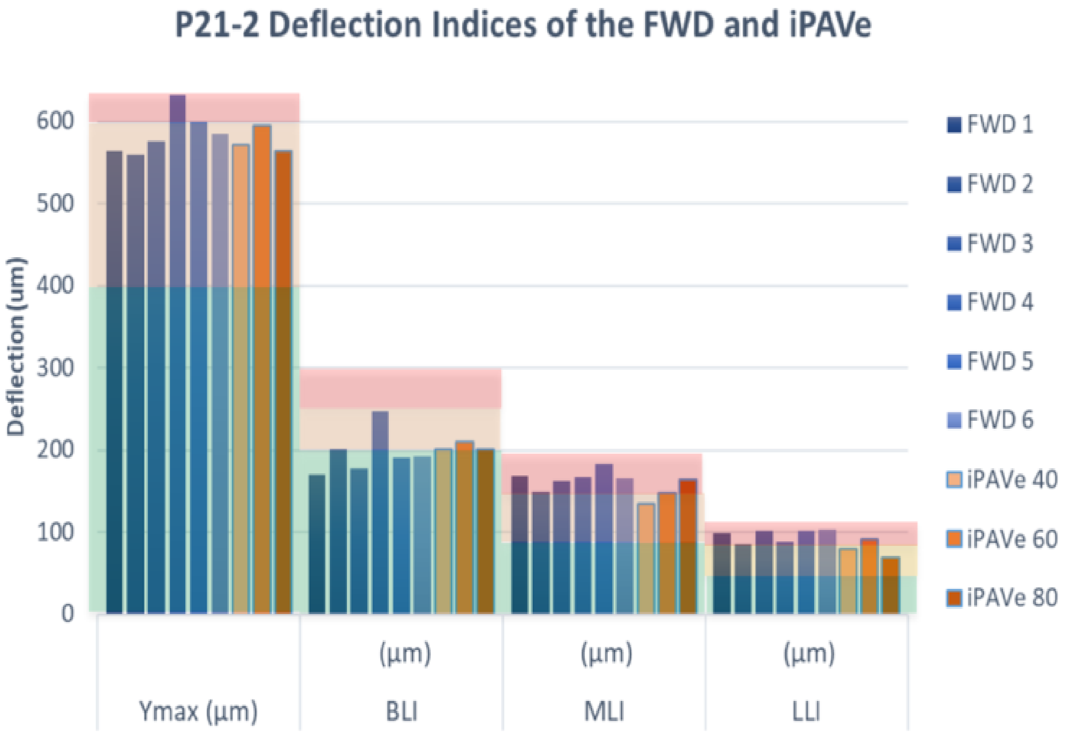
Current Studies

Using Network Level Data at Project Level

Subject of Paper – “A Comparative Evaluation of the Structural Capacity of Cracked and Uncracked Flexible Pavements Using Mechanisitic Empirical Methods Based on Deflection Measurements BY THE Falling Weight Deflectometer and a Traffic Speed Deflectometer Device” : HJ Visser and SR Tetley at SATC 2021







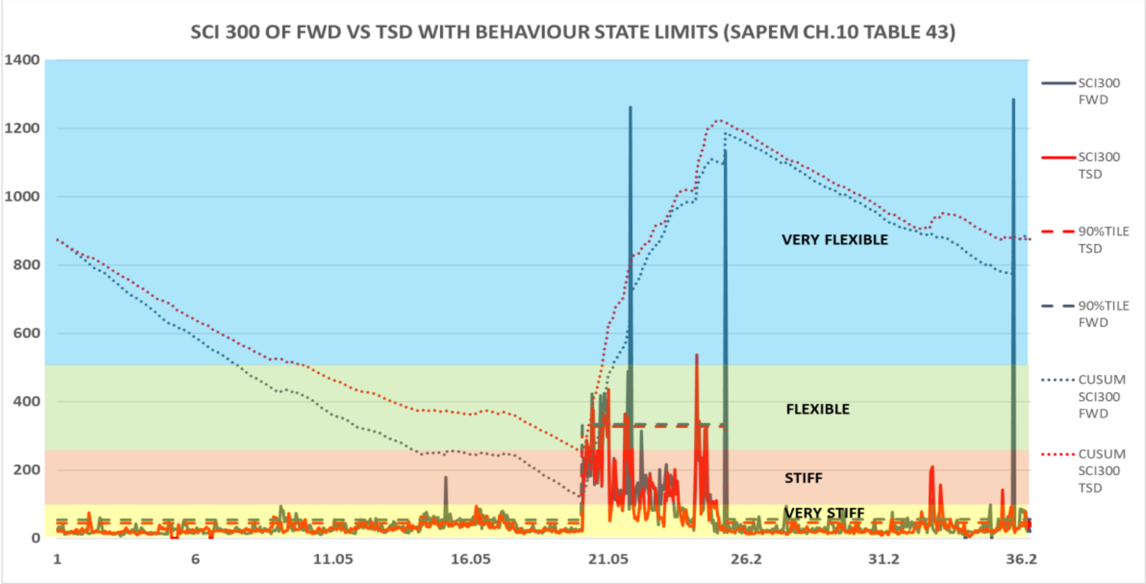
*[1] SAPEM Chapter 10, Table 44 (Horak 2008)

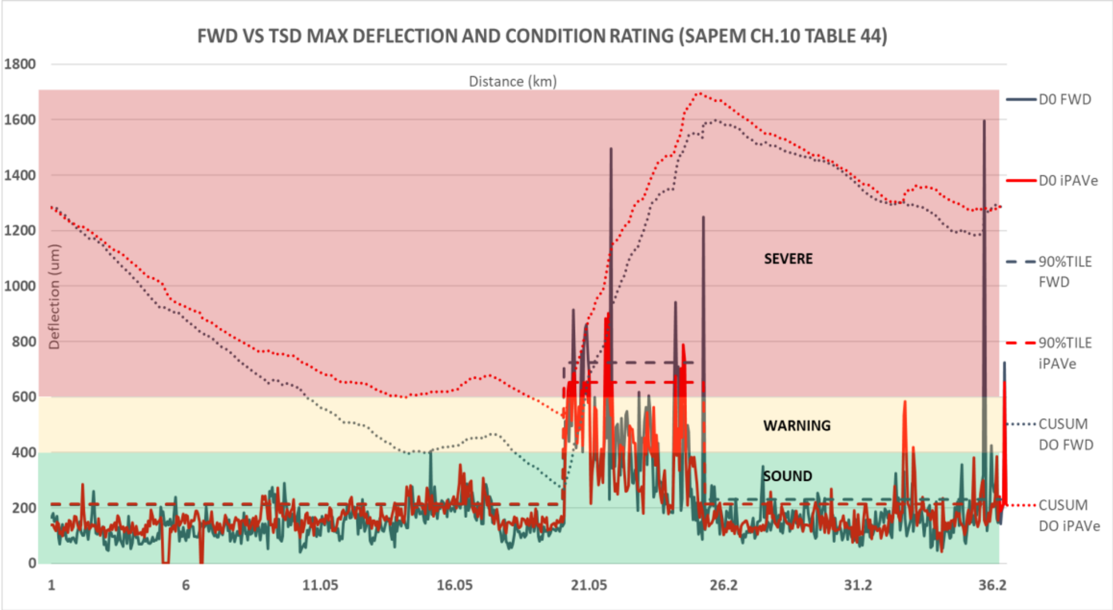
Current Studies

Using Network Level Data at Project Level

Expansion of this study to include other pavement types

Station	Test	Back calculated Stiffness (MPa)					Capacity (MESA)
		Layer 1	Layer 2	Layer 3	Upper Subgrade	Substratum	
KM 1 TO KM 20	FWD	6000	960	70	120	210	8.5
	TSD	5900	980	80	120	160	8.6
KM 20 TO 25,5	FWD	750	160	40	100	120	0.08
	TSD	700	140	140	100	90	0.07
KM 25,5 TO 36,5	FWD	6900	990	80	100	130	9.1
	TSD	6500	980	120	110	150	9.7





*[1] SAPEM Chapter 10, Table 43& 44 (Horak 2008)

Current Studies

Economic Benefit of Using Automated Full Spectrum Road Condition Assessments

Study to Investigate Whether There is Economic Cost/Benefit in Using Highly Accurate and Comprehensive Road Condition Assessment Data

Pilot Project Based on "Road Network" Consisting Approximately 66 Lane Kilometres Uniform sections identified, defined and analysed in HDM-4

Comprehensive Condition Assessment and Instrument Measurement (Physical Visual Assessment, NSV/FWD Combination and TSDD data)

HDM-4 Parameter	Scenario 1	Scenario 2	Scenario 3
Rutting	Estimated from visual assessment	Measured every 1 m	Measured every 1 m
Roughness (IRI)	Estimated from visual assessment	Measured every 1 m	Measured every 1 m
Deflection	N/A	Measured every 200 m	Measured every 5 m
Structural Number	Calculated in HDM-4 using layer coefficient method	Calculated in HDM-4 using maximum deflection	Calculated in HDM-4 using maximum deflection
Cracking	Estimated from visual assessment	Estimated from visual assessment (post rated)	Measured by Automated Crack Detection lasers

Uniform Sections Identified, Defined and Analysed in HDM-4

Current Studies

Economic Benefit of Using Automated Full Spectrum Road Condition Assessments

Economic Analysis

Subject of Paper – "The Use of Non-Destructive Road Condition Measurement Devices to Optimise Economic Benefit of Road Networks", Visser & Tetley, 18th IRF World Meeting, 2021

Scenario	Discounted Cost per lane km (US$)					Savings per km relative to Scenario 1
	Recurring	Capital	Agency Cost	Equipment cost	Total Agency Cost	
1. Visual Assessment	$ 44,352	$ 50,401	**$ 94,754**	**$ 11**	**$ 94,764**	
2. FWD & NSV	$ 38,402	$ 49,336	**$ 87,739**	**$ 113**	**$ 87,852**	**$ 6,913**
3. iPAVe TSDD	$ 37,860	$ 48,868	**$ 86,728**	**$ 233**	**$ 86,962**	**$ 7,803**

Base Scenario – Minimum maintenance	annually
Single Seal Surfacing	5
Double Seal Surfacing	5
Asphalt Overlay	7
Light Rehabilitation	10
Rehabilitation	15
Reconstruction	20

		20 Year Life Cycle Savings		Annual Savings	
Paved Road Network	**Length (km)**	**Scenario 2**	**Scenario 3**	**Scenario 2**	**Scenario 3**
China	4 943 000	$ 34,170,959,000	$ 38,570,229,000	**$ 1,708,547,950**	**$ 1,928,511,450**
USA	4 304 715	$ 29,758,494,795	$ 33,589,691,145	**$ 1,487,924,740**	**$ 1,679,484,557**
India	4 266 046	$ 29,491,175,998	$ 33,287,956,938	**$ 1,474,558,800**	**$ 1,664,397,847**
Japan	992 835	$ 6,863,468,355	$ 7,747,091,505	**$ 343,173,418**	**$ 387,354,575**
Russia	927 721	$ 6,413,335,273	$ 7,239,006,963	**$ 320,666,764**	**$ 361,950,348**
UK	424 129	$ 2,932,003,777	$ 3,309,478,587	**$ 146,600,189**	**$ 165,473,929**
South Africa	158 124	$ 1,093,111,212	$ 1,233,841,572	**$ 54,655,561**	**$ 61,692,079**
UEA	18 255	$ 126,196,815	$ 142,443,765	**$ 6,309,841**	**$ 7,122,188**

HDM-4
HIGHWAY DEVELOPMENT & MANAGEMENT

Optimum Section Alternatives (Unconstrained Budget)

Study Name: **iPAVe**
Run Date: **28-06-2021**
Currency: **ZAR (millions)**

Section	Road Class	Length (km)	Surface Class	Initial AADT	Alternative Desc.	Average Roughness IRI	Discounted Agency Financial Capital Costs	Discounted Agency Financial Recurrent Costs	Net Present Value
P21-1 Uniform Section 1 (Km 1 to Km 20,050)	High	19.05	Bituminous	5,266	Asphalt Overlay @ 5 IRI	2.1	18.75	21.37	1,006.10
P21-1 Uniform Section 2 (Km 20,050 to Km 25,450)	High	5.40	Bituminous	5,266	Asphalt Overlay @ 5 IRI	2.8	7.29	6.33	376.63
P21-1 Uniform Section 3 (Km 25,450 to Km 36,500)	High	11.05	Bituminous	5,266	Asphalt Overlay @ 5 IRI	2.2	14.69	12.97	768.34
R72 Eastbound Fastlane Section 1	High	1.00	Bituminous	553	Base Alternative	2.8	0.00	0.34	0.00
R72 Eastbound Fastlane Section 2	High	2.41	Bituminous	553	Base Alternative	4.4	0.00	0.84	0.00
R72 Eastbound Fastlane Section 3	High	1.30	Bituminous	553	Base Alternative	4.0	0.00	0.72	0.00
R72 Eastbound Fastlane Section 4	High	1.20	Bituminous	553	Base Alternative	4.7	0.00	0.41	0.00
R72 Eastbound Fastlane Section 5	High	1.79	Bituminous	553	Single Seal Surfacing	3.5	0.78	0.89	0.32
R72 Eastbound Slowlane Section 1	High	1.45	Bituminous	553	Base Alternative	3.1	0.00	0.50	0.00
R72 Eastbound Slowlane Section 2	High	1.55	Bituminous	553	Base Alternative	5.0	0.00	0.53	0.00
R72 Eastbound Slowlane Section 3	High	3.25	Bituminous	553	Base Alternative	5.1	0.00	1.21	0.00
R72 Eastbound Slowlane Section 4	High	1.45	Bituminous	553	Base Alternative	4.9	0.00	0.80	0.00
R72 Westbound Fastlane Section 1	High	5.95	Bituminous	1,286	Base Alternative	3.7	0.00	3.28	0.00
R72 Westbound Fastlane Section 2	High	1.69	Bituminous	1,286	Single Seal Surfacing	3.4	0.83	1.16	13.33
R72 Westbound Slowlane Section 1	High	5.80	Bituminous	1,286	Base Alternative	4.4	0.00	3.16	0.00
R72 Westbound Slowlane Section 2	High	1.85	Bituminous	1,286	Single Seal Surfacing	3.4	0.91	1.29	3.27
All Sections		66.19				3.09	43.24	55.80	2,167.98

HDM-4 Version 2.08 **Page -1 of 1**

To be Expanded 2022 to Full Road Network

Current Studies

Evaluation of Rigid Pavements

iPAVe TSDD Testing on National Roads in the KwaZulu – Natal Province

Distressed and Newer Pavements

Dowelled and Non-Dowelled JCP

CRCP

Composite Pavements

Fieldwork is Underway

Hopefully in a Position to Give Some Meaningful Feedback at TRB DaRTS Meeting

Data driven pavement people.

While we're driven by a passion for data and technology, our purpose is people and the pavements that take them smoothly and safely from A to B.

E: Simon.Tetley@arrbsystems.com
M: +27 79 882 2229
ARRB Systems Africa
14 Egret Street, Bloubergstrand,
Cape Town, 7441, South Africa

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