Overview of Ben Schoeman CRCP Accelerated Pavement Test

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Outline

1. Background
2. Test particulars
3. Pavement responses
4. Diagnostic Evaluation
5. Falling Weight Deflectometer
6. Application of Test Findings

1.1 Background

- Research was conducted as part of GFIP Work Package C: Rehabilitation and capacity upgrade of the Ben Schoeman Freeway
  - Capacity upgrade to ensure a Level of Service D for next 10 years
  - Rehabilitation to ensure a 10-year maintenance free period
- Research was initiated by BKS, undertaken in co-operation with SANRAL
- Testing was conducted by the CSIR using the HVS
- Research objectives:
  1) Characterise CRCP performance in terms of standard measures
  2) Contribute to the current body of knowledge through the development of a performance model for the test section

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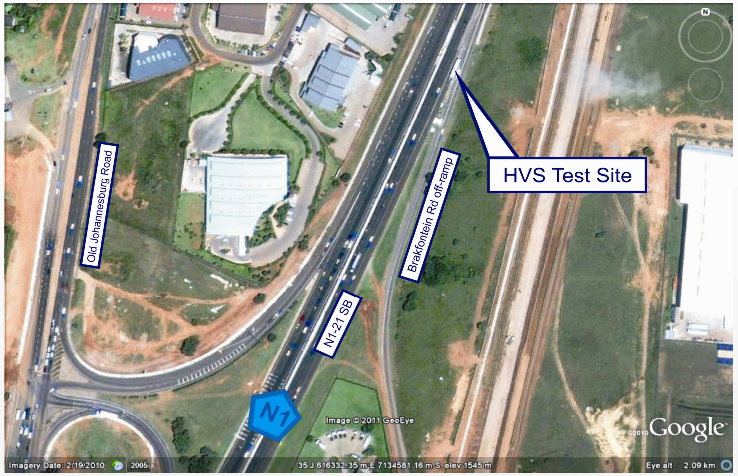
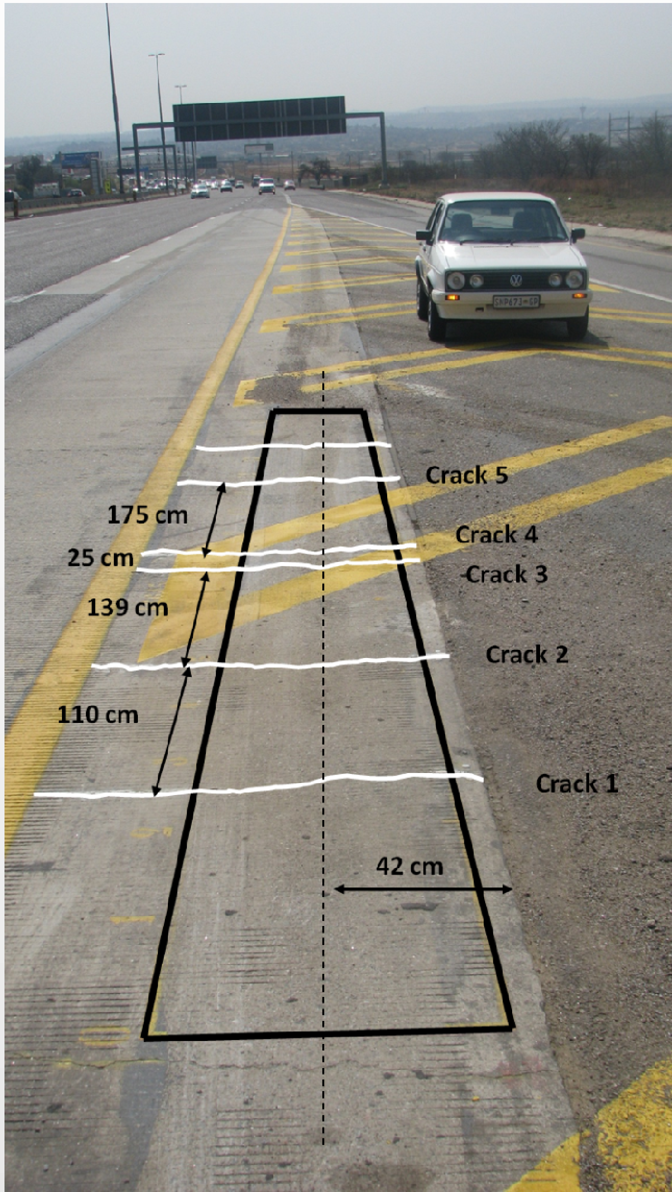
2.1 Test Section



Layer Thickness (mm)	Material	Year Constructed
185	Continuously reinforced concrete	1987
30	Open-graded asphalt overlay	1973
30	Continuously-graded asphalt overlay	1969
200	G1- Crushed stone base	1969
150	C2- Stablised gravel subbase	1969
150	G7 – Selected subgrade	1969
150	G9 – Selected subgrade	1969



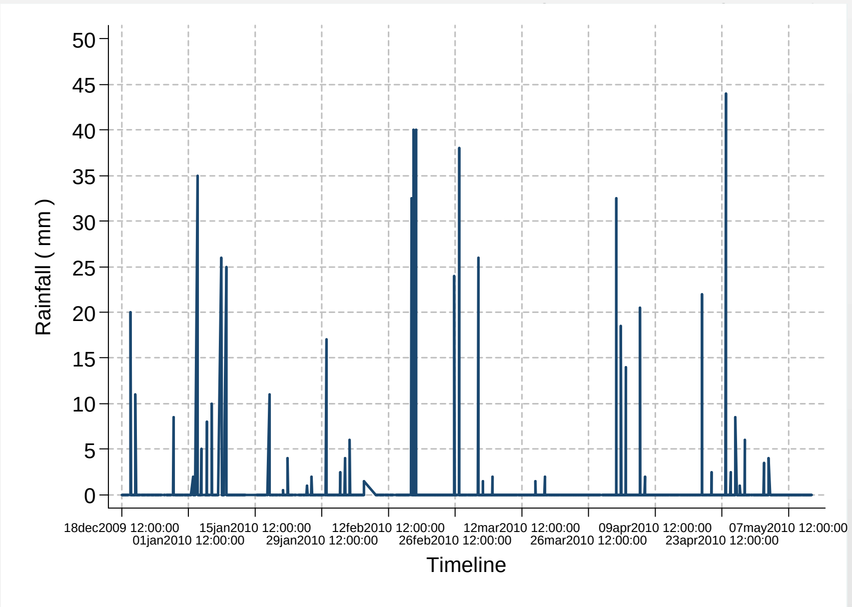
2.2 APT Test Plan

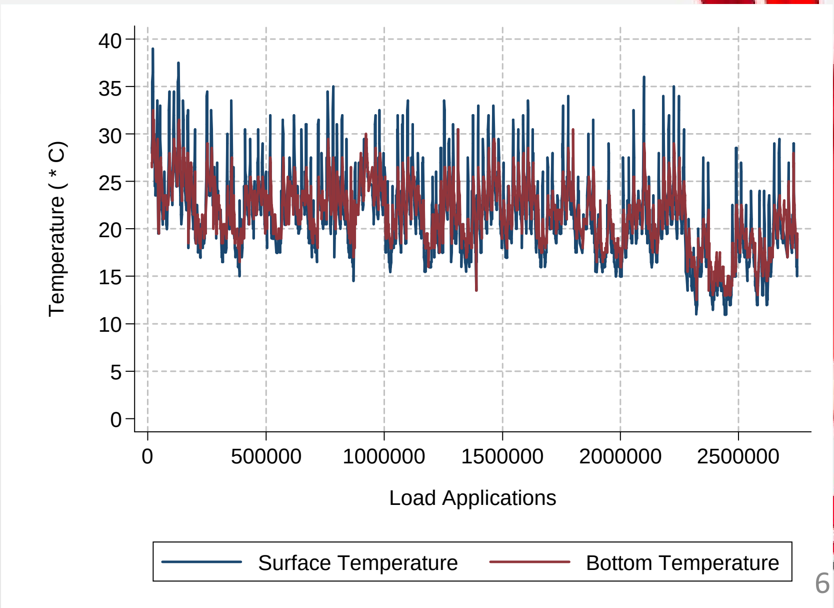
Characteristic	Description	Start	Stop
Test Duration	147 days	17 December 2009	12 May 2010
Trafficking mode	Canalised	0	2 750 200
Temperature control	Ambient	0	2 750 200
Loading direction	Bi-directional	0	2 750 200
Trafficking load Two 12R22.5 tyres at 800 kPa	40 kN	0	40 202
	60 kN	40 202	80 453
	80 kN	80 453	1 730 571
	100 kN	1730 571	2 750 200
Measurement interval	30 minutes		
Test load at 0500 h and 1300 h	40 and 60 kN under 80 kN loading	80 453	1 730 571
	40 and 80 kN under 100 kN loading	1 730 571	2 750 200

2.3 Instrumentation and Environmental Conditions

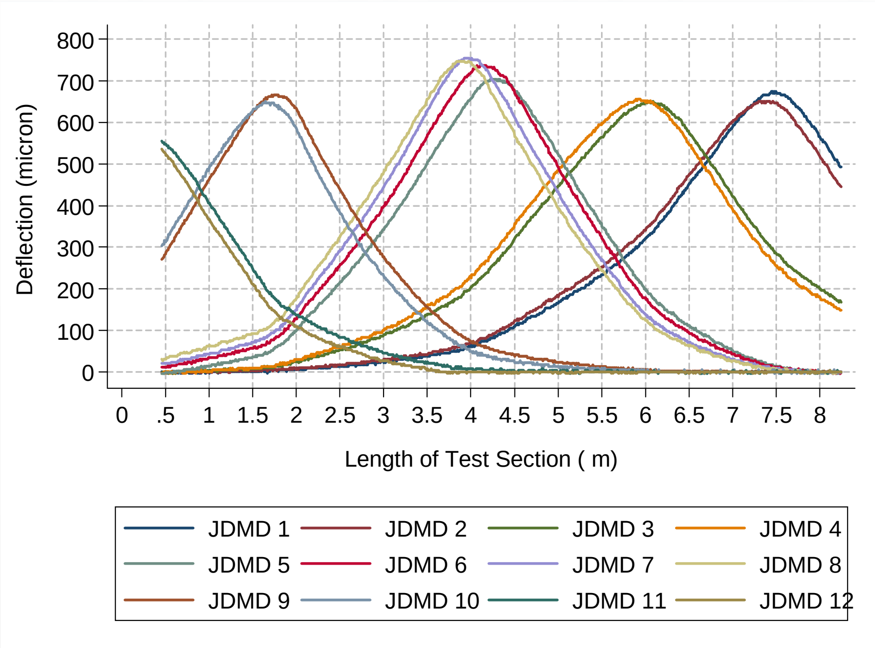
- Joint Deflection Measuring Devices
  - Vertical (10) / Horizontal (3)
- No Multi-depth Deflectometer
- Thermocouples
  - Surface and at 175 mm
- Weather station
- Watering cycle: 40 k wet – 5 l/h

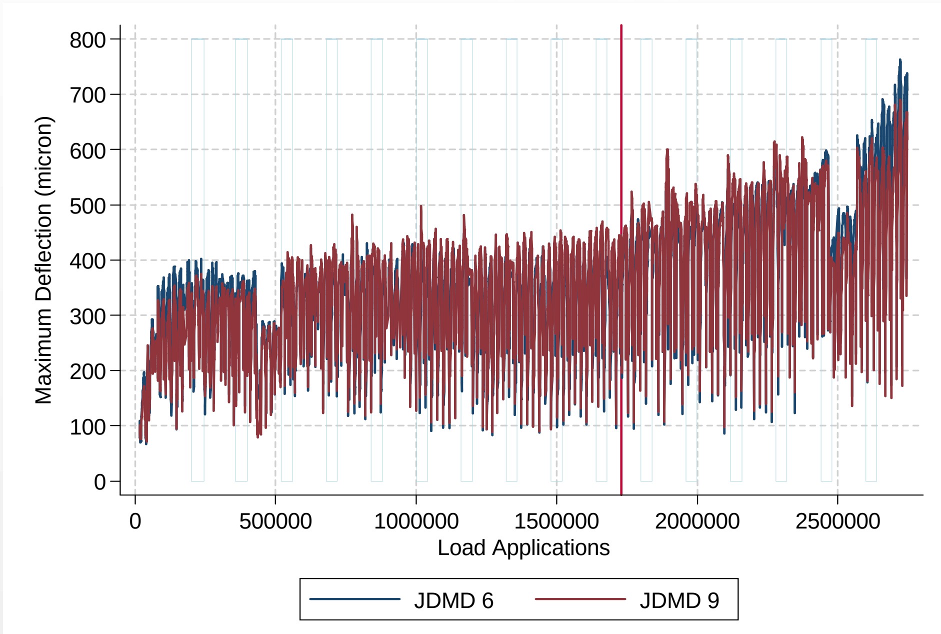
  200k dry ambient





3.1.1 Surface Deflection





Deflection profiles under dynamic loading

Deflection at all load levels, including standard test loads

Vertical line – 1.73 mil improved load from 80 kN to 100 kN

Visible variation due to twice daily standard test loads of 40 kN

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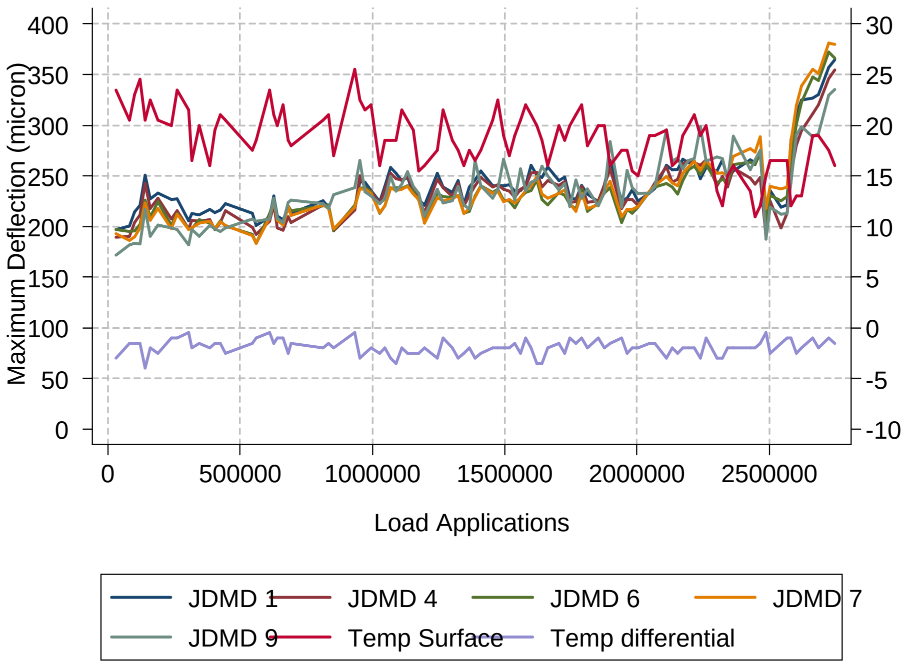
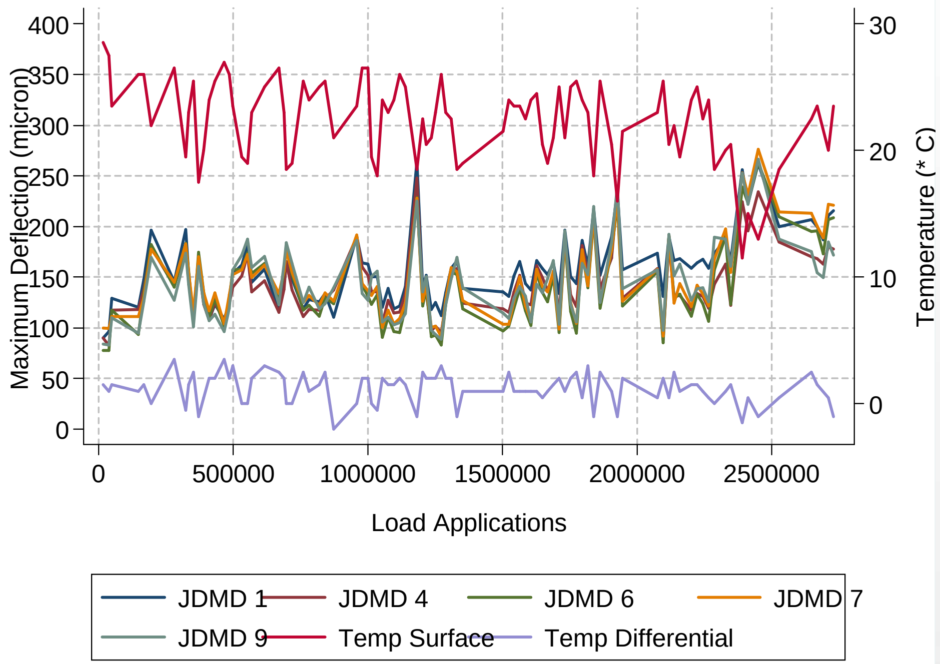
3.1.2 Surface Deflection – 40 kN





0500 h

1300 h

Deflection under twice daily standard load – 40 kN

Note inverse relationship between temperature and deflection

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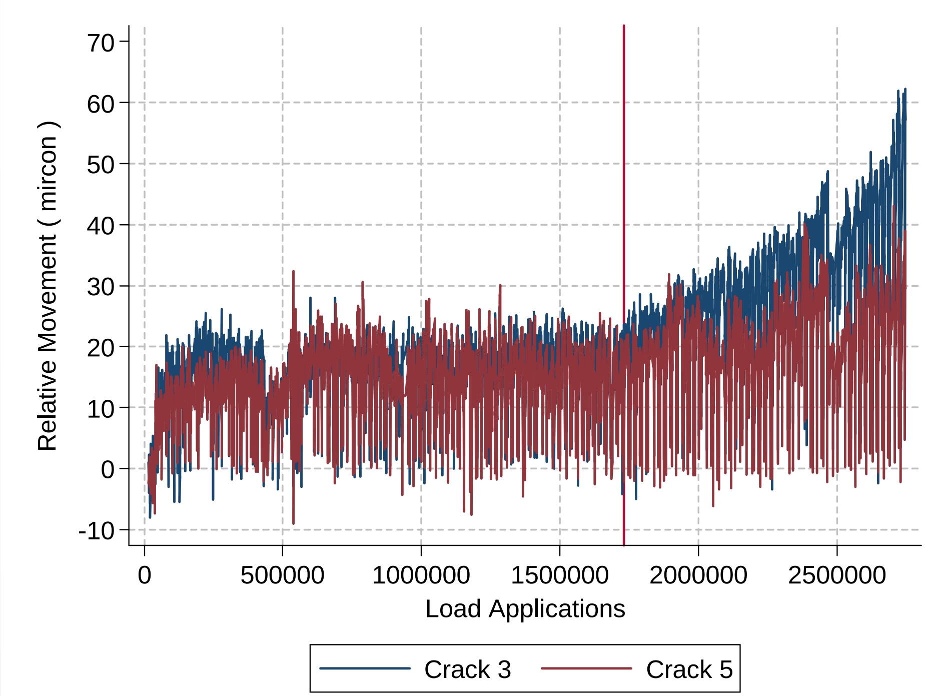
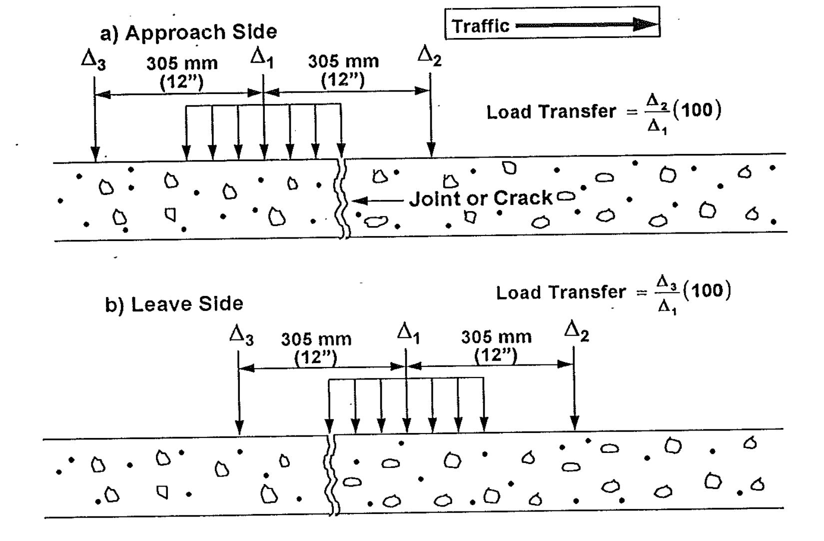
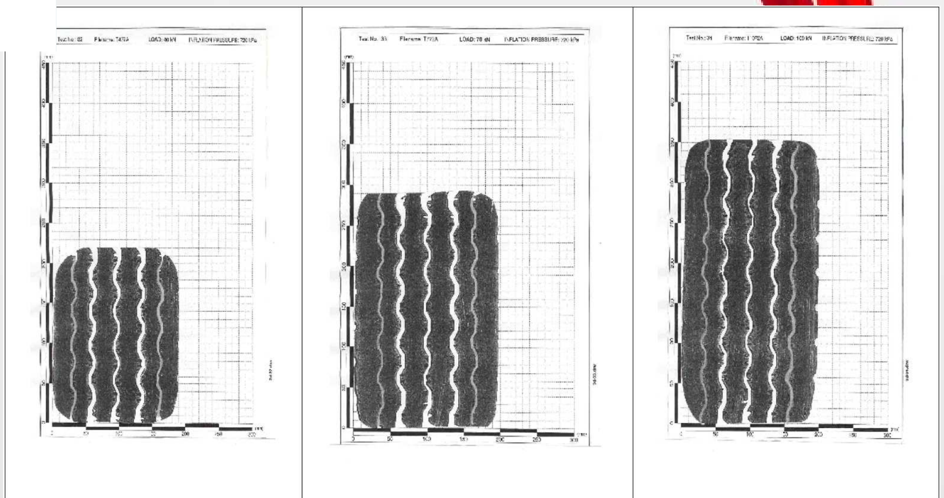
3.2.1 Relative Movement



Determined from JDMD deflection data

- When loading wheel was completely on one side of the crack
- Incorporated different tyre print sizes
- Variation is due to twice daily standard test loads



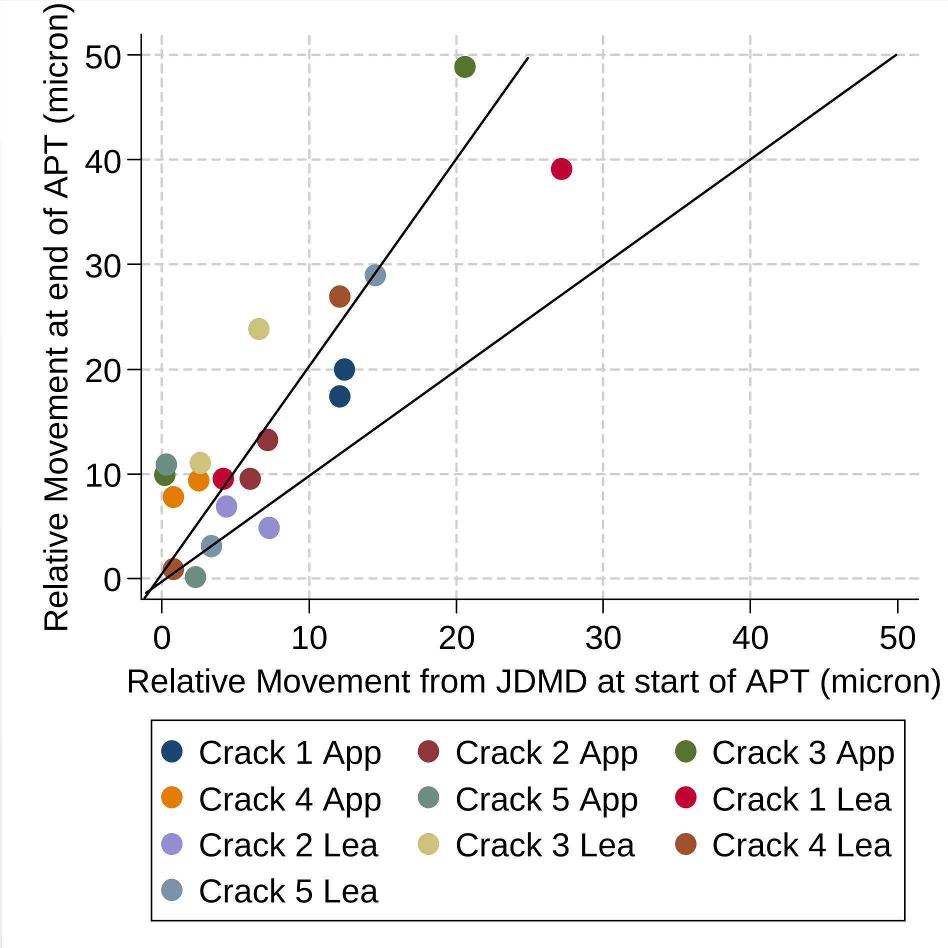


(a) Tyre Print: Case 1: Single Loads 20 kN, 720 kPa

(b) Tyre Print: Case 2: Single Load 35 kN, 720 kPa,

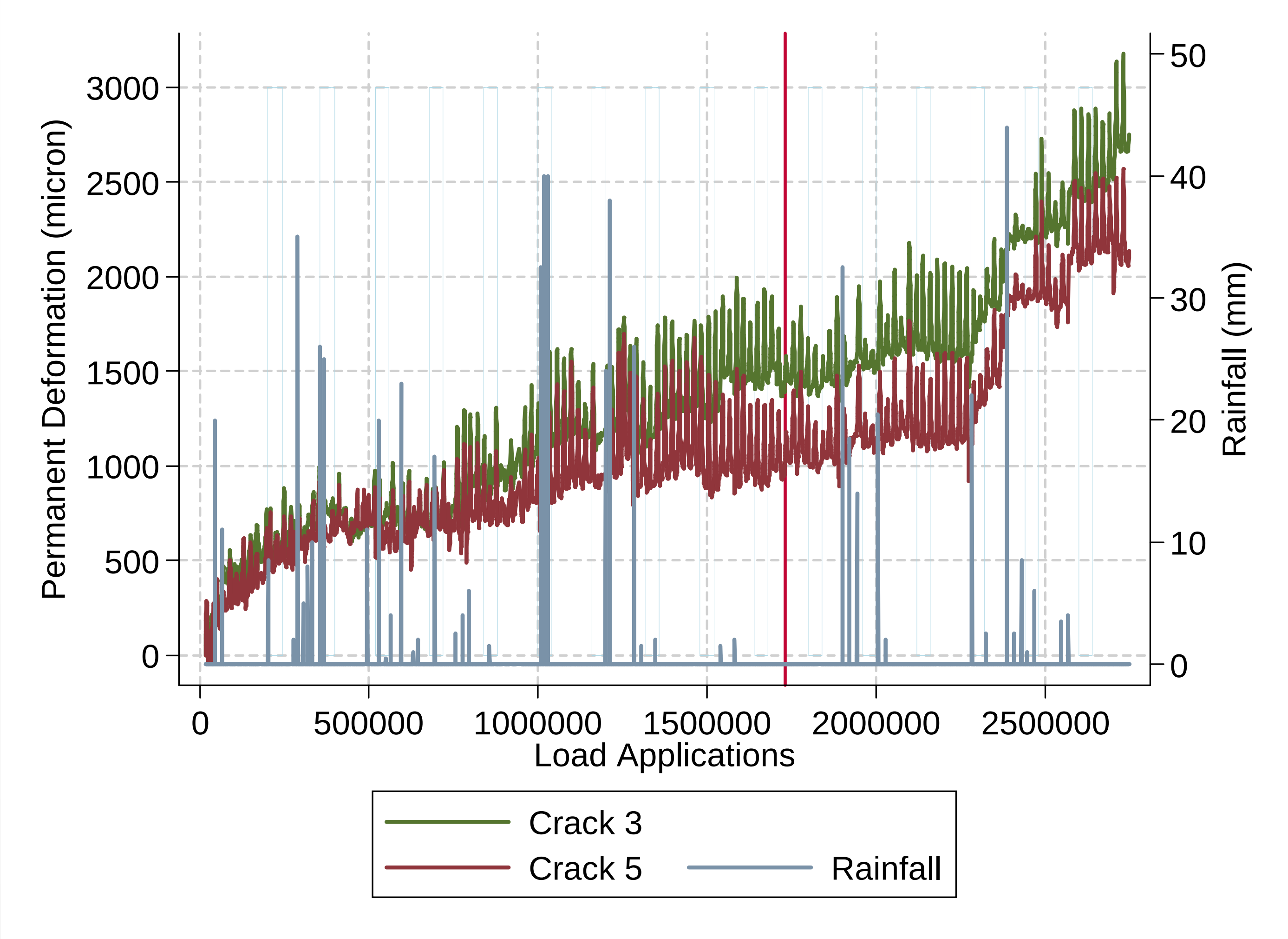
(c) Tyre Print: Case 1: Single Load 50 kN, 720 kPa

3.2.2 Relative Movement



- ➢ Comparison based on equivalent environmental conditions
- ➢ Average ratio between relative movement before and after = 2

3.3.1 Permanent Deformation



- ➢ Cyclical nature: warping and curling caused by daily environmental fluctuations

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4.1 Visual Surface Evaluation

Spalling at Crack 4

Cracks 1,2,3 and 5 intact

No pumping of material

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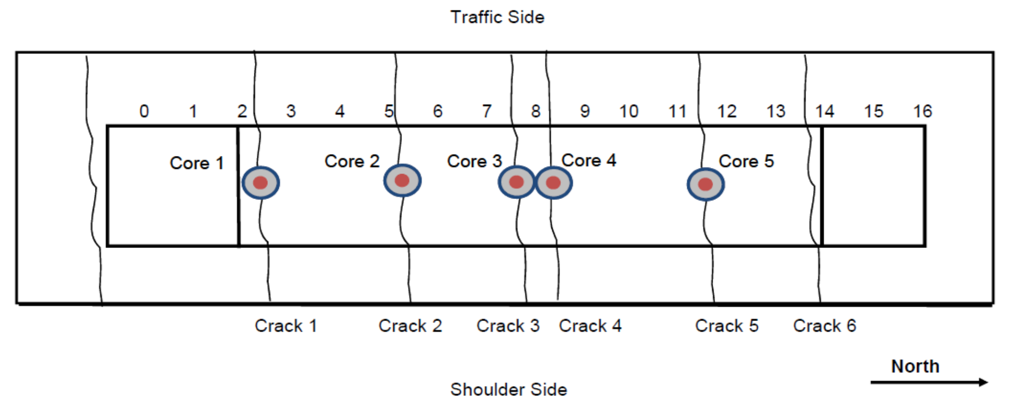
4.2 Diagnostic Investigation

Cores bisected the transverse cracks

- 50 mm core up to depth of 200 mm
- Filled with tinted epoxy
- 150 mm core up to 300 mm



4.3 Diagnostic Evaluation: Crack Widths

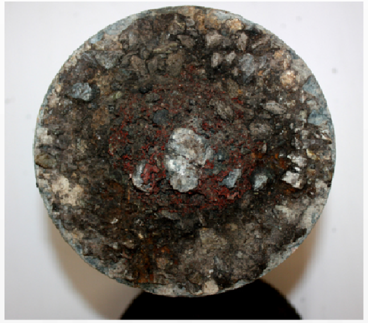
Position of measurement	Transverse crack number				
	1	2	3	4	5
Surface of core	0.840	1.080	1.430	0.730	0.630
Side of core -top	0.535	0.290	0.980	0.365	0.440
Side of core -middle	0.220	0.215	0.515	0.265	0.115
Side of core - bottom	0.080	0.215	0.510	0.155	0.105

Crack widths decrease with depth

Crack 3: greatest crack width

Crack 4: spalled crack

4.4 Diagnostic Evaluation: Interface



Deterioration of the CRC/HMA interface

- Stripping of the open-graded asphalt overlay
- Loss of fines, not visible at the surface

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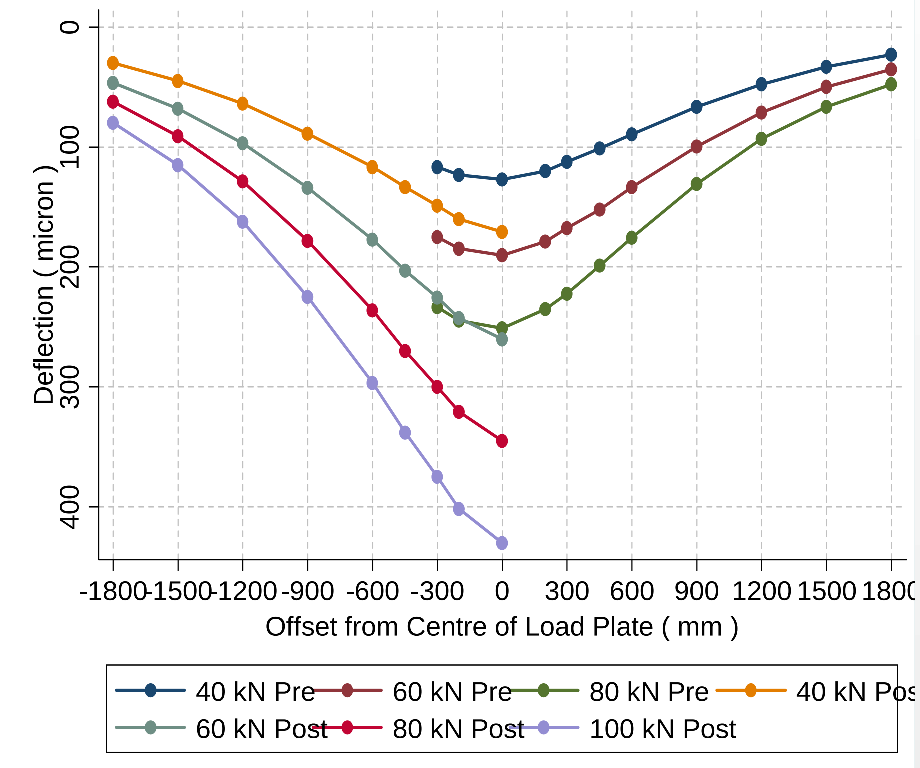
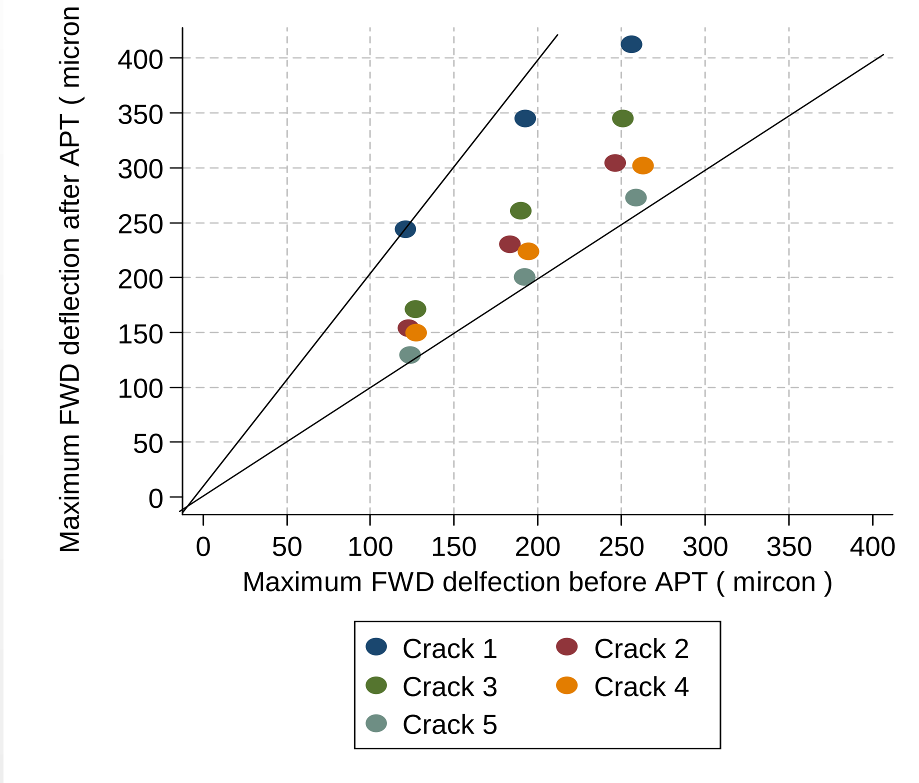
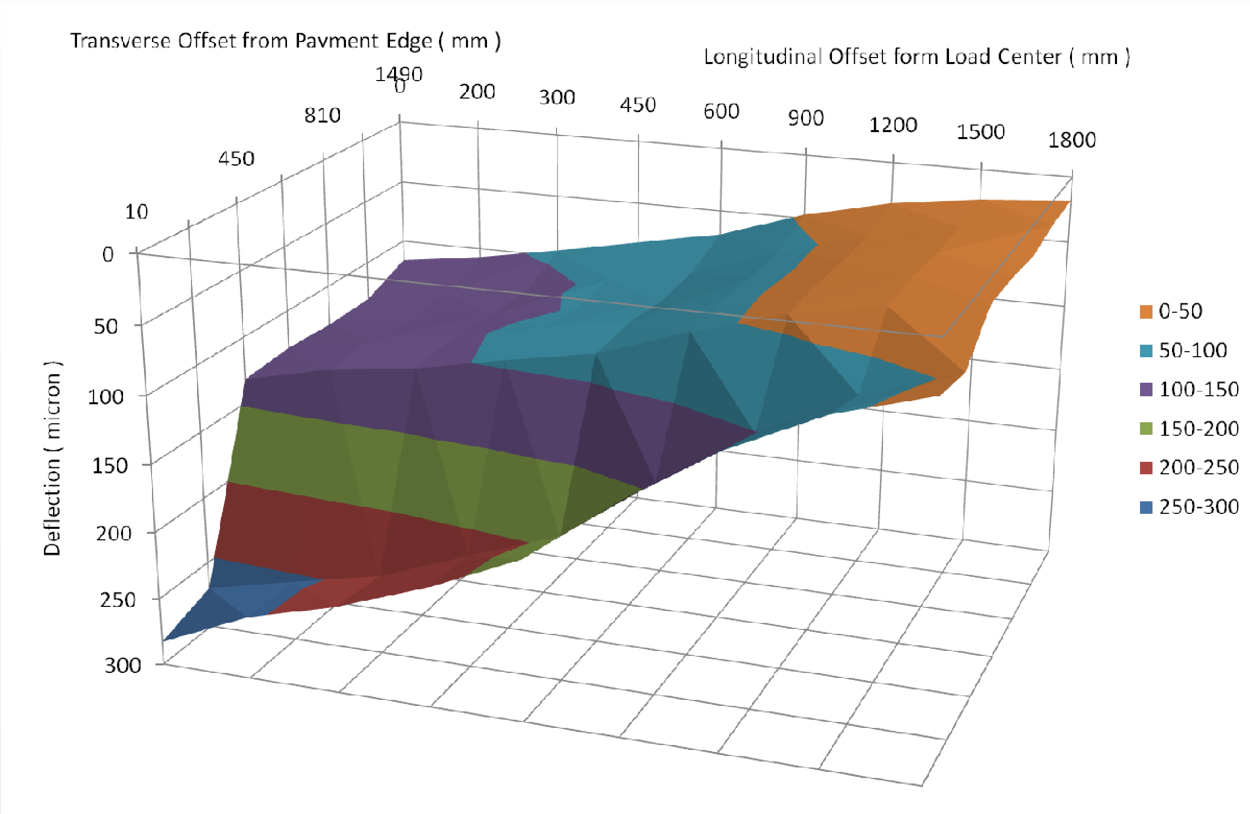
5.1 FWD Deflection





- FWD before and after APT
- Time Lapse between FWD after APT and HVS = 5 months
- Temperature and time of day comparable

5.2 FWD: Edge Loading and Backcalculation



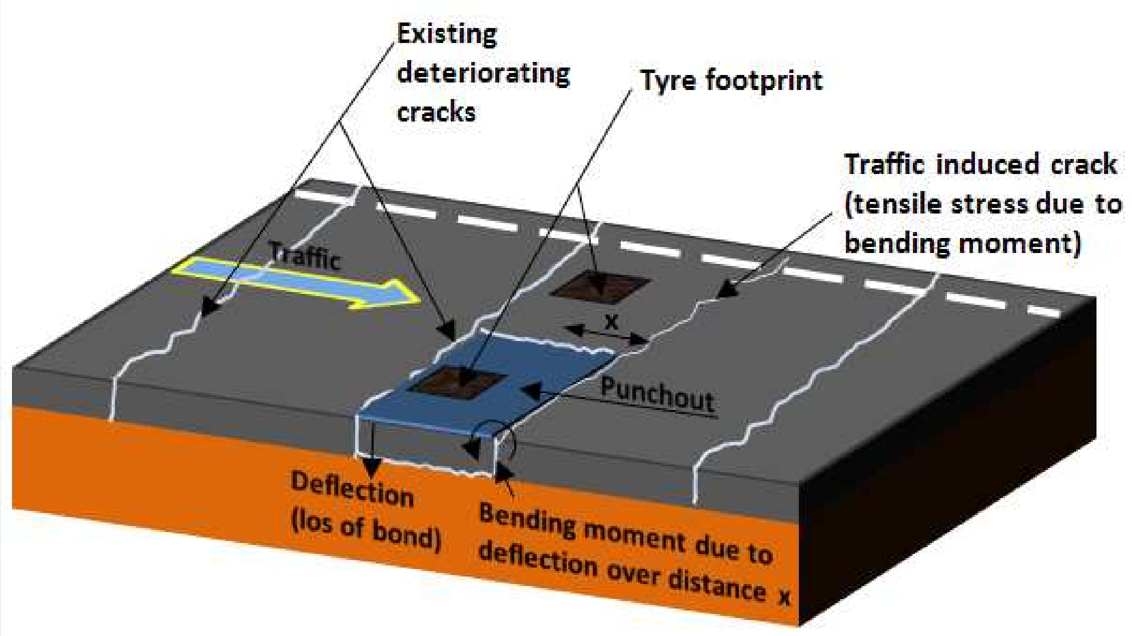
HVS = edge loading FWD = internal loading

Modulus of subgrade reaction indicate test section condition:

- 20th percentile of N20/N21 before start of APT,
- 7th percentile after APT

6. Application of Test Findings

Standard measures were used to develop a pavement performance model



Two predominant failure mechanisms

1. Loss of load transfer efficiency across a crack
2. Deterioration of the support structure

These mechanisms manifest in performance deterioration

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Questions / Discussion