

Contract Report: CR-2005/03

February 2005

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**Establishment of two
LTPP experiments in
association with HVS tests
on Road D2388 in Gauteng**

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DOCUMENT RETRIEVAL PAGE			Report No: CR-2005/03	
Title: Establishment of two LTPP experiments in association with HVS tests on Road D2388 in Gauteng				
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Client: Gautrans	Client Reference No: CR-2005/03	Date: February 2005	Distribution: Client Confidential	
Project No: TIK78	OE2: Infrastructure Engineering		Version: 1	
Abstract: This document summarises the establishment of two long-term pavement performance (LTPP) experiments adjacent to a previously conducted HVS experiment on Road D-2388 in Gauteng.				
Keywords: Long term pavement performance, LTPP, APT, HVS				
Proposals for implementation: Continue with monitoring at six monthly intervals.				
Related documents: CR-2003/7; CR-2003/25; CR-2004/17; CR-2005/05				
Signatures:				
P Paige-Green Language Editor	P Paige-Green Technical Review	B Verhaeghe Prog Manager	E van Heerden Info Centre	P Hendricks Director

TERMS OF REFERENCE

CSIR Transportek was requested by Gautrans to establish and monitor three long-term pavement performance experimental sections associated with two completed HVS studies in Gauteng. The terms of reference for the study were to:

- Locate and mark the experiments in line with the protocol prepared in 2003
- Instrument the sections (excluding multi-depth deflectometers)
- Carry out initial monitoring of the experiments
- Create a spreadsheet database of the data
- Prepare a first-level report for each experiment

A copy of the project proposal is attached in Appendix A.

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1. INTRODUCTION

During 2003, CSIR-Transportek developed a protocol for the establishment and operation of Long Term Pavement Performance (LTPP) sections¹. The primary objective of this was to initiate long-term monitoring of the performance of sections of road, particularly where Heavy Vehicle Simulator (HVS) testing had previously been carried out. Researchers will in future be able to compare data collected from these LTPP experiments with that collected from the shorter-term HVS experiments and use the results to develop more appropriate pavement designs and performance models. Relationships between HVS testing and real life performance will also be better understood.

This report summarises the establishment of two LTPP experiments on Road D2388 near Cullinan in the Gauteng Province. A series of HVS experiments was carried out on specially constructed sections on this road between July 1997 and October 1998.

2. HVS EXPERIMENTS ON ROAD D2388

2.1. Experimental Design

A 730 m long experimental section, consisting of 10 different base type/thickness combinations was constructed on Road D2388 near Cullinan in early 1997 to identify potentially suitable base types for low volume and basic access roads and to obtain reliable performance indicators in terms of the failure mechanisms and bearing capacity for the different material types. Nine of the bases were built using labour intensive construction methods, while the tenth, a crushed stone base, was constructed using conventional methods and served as a control. The following bases were tested:

- Waterbound Macadam - 100 and 150 mm
- Composite Macadam - 75 and 125 mm
- Emulsion treated natural gravel - 100 and 150 mm
- Modified clinker ash - 100 and 150 mm
- Emulsion treated modified clinker ash - 100 mm
- Crushed stone (G2) - 100 mm

HVS testing was planned in two phases:

- An initial rapid comparison of all sections to enable the most promising base types to be identified in terms of relative performance and cost
- A more comprehensive evaluation of the identified candidate sections

2.2. Findings from HVS Experiments

The most pertinent findings were associated with deflection, cracking as a result of binder ageing and permanent deformation Error! Reference source not found.

Deflection response on the treated sections was as follows:

- | | |
|----------|--|
| Sound: | 100 mm crushed stone |
| | 75 mm composite Macadam |
| | 100 mm Waterbound Macadam |
| Warning: | 100 mm emulsion treated natural gravel |
| | 125 mm composite Macadam |

150 mm Waterbound Macadam
150 mm emulsion treated natural gravel

Severe: 100 mm modified clinker ash
150 mm modified clinker ash
100 mm emulsion treated modified clinker ash

For strictly low volume road applications, materials considered to be in sound and warning condition are probably suitable. This was substantiated from the back calculated resilient modulus values. Those values obtained from the modified clinker ash bases were considered to be too low for a pavement base in a conventional high traffic design - high tensile strains are likely to develop in the surfacing over this material, leading to unsatisfactory performance.

Aged binder had an influence on the failure mechanism of most of the base layer sections². The fine cracks that were present on the test sections before the start of the test culminated as crocodile cracks in some of the test sections during the wet testing period.

In terms of pavement deformation, performance for low volume road applications was as follows:

20x10 ⁶ ESALs:	100 mm crushed stone
15-20x10 ⁶ ESALs:	150 mm emulsion treated natural gravel 150 mm Waterbound Macadam
5-15x10 ⁶ ESALs:	100 mm emulsion treated natural gravel 100 mm Waterbound Macadam
3-15x10 ⁶ ESALs: (Dependent on construction)	75 mm composite Macadam 125 mm composite Macadam 100 mm modified clinker ash 150 mm modified clinker ash 100 mm emulsion treated modified clinker ash

3. SECTION LOCATION AND ESTABLISHMENT

Although 10 different experiments were constructed on Road D2388, most were of insufficient length to accommodate an LTPP experiment. Therefore, only two experiments were selected, one on either side of the HVS experiments. Both were constructed with an emulsion treated ferricrete gravel, but on different selected layers - the first section (H1/04-G-D2388) on ferricrete and the second (H2/04-G-D2388) on sandstone.

The sections were numbered according to the recommendations in the protocol¹.

Schematics of the section locations and section layout are provided in Figures 3.1 and 3.2.

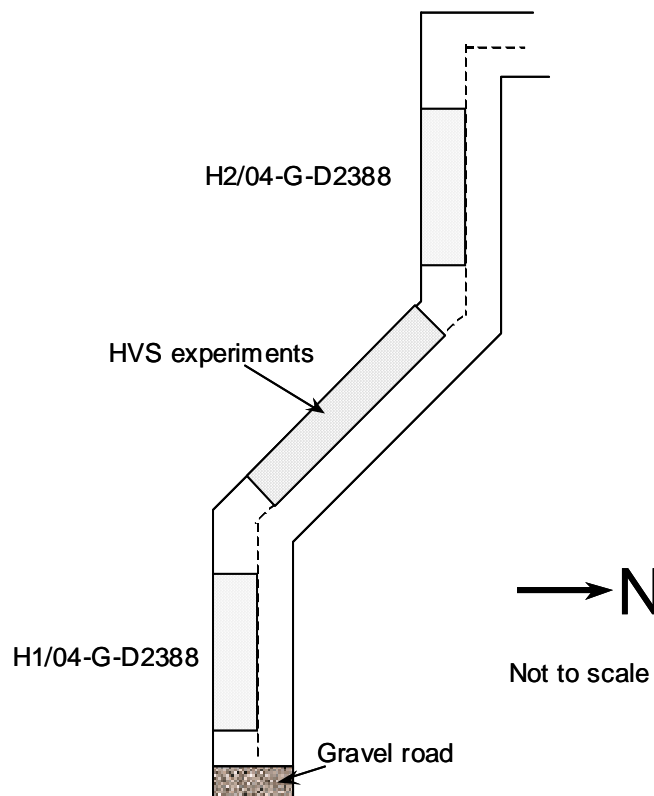


Figure 3.1: Schematic of section location

3.1. Experiment 1 - H1/04-G-D2388

This section could not be positioned adjacent to or at the end of the HVS section. The HVS sections were too short to accommodate an adjacent LTPP section, while the end of

the HVS section was too close to a relatively sharp bend. The section was thus moved towards the east and started at Chainage 3.463 (measured from the 3.0 km marker) running in the decreasing chainage lane. The end of the sealed section of the road is marked 3.51 but is actually at 3.528 km, 65.1 m from the end of the LTPP section.

The Global Positioning System (GPS) coordinates of the markers at the beginning and end of the section adjacent to the edge of the seal are provided in Table 3.1.

Table 3.1: GPS coordinates of LTPP section H1/04-G-D2388

Position	Latitude	Longitude
Start of section	25° 36' 32.94"	28° 35' 51.60"
End of section	25° 36' 35.28"	28° 35' 44.94"

The section was laid out in general accordance with the protocol with panel boundaries, numbers and lane centre marks painted onto the road surface. The positions for the following testing were also marked:

- Deflection (RSD, FWD and MDD)
- Rut depth
- Density and moisture
- Temperature

Aluminium tubes (1.0 mm wall thickness) were inserted into the pavement for the density measurements. Temperature buttons, programmed to record every 60 minutes were positioned in the pavement at the prescribed positions.

3.1.1 Deviations from Protocol

The following changes to the protocol were made when establishing the experiment:

- Road Surface Deflectometer (RSD) and Falling Weight Deflectometer (FWD) readings were taken at the same point
- Multi-depth deflectometers were not installed at the request of Gautrans
- The strata gauge measuring points on the centreline in Panels A, B and C were changed to the lane centre because of safety issues with regard to passing traffic
- Dynamic Cone Penetrometer testing was moved from the centreline to the lane centre of the panels because of safety issues with regard to passing traffic.

3.2. Experiment 2 - H2/04-G-D2388

This section starts at km 2.3 and ends at km 2.1. As with Experiment H1/04-G-D2388, the start point was positioned away from the HVS section (158 m) to obtain a straight section.

The Global Positioning System (GPS) coordinates of the markers at the beginning and end of the section adjacent to the edge of the seal are provided in Table 3.2.

Table 3.2: GPS coordinates of LTPP section H2/04-G-D2388

Position	Latitude	Longitude
Start of section	25° 36' 40.92"	28° 35' 11.10"
End of section	25° 36' 42.96"	28° 35' 04.38"

The section was laid out in accordance with the protocol with panel boundaries, numbers and lane centre marks painted onto the road surface. The positions for the following testing were also marked:

- Deflection (RSD, FWD and MDD)
- Rut depth
- Density and moisture
- Temperature

3.2.1 Deviations from Protocol

The same changes detailed for Experiment H1/04-G-D2388 were made on this experiment.

3.3. Material Sampling

No material samples were removed from either of the sections.

3.4. Weather Station

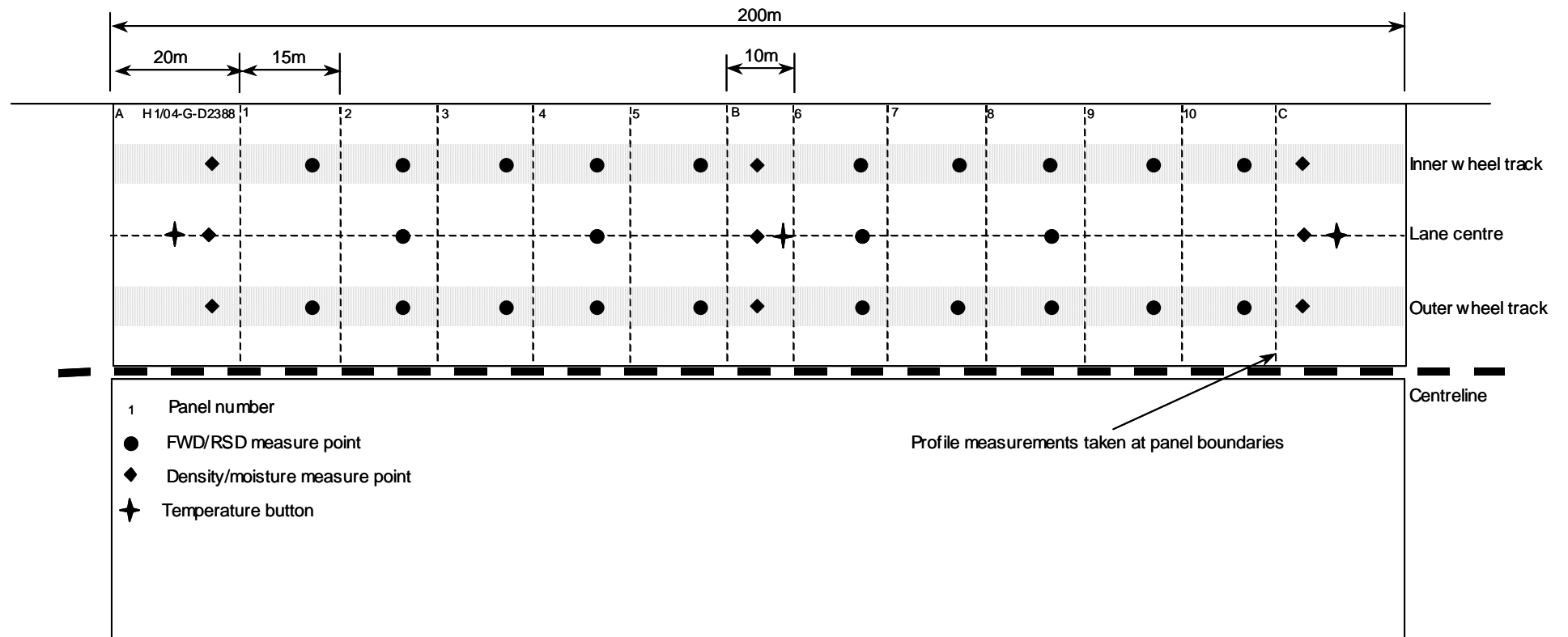
The South African Weather Service does not have any comprehensive weather data collection facilities in close proximity to the experimental sections. Arrangements were therefore made with a farmer, whose property is adjacent to Experiment H2/04-G-D2388, to provide rainfall data, while temperature data will be obtained from the Cullinan town council. Full contact details will be provided once a formal agreement is in place.

3.5. Traffic

There is no traffic data collection point in the vicinity of the experiments. The costs for installing a permanent weigh-in-motion sensor could also not be justified. Instead, the following procedure was followed:

- A seven-day electronic count with two loops per lane on two lanes
- A 12-hour detailed manual classified count
- A 12-hour individual axle load survey

This information will be used to establish traffic volume and loading estimates for the road. The counts were undertaken by Traffic Engineering Services.



Not to scale

Figure 3.2: Layout of LTPP test sections on D2388

4. REFERENCES

1. JONES, D. and Paige-Green, P. 2003. **A protocol for the establishment and operation of LTPP sections - 1st Draft.** Pretoria: CSIR-Transportek. (Contract Report CR-2003/11).
2. MANCOTYWA, W.S. 2001. **First level analysis report: Phase I testing of experimental sections on Road D2388 near Cullinan.** Pretoria: CSIR Transportek. Contract Report. (CR-99/011).

APPENDIX A

PROJECT PROPOSAL

APPENDIX A: PROJECT PROPOSAL

PROJECT PROPOSAL GAUTRANS/PP/2004/06 (Version 2)

03 August 2004

FULL ESTABLISHMENT AND MONITORING OF FOUR LTPP SECTIONS



Contact persons

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1. BACKGROUND

A protocol for the establishment and monitoring of LTPP sections in conjunction with HVS experiments was completed in 2002. In 2003 a small study was commissioned to layout sections at the HVS sections on Roads P2388 and P243/1 and to complete visual assessments and DCP measurements. In terms of the protocol, responsibility for gathering or arranging for the gathering of the remaining data rested with Gautrans. To date, installation of equipment and gathering of outstanding data has not been carried out. In order to ensure that the full benefit of the original project is obtained, the implementation phase should be re-initiated as soon as possible. This proposal describes an implementation phase with cost estimates.

2. PROBLEM STATEMENT

Considerable funding has been invested both in HVS studies and in the development of a protocol for conducting LTPP studies in association with HVS tests. It is important that the LTPP studies are implemented as soon as possible to maximise the usefulness of the information that can be collected.

3. METHODOLOGY

It has been agreed that, initially, only five LTPP sections will be considered at four HVS sites, namely P2388 (2 sections), P243/1 (1 section), N7 (1 section) and 538 (1 section). The latter two sections are situated in the Western Cape and funding for their monitoring will need to be sought from the Western Cape Government. Final selection of sections rests with the Project Director (Ms E Sadzik).

Each section will be established as proposed in the protocol. Costs have been itemised such that components can be omitted if considered unaffordable. However, it should be noted that one of the primary reasons for initiating the study was comparison of LTPP with HVS. Omission of a component will result in zero data for comparison of that parameter with HVS data already collected.

4. PROJECT DELIVERABLES

The following deliverables are anticipated:

- Summary reports on the completion of establishment of each LTPP section (4 reports).
- First level reports on completion of first monitoring of each LTPP section (4 reports).
- Spreadsheets with raw data from each LTPP section (5 spreadsheets)

5. BENEFIT TO THE ROAD AUTHORITY

Road authorities and their appointed consultants and researchers will have access to the data collected from both LTPP and HVS sections. In time, this information will enable the establishment of the link between APT results and real-life performance, which will realise the full potential of the large amount of HVS data that has been collected.

6. ESTIMATED COSTS FOR ESTABLISHMENT AND FIRST EVALUATION

6.1 P2388 (2 sections)

Establishment and initial monitoring			
Task	Units	Unit cost	Cost (R)
Time (DJ) incl lab result analysis*	80	725	58 000
Time (CF)	16	375	6 000
Time (Assistants)	16	150	2 400
MDD	0	15 100	0
Temperature buttons	6	150	900
Thermocouples	6	50	300
Nuclear gauge tubes	18	20	360
DCP points	18	10	180
FWD establishment	150	7	1 050
FWD measurements	48	80	3 840
RSD measurements	150	5.5	825
Cold mix	2	50	100
Running costs (Travel and S&T)	1	3 000	3 000
Traffic counts/WIM	-	-	-
Sub-total			76 955
14% VAT			10 774
Total			87 729
* using as built data - no new testing planned			

Subsequent monitoring			
Task	Units	Unit cost	Cost (R)
Time (DJ)	40	725	29 000
Time (CF)	8	375	3 000
Time (Assistants)	16	150	2 400
DCP points	18	10	180
FWD establishment	150	7	1 050
FWD measurements	48	80	3 840
RSD measurements	150	5.5	825
Cold mix	2	50	50
Running costs (Travel and S&T)	1	1 950	1 950
Traffic counts/WIM	-	-	-
Sub-total			42 295
14% VAT			5 922
Total			48 217

6.2 P243/1 (1 section)

Establishment and initial monitoring			
Task	Units	Unit cost	Cost (R)
Time (DJ) incl lab result analysis*	80	725	58 000
Time (CF)	16	325	5 200
Time (Assistants)	16	150	2 400
MDD	0	15100	0
Temperature buttons	3	150	450
Thermocouples	3	50	150
Nuclear gauge tubes	9	20	180
DCP points	9	10	90
FWD establishment	300	7	2 100
FWD measurements	24	80	1 920
RSD measurements	300	5.5	1 650
Cold mix	2	50	100
Running costs (Travel and S&T)	1	6 000	6 000
Traffic counts/WIM	-	-	-
Sub-total			78 240
14% VAT			10 954
Total			89 194
* using as built data - no new testing planned			

Subsequent monitoring			
Task	Units	Unit cost	Cost (R)
Time (DJ)	40	725	29 000
Time (CF)	8	375	2 600
Time (Assistants)	16	150	2 400
DCP points	9	10	90
FWD establishment	300	7	2 100
FWD measurements	24	80	1 920
RSD measurements	300	5.5	1 650
Cold mix	1	50	50
Running costs (Travel and S&T)	1	2 300	1 950
Traffic counts/WIM	-	-	-
Sub-total			41 760
14% VAT			5 847
Total			47 607

Total cost estimate for establishment and first monitoring of Gautrans sections: R272 747

7. PROJECT TEAM

Project Manager/technical specialist	Dr D Jones
Technical support:	Dr P Paige-Green
	Mr C Fisher

8. SCHEDULES

Time

In terms of the protocol, section monitoring should take place in May and October each year. Assuming that establishment and the first evaluation take place at the same time, the first level reports and data spreadsheets should be completed by 31 December 2004.

Payment

Invoices will be submitted with deliverables.