



# HVS FOCUS

APRIL 2005



## from the editor

Much has happened since our last HVS Focus in October 2003. The HVS of The Gauteng Provincial Government, Department of Public Transport, Roads and Works (Gautrans) was on display at The PIARC 22nd World Road Congress in Durban. The machine drew plenty of international attention from all over the world. Delegates from India and the Middle East were particularly interested in this uniquely South African designed accelerated pavement testing device. They are considering their own APT programs with HVS equipment.

Since PIARC, the HVS has been very busy, and we devote this issue of HVS Focus to the latest round of experiments completed since October 2003.

In this issue you can read about the following topics:

- The current testing program on the N12 in the proximity of Johannesburg

- What is being done to link results from HVS testing to long-term pavement performance. Gautrans have embarked on a study to monitor sections of road adjacent to HVS experiments throughout the country in order to evaluate actual pavement deterioration and to compare it to that recorded under HVS trafficking.
- The latest round of HVS testing on concrete completed in August 2004 on the N3 near Pietermaritzburg.

We trust that you will find this issue of HVS Focus informative and a good source of information on the latest findings related to accelerated pavement testing in South Africa.

Please direct comments, concerns and suggestions to:

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All the research reported in this issue of HVS Focus and other interesting investigations can be found on the HVS website hosted by Gautrans: <http://www.gautrans-hvs.co.za>

## HVS TESTING ON N12

The Gautrans HVS has been used to test a 30-year old Emulsion Treated Base (ETB) section on the N12-19 East of Johannesburg since January 2005. This section is one of 8 that form part of the original S12 experiment that was conducted in the early 1970s to compare various subbase, base and surfacing designs. The objective of the current tests is to determine the ultimate strength and failure mechanisms of the rehabilitated ETB section. This section was rehabilitated in 1974 after the initial CTB section failed prematurely. The CTB was ripped and 1 per cent emulsion was added to the material before being compacted and surfaced with 50 mm of asphalt and a 13 mm rubber seal. Since construction, the only maintenance has been a fog spray applied in 1992.

The test was initiated using a nominal 40 kN/690 kPa dual wheel load, which was increased to 80 kN/800 kPa after 20 000 load applications. For the last 850 000 load applications a load of 100 kN/800 kPa has been used.

The current data from the experiment indicate that the road structure is still in a very good condition, even after the application of an additional 10 to 20 years of heavy vehicle traffic. The road surfacing has remained intact, preventing the ingress of water.

The current focus of this test is to determine the ultimate failure mechanism of the road

structure, through the introduction of water that is allowed to penetrate sawcuts in the pavement surfacing.

It is believed that the information obtained from these tests will play an important role in ensuring that the road design guides for South Africa can be updated with relevant data from both accelerated and long-term pavement tests.



HVS testing on N12 ▲



Core from N12 section showing asphalt and ETB base ►

# LTPP EVALUATION OF HVS SECTIONS

While accelerated pavement testing (APT) can, and does, provide significant data for analysing and predicting the effects of traffic loading on the performance of various materials, it is not always capable of capturing environmental and other long-term effects. It is only when comparisons of APT and long-term pavement performance (LTPP) are available that there will be greater confidence in the interpretation and use of APT results.

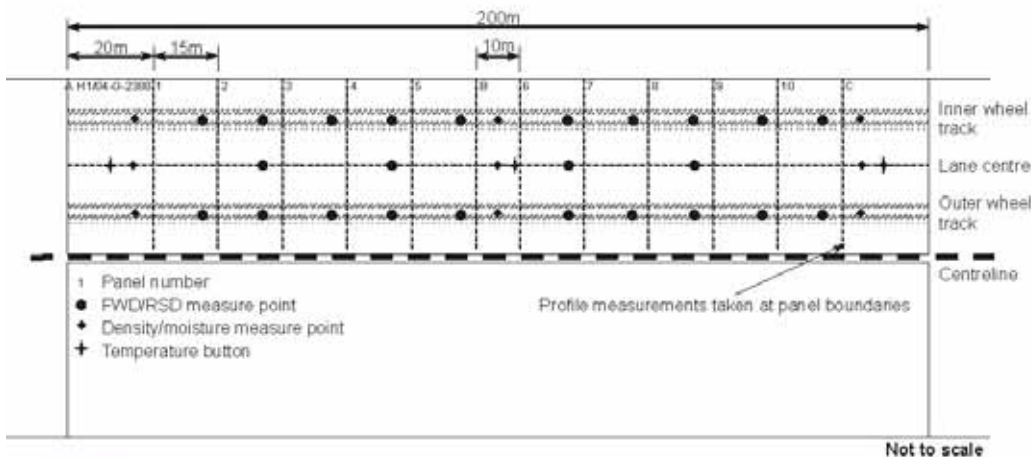
View of LTPP section at Cullinan



Taking RSD measurements at Cullinan



A typical LTPP section layout



To this end, Gautrans have initiated a study to assess the LTPP of sections adjacent to recently completed HVS experiments. The project started with the development of a protocol for the establishment and operation of LTPP sections, which includes:

- details on linking LTPP to HVS data collection;
- management and responsibilities;
- site location and establishment;
- data collection and storage, and
- reporting criteria.

To date, three LTPP sections have been established, two adjacent to the HVS sections constructed near Cullinan on Road D2388 (labour intensive constructed emulsion treated gravel) and one adjacent to the HVS sections on Road P243/1 between Vereeniging and Heidelberg (deep in situ recycling with foam bitumen). It is expected that the foam bitumen treatment on the N7 near Cape Town will also be included in the program. Each section is 200 m long and is divided into 10 x 15 m long evaluation panels and 3 panels reserved for destructive testing (ends and middle).

Initially the sections will be evaluated twice a year at the beginning (May) and end (November) of the dry season. Current evaluations include:

- a visual assessment;
- transverse and longitudinal profile;
- DCP;
- in situ density and moisture content;
- riding quality measurements, and
- deflection measurements (Falling Weight Deflectometer (FWD) and Road Surface Deflectometer (RSD)).

Provision has also been made for multi-depth deflectometers. However, these have not yet been installed.

Traffic is determined from a seven-day traffic count, while environmental conditions are determined from rainfall and temperature readings collected at nearby farms and by temperature buttons installed below the surfacings.

The sections have been evaluated twice since the establishment of the LTPP sections. First level analysis reports have been prepared following each evaluation, but no comparisons with HVS data have been conducted as yet.

# HVS TESTING OF CONCRETE PAVEMENT STRUCTURES IN KWAZULU-NATAL

The South African National Road Agency Ltd. (SANRAL), Gautrans, The Cement and Concrete Institute (C&CI) and CSIR Transportek joined forces to conduct long needed research on the performance of concrete roads in South Africa. Because of concrete's high strength and long predicted life span the HVS is the ideal tool to access the durability and performance of these rigid pavement structures in a relatively short period.

## BACKGROUND

The first South African mechanistically-based concrete pavement design manual, the M10 Manual, was issued in 1995. The M10 manual introduced the load transfer constant  $C$  as a basis to distinguish between the load transfer capabilities of aggregate interlock, dowels and continuously reinforced concrete pavements (CRCP). The principles used in the M10 Manual were further developed and refined and are available as a design tool in the form of a software package called *cncPave*. Based on the use of *cncPave* and the monitoring of the performance of existing concrete roads and trial sections, it became apparent that verification was needed to refine and calibrate the performance models used in the software.

To address especially the load transfer issue, two HVS experimental Portland cement concrete (PCC) sections were constructed at the Hilton off ramp, close to Pietermaritzburg on the N3. These sections were subjected to accelerated loading for a period of over 7 months starting November 2003.

## TESTING OBJECTIVES

The specific testing objectives were to:

1. Investigate the influence of the environment and accelerated loading on joint deterioration of doweled and plain aggregate interlocking joints using quartzite and dolerite materials, and
2. Determine the remaining life of an in-service concrete inlay pavement section on the N3.

To assess the environmental influence on PCC, the pavement sections were instrumented to record the vertical slab edge and corner curling movements due to daily temperature variations.

## SIGNIFICANT FINDINGS

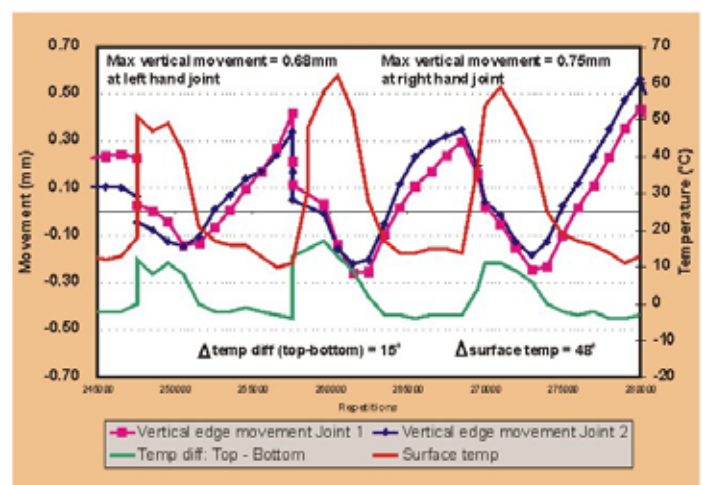
Temperature changes have a significant effect on slab edge and corner curl. Slab curl due to differential temperatures between the top and the bottom of the slabs were monitored every 2 hours together with ambient temperature, and the temperatures at the top and bottom of the slabs. Slab curl as high as 0.75 mm was recorded on the doweled quartzite

sections under the influence of a maximum temperature differential of 15°C and a maximum surface temperature of 48°C.

This effect highlights the importance of proper concrete pavement design. At night the edges of the concrete slabs curl upwards due to the negative temperature differential between the surface and the bottom. This curling effect creates a cavity under the slab and the loss of support from the pavement structure under the concrete will have a negative effect on the long-term performance of the pavement, especially when heavy vehicles travel close to the shoulder of the road at night.



▲ HVS test sections at Hilton



▲ Typical correlation between temperature and slab curl

This effect was also observed from elastic deflection analysis. Deflections measured at night were significantly greater than those measured during the hottest part of the day.

Load Transverse Efficiency was measured throughout the testing period. The doweled joints performed significantly better than the plain aggregate interlocking joints.

### TESTING OF THE IN-SERVICE PCC INLAY SECTION ON THE N3

During the second phase of the study, the remaining life of an existing concrete in service inlay was determined through HVS testing.



The section was subjected to 340 000 60 kN load applications followed by 223 000 80 kN load applications. Due to the slow rate of any physical deterioration, water was introduced in all cracks from 130 000 repetitions onwards at a rate of approximately 22 litres per hour. Even with the aggressive loading and the introduction of water very little additional damage was detected.

Deflection sensors (JDMDs) placed along the edge of the testing area reported deflections in the order of 0.2 mm at the end of the test. The relative movement across all cracks was also measured at 2 hour intervals. Relative movements of less than 0.15mm were recorded, even after the application of the aggressive 80kN load.

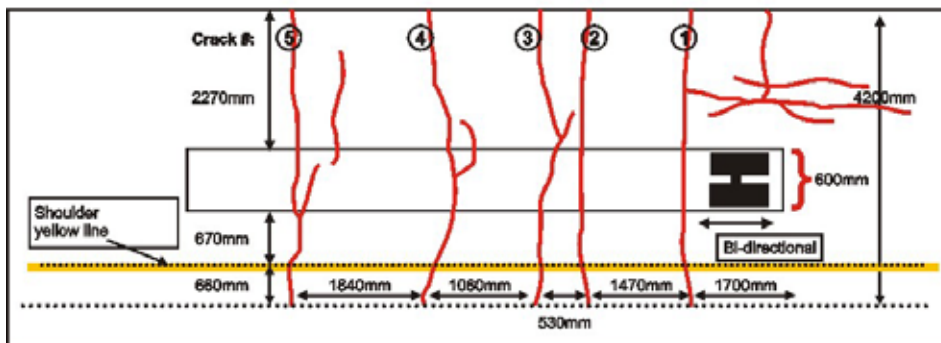
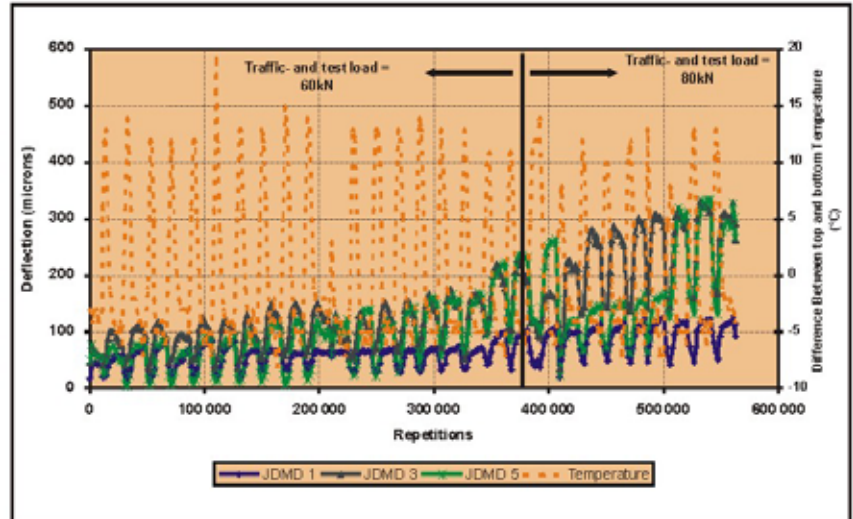
Using the 4.2 damage factor the pavement was subjected to 5.9 million E80s in addition to the 6.5 million prior to the start of HVS testing and the pavement was not considered failed after the completion of the test.

The benefit of HVS testing is clearly illustrated by this study. Due to the presence of a significant cracking pattern it was thought that the pavement had reached the end of its structural life. Through HVS testing it was discovered that the pavement has not failed yet and that a significant amount of traffic can still be carried before any major rehabilitation will be required.

◀ HVS testing on the N3 PCC inlay

The selected area was representative of the condition of a particular section of the N3 near Pietermaritzburg. The inlay consists of 180 mm continuously reinforced concrete (CRCP) placed on top of 150 mm of asphalt and 250 mm of stabilised dolerite crushed rock.

The pavement, constructed in 1998, had carried approximately 6.5 million standard axle loads. Due to the presence of a significant cracking pattern it became important to determine how long the structure would last before major rehabilitation would be required.



▲ Elastic deflections measured on cracks at the inlay HVS section

◀ Crack pattern at the inlay HVS test section