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HVS FOCUS

# From the editor

Much has happened since our last HVS Focus in 2005. Increasing expenditure on the rehabilitation of our road network has also sparked an increase in research into more cost-effective road building and rehabilitation strategies. The interest in accelerated pavement testing (APT) in South Africa has grown such that for the first time in 15 years, both HVS machines currently in South Africa (the HVS Mk IV owned by The Gauteng Provincial Government, Department of Public Transport, Roads and Works, and the Mk III owned by the CSIR) are utilised on a 24/7 basis since 2006.

The national interest in rapid rehabilitation, long-life pavements as well as labour-intensive construction has led to a major study in the use of ultra-thin continuously-reinforced concrete to be used as an overlay on our national road network. This study, which is in its final phase, consists of an elaborate laboratory study, dynamic finite element modelling, HVS evaluation of trail sections and full-scale implementation at the traffic control centre on the N3 near Heidelberg. This study is mainly financed by the South African National Road Agency (Ltd) (SANRAL) and the Gauteng Department of Public Transport, Roads and Works (GDPTRW). We will highlight this topic in the next issue of HVS Focus.

On the asphalt side, the HVS is currently evaluating various rut-resistant hot mix asphalt (HMA) mixes. The study supported, by SABITA, the GDPTRW and the CSIR, is addressing the issue of rutting at intersections. The second phase of the study will investigate the fatigue properties of various mixes. A comprehensive report on this will appear in the next HVS Focus.

This issue of HVS Focus concentrates on the following topics:

- a summary on the strategic planning of the HVS programme by the GDPTRW for the five-year period 2005 – 2009
- an article on the appropriate use of labour-intensive construction methods
- feedback on a two-year study on material classification and the structural design of bituminous stabilised materials
- a brief summary of HVS investigations in recent years plus what is planned for the immediate future.

Good news is that two more countries have joined the HVS family – China recently became the first Asian country to order an HVS. A newly-developed MK VI has just been delivered to Chang'an University, Xi'an, China and a MK IV will be delivered to the Central Road Research Institute (CRRI) in New-Deli, India early in 2009. This brings the total number of HVS units currently in operation to 10, making it the most successful mobility APT testing device available worldwide.

Lastly we would like to say a warm goodbye to Elzbieta Sadzik. She has been overseeing the HVS programme on behalf of the GDPTRW and has now left the Department after serving the HVS programme for more than 15 years. We would like to acknowledge the excellent work and her devoted interest in the HVS programme. Not only has she been instrumental in the use of the HVS for fast-tracking research locally, but she also assisted in propelling this unique South African technology to the world stage.

South Africa is still seen as one of the world leaders in APT and her contribution towards this is greatly realised. The Department's HVS-associated technology development programme is represented in eight of the 64 papers presented at this year's international conference on APT in Madrid, Spain and is also involved in two of the four workshop sessions. Well done, Elzbieta, and all the best for your new future.

We trust that you will find this issue of HVS Focus informative and a valuable update on the latest findings relating to accelerated pavement testing in South Africa.

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*For all HVS international activities visit www.hvsia.co.za*

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

# HVS Strategy 2006 - 2009

The Gauteng Department of Public Transport, Roads and Works (GDPTRW) has been operating a Heavy Vehicle Simulator (HVS) since 1978 and its current HVS is one of two machines operating in South Africa. The Department's HVS-associated technology development programme (HVS Programme), as part of a broader accelerated pavement testing (APT) programme coordinated by the Department, has had a major technological and economic impact on the design, construction and maintenance of roads. This is true for Gauteng nationally, and internationally; it has impacted on, for example:

- the development of pavement design standards and guidelines
- the development of material specifications and guidelines
- the development of human resources
- capacity building in the road construction industry
- implementation of labour-intensive technologies
- the development of innovative products and designs
- the provision of cost-effective, fit-for-purpose road infrastructure engineering solutions.

Of particular interest in the recent past and in line with current departmental strategies, the HVS has been used to evaluate and optimise the use of special materials, road designs and construction methods for labour-intensive construction, thus facilitating the creation of jobs in the road building industry. This work contributed towards a better understanding of the use of labour-intensive construction techniques, taking cognisance of input factors (e.g. material type and environmental conditions), performance requirements and quality standards. The study was particularly important to the Department, which aims to maximise the employment of labour in the construction, rehabilitation and maintenance of Categories A, B and C roads in Gauteng so as to reduce unemployment and push back the frontiers of poverty.

The future programme will, address, among others, cost-effective and efficient means of rehabilitating the Gauteng road network, where over 70%of its roads have reached the end of their design life span. Specific attention will be given to public transport routes and freight corridors, along with further investigation of ways in which the use of labour could be maximised in road construction and maintenance without compromising quality and, hence, performance.

The 2006 - 2009 strategic plan identifies and prioritises strategic areas for HVS testing that will provide the primary, but not exclusive, testing support to the overall APT programme. It is developed to be in support of the key strategic goals and objectives of transport and construction, both provincially and nationally, as indicated in the various white papers and prevailing strategic documents.

Seven strategic focus areas have been identified for which APT could be used to support the identified research needs:

- sustainable development and the environment
- labour-intensive construction
- asphalt performance
- provision of low-volume roads (including upgrading of unpaved roads)
- vehicle pavement interaction (including dynamic loading, contact stresses and comparative testing)
- concrete pavements
- structural pavement design methods.

In each of these seven focus areas, a needs analysis was done to identify gaps where APT-related investigations are required to improve the knowledge base. Projects were then identified and prioritised for consolidation and overall prioritisation by the APT Steering Committee. The following programme has been developed for implementation during the period:

- The HVS testing programme will focus on completing the mainly SANRAL-sponsored investigation of continuously-reinforced thin-layer concrete at Heidelberg
- Construction of the standard mixes and mixes for intersections as part of the hot mix asphalt (HMA) investigation will proceed in August and September 2006
- The HVS testing as part of the HMA test matrix will be supplemented by testing using the MMLS. Comparative analysis of results between the HVS and the MMLS will form part of the investigation
- Work related to the labour-intensive construction focus area received significant attention during 2006 and 2007 through the reassessment of previous HVS and LTPP sections. These will be done to provide improved methodologies for the selection of projects suitable for labour-intensive construction and the development of appropriate standards and specifications for base and surfacings constructed using these methods
- Work related to sustainable development and the environment will continue to focus on the ongoing project for the development of a bituminous stabilisation guideline for foam and emulsion-treated materials, especially relating to recycling
- The suitability of labour-intensive methods for the construction of thin-layer concrete will also be investigated
- Many of the issues relating to low-volume roads will provide inputs into the development of improved standards and specifications for materials, construction techniques and quality assurance of both mechanical and labour-intensive construction of these roads. Specific attention will be given to the suitability of labour-intensive methods for these roads in both rural and urban environments.
- Much of the work in the VPI focus area will be completed up to March 2006; this will provide valuable inputs into the HVS and MMLS testing relating to the HMA focus area. No major projects are planned in this focus area up to 2009, although small ad hoc investigations may be required.
- The structural pavement design focus area is currently in the inception phase and funded by SANRAL. It is anticipated that the GDPTRW will play a secondary role in this area with the lead being taken by SANRAL.

# Labour-intensive construction investigation

South Africa has historically had a high unemployment rate, with Statistics South Africa reporting an unemployment rate of 25,5% as of September 2006. Given that many unemployed people are 'unskilled' and that there is little demand for 'unskilled' persons in the South African labour market, the challenge facing government has been to provide employment for these people. In light of this challenge, government launched the Expanded Public Works Programme (EPWP) in 2003/4 to create temporary work opportunities using public sector expenditure mainly in the infrastructure sector.

The EPWP has a target of providing employment opportunities and training to at least one million targeted unemployed people in its first five years. As a result, the infrastructure sector has had to increase the labour content on government-funded projects, as part of the existing budget, through the application of appropriate labour-intensive technologies, where technically and economically feasible.

The EPWP has its focus on the labour-intensive construction of low volume roads, pipelines, stormwater drains and urban sidewalks within a generally ring-fenced and isolated environment. The main reason for this is that labour-intensive construction and maintenance of roads are often regarded as inferior due to perceived quality, costs and productivity issues. Hence, road authorities generally allocate only low volume roads for labour-intensive construction and maintenance (to minimise risk of investment) at the exclusion of the larger formal construction sector.

In the past few years, however, developments in appropriate labour-intensive technologies, labour optimisation and project management techniques have improved significantly to a point where it is now possible to integrate labour as a critical and measurable component for the whole of the construction sector.

*LIC pilot project at the traffic control centre on the N3 near Heidelberg*

Consequently, the Gauteng Department of Public Transport, Roads and Works (GDPTRW) is in the process of finalising a manual titled 'Job creation, skills development and empowerment in road construction, rehabilitation and maintenance'. The manual is a best-practice guideline for the formal and emerging construction sector to promote sustainable job creation and empowerment in the planning and execution of all road construction, rehabilitation and maintenance projects. Recommendations on the use of appropriate labour-intensive techniques are also provided to ensure that the labour content of all projects is increased and optimised without adversely affecting the cost and quality of projects. The manual is primarily intended to provide guidance to road authorities and their consultants on:

- optimal labour components for specific design elements
- appropriate contract documentation, specifications and tender evaluation procedures to encourage the use of labour
- legal requirements relating to the employment of unskilled and semi-skilled labour
- quality and cost of labour relating to group tasks and group balancing
- training, mentoring and incubation programmes including the current requirements.

The following benefits of the manual are identified:

- optimisation of the use of labour on all projects (new construction, rehabilitation and maintenance)
- increased sustainability of job opportunities through the optimisation of labour on all projects
- increased use of appropriate labour-intensive technologies
- increased involvement by the formal construction sector in job creation and mentoring of emerging contractors
- improvement in performance of the emerging sector through training, mentoring and incubation.

The table (right) summarises HVS investigations in recent years. As mentioned earlier, all HVS-related reports can be found on the HVS website: www.gautrans-hvs.co.za. Readers are encouraged to visit the site for additional information on these studies.

## Summary of HVS studies in recent years

| Brief description of topics/tests carried out during recent years |
|---|
| Hot-mix asphalt study to evaluate the rutting resistance of various asphalt mixes |
| Structural strength and bearing capacity determination of foam and emulsion-treated base materials |
| Vehicle-pavement interaction. Quantification of vertical and horizontal (longitudinal and transversal) contact stresses of various tyre types, axle configurations and tyre pressures |
| Concrete study to investigate the influence of the environment and accelerated loading on joint deterioration of doweled and plain aggregate interlocking joints.<br><br>Determination of the residual life of in-service CRCP pavement sections<br><br>Evaluation of ultra-thin continuously reinforced concrete pavement (UT-CRCP) types. The applicability of using UT-CRCP of layer thicknesses of between 35 and 50 mm to be used as an overlay or rehabilitation option for heavily trafficked highways. |
| Forthcoming topics / tests<br>1. Evaluation of high-modulus asphalt mixes<br>2. Examination of ultra-thin CRCP for low-volume roads applications<br>3. Hot-mix asphalt study to evaluate the fatigue properties of various asphalt mixes. |

# Materials classification and structural design for bituminous stabilised materials

Society is becoming increasingly aware of the sensitivity of our environment, with a great deal of focus on environmentally-sustainable practices. With much of the South African road network needing some kind of rehabilitation, it is desirable to perform this rehabilitation with minimal environmental impact. One method of rehabilitating roads in a cost-effective, environmentally-sustainable and practical manner is to recycle the existing materials in the road. Recycling and stabilising with bitumen using either bitumen emulsion or foamed bitumen have proved to be an effective method of rehabilitating roads.

Although bitumen stabilised materials (BSMs) have been used in South Africa for many years, a need existed to capture the available experience into a guideline document accessible to practitioners at all levels. The compilation of this guideline is being funded jointly by the GDPTRW and SABITA and will be published by the Asphalt Academy. Two aspects of the compilation of the guideline, which required developmental work, were the material classification and structural design methods.

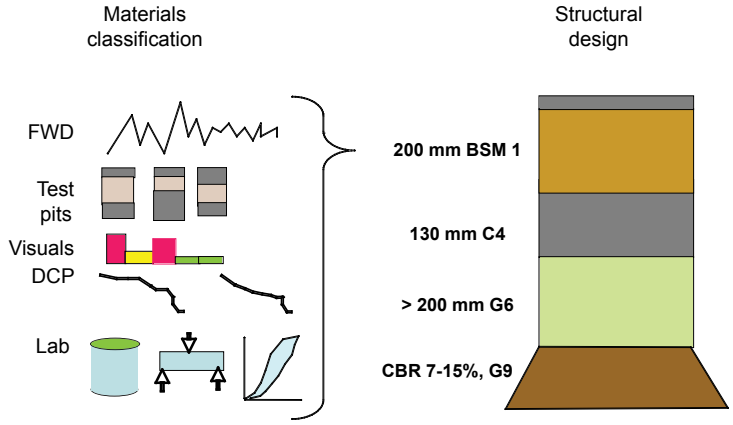
A key component of recycling is determining the quality of the existing material that is to be recycled. To aid such material classification, a system for consistent and rational material quality assessment has been developed. Although the method was developed for BSMs, it is applicable to almost all road materials used in southern Africa. The purpose of the material classification system is to provide a reasonable assessment of the material quality, based on many possible material tests. Benefits of the method are:

- The assessed material quality is not dependant on the subjective interpretation of the engineer, which allows more practitioners to use the method
- The risk associated with inappropriate material quality assessments is reduced
- Practitioners are encouraged to include data from all the tests for which clients have paid.

A structural design method has also been developed for BSMs; again it is applicable to most southern African road materials. The method was based on observations from in-service pavements and HVS tests that were treated with either bitumen emulsion or foamed bitumen. The oldest of these pavements have been in-service for more than 20 years. As with the material classification method, the procedures for structural design are robust and cannot easily be applied in a manner that could result in an inappropriate design, thereby reducing the risk.

Both the material classification and structural design methods that will be included in the BSM guideline document will make a valuable contribution to ensuring that roads can be recycled cost-effectively, reliably and in an environmentally-sensitive manner using bitumen stabilised materials.

## The design process




## Materials classification report – Example

| | | Test limits for material class | | | | Cumulative certainty for material class | | | |
|---|---|---|---|---|---|---|---|---|---|
| Test or Indicator | Samples | G4 | G5 | G6 | G7 | G4 | G5 | G6 | G7 |
| DCP penetration | 12 | | | | | 0,13 | 0,29 | 0,06 | 0,00 |
| FWD stiffness | 67 | | | | | 0,26 | 0,32 | 0,11 | 0,00 |
| Grading analysis | 3 | | | | | 0,37 | 0,34 | 0,11 | 0,00 |
| % Passing 0,075 | 3 | | | | | 0,43 | 0,37 | 0,11 | 0,00 |
| Plasticity Index | 5 | | | | | 0,46 | 0,47 | 0,11 | 0,00 |
| California bearing ratio | 2 | | | | | 0,49 | 0,54 | 0,16 | 0,03 |
| Relative moisture content | 4 | | | | | 0,52 | 0,57 | 0,19 | 0,00 |

**Outcome:** Material is most likely a G5 design equivalent

**Confidence:** Conficence of the assessment if **medium**. For structural rehabilitation, it is recommended that the sample size and number of test indicators be increased.

*Don't forget the 3rd International Conference on APT in Madrid, Spain, 1 – 4 October 2008*
*www.cedex.es/apt2008*