CONTINUOUSLY REINFORCED CONCRETE INLAY AT TOWNHILL COMPULSORY TRUCK STOP

Anna-Carin Brink¹, Dennis Rossmann² and Sarah Skorpen³

¹PhD, PrEng, Principal Specialist, Stewart Scott International, PO Box 1066, Pietermaritzburg, Kwazulu-Natal, South Africa, 3200; annab@pmb.ssi.co.za
²PrEng, Pavement and Materials Specialist, South African National Roads Agency Limited, 58 Van Eck Place, Mkondeni, Pietermaritzburg, Kwazulu-Natal, South Africa, 3201; rossmannd@nra.co.za
³Associate, Stewart Scott International, PO Box 1066, Pietermaritzburg, Kwazulu-Natal, South Africa, 3200; sarahs@pmb.ssi.co.za

ABSTRACT:

The aim of this paper is to present an overview of the construction of a continuously reinforced concrete inlay at the compulsory truck stop on an interstate freeway: National Route 3, Section 3, km 20.0. The truck stop is situated in a truck lane on the southbound carriageway of the freeway, just before Pietermaritzburg in the province of Kwazulu-Natal in South Africa. The existing pavement had failed and became unsafe. The trucks moving over the rocking concrete slabs generated so much noise that people living close to the truck stop started to complain. This section of the freeway carries close to 2 850 heavy vehicles (>16 ton) per day, adding up to approximately 2 million tons per month. Due to the steep (8%) downward gradients, the trucks have to come to a complete stop, before proceeding downhill in their lowest gear. The contractor devised an innovative method for accommodating the heavy vehicle traffic, causing the least disruption to both the heavy and light vehicles, during construction. Simultaneously the arrestor bed adjacent to the truck stop needed maintenance and a temporary arrestor bed facility had to be reinstated for the duration of the contract. This paper will present inter alia the background to the investigation, the traffic analysis carried out, rehabilitation design and the analysis output to reconstruct a highly sensitive heavy-vehicle-traffic safety facility.

KEY WORDS:

CONTINUOUSLY REINFORCED CONCRETE / TRUCK LANE / ARRESTOR BED.

1. INTRODUCTION

During February 2005 Stewart Scott International (SSI) was approached by the South African National Roads Agency Limited (SANRAL) to do a preliminary investigation into the condition of the concrete pavement at the compulsory truck stop on National Route 3 (N3), Section 3, km 20.0. The truck stop is situated in a dedicated heavy vehicle truck lane, on the top of what is known as Townhill, on the southbound carriageway of N3, just before Pietermaritzburg in Kwazulu-Natal. A gravel arrestor bed, designed to bring runaway trucks to a halt, is situated adjacent to the truck stop.

The preliminary investigation confirmed that the approximately 200 m long section of jointed concrete pavement at the truck stop had failed catastrophically. The visual inspections included recording the condition of the concrete pavement, photographically, and taking video clips of the movement of the slabs, while under truck traffic. Due to the urgency of the project and availability of as-built data it was not deemed necessary to dig a test pit and carry out materials testing. SSI was thereafter appointed to carry out the detail design, tender documentation and construction for the emergency repair work of the concrete pavement at the compulsory truck stop area.
2. LOCATION AND DESCRIPTION OF THE ROUTE

The compulsory truck stop is situated on N3, Section 3 at km 20.0 on the southbound carriageway just before Pietermaritzburg. N3 is the main freeway linking Durban Harbour on the East Coast with the Gauteng Province (the main industrial hub in South Africa) – 600 km inland. Between N3, Section 3, km 10.0 and km 26.0, the road consists of a dual carriageway freeway with at least three lanes in both directions. Along most of this road section, both uphill and downhill, a dedicated truck lane has been provided by replacing the left-hand lane with a 180 mm to 200 mm thick continuously reinforced concrete (CRC) inlay. Along some of the uphill sections a fourth concrete climbing lane has also been provided. The other two lanes with an asphalt wearing course are mainly for light vehicles. Directly upstream of the truck stop all three lanes have an asphalt surface. At the truck stop, the road splits. The middle and fast (asphalt surfacing) lanes go to the right around the truck stop with the arrestor bed in the middle. The truck lane becomes a jointed concrete pavement for approximately 200 m, where after a CRC inlay starts again. It is this 200 m section of jointed concrete pavement and underlying pavement layers where heavy vehicles are forced to come to a halt and engage into lowest gear, which had to be reconstructed.

Furthermore, the truck stop and arrestor bed are situated on the downhill side at the top of a particularly steep, 8% downward incline, known as Townhill. At the Hilton Interchange which is approximately 6 km north of the truck stop, all 16-ton trucks have to come to a stop for the first time, before proceeding down the incline to the top of Town Hill at a speed limit of 60 km/h, where they have to come to a stop once more. Despite the precautions, it often happens that trucks loose their brakes along the 6 km section between the Hilton Interchange and Town Hill. For this purpose an arrestor bed has been provided adjacent to the truck stop. At least two trucks per week end up in the arrestor bed. A locality plan of the area is shown in Figure 1.
3. BACKGROUND TO THE SOUTH AFRICAN CONCRETE PAVEMENT DESIGN METHOD

The technology previously applied in South Africa to design concrete road pavements was based on empirical methods developed from observations during the AASHO road test, the Alconbury Hill Experiment in the UK and also local Heavy Vehicle Simulator (HVS) tests (Du Plessis and Freeme, 1989) (The HVS is used for accelerated pavement testing and is capable of applying up to 20 000 wheel loads per day, ranging from 40 kN to 100 kN). This was followed by designers using procedures developed by the US Portland Cement Association, Road Note 29 (Developed by the UK Transport and Road Research Laboratory), the US Army Corps of Engineers method and also procedures developed by the California State Highway Department (Mitchell et al, 1988). Local application of these design methods resulted in the construction of mostly jointed concrete pavements, without dowels at the joints, relying on aggregate interlock load transfer. Slab thicknesses of between 200 and 235 mm with 100 mm thick cement stabilised subbases were typically used to decrease the risk of subbase erosion, pumping and subsequent differential settlement or faulting at joints.

The South African Department of Transport commissioned a research project aimed at providing a manual for the design and construction of concrete pavements in South Africa, during 1986. This study covered subjects such as the performance of existing concrete pavements, simulation of pavement response under laboratory conditions, mathematical analysis, mechanistic design and construction and resulted in the Concrete Pavement Design and Construction, Manual M10 (Manual M10, 1995).

During 1999, however, the South African concrete pavement community deemed it necessary to upgrade Manual M10 (Manual M10, 1995) to a design method based on mechanistic design principles. Several of the concrete road sections constructed in South Africa have been and are still being monitored for their performance and the information gathered could therefore be used to develop the current mechanistically-based concrete pavement design method, cncPave.

When implemented, it was found that the performance models used in cncPave did not always render accurate predictions of the extent of failure and needed refinement. The construction of jointed pavement test sections at Hilton on the N3 and the testing of their performance under HVS traffic, presented the opportunity to determine the remaining structural life of the CRC inlays already constructed on the N3, as well. The CRC inlay on the N3 had been constructed some six years previously using labour intensive construction methods. At the HVS test site the CRC was approximately 180 mm thick, contained 0.61% longitudinal steel and was constructed on a 50 mm asphalt interlayer over a 150 mm crushed stone layer. At the time of testing, it had already carried more than the 6 million Equivalent 80-kN traffic loads (E80's) that it was designed for.

The use of the HVS on a section of the inlay on N3 where structural failure seemed to be imminent was an ideal opportunity not only to refine the performance models, but also to establish the remaining life (and thus the performance) of such inlays. In this way, a better understanding of the link between HVS performance predictions and actual performance under real traffic could be created and incorporated into cncPave. Since the HVS testing was limited to one suitable site, some additional evaluations were carried out on the rest of the inlay on the N3 close to Durban to establish the actual performance of this pavement (Strauss et al., 2005). cncPave could therefore be used with confidence to design the CRC inlay for the Townhill compulsory Truck Stop, which is the subject of this paper.

The development of the South African mechanistic concrete pavement design method, cncPave, (initially called cncRisk) has been widely published (Strauss et al, 2001) and is available from the Cement & Concrete Institute’s website, www.cncl.org.za. It is therefore not deemed necessary to provide further detail in this paper.
3.1. Environment

Of particular importance when designing road pavements in South Africa, is the fact that the sub-continent can be divided into three climatic regions, namely:

- A relatively large dry region;
- A moderate region; and
- A few small wet regions.

The moisture conditions largely determine the weathering of natural rocks, the durability of weathered natural road building materials and also, depending on drainage conditions, the stability of untreated materials in the pavement. In the dry regions mechanical weathering is the main mode of materials deterioration, whereas in the wet regions, chemical weathering predominates.

The area through which the road passes is classified as a summer rainfall area. The climate is regarded as “wet” with moderate winters and hot summers. The Weinert N-value for this region is less than 2 (see Figure 2), which implies that chemical weathering of materials can be expected (TRH4, 1996). In other words, it could be expected that the micaceous mudrocks (shale) that underlies the Pietermaritzburg area will weather to clay.
4. TRAFFIC ANALYSIS

Traffic data was obtained from the high-speed weigh-in-motion (HSWIM) site on the N3 at Pietermaritzburg. As light vehicles have no need to use the truck stop facility, only the heavy vehicle traffic data was analysed. An extract of the traffic counts for June 2004 is given in Table 1.

Table 1 – Traffic data from HSWIM station, site 3003 (Mikros, 2005)

<table>
<thead>
<tr>
<th>Traffic Class</th>
<th>Monthly Total Vehicles</th>
<th>Daily Total Vehicles</th>
<th>Total Mass (t)</th>
<th>Total Axles</th>
<th>Number of Axles &gt; 9t</th>
<th>% Overload</th>
<th>Mass per Vehicle (t)</th>
<th>Average no. of Axles/Vehicle</th>
<th>Average Mass/Axle (t)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>1232</td>
<td>42</td>
<td>14764</td>
<td>2352</td>
<td>276</td>
<td>11.73</td>
<td>11.98</td>
<td>2.0</td>
<td>5.99</td>
</tr>
<tr>
<td>5</td>
<td>22759</td>
<td>775</td>
<td>154043</td>
<td>43440</td>
<td>637</td>
<td>1.47</td>
<td>6.77</td>
<td>2.0</td>
<td>3.38</td>
</tr>
<tr>
<td>6</td>
<td>552</td>
<td>19</td>
<td>9040</td>
<td>1651</td>
<td>137</td>
<td>8.30</td>
<td>16.38</td>
<td>3.0</td>
<td>5.46</td>
</tr>
<tr>
<td>7</td>
<td>25</td>
<td>1</td>
<td>114</td>
<td>66</td>
<td>0</td>
<td>0</td>
<td>4.56</td>
<td>3.0</td>
<td>1.52</td>
</tr>
<tr>
<td>8</td>
<td>5964</td>
<td>203</td>
<td>86857</td>
<td>17179</td>
<td>958</td>
<td>5.58</td>
<td>14.56</td>
<td>3.0</td>
<td>4.85</td>
</tr>
<tr>
<td>9</td>
<td>4529</td>
<td>154</td>
<td>65535</td>
<td>15598</td>
<td>405</td>
<td>2.60</td>
<td>14.47</td>
<td>3.0</td>
<td>4.82</td>
</tr>
<tr>
<td>10</td>
<td>97</td>
<td>3</td>
<td>2212</td>
<td>460</td>
<td>32</td>
<td>6.96</td>
<td>22.80</td>
<td>5.0</td>
<td>4.56</td>
</tr>
<tr>
<td>11</td>
<td>224</td>
<td>8</td>
<td>5007</td>
<td>1080</td>
<td>54</td>
<td>5.00</td>
<td>22.35</td>
<td>5.0</td>
<td>4.47</td>
</tr>
<tr>
<td>12</td>
<td>4787</td>
<td>163</td>
<td>125595</td>
<td>23010</td>
<td>1348</td>
<td>5.86</td>
<td>26.24</td>
<td>5.0</td>
<td>5.25</td>
</tr>
<tr>
<td>13</td>
<td>13955</td>
<td>475</td>
<td>448183</td>
<td>81354</td>
<td>3009</td>
<td>3.70</td>
<td>32.12</td>
<td>6.0</td>
<td>5.35</td>
</tr>
<tr>
<td>14</td>
<td>368</td>
<td>13</td>
<td>8608</td>
<td>1780</td>
<td>13</td>
<td>0.73</td>
<td>23.39</td>
<td>5.0</td>
<td>4.68</td>
</tr>
<tr>
<td>15</td>
<td>420</td>
<td>14</td>
<td>11061</td>
<td>2394</td>
<td>81</td>
<td>3.38</td>
<td>26.34</td>
<td>6.0</td>
<td>4.39</td>
</tr>
<tr>
<td>16</td>
<td>23174</td>
<td>789</td>
<td>980986</td>
<td>157353</td>
<td>13068</td>
<td>8.30</td>
<td>42.33</td>
<td>7.0</td>
<td>6.05</td>
</tr>
<tr>
<td>17</td>
<td>1856</td>
<td>63</td>
<td>74973</td>
<td>14392</td>
<td>340</td>
<td>2.36</td>
<td>40.39</td>
<td>8.0</td>
<td>5.05</td>
</tr>
<tr>
<td>Totals</td>
<td>79942</td>
<td>2722</td>
<td>1986978</td>
<td>362109</td>
<td>20358</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In addition to the above data the average annual daily truck traffic (AADTT), since August 1999, was obtained in order to determine the heavy vehicle growth rate. The average heavy vehicle growth rate was 8% per year during the past 5 years. However, if this growth rate is used, the
road would reach capacity within 16 years, with an ADTT of 10 000. This would imply approximately 7 trucks per minute, travelling bumper-to-bumper, throughout the day. At present trucks are already travelling bumper-to-bumper down Town Hill during peak hours. It is an extremely dangerous situation, especially when truck drivers get impatient and attempt to overtake by moving into one of the light vehicle lanes, or when a truck’s brakes fail and it ends up in the arrestor bed. It has however been observed that the substantial growth in heavy vehicle traffic has started to decline. An average annual heavy vehicle growth rate of 4% was therefore considered to be more realistic and was used in the analysis.

The estimated E80 per heavy vehicle, calculated from data from HSWIM site 3003, is 2.98 and an ADTT value of 2 850 was taken for design and forecasting purposes (Mikros, 2005). A sensitivity analysis where the traffic growth rate was varied between 2% and 8% has been conducted. The E80 per heavy vehicle factor was also varied minus 15% and plus 15%. The sensitivity analysis and the design traffic loading (if a growth of 4% per year could be sustained) is given in Table 2.

<table>
<thead>
<tr>
<th>AADTT</th>
<th>E80 per heavy</th>
<th>Growth Rate (%)</th>
<th>Year 10</th>
<th>Year 15</th>
<th>Year 20</th>
<th>Year 25</th>
<th>Year 30</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 850</td>
<td>2.53</td>
<td>2</td>
<td>29</td>
<td>46</td>
<td>65</td>
<td>86</td>
<td>109</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>33</td>
<td>55</td>
<td>82</td>
<td>114</td>
<td>154</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8</td>
<td>41</td>
<td>77</td>
<td>130</td>
<td>208</td>
<td>322</td>
</tr>
<tr>
<td>2 850</td>
<td>2.98</td>
<td>2</td>
<td>35</td>
<td>55</td>
<td>77</td>
<td>101</td>
<td>128</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>39</td>
<td>65</td>
<td>96</td>
<td>134</td>
<td>181</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8</td>
<td>49</td>
<td>91</td>
<td>153</td>
<td>245</td>
<td>379</td>
</tr>
<tr>
<td>2 850</td>
<td>3.43</td>
<td>2</td>
<td>40</td>
<td>63</td>
<td>88</td>
<td>116</td>
<td>148</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>45</td>
<td>74</td>
<td>110</td>
<td>154</td>
<td>208</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8</td>
<td>56</td>
<td>105</td>
<td>176</td>
<td>281</td>
<td>436</td>
</tr>
</tbody>
</table>

From Table 2 it is evident that this road section is subjected to high volumes of heavy vehicle traffic.

5. PAVEMENT REHABILITATION DESIGN

5.1. Existing pavement

As mentioned, the entire jointed concrete pavement section adjacent to the arrestor bed showed signs of catastrophic failure. The difference in surface level between sections of shattered slabs was as much as 100 mm in places (see Photo 2). The nature of the pavement failure indicated that the supporting layers, including the subbase and selected layers, have probably also failed. Pavement rehabilitation would therefore involve reconstruction of the supporting layers as well.

The existing pavement consisted of:

| 250 mm | Jointed concrete pavement (JCP) |
| 150 mm | Cement stabilised subbase (C3) |
| 300 mm | Selected material (G7)          |
|        | In situ (G7)                    |

The subsoil drainage system did not appear to be functional, and it was therefore evident that insufficient drainage of both the arrestor bed and the concrete pavement were factors contributing to failure of the pavement. This, combined with a constant stream of slow-moving heavy vehicles on the relatively light and old pavement, resulted in the catastrophic failure witnessed at the truck stop.
5.2. Designed pavement

Due to the strategic location of the truck stop and the fact that it is undesirable to disrupt the heavy vehicle traffic for maintenance activities, the design period chosen was 30 years. Furthermore, since asphalt surfaces are prone to rutting and shoving in areas where heavy vehicles have to come to halt and that critical sections of the existing slow lanes on the N3 have successfully been replaced with CRC inlays, it was considered as the only alternative. The software package cncPave (see Figure 3), described in paragraph 3 was used to conduct the pavement design.
The pavement rehabilitation design is shown schematically in Figure 4 and was as follows:

- 250 mm Continuously reinforced concrete (with Y20 @ 150 c/c longitudinal reinforcement)
- 30 mm Asphalt interlayer (continuously graded fine) (AC)
- 100 mm Lean mix concrete subbase (10 MPa)
- 150 mm Upper selected layer, compacted to 95% of modified AASHTO density (G7)
- 150 mm Lower selected layer compacted to 93% of modified AASHTO density (G7)

![Figure 4 – Schematic layout of rehabilitation design](image)

### 6. CONSTRUCTION

The main focus during the rehabilitation of the compulsory truck stop was that the work had to be done in as short a time as practically possible. The Contractor therefore had to make optimal use of equipment, machinery and labour for every activity from the accommodation of traffic to the construction of the CRC pavement to speed up the construction process.

#### 6.1. Accommodation of traffic

Accommodation of traffic was a critical safety aspect of the project, especially due to the fact that, during construction, the existing arrestor bed at the truck stop would temporarily be unavailable. A temporary arrestor bed therefore had to be provided. The gravel in the existing arrestor bed was cleared out and used to reinstate an old arrestor bed (at N3/3, km 19.6) (see Photo 3). The existing gravel had to be washed and screened and any shortfall had to be replaced with similar and suitable gravel.

The truck traffic would have been accommodated on the asphalt pavement around the truck stop area. In order to still accommodate the traffic in three lanes, it would have involved sandblasting the road markings off the asphalt pavement around the arrestor bed basin and remarking the asphalt pavement to three lanes. The merging of traffic needed to take place before a right hand bend approximately 400 m before the truck stop. Advance warnings would have been required up to 1.6 km before the truck stop in order to calm traffic before reaching the construction area.

However, at the start of the contract the Contractor came with the proposal that, seeing that the gravel had to be cleared out of the arrestor bed and that a temporary arrestor bed had to be provided in any case (see Photo 3), he would put RAP material in the arrestor bed basin to protect the concrete and accommodate the truck traffic straight through the 6 m wide arrestor bed. Prior to entering the arrestor bed, trucks still had to come to a halt, before proceeding. The Client was impressed with this innovative proposal and gave the go-ahead (see Photo 4). No incidents involving trucks occurred during the contract period.
6.2. Layerworks

After removal of the blocks of concrete from the failed jointed concrete pavement, excavations in the underlying pavement layers were started. Two layers of cement stabilised crushed stone and a thin asphalt layer were encountered beneath the concrete. As could be expected, a thick layer of yellow, completely weathered dolerite clay was also exposed over a short section. The clay was saturated and spongy and was excavated to a depth of 300 mm and spoiled (see Photo 5). The excavated crushed stone material was re-used for the selected layers.

6.3. Lean mix concrete subbase

The subbase was constructed from 10 MPa lean mix concrete. This created a sound working platform for the construction of the asphalt interlayer.
6.4. Asphalt interlayer

An aspect of the rehabilitation design that needs further clarification is the asphalt interlayer. The initial CRC inlays that were constructed on the N3 also had to be done under traffic. Furthermore, due to the restricted work space and that it was not possible to get in with large-scale construction equipment, the work had to be done labour-intensively. The easiest method to obtain a sound working platform, after removal of the failed asphalt surfacing and crushed stone base material, was to place an asphalt interlayer. This evolved into the current practice where a thin, asphalt layer is constructed between the concrete pavement and the subbase. The assumption is that it provides a flexible “cushion” that can absorb warping and/or curling of the concrete pavement due to temperature and moisture gradients in the concrete pavement.

However, experience has taught that the asphalt beneath concrete overlays in the vicinity of Pietermaritzburg tend to strip, especially at the joints which are more susceptible to the ingress of water. To prevent stripping, the asphalt interlayer therefore has to have as high a binder content with as little voids as possible. A continuously fine-graded mix was specified for the asphalt interlayer with a 6.7% binder content and 1 – 3% voids.

From the above it is obvious that there are clearly contradicting factors involved with the construction of an asphalt interlayer, which warrants further research.

6.5. Subsoil drain and side drain

The main aim of the drainage design was to drain both the arrestor bed and the pavement layers.

Additional drainage was provided to the side of the arrestor bed at 50 m intervals by drilling holes through the side of the concrete basin after removal of the arrestor bed gravel. Pipes were then installed with sufficient protection at the inlet so that it was capable of draining the water out, without the loss of gravel or blockage of the holes.

Once through the concrete, the pipes were taken to a level beneath the layer works, with sufficient cover to protect the subsoil drains, where after it was connected up with the new subsoil drain installed adjacent to the layerworks (see 6.5.Photo 6).
When reconstructing the concrete side drain adjacent to the new CRC pavement, special precautions were taken to allow for heavy vehicles going into the side drain by providing mesh reinforcement in each panel and dowel bars for load transfer at the construction joints (see Photo 7).

6.6. Continuously reinforced concrete pavement

The 28-day compressive strength for the concrete pavement was specified as 45 MPa and the minimum compressive strength that was required before opening to traffic was 30 MPa. The cement content of the concrete mix was 464 kg/m³ and 194 l/m³ was used, giving a water : cement ratio of 0.42. Dolerite aggregate with a maximum size of 26.5 mm was used in the mix (see Photo 8).
Longitudinal movements produced by temperature and moisture changes in CRC pavements are limited to the end sections. The “active” sections are normally from 90 m to 150 m long, resulting in end movements of as much as 50 mm (C&CI, 2005). As this is more than the conventional expansion joint can accommodate, specially designed anchor beams were constructed at both ends of the CRC inlay.

When designing a CRC pavement, there is a balance between the pavement thickness, the compressive strength and the diameter and spacing of the steel reinforcement. The 250 mm thick, 45 MPa concrete with Y20 @ 150 c/c longitudinal reinforcement was designed to have narrow transverse cracks at 1.5 – 2.0 m spacing.

The approximately 200 m length of CRC was constructed over a period of 6 days. The average length constructed was 33 m/day at an average production rate of 40 m³/day. The first shrinkage crack appeared within 2 weeks after construction. At present (4 months after construction) there are only 14 transverse cracks apart from the 5 construction joints. The shortest spacing between cracks (disregarding construction joints) is 1.5 m and the largest, 11.1 m. Neither of the two outer sections is cracked. From visual observations it appears as if the CRC is beginning to perform as it was designed to.

7. CONCLUSIONS

The above paper describes the measures taken to rehabilitate a highly sensitive heavy-vehicle-traffic safety facility in the southbound truck lane on National Route 3, Section 3 at km 20.0; the freeway with the highest traffic loading in South Africa. Through the Contractor’s innovative method to accommodate the heavy vehicle traffic during construction, there was minimum disruption to both the heavy and light vehicles. Simultaneously an arrestor bed adjacent to the truck stop needed maintenance and a temporary arrestor bed facility had to be reinstated for the duration of the contract. Not only was a jointed concrete pavement that failed catastrophically, replaced with a CRC pavement, but the subgrade and selected layers were reconstructed and an improved subsoil drainage system and concrete side drain were constructed. The entire operation was carried out labour intensively. The software package, cncPave, developed in South Africa, was used to design the CRC inlay. Due to the fact that an HVS test section on the N3 was used to calibrate the software, we are confident that design and reality will meet through the performance of the facility.
REFERENCES


