ATTACHMENT TO PAPER 'TESTING OF CONCRETE BLOCK PAVEMENTS BY THE AUSTRALIAN ROAD RESEARCH BOARD'

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Since publication of the above paper in the Conference Proceedings, testing of Sections 7, 8 and 9 (see table 2 of the paper) has concluded. The development of rutting on these sections is shown in figure 1 of this attachment. It can be seen that all pavements had failed after 3500 ESAs. Figure 5 of the paper had indicated that, after 300 ESAs, Section 7 (composed of Unidecor blocks - see figure 3 of the paper) was performing as well as Section 9 (composed of Unipave blocks). Figure 1 of this attachment indicates that there was little difference between the performance of the two shapes, but as all pavements failed it is difficult to draw any conclusions regarding the relative performance of the two block shapes.

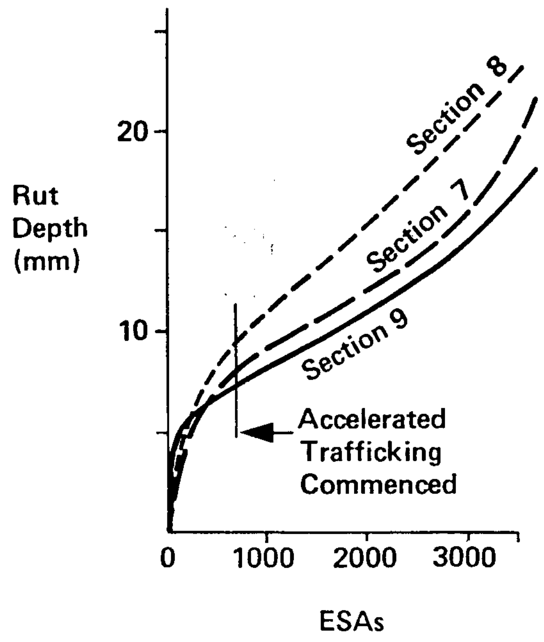

Figure 1. Rut depth vs. ESAs for test sections 7, 8 and 9 at ARRB.

The performance of Sections 7 - 9 was in line, from a pavement life viewpoint, to the T1 curve of the Australian design guide for block pavements (see paper) and the suggested ranges of traffic. This suggests that for a range of subgrade CBRs 2 to 4 the T1 curve should be located in the position currently occupied by the T4 curve.

In situ dry densities were not recorded on the subgrades of Sections 7 - 9 at construction but later testing showed that the general trend was for the densities of all layers to decrease during trafficking. This was accompanied by a corresponding increase in moisture content and decrease in subgrade CBR. The in situ CBR of the 'A' grade crushed rock increased during testing, whilst the CBR of the 'B' grade crushed rock remained constant.

ARRB also monitored the performance of an over-designed, heavily-trafficked concrete block pavement at the exit to a quarry road. This pavement was 50 m long and subjected to trucks with gross weights as high as 40 t. Two existing asphalt sections were also monitored as 'controls'. The performance of this pavement after two years and 150000 ESAs was excellent. The most useful data were the variation in skid resistance of the block pavement and the comparison with the values obtained on the asphalt control sections. These data were reported in Mr. Mavin's paper to the Conference.

The final report on the testing of the block pavements at ARRB is currently being prepared and will be available shortly. Those who wish to order a copy of this report, or a copy of the report on the testing of the heavily-trafficked pavement, should contact the authors at the Australian Road Research Board, P.O. Box 156 (Bag 4), Nunawading, Victoria 3131, Australia.

Question Mr. C.F. Morrish (Cement and Concrete Association of Australia)

The Cement and Concrete Association of Australia applauds the action of the Australian Road Research Board in undertaking an investigation of interlocking pavements over low quality subgrades, as in our design guides we were forced to extrapolate on data to cover such subgrades. However, our experience in the field with similar pavements to those tested does cause me to question some of the conclusions reached by Mr. Sharp to the possible causes of rapid failure:

a. To what extent was water entry monitored to determine whether this was vertically through the paving joints or horizontally from surrounding ground?
b. Was the evidence of subgrade deformation similar to the deformation of the pavement surface, or did most of the deformation occur within the pavement system, a possible reflection of increased plasticity in the sub-base resulting from the extent of water entry?
   Any justification for thicker sub-bases would appear to be dependent on clear evidence of deformation of the subgrade.

Answer Mr. K.G. Sharp and Mr. P.J. Armstrong

a. Moisture content readings were taken at locations other than under the block pavement in the early stages of testing (Sharp and Armstrong 1981, table IV). Readings were taken in the centreline of the adjacent asphalt road and in the clay shoulders, north of the asphalt road and south of the block pavement.
   The subgrade moisture content under the block pavement at chainage 45 m in February 1981 was 27.5% in the top 100 mm, whilst that 1.5 m south of the block pavement was 20.8%. In March, the readings were 27.2% and 22.2% respectively. At chainage 74 m in February, the value under the block pavement was 23.9% whilst that under the asphalt road was 20.2%.
   Two attemps were also made to locate the water table. This was found on both occasions to be 3 - 4 m below the surface, so it is reasonable to assume that the block pavement was not constructed on an area having a high water table.

Morris (1984) concluded that his results (obtained from preliminary data collected under ARRB Project 392 - Pavement Design: Residential Streets) confirmed previous findings (e.g. Morris 1968) that clay subgrades under residential streets will attain near saturation and that pavement thickness should be determined on this basis. The results obtained for the heavily-trafficked concrete block pavement at the Shire of Flinders (Sharp et al. 1984) also indicated that the moisture content on the subgrade (not clay) was greater after two years service than at construction.

Given the layout of the test pavements at ARRB - longitudinal drains along both sides, transverse drains at both ends, an asphalt road abutting the block pavement on the high side, and another drain on the high side of the asphalt pavement - it is suggested that adequate drainage had been provided and it would not be expected that any more drainage could (or should) have been provided. Given all the drainage provided, and the 'pre-cracked' nature of the block pavement surface, it is not unreasonable to assume that the most likely location for water ingress would be through the joints of the block pavement surface.

b. The matter of subgrade deformation is difficult to prove one way or the other. We performed sieve analyses and laboratory plasticity index determinations on the crushed rock materials before and after testing and there was no evidence at all of clay migration from the subgrade during testing.

We also took levels on each layer at construction and at specified chainages after testing in an effort to determine which layers had deformed under traffic. This technique has its problems, especially if you are trying to find only a total of about 20 mm of rutting in all the layers. It was observed that the crushed rock had been pushed into the subgrade (during compaction or trafficking?). When taking a level after testing you have to guess the correct location of the 'top of the subgrade'. For example, do you remove the crushed rock embedded into the clay (size 19 mm)?
Nevertheless, we found evidence of subgrade deformation in Sections 7 and 8, whilst in Section 9 the subgrade had expanded. This is to be expected with this type of material: it does not mean, of course, that the material did not also deform after it wet up and expanded.

We believe that water entry into the crushed rock caused these layers to 'break up' as witnessed by the drop in density during trafficking. Sieve analyses indicated that the fines were still present after testing, but the ability of the crushed rock to withstand load had been reduced. We are going to perform triaxial testing on the crushed rock, both dry and wet, to see if the particular material used (a very common and high quality wetmix) is susceptible to water. If water is penetrating the joints of a block pavement, there may be some crushed rock materials less suitable than others. It is also noted that the CBR of the crushed rock in Section 9 was satisfactory at construction (as was the density), yet the section still failed.

REFERENCES

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----------- GOSCHNICK, S.B. and BUFFINGTON, S. (1984). The performance of a heavily-trafficked concrete block test pavement at the Shire of Flinders. Australian Road Research Board. Internal Report, AIR 363-5.