The Asphapol process and Polyphalt materials

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The Asphapol Process has been used since 1973 for buried joint applications and for overlays to pavements where reflection cracking has or is likely to occur. The process incorporates a specifically designed material Asphapol Cushion Course which contains a polymer additive, Asphapol 2000. Asphapol Cushion Course can provide a running surface or alternatively it can be overlaid by other Asphapol 2000 modified materials. The materials used in this process have improved structural properties, durability and the resistance to reflection cracking.

The polymer Asphapol 2000, is now to be made available to the industry for engineers to evaluate for their specific needs. Asphapol 2000.
modified bitumen enhances resistance to deformation, principally because of increased viscosity of the binder at high road temperatures,and also exhibits a far greater degree of flexibility at low temperatures, associated with greater ductility of the binder compared to conventional bitumen at these temperatures. Associated Asphalt, an experienced surfacing contractor laying 1.5 million tonnes of material annually, dictated that the modified materials should be as easy to manufacture, lay and compact as conventional materials and they have achieved these objectives.

One of the practical problems in the usage of any pre-blended binder is the storage of these materials for supply on demand. If delays occur in the programme of the contract being supplied, the keeping of blended binders at storage temperatures can incur risks of hardening, chemical deterioration and separation. When the blended binder is not utilised the manufacturer is left with the problem of the disposal of an expensive commodity. There is also the difficulty of proving to the client's satisfaction that the full amount of modifier has been used in the binder. This last factor is important because, in common with many polymers, the full recovery of the Asphapol 2000 polymer from the mixed material requires additional care and some modifications to the standard test methods.

Asphapol 2000 is a polymer in the form of a latex emulsion containing 67% solids and it is added to the hot mix in the mixer box. On addition it disperses rapidly and evenly due to the water carrier and the interaction of the polymer which swells in contact with the oils and resins in the bitumen. It is added approximately 10-15 seconds after the bitumen and foams, with the steam being driven off, ensuring complete dispersal of the polymer throughout the entire mix. The addition can be made either by hand for small tonnages or by a fully transportable dual diaphragm stainless steel pump. In the latter case the dosage is metered to an accuracy of 0.1% and recorded via solid state electronics, thus ensuring an accurate record of total volume used. Within the agreements concluded with any manufacturer of Asphapol 2000 material, there is a requirement to make such data records available to the client at all times.

Extensive testing of Asphapol and Asphapol 2000 materials has been carried out in the laboratories of Associated Asphalt. Nottingham University and SWK Pavement Engineering have also performed a range of specialised tests to quantify enhancements in performance. A summary of the findings of these tests are reported below.

Binder modification

The binder modifier, Asphapol 2000, consists of a rubber (SBR), produced by co-polymerising a hard and soft monomer. The monomer ratio has been optimised for road performance.

The effect of adding Asphapol 2000 to bitumen is to reduce the viscosity and also to improve ductility at low temperatures. However, the viscosity is increased at high temperatures in the range 30-80°C and this is associated with improvement to the performance of bituminous surfacing materials during periods of hot weather.

Conventional test results for the Asphapol 2000 binder demonstrate the increase in penetration index and ductility of the binder with the addition of Asphapol 2000. Typical values are as follows:-

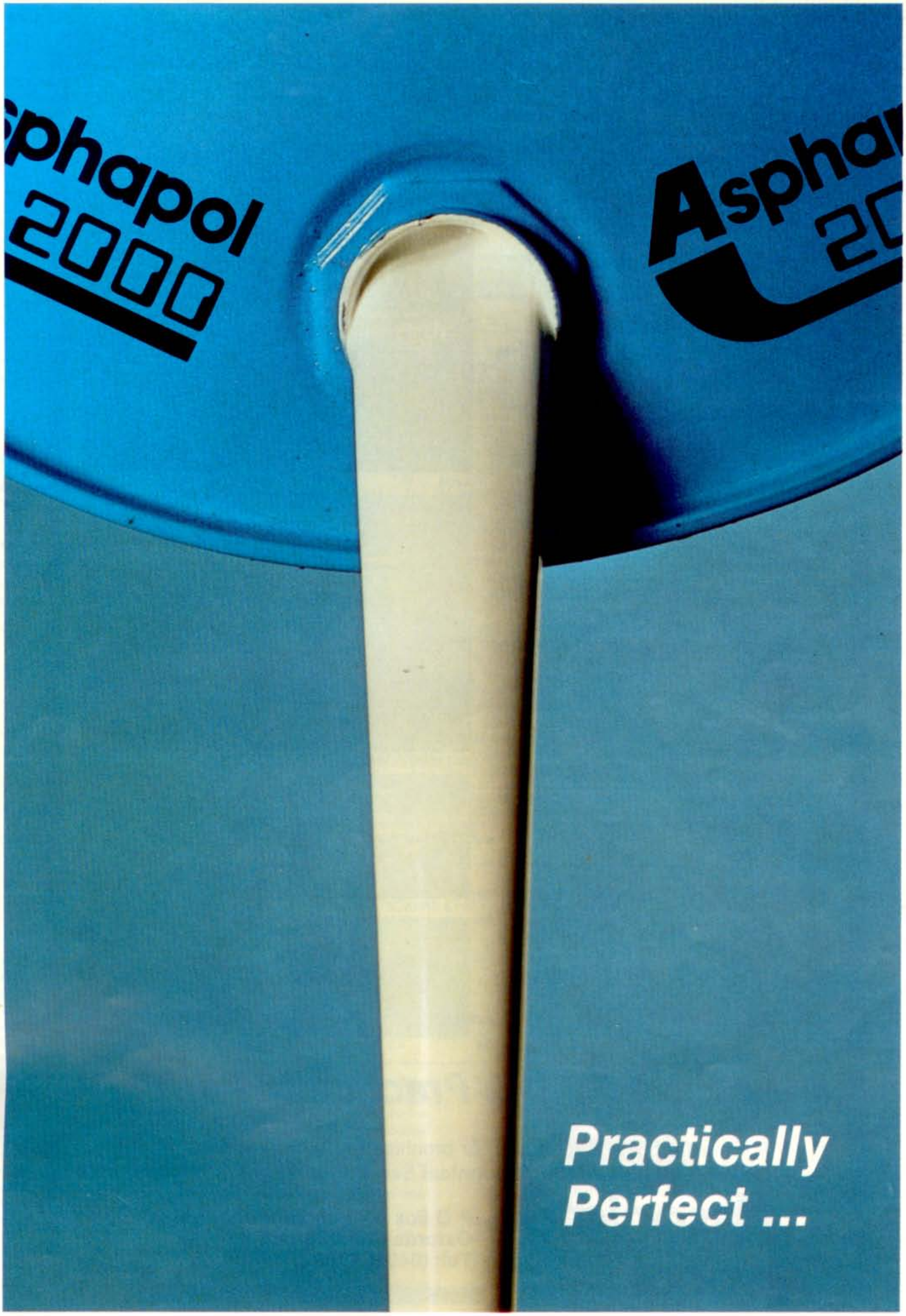
Binder Type	Pen @ 4°C (mm/10)	Pen @ 25°C (mm/10)	Softening Point (BS 4692)	Ductility at 10°C (cm)	Penetration Index
50 Pen	8	48	54.0	1.0	−0.5
50 Pen + 5% Asphapol 2000	11	46	68.0	9.0	+2.1
70 Pen	8	67	49.0	8.0	−1.0
70 Pen + 5% Asphapol 2000	9	59	66.0	15.0	+1.08
100 Pen	12	101	46.5	53.5	−0.6
100 Pen + 5% Asphapol 2000	14	82	56.5	88.5	+1.0

The use of SBR in bituminous mixes has been compared to the use of other polymers[3] and Figure 1 shows comparisons of tensile strength and elastic recovery measured during ductility testing. It can be observed from this figure that the behaviour of SBR is similar to SBS and due to their elastomeric properties polymers such as SBR and SBS are able to resist deformation after suffering severe strains.

Engineering properties

It was necessary, because of the change in binder properties, to evaluate the engineering properties of the modified materials and extensive laboratory testing was carried out on two of them. One was Asphapol Cushion Course which is a Hot Rolled Asphalt type material which has been designed to act as a stress absorbing membrane interlayer, (SAMI). The other was a Asphapol 2000 modified DBM. In addition a programme of wheel tracking tests were performed on a wide range of Asphapol 2000 modified HRA wearing course materials.

continued on page 51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continued from page 48

Fatigue Strength

Fatigue can be defined as the phenomenon of fracture under repetition of fluctuating stress, the maximum value of which is generaly less than the tensile strength of the material.

Uniaxial fatigue tests were used on the Asphapol 2000 modified DBM and these indicated that crack initiation time for this material was similar to the conventional materials. Beam tests were carried out on the Asphapol Cushion Course material and the results obtained showed that this material was more resistant to propagation of cracks compared to standard materials. In these tests asphalt beams are set up on a resilient support with a gap in the underlying layer to simulate a joint or crack in an existing pavement. The object of these tests was to compare the ability of Asphapol Cushion Course with that of conventional Hot Rolled Asphalt wearing course, to resist reflection cracking due to repeated loading.

The results obtained are presented in Figure 2. At 150,000 cycles the length of the reflection cracking in the Cushion Course is less than a quarter of the mean crack length in the Hot Rolled Asphalt.

Permanent Deformation Testing

An assessment of the permanent deformation characteristics is necessary to predict the extent to which material will resist the tendency to contribute to surface rutting in the wheel track.

Permanent deformation tests were carried out on Asphapol Cushion Course and Asphapol 2000 materials. Brief details of the tests and extracts from those results are presented below.

(i) Uniaxial Creep:

The uniaxial creep test, involves application of a constant axial stress of $100kN/m^2$ to a cylindrical specimen at a temperature of 40°C for one hour. The axial deformation is monitored continuously for the duration of the test. Figure 3 shows axial deformation plotted against time for the Asphapol Cushion Course specimens. For comparison, results obtained for a conventional Hot Rolled Asphalt wearing course under identical test conditions are also shown.

These results indicated that the deformation of the Asphapol Cushion Course material is approximately half that obtained for a conventional Hot Rolled Asphalt wearing course over the range covered and this confirms extensive site observations that have been made by Associated Asphalt over the past ten years.

(ii) Wheel Tracking:

The wheel tracking test developed by the Transport and Road Research Laboratory has been found to provide data which correlates well with observed rutting of Hot Rolled Asphalt wearing courses laid in pavements in the United Kingdom.

Samples of Asphapol 2000 materials were subjected to wheel tracking at two temperatures using this equipment and selected results are given below together with the results obtained from the Marshall test:

Material Type	Wheel Tracking 45°C (mm/hour)	Results 60°C (mm/hour)	Marshall Stability (kN)	Test Results (mm)	Flow Quotient (kN/mm)
30% HRA 50 Pen	2.9	FAIL	4.7	1.6	2.94
Asphapol 2000 30% HRA 50 Pen	1.5	1.9	7.5	2.8	2.67
30% HRA 70 Pen	4.3	FAIL	4.0	2.6	1.55
Asphapol 2000 30% HRA 70 Pen	0.5	1.5	7.5	3.7	2.1
30% HRA 100 Pen	5.8	FAIL	3.6	4.1	0.9
Asphapol 2000	0.8	5.2	5.1	2.8	1.8

The results at 45°C indicated that the deformation rate occurring in the Asphapol 2000 materials was only half that of the conventional materials. At 60°C all the conventional materials had failed whereas the Asphapol 2000 materials were still showing low rates of deformation.

Low temperature flexibility

To evaluate Asphapol Cushion Course as a bridge deck joint and concrete pavement overlay material it is necessary to assess the performance due to diurnal and/or seasonal thermal movements. Two test methods were used for this purpose.

Thermal Cycling

These tests were conducted on Asphapol Cushion Course and specifically directed to studying its application over buried joints in bridge decks. The deformation range investigated was equivalent to 25mm over a metre length, ie. 2.5% strain. This deformation was imposed while the temperature was varied by 20°C. Tension was applied as the temperature fell and compression as the temperature rose. This is considered to be a rather severe representation of what occurs in practice.

The mode of failure that occurred was not within the Asphapol material but at the fixings and other points of stress concentration (occurring at changes of section). This was taken to indicate that failure of Asphapol Cushion Course is unlikely to occur before the failure of the interface with the existing material. It appears that the material accommodates the thermal movement by the development of a series of microcracks which open and close.

Bend Test

This test was initially developed by the Transport and Road Research Laboratory[4] to evaluate the flexibility of water proofing membranes on bridge decks. Load is applied centrally to a simply supported specimen measuring 365mm × 160mm × 45mm, to ensure a constant rate of deflection. The deflection is recorded when the sample fails and this is termed the "bend value". If failure does not occur by the end of the test the crack length is recorded.

Typical results from this test are as follows:—

Material Type	Typical Bend Values (mm)
30% HRA 50 PEN	5
Asphapol 2000 30% HRA 50 PEN	15
30% HRA 100 Pen	15
Asphapol 2000 30% HRA 100 Pen	18
DBM 100 Pen	8
Asphapol 2000 DBM 100 Pen	16

It can be seen that the Asphapol 2000 materials accommodate more bending before failure occurs and this indicates that they are more flexible than the conventional materials.

MATERIAL TYPE	MARSHALL TEST RESULTS STABILITY (kN)	FLOW (mm)	QUOTIENT (kN/mm)	WHEEL TRACKING RESULTS at 45°C (mm/hour)	at 60°C (mm/hour)
30% HRA 7% (70 PEN) BINDER + 5% EVA	8	4.5	1.78	0.7	5.8
30% HRA 8% (100 PEN) BINDER + 5% Asphapol 2000	5.1	2.8	1.8	0.8	5.2
30% HRA 8% (90 PEN) BINDER + 7% SBS	5.3	3.3	1.6	1.2	7.5

Table 1
Comparison of results obtained from different binder additives

Summary

The Asphapol process has been in use since 1973 and it has been demonstrated that it has positive advantages over conventional materials, in applications including overlays to concrete and bituminous roads, the construction of new pavements and joint repairs. The advantages found and other engineering data and test results have now been incorporated in a document[5] of which the following is a summary:

Technical Advantages

(i) Asphapol and Asphapol 2000 materials have a greater resistance to permanent deformation than similar conventional materials.

(ii) The elastic stiffness of Asphapol Cushion Course and Asphapol 2000 materials are similar to conventional materials.

(iii) The fatigue characteristics of conventional and Asphapol 2000 materials are similar. However, the test results indicate that Asphapol Cushion Course is significantly more effective in the prevention of reflection cracking.

(iv) Thermal cycling tests indicate that Asphapol Cushion Course appears to accommodate thermal movement by the development of a series of microcracks which open and close.

(v) Results obtained from the bend test indicate that materials incorporating Asphapol 2000 binder are more flexible than conventional ones.

Practical Advantages:-

(i) Asphapol 2000 is competitive with other polymer additives in initial cost.

(ii) Asphapol 2000 is simpler and cheaper to use than other polymer additives because it is added direct to the hot mix. Therefore, there is no wastage or heated storage, no possible hardening of blended stored binder, no dedicated bitumen storage tank and no specialised dedicated bitumen source. Asphapol 2000 additive has been found to be compatible with all bitumens evaluated to date.

(iii) Provided it is stored in a frost free environment, Asphapol 2000's shelf life is indefinite.

(iv) Asphapol 2000 materials equal

continued on page 52

Note: this document had been modified from the original to correct a layout mistake during the publishing. The content is otherwise identical to the original. GM Rowe.

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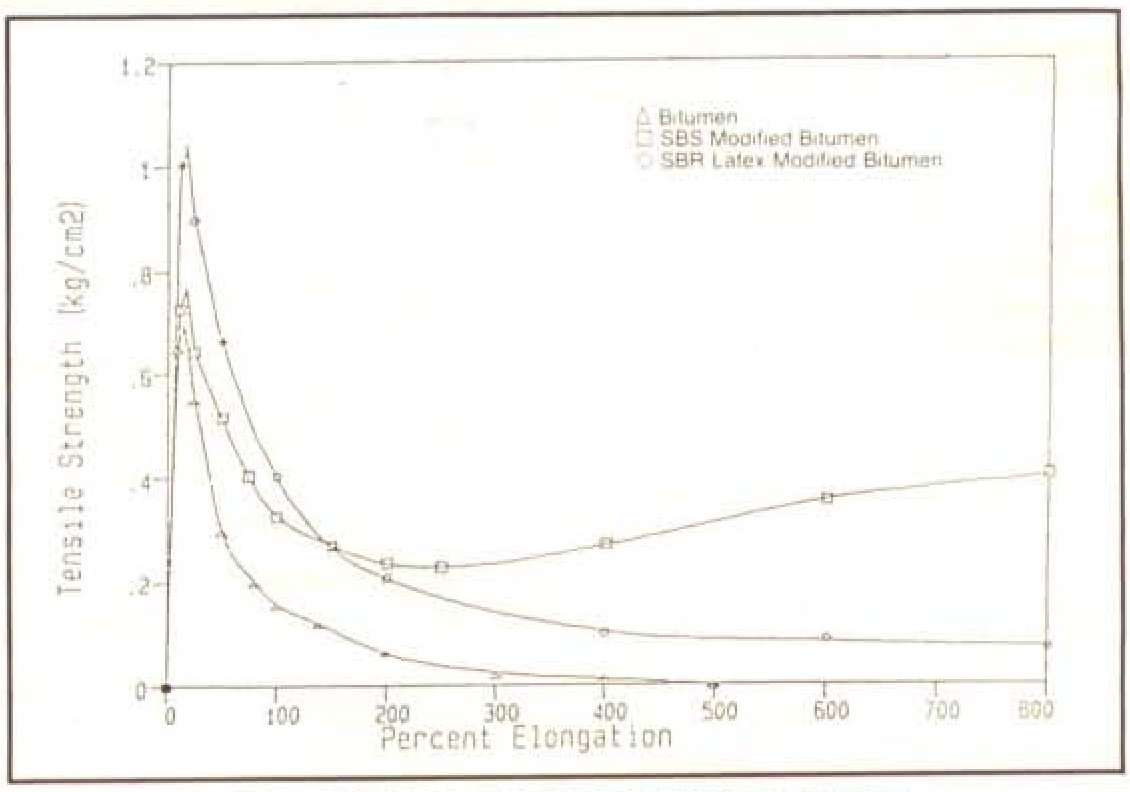

Figure 1 a Stress and strain curves

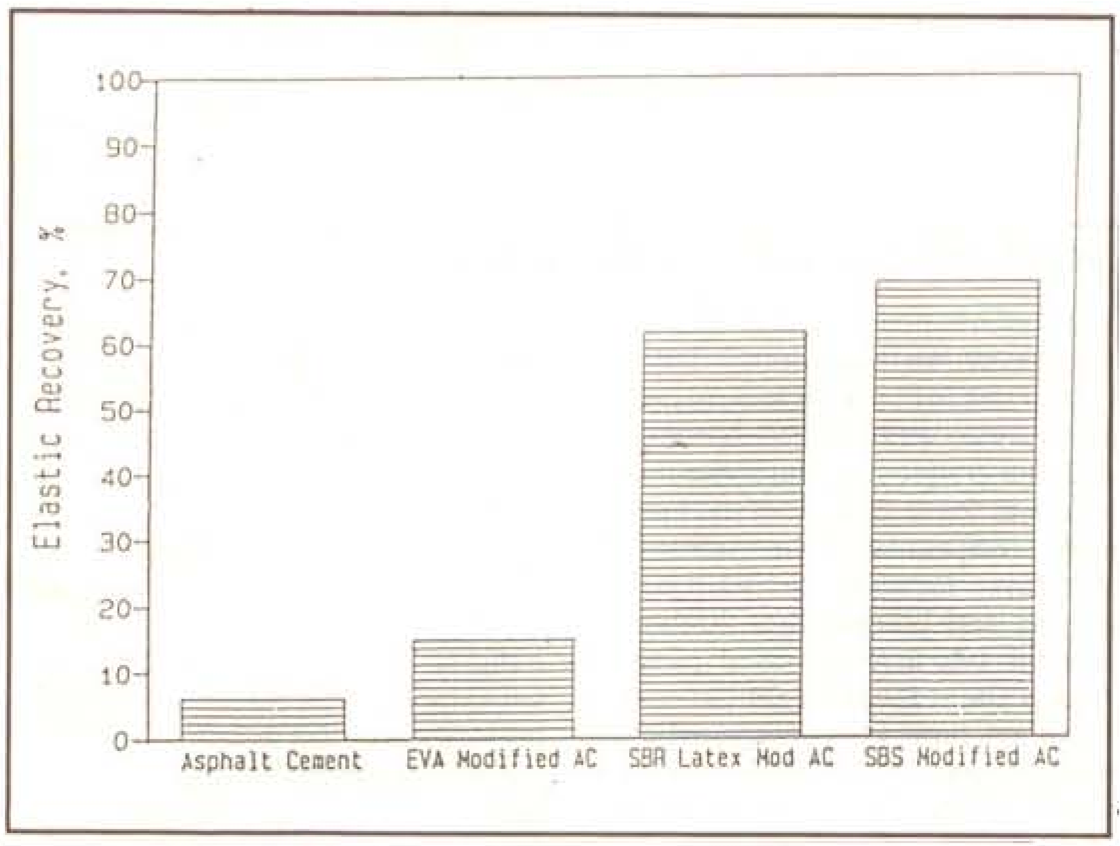

Figure 1b Elastic Recovery After Ductility

or exceed the performance of other polymer modified materials in measured 'end performance' tests such as wheel tracking, Table 1.

The Asphapol systems and Asphapol 2000 modified materials therefore offers pavement engineers an alternative solution to design and rehabilitation of new and existing roads based upon proven experience gained with the materials during the past fourteen years and extensive laboratory evaluation.

References

1. ASSOCIATED ASPHALT CO. LTD *'Asphapol' Improved Surfacings for Carriageways* Trinidad Lake Asphalt 5, April 1981.

2. HEATHER, W. and LAITINEN, J *How Are Concrete Pavements Strengthened Using Bituminous Overlays* Paper presented during workshop; Maintenance, Repair and Strengthening of Concrete Pavements. Cement and Concrete Association, July 1987.

3. KING, G. N. and KING, H.W., *Polymer Modified Asphalts — An Overview: Solutions for Pavement Rehabilitation Problems edited by Stanford PL* American Society of Civil Engineers, 1986.

4. MACDONALD, M.D. *Waterproofing Concrete Bridge Decks: Materials and Methods,* Transport and Road Research Laboratory, Laboratory Report 636, 1974.

5. SWK PAVEMENT ENGINEERING *The Asphapol Process: Test Results and Engineering Information,* SWK Pavement Engineering, Report obtainable from Associated Asphalt, PO Box 60, Henley-on-Thames, November 1987.

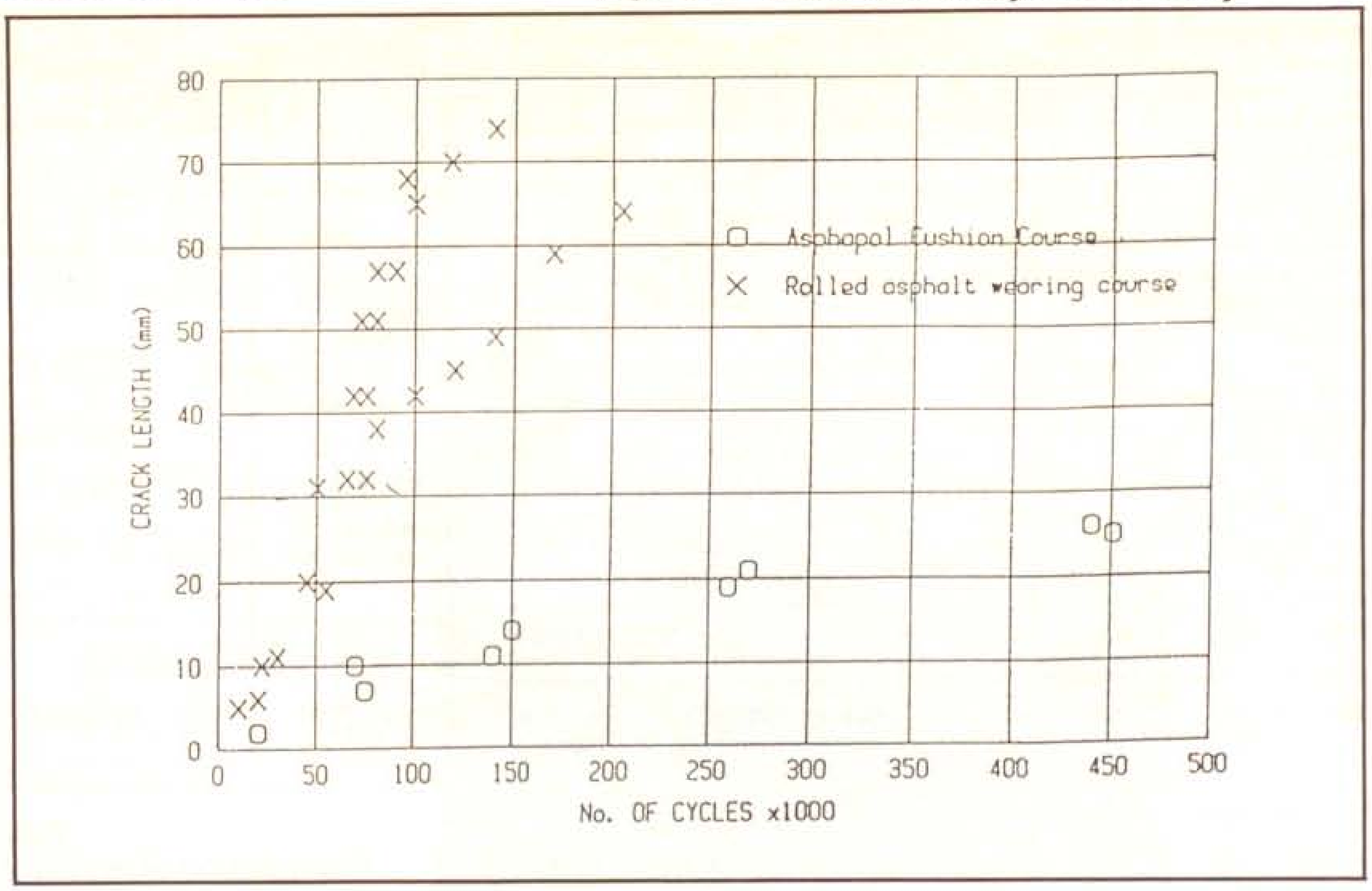

Figure 2 Reflection Cracking Results

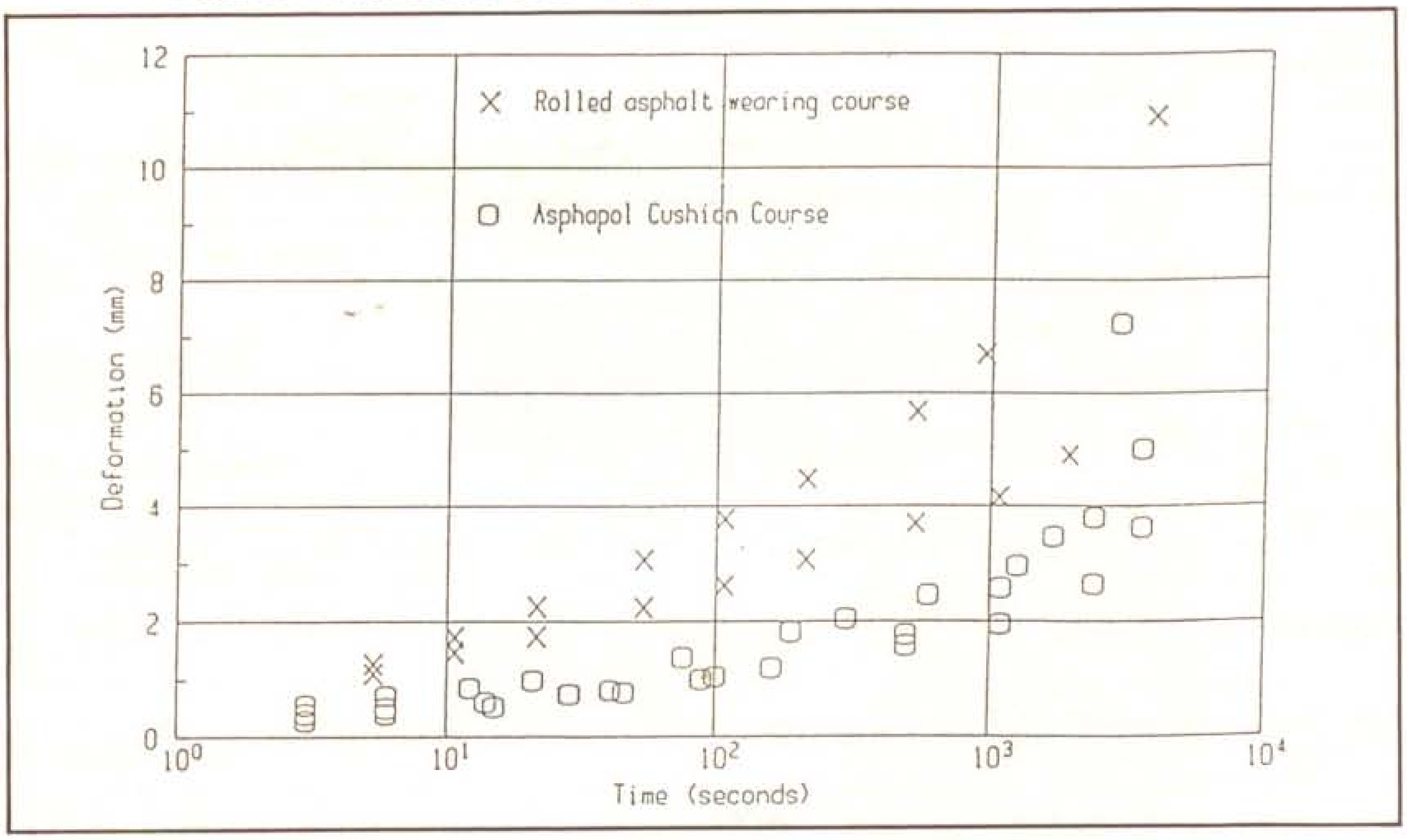

Figure 3 Uniaxial Creep Results for Asphapol Cushion Course and a Typical Rolled Ashpalt Wearing Course Mix