"New Fashioned Flexible Pavements"

SESSION 5

BREAKFAST WORKSHOP

Stone Mastic Asphalt — Australian Experience

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STONE MASTIC ASPHALT
- Australian Experience

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INTRODUCTION

Stone Mastic Asphalt (SMA) is a gap graded asphalt mixture that comprises a large proportion of coarse aggregate particles in a bitumen-rich mastic binder. A true SMA should achieve stone to stone contact of the coarse aggregate. This generally requires something like 70% of a single sized aggregate. The fine aggregate/filler/bitumen mixture then almost, but not totally, fills the voids in the coarse aggregate structure.

It is not intended to provide a detailed technical description of SMA in this paper. A suitable reference for those seeking such detail is provided in APRG Technical Note 2. It could also be noted that AS 2150 -1995, Hot Mix Asphalt, includes SMA mixes.

The properties imparted by SMA are:

- Good deformation resistance as a thin surfacing layer (generally a maximum thickness of three times nominal size)
- Low surface noise and good texture - somewhat similar in surface appearance to open graded asphalt
- Exceptional flexibility and resistance to reflection cracking - a combination of the influence of high bitumen content and self healing ability of the coarse aggregate structure.

HISTORICAL DEVELOPMENT IN AUSTRALIA

The first trial of section of SMA in Australia was placed by Vic Roads in early 1990 based on some rather sketchy data and a trial shipment of Arbocell cellulose fibre. With only a short production run, the contractor did not fully achieve the design objectives and the trial was only partially successful.

The next serious attempt was in early 1993. With the help of technical support from Rettenmaier, Germany, trials were placed on the South Eastern Arterial and the Hume Highway. These were judged successful and subsequently over 15,000 tonne has been placed on major arterials around Melbourne. These represent a variety of applications which are discussed below.

Only a small number of trials have been done in other states. Of the limited trials in NSW, some are believed to be successful but at least one is showing significant rutting. This is further discussed in this paper.

Brisbane City Council have placed SMA on a number of sites around Brisbane. Only one or two other trials have been placed elsewhere in Queensland including a successful trial on Albany Creek Road in 1994.

COMPOSITION AND MANUFACTURE OF SMA MIXES

The Victorian work includes 10mm and 14mm mixes. It has nearly all been done with cellulose fibre added at the rate of 0.3% of the total mix and Class 320 bitumen.

The cellulose fibre goes through a dry mixing cycle with the aggregate in a pugmill mixer to achieve good dispersion before adding the bitumen binder. This process is only appropriate to batch plants. A factor requiring caution is the risk of damaging the fibre if aggregate temperature is too high.

A trial was also done with glass fibre. Compared to cellulose, it is heat resistant and is manufactured to a controlled uniform product. The practical difficulty is that the fibres tend to cling and resist uniform dispersion. This can be overcome with modification to addition and mixing processes but with some difficulty.

Cellulose fibre is not suited to drum mixers, although the manufacturers claim to be able to supply it pre-blended with bitumen in pellet form which can then be added to the drum mixer with the remaining binder. As far as known, that has not been done in Australia. On the other hand, glass fibres can be added directly to drum mixers provided it is introduced through a special pipe at the same point as the bitumen. Again it is believed that no-one has done this in Australia.

Binder content is generally around 6.5% which is nearly 2% more than a typical 14mm dense graded mix. Such high binder contents are a factor in creating a filler/bitumen mastic within the stone structure. Filler content is also higher, contributing to the stiffness of the mixture and assisting in reducing binder drain-off.

The high binder content is the major factor in the flexibility and crack resistance achieved by SMA mixes. A simple calculation of fatigue factor using the Shell formula gives a six-fold increase in fatigue life. This is achieved **without the use of polymers**! If an SMA mix cracks from environmental effects, traffic can realign the coarse aggregate and allow the mix to self heal. A dense graded mix is less able to behave in such manner. The presence of polymers could even reduce such self healing by inhibiting the flow characteristics of the bitumen binder.

The primary reason for adding fibre is to reduce risk of binder drain-off during handling and transport. Laboratory tests show that polymers may only marginally reduce drain-off whereas fibres control it completely. It is difficult to understand why some users suggest that polymer modified binders should be used in SMA, although it is conceded that polymers may allow manufacture in a drum mixer where the use of fibres is impractical.

A key factor with SMA mixes is that the 'mastic' must not totally fill the coarse aggregate voids. This requires more care in design and manufacture than normal dense graded mixes. Placing procedures are also critical. Use of vibratory and multi wheel rollers can cause binder to be drawn to the surface of the mix, as can opening to traffic while the mix is still warm. Compaction, therefore, should be with non-vibratory steel wheel rollers and the mix must be allowed to cool before trafficking. The latter factor can be difficult in intersection work and could be a factor in initial flushing in some intersection trials.

Another factor to be taken into account in the application of SMA is layer thickness. This type of mix actually has a lower shear resistance than dense graded mixes. Its rut resistance relies on the stone interlock achieved in a thin layer where there is little room for movement. As a thick layer, flow and rutting become much more likely.

Mention was made above of rutting occurring in one of the NSW trials. This did not show up for some twelve months so is not likely to be a result of design or placing factors but more likely to be either due to the thickness being greater that desirable at 50mm for a 14mm mix, or to failure to remove sufficient of the severely rutted asphalt that was there before placing the SMA layer.

One of the Victorian trials was to place SMA as a 20mm mix in a 160mm thick layer in a weak pavement to assess its ability to provide good fatigue resistance. There is little doubt that the fatigue objectives will be achieved but the author has reservations about the structural effectiveness and deformation resistance in such an application.

PROJECT EXAMPLES

The following project examples illustrate the appropriate applications for SMA based on the characteristics referred to in the introduction earlier.

Deformation Resistant Surfacing Layer

The intersection of Burwood Highway and Springvale Road was surfaced in early 1995 as one of a series of different treatments of heavily trafficked intersections in the Eastern suburbs of Melbourne. Significant flushing is now evident in the wheel paths on the intersection approach. Several other heavily trafficked roads have also been surfaced and performance is being monitored by Vic Roads.

Low Surface Noise and Water Spray

In conjunction with widening of the South East Arterial to six lanes, the outbound carriageway through Dandenong North was surfaced with SMA and the inbound carriageway with open graded asphalt. Some 6 km was completed in 1993 and a further 2 km in 1994. This gives the opportunity to compare long term performance in similar operating conditions. Road tyre noise and surface water spray of the SMA are only marginally inferior to open graded asphalt but the SMA is expected to be substantially more durable.

Flexible Overlay

Sections of the South East Arterial through Chadstone and Mount Waverley show high deflections and cracking of the asphalt surface. SMA surfacing has been used as an alternative to major rehabilitation and pavement strengthening. Various sections have been done in last two years including the thick layer referred to earlier.

Surfacing Resistant to Reflective Cracking

The comparative resistance of bituminous surfacings to reflective cracking is dramatically demonstrated on the Bituminous and Concrete Surfacings Trial placed on Keilor Park Drive, Melbourne in March 1994. The trial was placed to compare the noise, spray reduction and skid resistance of varying surfacing types on a plain jointed concrete pavement. It also gives the opportunity to compare resistance to reflective cracking.

Details of the trial were reported by Midgely and Foley (1994) and the paper reproduced in Asphalt Review Vol. 14, No. 1, April 1995. The paper reports the following percentage of transverse joint length with reflective cracking in each surfacing type, inspected after three months of service.

Surface Type	Dense graded asphalt	Open graded asphalt	SMA	Slurry	SAM Seal
Lane 1 (slow	5%	2%	0%	95%	17%
Lane 2 (fast)	1%	0%	0%	97%	7%

Table 1. Crack Survey Results After Three Months

Within 12 months, all joints in the slurry and dense graded asphalt had clearly reflected through and opened to around 5mm or more in width. The SAM seal was also extensively cracked. The open graded asphalt had some open cracks and the line of most joints could be identified in the surface of the layer. There was virtually no cracking at all in the SMA although the line of some joints was faintly discernible, indicating movement at the joint and creep in the SMA to accommodate the movement. A similar mechanism was possibly taken place on the open graded asphalt although not as effectively as in the SMA.

Now that the surfacings have been in place some 28 months there is an increase in cracking in both the open graded and SMA sections. Joints with greater levels of movement have cracked but there are still a significant number that show no cracking at all or slight deformation indicating movement and self healing. In this there is not a great deal of difference in the open graded or SMA but then that is not surprising given the coarse structure and high binder content of both mixes. Over the last 12 months there has been a large increase in traffic on this road as a temporary link in the Western Ring Road.

The other sections all show cracking at every transverse, and some longitudinal, joints with various levels of spalling and deterioration at the edges of the cracks.

CONCLUSIONS

Stone mastic asphalt is slightly higher in cost to normal dense graded asphalt due to high binder content and fibres used to inhibit binder drain-off. The result is a mix with exceptional flexibility without the use of polymer modified binders. Surface characteristics approach that of open graded asphalt but in a more durable surfacing.

As rut resistant surfacing for intersections there has been mixed success which indicates that some learning is still involved. There are a whole range of factors which have been referred to in this paper which include design, manufacture and placing as well as existing surface condition and layer thickness.

REFERENCES

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