

## FOAM BITUMEN STABILISED PAVEMENTS

### 1. INTRODUCTION

Foamed bitumen stabilisation is one form of pavement rehabilitation involving recycling of existing materials. This Note describes in-situ stabilisation on the road, however, the material may also be produced at a batch plant.

Mobil has continued to develop the technology since the late 1960s. Water is injected into hot bitumen, causing a foaming action that aids bitumen dispersal through the mix, with the bitumen preferentially coating the finer particles in the mineral aggregate, rather than coating all particles, as with asphalt. The bitumen and fines form a binder between the coarse particles. Bitumen content is usually 4% by mass of the mix.

VicRoads is monitoring three trials constructed by Emoleum (Aust.) Ltd, in mid-1993 on major roads in Melbourne, to characterise and assess the performance of the stabilised material.

### 2. PAVEMENT INVESTIGATION

Pavement and subgrade dippings and deflection testing should be undertaken prior to any rehabilitation works, to determine the structural condition of the pavement and cause of the defects. The suitability of foamed bitumen stabilisation as a rehabilitation option in each particular case can then be determined.

It is essential to determine the variation in pavement depth and composition and the location of all underground services, to avoid construction delays and ensure that the intent of the pavement design is met. The recycling plant can only pulverise asphalt patches down to 150mm depth, therefore, deeper patches should be pulverised separately, prior to stabilisation. Ground probing radar can be used to locate asphalt patches.

### 3. MIX DESIGN

Proprietary bitumen foaming equipment is needed for the laboratory mix design. VicRoads should conduct surveillance of laboratory mix design done by contractors.

#### (a) Material Characteristics

The performance of the stabilised product varies with material quality and particle size grading. A maximum Plasticity Index of 12 is recommended. Gap graded materials

can be improved by mechanical stabilisation. Secondary additives such as Flyash, Cement Works Flue Dust or Lime, may be used to alter the properties of the material, to make it more amenable to treatment with the bituminous binder. Cementitious additives should not exceed 2% by mass of the mix, to avoid possible shrinkage cracks.

Figure 1 below shows three zones designated by the contractor on the trials, for particle size grading after compaction. Zone A is appropriate for heavily trafficked roads and zone B is for lightly trafficked roads. Material conforming to zone C lacks fines and would need addition of finer materials prior to stabilisation. Similarly, the performance of material conforming to zone B could be enhanced by the addition of coarse particles to adjust the grading to zone A.

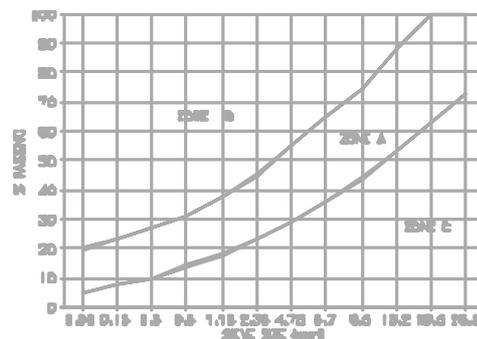


Figure 1 - Material Grading Zones

#### (b) Compaction

The Optimum Moisture Content (OMC), Maximum Dry Density (Modified) and density adjustments for oversize material, are determined as for granular materials. Material at various moisture contents is foamed with a 'seed' value of 4% bitumen (which is the usual optimum bitumen content for Modulus) and then compacted.

In the laboratory, representative samples of pavement material are prepared by either gyratory or Marshall compaction, at a range of bitumen contents and then tested as per section (c) below. For large size material (i.e >20mm), a 150 mm diameter mould should be used for the compaction, which then precludes Marshall compaction.

In the road trials, the contractor advised that a (minimum) density ratio of 92% (ratio of field to laboratory compaction) is appropriate. The low compaction level may be offset by the binding effects of the bitumen. The foam stabilised material is compacted cold, remaining workable for a few

hours. Performance of the field trials will be monitored, to determine if the above compaction standard is appropriate, or if it should be increased.

### (c) Modulus and Creep Testing

After laboratory compaction, samples are cured for 3 days at 60°C. MATTA (MATERIALS TESTING APPARATUS) Resilient Modulus and Dynamic Creep tests are then performed. MATTA testing is also done on samples which have been soaked in water at 60°C for 24 hours, after the previous dry curing. The design bitumen content is usually 4%, yielding maximum Modulus for both cured states. If maximum Modulus occurs at other than 4% bitumen, then OMC must be redetermined (as above).

## 4. PAVEMENT DESIGN

Further analysis via field and laboratory testing is needed to verify the design assumption that foamed bitumen stabilised material has the same fatigue performance as normal hot mix dense graded asphalt. The Mechanistic Design Procedure described in the AUSTRROADS pavement design guide may be used, however, the fatigue performance of the stabilised material needs to be characterised, to enable determination of its design life. The variation in pavement material depth and quality must be considered in the pavement design.

## 5. CONSTRUCTION

The construction procedure generally involves ripping/pulverising in-situ material, watering, spreading of additives, foam stabilisation and then shaping and compaction. Desirably, the stabilisation would be undertaken during drier times of the year, to avoid the effects of excess moisture in the pavement.

The following items of plant were used on the trials : Road Reclaimer (with foam stabilising equipment), Bitumen Tanker, Water Cart, Grader, Tandem Vibratory Steel Drum Roller. A vibrating Padfoot Roller may also be useful for deep compaction. Stabilisation to 300 mm depth in one pass was achieved by heavy vibratory compaction plant. In urban areas, however, it may be necessary to stabilise in two lifts, using lighter plant, to avoid property damage.

Testing during construction should include the following:

- density testing and moisture content
- particle size distribution and bitumen content
- MATTA Modulus & Creep testing.

Consideration should be given to detouring traffic from the site during construction, to expedite the work.

## 6. SURFACING

After stabilisation, the unsealed road may be opened to traffic temporarily. If rainfall is imminent, however, then it

would be necessary to apply a primerseal soon after construction, to waterproof the pavement. A final sprayed seal, or asphalt wearing course, may be placed later, to provide the final wearing surface. If an asphalt wearing course is to be placed soon after construction, then apply a size 7mm Emulsion Primerseal, but if the asphalt is to be deferred at least 9-12 months, then apply a size 10 mm Cutback Primerseal instead.

Deflection testing of the pavement should be done prior to placement of an asphalt surfacing, to confirm that the proposed asphalt thickness is adequate, to avoid premature fatigue induced cracking.

## 7. PERFORMANCE

Performance monitoring of the stabilised pavement should involve the following:

- assessment of 'before' and 'after' deflection test results
- automated survey of roughness and rutting
- visual survey of pavement defects.

Deflection testing, on trials to date, generally indicates that the foam bitumen stabilisation initially stiffened the pavement. Prior to stabilisation, deflections were generally high only in the outer wheelpaths, probably due to moisture effects. Reduction in deflections suggests that the stabilised material is less moisture sensitive and/or the stabilised material provides a bridging effect over weaker subgrade areas.

Monitoring of the trials is essential to assess any changes in the performance of the stabilised material, due to field curing and/or fatigue effects.

## 8. APPLICATIONS

Depending upon pavement rehabilitation needs, in-situ foamed bitumen stabilisation may be a suitable alternative to extensive asphalt patching and/or asphalt overlay, cement recycling, granular resheeting, or complete reconstruction. A whole-of-life economic analysis, preferably including traffic delay costs, should be done to determine the most economical option.

## 9. REFERENCES

Guide to Stabilisation in Roadworks:- NAASRA(1986) Bitumen Stabilisation - A New Approach To Recycling Pavements:- S.Maccarrone, G.Holleran, D.Leonard AAPA 1993 Members' Conference Papers

## 10. CONTACT

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