AustStab Construction Tips

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Foamed bitumen stabilisation

Introduction

Foamed bitumen stabilisation is a road construction technique whereby hot-foamed bitumen is used to bind the existing or imported granular material to produce a flexible bound pavement material for use in base and subbase pavement layers, and in particular for road rehabilitation.

Foamed bitumen as a binder was realised in 1956 by Dr Ladi Csanyi at the Engineering Experiment Station in Iowa State University, USA. The original construction process designed by Csanyi consisted of injecting steam into hot bitumen to produce the foamed bitumen. The steam foaming approach was very convenient for stationary asphalt plants, but it proved too difficult for insitu operations with the type of equipment available in the 1950s to 1960s.

In the late 1960s the process was modified by adding cold water rather than steam into the hot bitumen. This approached became much more practical for both plant mix and insitu operations.

Today, the usage of the foamed bitumen process has increased in Australia. AustStab members are using specialised insitu and plant mix equipment to produce foamed bitumen stabilisation (refer to Figures 1 and 2).

What is foamed stabilisation?

Foamed bitumen is a mixture of air, water and hot bitumen and the typical quantities are 98% bitumen, 1% water and 1% foaming agent additive. When hot bitumen (160 to 200^{o}C) comes in contact with cold water (15 to 25^{o}C) the mixture expands to about greater than 10 times its original volume and forms a fine mist or foam.

Bitumen emulsion is where larger quantities of water (about 40%) and a special emulsifying additive is added to cold bitumen and therefore, is unlike the foamed bitumen process.

The foamed material is incorporated into the mixing drum where it wets and coats the surface of the fine particles (typically less than 75µm in diameter) to form a flexible yet strong stabilised pavement material. As the foam collapses most of the water is lost in the form of steam. The residual bitumen has properties similar to the original bitumen and is well dispersed through the matrix in very small droplets. The bitumen droplets are attracted to and coat the finer particles, forming a uniform matrix that effectively binds the mixture of particles together. The resultant bitumen stabilised material has the colour of the parent aggregate as shown in Figure 3, and may be touched by hand after it has been processed.

Figure 1 Foamed bitumen insitu stabilisation using a modified specialist reclaimer.

Figure 2 Foamed bitumen stabilisation using a mobile batch plant. The material is placed using conventional road making and/or asphalt laying equipment.

Figure 3 The foamed bitumen stabilised material has the colour of the dominant parent aggregate.

Figure 4 The hard surface of the road after foamed bitumen stabilisation.

The benefits …

The benefits of foamed bitumen stabilisation are:

- an increase in strength over granular pavement materials
- quick construction method
- lower costs than reconstruction
- may be trafficked immediately
- bitumen provides a durable and waterproofness to the pavement material

The limitations …

The limitations are:

- requires a suitable grading of fines in the pavement material
- purpose built equipment and experienced operators are required

Where would you consider this rehabilitation option?

This effective pavement rehabilitation option may be considered in most situations, such as:

- A pavement has been repeatedly patched to the extent that pavement repairs are no longer cost effective;
- A weak granular base overlies a reasonably strong subgrade.
- Conventional reseals or thin asphalt overlays can no longer correct flushing problems.
- An alternative to full-depth asphalt in low to moderate trafficked roads.

The foamed bitumen stabilised pavement layer whilst flexible cannot be expected to bridge over a very weak subgrade. Where subgrade failures have been identified in the pavement investigation report it is recommended that subgrade strengthening be carried out before stabilisation occurs.

Similar to cement stabilisation, the designer needs to plan suitable lead time for laboratory testing and design evaluation for foamed bitumen stabilisation. It is suggested that a minimum of three weeks be given from the time of nominating project rehabilitation option.

Materials

The bitumen used for this process is typically Class 170 complying with AS 2008. The amount of bitumen required for stabilisation is dependent on the pavement material and is determined using laboratory testing.

Typical application rates for foamed bitumen stabilisation are 2 to 4%. The addition of supplementary binders, such as lime or cement, is applicable in some situations.

Figure 5 Foamed bitumen being produced in the laboratory.

Potable water is used for the foaming process and additional water may need to be incorporated to increase the moisture content of the pavement material during mixing.

Research in Australia and overseas has shown that the parent material applicable can range from high quality quarried material to marginal materials. The parent material may be modified so as to achieve a suitable grading curve, by the addition of complementary material prior to stabilising. One of the key elements is to have suitable grading curve as shown in Figure 6.

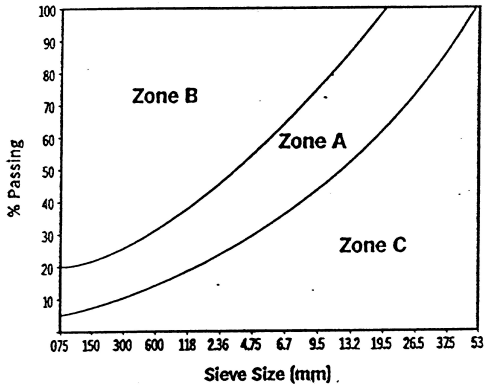

Figure 6 The grading curve of the material to be stabilised should fall within the Zone A range.

How do you design these pavements?

Foamed bitumen stabilisation of the base course results in a flexible pavement. Mechanistic design procedures are used to predict the traffic life of the pavement. Similar to other flexible pavements, foamed bitumen stabilisation can be designed using programs such as CIRCLY by inputting the appropriate material properties in the pavement layers.

Can you recycle these pavements?

Similar to cement stabilised pavements, foamed bitumen stabilised materials may be recycled again by carrying out laboratory tests to assess the bitumen content and material grading. Additional fines may be required in the existing pavement material.

Project examples

Various foamed bitumen projects have been carried out in the past, and the following examples from around Australia may assist designers in understanding their application.

High St, Riverton, John St., Bentley & Nicholson & Spencer Roads Intersection, Ferndale
City of Canning, Western Australia

Various options were considered for rehabilitation and foamed bitumen was chosen on low cost and quick construction (see Figure 7). A 40 mm asphalt wearing course was used to finish the street.

Figure 7 Tanker coupled to reclaimer during stabilisation stage.

Bordertown, Dukes Highway, South Australia
Transport SA

Insitu and plant-mix foamed bitumen stabilisation were trialed for the Dukes Highway rehabilitation work (also refer to Figure 2). Conventional road making equipment was used to construct the road with plant-mix material (see Figure 8). Stabilisation was carried out to a depth 250 mm and a 2-coat seal was applied as the wearing surface. This option was selected in a reactive clay subgrade to minimise potential shrinkage cracking in the base layer.

Figure 8 Plant-mix foamed bitumen stabilised material being layed using conventional road making equipment.

Warwick (North), New England Highway, QLD
Qld Department of Main Roads

Insitu bitumen stabilisation was trialed for some 18 km on the New England Highway. The designer recognised that an economical procedure utilising the large reclaimer's mixing nominal width of 2.4 m (see Figure 1) was to stabilised to a depth of 250 and 200 mm in the outer and inner wheel path respectively. A detailed paper of this project can be read on the AustStab web site.

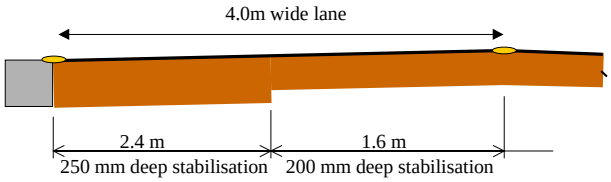

Figure 9 Cross-section of roadway

Avoca Road, Canley Heights, NSW
Fairfield City Council

FCC have utilised road stabilisation for well over 30 years and specified 250 mm deep foamed bitumen stabilisation for a section of this collector road. The Council engineer was so confident of the technology that the section of work occurred adjacent to the Council Chambers (see Figure 10).

Figure 10 Full-width stabilisation in one day with one lane open to traffic (Avoca Road).

Sayers Road, Wyndham, Victoria
City of Wyndham

Full-width insitu foamed bitumen stabilisation for a section of collector road that had previously been stabilised. Additional granular material was incorporated with the existing material to ensure the grading curve was effective for foamed bitumen. The base was stabilised to a depth of 275 mm.

Figure 11 View of Sayers Road before line-marking.

Contractors

The following contractors provide this service:

FoamTec International
Contact: Chris Rootsey
Tel: 02 9420 8071 Fax: 02 9420 8073
Email: chrisroo@zip.com.au

Pavement Technology
Contact: Oliver Vido
Tel: 03 9706 6100 Fax: 03 9706 6911
Email: ptl.vic@bigpond.com

Stabilised Pavements of Australia
Contact: Warren Smith
Tel: 02 4340 0111 Fax: 02 4340 1299
Email: warsm@ozemail.com.au

Bitumen Suppliers

Mobil Bitumen
Contact: Sam Maccarrone
Tel: (03) 9289-3145 Fax: (03) 9391-7274

Shell Bitumen
Contact: Nigel Preston
Tel: (03) 9666-5463 Fax: (03) 9666-5174

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1. Smith, W (1999). *Foamed Bitumen Stabilisation Project – Warwick, QLD*, Joint Transport South Australia/AustStab Seminar 15 April 1999.
2. Maccarrone, S et al *Pavements recycling using foamed bitumen* Proceedings of the 17th Australian Road Research Board Conference, Gold Coast, Australia, 1994.
3. Bowering, RH & Martin, CL *Performance of newly constructed full depth foamed bitumen pavements*. Proceedings of the 8th Australian Road Research Board Conference, held in Perth, Australia, 1976.
4. M Kendall, B Baker, P Evans & J Ramanujam *Foamed bitumen Stabilisation* Proceedings Roads at Work - Developing Southern Queensland, Southern Region Symposium, Qld Department of Main Roads, Goondiwindi, 21 October 1999

Web Sites

AustStab home page
http://www.auststab.com.au
Qld Dept. of Main Roads TTD Pavement Rehabilitation
http://www.ttdpavement.qld.gov.au
CSIR Transportek
http://foamasph.scir.co.za:81/

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