

AustStab Technical Note

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Foamed bitumen stabilisation

1 Introduction

Foamed bitumen stabilisation is a road construction technique whereby hot 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 approach 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 stabilised materials (refer to Figures 1 and 2).

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 up to 1% foaming agent. When hot bitumen (160 to 200°C) comes in contact with cold water (15 to 25°C) the mixture expands to greater than 10 times its original volume and forms a fine mist or foam.



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.

The foamed material is sprayed into the mixing drum where it wets and coats the surface of the fine particles (typically less than 0.0075mm 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 squeezed by hand after it has been processed small specks of bitumen will adhere to the palm.



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.

3 The benefits and limitations

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 are:

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

4 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.
- A granular base too thin to consider using cementitious binders
- Conventional reseals or thin asphalt overlays can no longer correct flushing problems.
- An alternative to full-depth asphalt in moderate to high trafficked roads.
- Unfavourable wet cyclic conditions unsuitable for granular construction.
- Situations where an overlay is not possible due to site constraints eg entries to adjacent properties & flood prone areas
- A requirement to complete the rehabilitation quickly to prevent disruption to business or residents

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 by lime stabilisation 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.

5 Materials

The bitumen used for this process is typically Class 170 complying with AS 2008 [Ref.1]. 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 pavement 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. Good results are obtained when the pavement material gradings fall into Zone A, and successful stabilisation has occurred when part of the grading is in Zones B or C. These materials should only be considered based on resilient modulus testing.

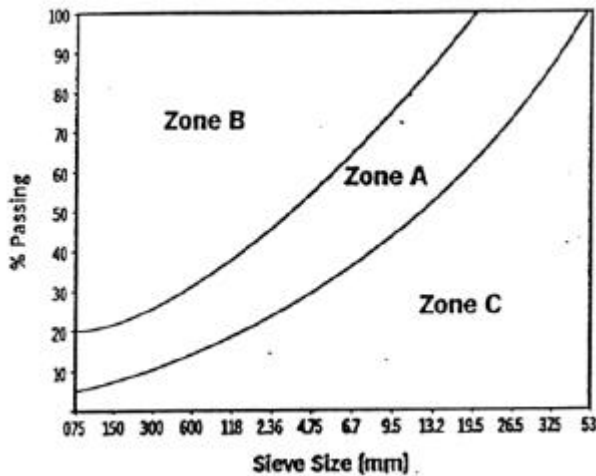


Figure 6 The grading curve of the material to be stabilised should fall within the Zone A range. [Ref.2]

Laboratory testing to establish the material proportions is documented in an Austroads technical report [Ref.3].

6 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.



Figure 7 Foamed bitumen stabilisation as base course material for Bruce Highway Innisfail, Queensland.

7 Tips on sealing

Due to the inherent bitumen content in pavements stabilised with foamed bitumen, the adhesion of bitumen wearing courses is usually excellent. However, the application rates for these bitumen wearing courses over foamed bitumen stabilised layers need to be looked at to prevent excess bitumen

problems (i.e. bleeding of seals and instability of asphalt layers).

As a general rule the bitumen application rate for bitumen seals on foamed bitumen layers is usually reduced from the normal design rate by approximately 10%. When an asphalt layer is to be applied, it is also common practice to do away with either the prime seal or the tack coat, depending on the timing of the asphalt application and the traffic conditions.

The reduction in the bitumen in the application of the wearing course is a cost advantage to the overall process.

8 Specifications

Specialised plant is required for both insitu and plant-mix foamed bitumen stabilisation. The Association provides model specifications for the construction of local and main roads, and a copy may be obtained from the web site at www.auststab.com.au/specifications/

9 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.

10 References

1. AS 2008 *Residual bitumen for pavements* Australian Standards, Sydney, 1997.
2. Maccarrone, S et al *Pavements recycling using foamed bitumen* Proceedings of the 17th Australian Road Research Board Conference, Gold Coast, Australia, 1994.
3. Austroads *Mix Design for stabilised pavement materials* Report No. AP/T16, Sydney 2002.

11 Bibliography

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.

Kendall, M, Baker, B, Evans P & Ramanujam, J *Foamed bitumen Stabilisation* Proceedings Roads at Work - Developing Southern Queensland, Southern Region Symposium, Qld Department of Main Roads, Goondiwindi, 21 October 1999.

Smith, W (1999). *Foamed Bitumen Stabilisation Project – Warwick, QLD*, Joint Transport South Australia/AustStab Seminar 15 April 1999.

Leek, C *An investigation of the performance properties of insitu foamed bitumen stabilised pavements* Institute of Public Works Engineering Australia, Foundation Funded Research Project, Canning Vale, WA, 2002.

Contractors

The following contractors provide this service:

Highway Stabilisers

Contact: Steve Hey
TEL: 03 9775 2202 Fax: 03 9775 2656
Email: stevenhey@compuserve.com

Pavement Technology

Contact: Oliver Vido
Tel: 03 9706 6100 Fax: 03 9706 6911
Email: oliver.vido@adbri.com.au

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: Gerard Gnanaseelan
Tel: (03) 9289-3145 Fax: (03) 9391-7274

Shell Bitumen

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

Web Sites

AustStab home page
www.auststab.com.au

Austrroads Pavement Reference Group home page
www.austrroads.com.au/aprg/

CSIR Transportek
foamasph.scir.co.za:81/

Mobil Bitumen
www.mobil.com.au

Qld Dept. of Main Roads TTD Pavement
Rehabilitation
www.ttdpavement.qld.gov.au

Shell Bitumen
www.shell.com.au/bitumen/

Wirtgen Australia
www.wirtgen.de

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