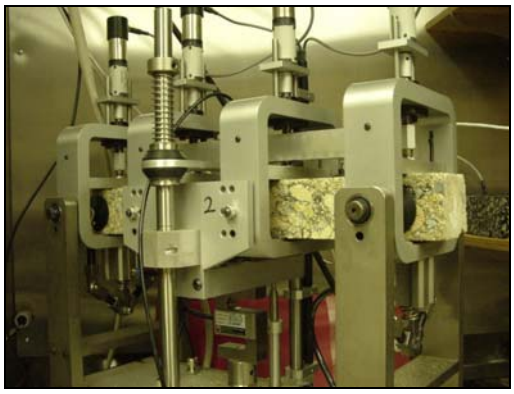
Model Specification for Insitu Stabilisation of Main Roads using Bituminous Binders

Version B2 – 2006



AUSTRALIAN STABILISATION INDUSTRY ASSOCIATION LIMITED

AustStab

Preface

The purpose of this specification is for the construction of new or existing main roads by insitu stabilisation with a bituminous binder, with or without a supplementary binder, such as cement, cement flue-dust, fly ash, slag or lime. Incorporation of the binder shall be accomplished using a purpose built stabilising mixer with mixing box referred to as a "stabiliser". This specification is only applicable to foamed bitumen stabilisation.

A lack of design details, poor specification clauses, and poor construction practices by contractors with little knowledge of the process, quality control and materials may cause early distress of roads. Also, one of the problems faced by contractors during tendering is the variation of specifications. For example, in insitu stabilisation specifications are likely to change from one region to another region or State.

In attempt to minimise problems with road stabilisation AustStab has sought to produce a range of model specifications for use by State Road Authorities, Councils and Shires. A working group in AustStab was formed to prepare this model specification aimed at specifying insitu stabilisation of main roads for both urban and rural areas. It also gave consideration to practices adopted in all regions of Australia, such as the evaluation of lot size and density measurements for conformance assessment.

In the specification there are options to include and delete paragraphs and clauses based on the contractual requirements and practices by State Road Authorities in Australia. At the end of the specification is a schedule of rates that is required to be completed by the contractor in their submission to the tender documents.

The 12-page specification is available on a WORD file and may be requested from the AustStab Internet web site at **www.auststab.com.au**. Amendments to the specification will be on the AustStab web site or you may telephone AustStab. If this document is read from Adobe Acrobat some reference documents are directly linked to the AustStab or other appropriate web site for easy reference. It is hoped that the model specification and commentary will be widely used and the Association looks forward to your feedback, such that further amendments will reflect best practice.

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AustStab Model Specification for Insitu Stabilisation of Main Roads using Bituminous Binders

1 GENERAL

Foamed bitumen stabilisation is to be carried to a nominal *** m width and to a nominal finished depth of *** mm (refer typical cross section). The area to be treated is approximately *** m^2 and will be comprised of **********.

The proposed bitumen content is ***% of MDD at ***kg/m^2. Additional supplementary binder is *** and will be spread at *** kg/m^2.

The client's representative shall carry out a detailed inspection of the site for services and asphalt patching greater than 75 mm in thickness.

2 SCOPE OF WORKS

2.1 Overview

The work included under this contract comprises the supply of all materials, plant and labour necessary for the completed and proper construction of the proposed foamed bitumen stabilisation work in accordance with the design and specification requirements.

The stabilised pavement shall be composed of a combination of pavement materials and binder uniformly mixed, moistened and compacted in accordance with this Specification and shaped to conform to the lines, grades, thicknesses and typical cross-sections shown on the plans, or as directed by the client's representative.

Stabilisation shall be undertaken by using equipment meeting the requirements described in this specification.

2.2 Works not included in contract

Works not included in the contract are:

- Traffic control
- Shape correction [*Delete if not required*]
- Bituminous surfacing
- Treatment of unsuitable subgrade
- Pegging of the control line (by the client's representative)
- Offsetting the control line

3 REFERENCE DOCUMENTS

The standard specifications and test methods referred to are listed in Table 1, using abbreviated titles. Unless otherwise specified, the applicable issue of a reference document will be that current one week before the closing of tenders, or where no issue is current at that date, the most recent issue.

Table 1 Reference documents.

Binder	Australian Standard
Bitumen	AS 2008
GP & GB Cement	AS 3972
Lime	AS 1672
Fly ash	AS 3582.1
Slag	AS 3582.2

4 MATERIALS

4.1 Binder

All binders shall be supplied by the Contractor, shall comply with the Australian Standards as noted in Clause 3. Supplementary binders shall not be older than three months from time of manufacture.

When required by the Client's representative, the Contractor shall furnish documentary or other acceptable evidence of the quality and age of the binder, and any binder that is not satisfactory shall be rejected**.**

4.2 Water

The water used for the work shall be supplied by the Contractor and shall be potable. Where the water is drawn from natural sources, an efficient filter is to be provided on the suction pipe to ensure freedom from weeds, roots, etc., which could cause blockage of jets in the stabiliser.

4.3 Granular Materials

[*Delete if not applicable*]

If additional granular pavement material is required to improve the existing pavement material, this material shall be supplied by the client's representative and spread by the contractor to the specified rate and/or levels.

[*Delete if not applicable*]

If additional granular pavement material is required to improve the existing pavement material or to correct pavement levels, this material will be supplied and spread by the contractor to the specified levels.

4.4 Recycled Asphalt Profilings

[*Delete if not applicable*]

Reclaimed asphalt pavement (RAP) used as a supplementary pavement material shall be pulverised asphalt obtained from the profiling of asphalt pavements or by crushing to a graded material with a maximum particle size of 40 mm. Materials shall be free flowing and capable of uniform spreading and incorporation into the recycled pavement. It shall be spread by the Contractor at the rate and/or to the levels specified in the schedule of job details.

5 EQUIPMENT

The reclaimer / stabiliser to be used for the stabilisation works shall satisfy the following requirements:

- a minimum power capability of 300 kW (400 hp) to ensure adequate mixing of materials,
- bitumen injection systems must be linked to the ground speed to ensure an accurate application throughout runs, irrespective of the speed of the plant,
- an inspection or test jet must be fitted to ensure the flow of bitumen and that the required expansion and half life qualities of the bitumen are being achieved, and
- bitumen jets must be self cleansing.

6 CONSTRUCTION PROCESS

6.1 Lowering of Services and Initial Shaping

The client's representative will lower all services and utilities as necessary.

[*Delete if not applicable*]

Form the area to be stabilised to the finished level of the stabilised pavement before the contractor commences work.

6.2 Initial Surface Preparation and Milling

[*Delete if not applicable*]

The surface of the insitu material shall be given a light compaction or proof rolling to reveal any irregularities in the surface of the material, and to allow the stabilising equipment to traverse the area without excessive displacement of the surface.

The surface shall then be trimmed to the required alignment, levels and cross-sections necessary to produce the required final compacted thickness of stabilised material.

If the client's representative has identified thick in-fill layers of asphalt the contractor is required to mill the asphalt and evenly spread the milled asphalt onto the surface of the existing pavement to minimise the need for imported granular material.

6.3 Climatic Restraints

Stabilisation (including spreading, compacting and finishing) shall not be carried out when the temperature measured at a depth of 50 mm in the pavement is below 10^0 C.

Stabilisation (including spreading, compacting and finishing) shall not proceed:

(a) during rain
(b) during periods when the wind is sufficiently strong to cause particles of the supplementary binder to become air-borne, unless other procedures are adopted to mitigate the generation of binder in the air.
(c) during conditions that may cause nuisance or danger to people, property or the environment.

Details of procedures for ceasing operations in the event of rain or strong wind shall be submitted as part of the QUALITY PLAN.

6.4 Interruption of works

The stabilised material may be remixed again up to 7 days in duration from the incorporation of the foamed bitumen without any additional bitumen. This remixing may only be done with the equipment noted in Section 5.

Further laboratory testing is required should the stabilised material not meet specification requirements and additional binder is required to be added.

If, due to climatic conditions, plant breakdown or other causes, the binder cannot be uniformly incorporated in the pavement in accordance with the above procedure before becoming damp, then additional binder shall be spread before final mixing.

6.5 Application of Binder

6.5.1 Bituminous Binder

The binder shall be uniformly incorporated by a controlled device that provides calibration to the application rate of bitumen. The minimum expansion rate shall be 10 and the minimum half-life shall be 20 seconds.

Mixing uniformity shall be continuously inspected visually by the contractor and work shall stop when bitumen streaks or blotches are observed.

The mixing chamber shall be equipped with a spray system to allow variable widths of binder to be incorporated into the pavement material.

The contractor shall record the area of application and tonnage of binder used per run. The inspection nozzle shall be used to verify the foaming characteristics for every bitumen tanker load. These records shall be kept for at least 12 months after completion of the project. The construction tolerance for the application rate is ±10%.

6.5.2 Supplementary Binders

Supplementary binders shall be uniformly spread with the use of a spreader equipped with calibrated electronic load cells to ensure that a controlled mass is spread across the pavement. The rate of spreading shall be such as to provide the specified binder content in the compacted material. The spreader shall be equipped with gates to allow variable widths of binders to be deposited onto the pavement surface.

The contractor shall record the area of spread, tonnage of binder used per run, and mat or tray results at regular [at least daily] intervals, and keep these records for at least 12-months after completion of the project. The construction tolerance for the spread rate is ±10% of the specified value.

Once the binder has been spread, the only traffic that may travel over the area to be stabilised shall be construction plant employed for the stabilisation work.

If the binder is quicklime slaking shall be carried out before mixing.

6.6 Joints

Mixing shall proceed in lanes working from one side of the pavement to the other, without intervening lanes of unmixed material.

The overlap at joints shall be 100 to 200 mm, and additional binder should not overlap beyond this region. Joints are deemed to be fresh when the pavement materials on both sides of the joint have been stabilised and compacted within the nominated working time.

Where joints are completed the outside 300 mm of material from the first run should be left uncompacted until the adjacent material is mixed.

6.7 Moisture Content

The total fluid content of the material immediately after mixing shall be 80% to 100% of the moisture content specified by the Client's representative.

Water shall only be applied through the mixing chamber of the stabiliser to meet the moisture content requirement unless pre-moisturing and mixing is carried out.

6.8 Compaction

The compaction achieved, as determined by tests of the insitu material, shall not be less than the % of the maximum dry density specified in Clause 8.4.

6.9 Finishing

The finished surfaces shall be true to line and level, with correct crossfall, and free from loose pockets, holes, bumps and flakes of material.

[*Delete next paragraph if not applicable*]

The finished surface shall be as specified and to within ±10 mm.

[*OR*]

The pavement surface is to be finished to a straight uniform profile from the crown of pavement to the lip of gutter with full width stabilisation.

Where shoulders only are to be stabilised, the finished profile shall comprise a straight uniform crossfall from the edge of the existing pavement to the outer edge of the construction.

All final trimming shall be cut to waste or reused in other applications as directed by the client's representative.

6.10 Curing

The compacted and trimmed surface may be opened to traffic before the next pavement layer is constructed.

7 PRELIMINARY TRIAL

If directed by the client's representative, the Contractor shall carry out a preliminary trial of the proposed stabilising operation.

The trial shall determine:

a) the effectiveness of the construction plant;
b) the number of passes of the stabilisation machine necessary to achieve uniform pulverisation and mixing;
c) the field moisture content required to achieve specified compaction requirements;
d) the rolling routine required to meet specified compaction requirements.

The trial section shall be located within the Works area.

The length of the trial section shall be between 50 and 100 metres over the full width proposed to be stabilised.

8 ACCEPTANCE CRITERIA

8.1 Lot determination

Compaction is to be accepted by density testing in lots of similar material and work. Unless otherwise specified, the maximum lot size shall be the area of work completed on the same day up to 7,500 m^2 provided that the whole of the lot is essentially a uniform material similar to material used for the relevant mix design applicable to the lot.

8.2 Application and spread rate

The bitumen application rate shall be verified through dipping of the tanker at the start and finish of each run. The contractor shall verify the application and spread rate for supplementary binders as per AustStab National Guideline as directed by the client's representative.

Where the actual spread rates (kg/m^2) calculated for a spreader run include one or more lengths in which the spread rate is greater than the nominated rate per spread, and no lengths in which the spread rate is less than the nominated rate per spread, the run shall be accepted on the basis that any stabilising binder spread in excess of the nominated rate has been supplied at no cost to the client's representative.

Where the spread rates calculated for a spreader run include one or more lengths in which the spread rate is less than 100% of the nominated rate per spread extra stabilising agent shall be spread to achieve the nominated spread rate allowing for the completion of mixing, compaction and testing within the allowable working time.

The construction tolerance on the application rate of the foamed bitumen is ± 10% of nominated rate and supplementary binder is ± 10% of nominated spread rate.

Table 2 Deductions for bitumen application or supplementary binder rate.

Relative rate of measured to specified	Per cent deduction applied to Pay Item P1 or P2 and P6 + P7
85 – 89 %	20
80 – 84 %	40
75 – 79 %	60
≤ 74 %	Lot to be rejected

8.3 Depth

The depth of stabilisation shall be verified by measuring the depth of "cutting" adjacent to an existing pavement material in at least two locations within the lot and measured to the nearest 5 mm. The construction tolerance for the stabilised and compacted depth is ±20 mm.

Should the pavement depth exceed –0 mm of the specified depth and the stabilised material is less than 7 days in age, the material may be remixed without the addition of bitumen. After 7 days in duration, the contractor shall submit a revised pavement design.

8.4 Density

[*Insert specific regional conditions regarding lot compliance to density measurements*.]

8.5 Surface Profile

After final trimming the construction tolerance on the finished pavement level shall not vary by more than 10 mm in any direction when tested with a 3m straight edge. In addition, the crossfall shall not differ by more than ± 5% of the nominated rate.

8.6 Ride Quality

For sections where the ride quality is less than or equal to 49 counts per kilometre for 100m lengths, an incentive payment in accordance with Table 3, shall be applied.

For those 100 m lengths where the ride quality is non-conforming, deductions, in accordance with Table 3 shall be applied.

Table 3 Incentives and deductions for ride quality.

Roughness Count/Kilometre over 100 metre length	Incentives/Deductions (per cent of Pay Item P7)
< 25	+ 3%
25 – 34	+ 2%
35 – 39	+ 1%
40 – 49	Nil
50 – 54	- 2%
55 – 59	- 4%
60 – 64	- 8%
65 - 69	- 12%
≥ 70	Reject

9 MINIMUM TESTING FREQUENCY

The Contractor shall test the materials and the stabilised pavement layer at a frequency which is sufficient to ensure that the materials and work under the Contract comply with the specified requirements but which is not less than that shown in Table 4.

Table 4 The minimum frequency of testing.

Test	Minimum frequency of testing
Uniformity of bitumen application rate	One test for each separate continuous run. The Contractor shall have a current certificate of calibration for the bitumen tanker and shall produce evidence of the actual running bitumen application rate when requested by the Superintendent.
Uniformity of spreading of supplementary binder	At the start for each separate continuous spreading run except where calibrated load cell computerised spreading devices are fitted with a system to monitor the spread rate every 100 m.
Density ratio	Every lot as defined in Section 8.1

10 REWORKING

During the construction process or within 7 days afterwards, reworking can be carried out if compaction and finishing does not meet the requirements set out in this Specification. After this period or should the remedial work not meet the requirements of the specification for compaction, the Contractor shall present a design solution for the design traffic specified by the Superintendent.

Where restabilisation is proposed, the Contractor shall:

(a) arrange, through an appropriately NATA registered laboratory, a restabilisation proposal which takes into account the effects of the bitumen and supplementary binder already incorporated in the rejected layer, and
(b) submit to the Superintendent details of the restabilisation proposal.

Where an alternative to restabilisation is proposed the Contractor shall supply:

(a) design documents including pavement design calculations,
(b) test certificates and a report relating to the laboratory investigations, and
(c) details describing the method of carrying out the proposed work.

Where material is nominated to be removed and replaced, all conditions of this Specification shall apply.

Where a lot is rejected because of roughness the Contractor shall nominate a proposed rectification.

All costs associated with restabilisation, submission of an alternative design or rectification shall be borne by the Contractor.

11 MEASUREMENT & PAYMENT

11.1 Pay Items

Payment for the activities associated with completing the work detailed under this Specification shall be made in accordance with Pay Items P1 to P10.

Where stabilised material is rejected because of its failure to meet the requirements of this Specification, all costs for restabilising, redesign or rectification together with any extra costs incurred by the Contractor in respect of delays caused by such work, shall be borne by the Contractor.

11.2 Pay Item P1 - Supply bitumen and additives

The unit of measurement shall be tonnes of bitumen.

The quantity shall be determined by multiplying the specified width of stabilisation by the specified length by the application rate. Additional areas (eg parking areas, slip lanes etc) directed to be stabilised shall be included when calculating the total area treated.

No account shall be made of the tolerances allowed in the application rate, or for areas applied outside the area directed for treatment.

This Pay Item shall include all costs associated with supply of the bitumen and additives to achieve the desired bitumen foaming characteristics.

11.3 Pay Item P2 – Supply and deliver supplementary binder

The unit of measurement shall be tonnes of supplementary binder.

The quantity shall be determined by multiplying the specified width of stabilisation by the specified length by the application rate. Additional areas (eg parking areas, slip lanes etc) directed to be stabilised shall be included when calculating the total area treated.

No account shall be made of the tolerances allowed in the spread rate, or for areas applied outside the area directed for treatment.

This Pay Item shall include all costs associated with supply to site of the supplementary binder.

11.4 Pay Item P3 - Supply & spread additional granular material

The unit of measurement shall be tonnes of granular material.

The quantity shall be determined by multiplying the specified width of stabilisation by the specified length by the unit mass and depth of layer or by delivery docket. Additional areas (eg parking areas, slip lanes etc) directed to be stabilised shall be included when calculating the total area treated.

This Pay Item shall include all costs associated with supply to site of the additional granular material and spreading the material to achieve the desired depth or content.

11.5 Pay Item P4 - Supply & spread RAP material

The unit of measurement shall be tonnes of RAP material.

The quantity shall be determined by multiplying the specified width of stabilisation by the specified length by the unit mass and depth of layer or by delivery docket. Additional areas (eg parking areas, slip lanes etc) directed to be stabilised shall be included when calculating the total area treated.

This Pay Item shall include all costs associated with supply to site of the recycled asphalt profilings (RAP) and spreading the material to achieve the desired depth or content.

11.6 Pay Item P5 - Pre-pulverisation of existing material

The unit measurement shall be m^2.

This Pay Item is for all work associated with pre-pulverisation of the existing material and includes asphalt patches to a maximum thickness of 75 mm.

11.7 Pay Item P6 – Spread and mix supplementary binder, and mix and incorporate bitumen

The unit measurement shall be m^2.

This Pay Item is for all work associated with incorporation of the bitumen and supplementary binder to the required layer thickness with a purpose built stabilising mixer, and the supply and incorporation of water.

11.8 Pay Item P7 - Compact and trimming

The unit measurement shall be m^2.

This Pay Item is for all work associated with compaction and trimming of the stabilised material to the specified levels of density and strength.

11.9 Pay Item P8 – Density testing

The unit measurement shall be m^2.

This Pay Item is for all work associated with the extraction of samples, delivery, laboratory testing, and reporting of results.

11.10 Pay Item P9 – Rise and fall cost for bitumen

Should the cost of the supply of bitumen vary from the tender date and the project timing, the contractor shall submit rise or fall documentation from the bitumen supplier. The unit measurement shall be tonnes.

11.11 Pay Item P10 – Ride quality testing

The unit measurement shall be m^2.

This Pay Item is for all work associated with the use of calibrated devices to measure ride quality and reporting of results.

Summary of pay items

Pay Item	Description	Unit	Quantity	Rate ($)
	[*Delete not applicable rates*]			
P1	Supply bitumen and additives	t		
P2	Supply and deliver supplementary binder	t		
P3	Supply & spread additional granular material	t		
P4	Supply & spread RAP material	t		
P5	Pre-pulverisation of existing material	m^2		
P6	Spread & mix supplementary binder, and mix & incorporate bitumen	m^2		
P7	Compact and trimming	m^2		
P8	Density testing	m^2		
P9	Rise and fall cost for bitumen			
P10	Ride quality testing	m^2		

All rates are exclusive of GST.

Commentary to AustStab's Model Specification for Insitu Stabilisation of Main Roads using Bituminous Binders

Introduction

The purpose of this commentary is to provide a background to the clauses in the model specification to assist the specifier in completing the document ready for tendering. The model specification was prepared by the members of AustStab and provides best practice. This commentary makes reference to various **AustStab National Guidelines** and these are available from members or the AustStab Web site at **www.auststab.com.au**

The specification allows for part or full-service contracts. A full service contract is defined where the contractor will supply all materials and equipment, mix, compact, trim and cure.

The aim of this specification is for State Road Authorities to specify the same construction principles around Australia and the specification may be used for new or existing roads.

The State Road Authorities representative for the work is described as the client's representative in this document. Other terms used in this document are defined in the AustStab National Guidelines.

It is recommended that this specification is only applicable for large projects, typically greater than 5,000 m^2 in area. However, the roughness criteria should be based on a minimum continuous run of 1,000 m and full width of the pavement including shoulders.

The format for this commentary follows the same number and title sequence as the specification.

Amendments to the specification will be available through AustStab members, listed in *AustStab News* and the AustStab web site.

1 GENERAL

Road stabilisation involves the use of specialised equipment that operates to the specified depth plus construction tolerances. The equipment can damage services and therefore, the client's representative should identify if any services that have to be lowered before work commence. The time required to lower services should be considered in the program of works.

The unexpected service that is higher than identified in the initial inspection should be immediately repaired to not cause significant delay in the mixing or compaction of the stabilised pavement.

Modern reclaimers/stabilisers are manufactured with the mixing box located centrally. These purpose built machines (see Figure 1) incorporate special foamed bitumen spray bars and rotors aimed at mixing the material within the mixing hood. The use of agricultural equipment, profilers, rotary hoes and graders are not substitutes for insitu stabilising as they tend to have very poor mixing properties that result in a reduction in the pavement life [Ref.1]. In addition, foamed bitumen can only be applied within the mixing chamber (see Figure 2) due to the limited time of foamed bitumen to coat the fine particles.

Large reclaimer/stabilisers also have the ability to pulverise existing asphalt to depths of about 75 mm and incorporate the asphalt in the final mix. In fact, the existing asphalt contains very good aggregates to enhance the strength of the stabilised layer.

Figure 1. *Dedicated reclaimer/stabiliser for insitu foamed bitumen stabilisation.*

The specification has been written especially for foamed bitumen stabilisation construction techniques. Bitumen emulsion may be used for stabilisation but this specification would require amendments. Should you need guidance on this matter, please contact the Association.

The foamed bitumen process is where hot bitumen (about 180°C) comes in contact with cold water in precise quantities to create a foaming of the bitumen as shown in Figure 2. The reduced viscosity of the foam bitumen and its larger volume enables it to be uniformly mixed with the pavement material. Additives are commonly used with the bitumen to aid the foaming characteristics..

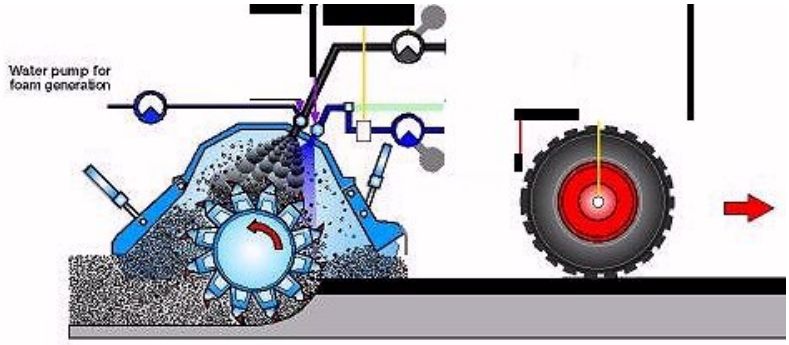

Figure 2. *Long-section of mixing chamber of reclaimer/stabiliser showing entry of foamed bitumen and water, for foamed bitumen stabilisation.*

In Australia, bitumen emulsion stabilisation is also used in conjunction with a supplementary binder, such as cement, cement flue-dust, fly ash, slag or lime, to improve the short-term properties of the stabilised material for trafficking. This specification assumes that the use of supplementary binders is in the low binder range of less than 2% by weight of the pavement material. Lime is also used in some cases to reduce the PI of the material and to enhance the adhesion of the aggregates .

2 DESCRIPTION

The general construction process is

(a) Levels should be adjusted prior to the stabilisation process:

(i) where levels are to be increased granular material to meet the new road profile or supplement the existing pavement material is evenly spread on the prepared road surface. In most urban areas this is not normally required.

(ii) where levels are to be reduced the pavement may be pulverised in conjunction with the removal of the excess material prior to stabilising.

Even if level adjustment is not required, a foamed bitumen stabilisation project requires the existing pavement material to be pulverised using a reclaimer to 90% of the depth. Water may also be added in this operation to increase the pavement material moisture content to about 70 to 90% of OMC.

Full depth reclaiming or pulverisation is not normally required in this operation as the next pass will reclaim to full depth and mix with bitumen. This approach reduces the potential for a lens of unbound material to form at the underside of the stabilised layer.

(b) When a supplementary binder is required it is spread upon the prepared pavement prior to the incorporation of bitumen and the reclaimer/stabiliser is used for the mixing. The binder is spread directly on the pavement as long as the levels are correct. When slaking lime some consideration should be given to the control of the slaked lime on the surface of the pavement.

If a direct feed or integrated reclaimer/spreader is used, the contractor may then use hydrated lime in lieu of quicklime. An adjustment of the spread rate to allow for the equivalent CaO content may be required

(c) The bitumen and soil is then mixed to achieve the compacted depth.

(d) As soon as material is sufficiently compacted, grading must commence and be carried out in conjunction with compaction until a smoothly graded finish is obtained.

(e) Final surface layer is constructed, and this may consist of a sprayed-seal or thin layer of asphalt.

It is considered inappropriate construction practice to spray bitumen on the pavement and stabilise the material using a conventional stabiliser or stabiliser/reclaimer as this practice lacks uniformity of mixing and a lack of uniform control of the bitumen application rate.

3 REFERENCE DOCUMENTS

Each State Road Authority has various test methods and Australian Standards for the evaluation of binders and the stabilised material. The specification only list the essential binder Standards and each State Road Authority should include in this section those regional test methods and other specifications required for the project.

4 MATERIALS

4.1 Binder

All bitumen and supplementary binders used for road stabilisation should comply with an Australian Standard as noted in the specification.

All binders proposed for the project should be proven in laboratory trials.

More information on binders may be sought from references 2 and 3.

4.2 Water

The water used for stabilisation should be potable. That is, the characteristics of the water that is sought are that it is soft, reasonably clean, and free from oil, acid, alkali, organic or other impurities. Salty water may be used with care for bituminous stabilisation.

4.3 Granular Materials

In many roads the granular pavement material is either crushed rock from an established quarry or recycled asphalt pavement (RAP) material. The grading requirements for these materials are based on the grading of the parent material and the availability of the local quarry material.

Where possible the client should advise the approximate area and depth for granular material required for the project.

4.4 Recycled Asphalt Profiling (RAP)

It is common to use the existing seal or asphalt in foamed bitumen stabilisation. Whist the additional bitumen from the profiling will increase the total bitumen content of the pavement material, it should not reduce the stiffness of the stabilised material due to the higher bitumen content.

In any project where significant amounts (ie >10%) of RAP material is being used relative the granular pavement material, the RAP material must be incorporated in laboratory trial samples.

Where possible the client should advise the approximate area and depth for RAP material required for the project.

5 EQUIPMENT

Specialist equipment is required for foamed bitumen stabilisation as the foaming process only allows one application opportunity for the introduction of bitumen.

In the specification the minimum requirements are noted as:

- a minimum power capability of 300 kW (400 hp) to ensure adequate mixing of materials,
- bitumen injection systems must be linked to the ground speed to ensure an accurate application throughout runs, irrespective of the speed of the plant,
- an inspection or test jet must be fitted to ensure the flow of bitumen and that the required expansion and half life qualities of the bitumen are being achieved (see Figure 3), and
- bitumen jets must be self cleansing.

Whilst these are the minimum requirements, other essential equipment features are necessary, such as:

- a central mixing chamber
- the bitumen foaming jets can be shutoff individually for road tapering effects, or for partial reclaimer width stabilisation
- easily read bitumen temperature gauges
- the correct coupling fittings for the bitumen lines
- fire extinguishers (see Figure 4).

Figure 3. *Operator assessing foaming nozzle operation from special inspection system on the reclaimer.*

Figure 4. *View of two 9 kg fire extinguisher on reclaimer.*

In addition, well-trained reclaimer operators are required to ensure that the foaming operations are working during the process.

AustStab has developed in conjunction with Austroads members an addendum to the Bitumen Spray Sealing

Safety Guide. This 10-page addendum provides safety guidelines for this operation and is available from AustStab.

6 CONSTRUCTION PROCESS

6.1 Lowering of Services and Initial Shaping

Experience with many projects has indicated that the client is in a better position to organise and/or to carry out the work to lower all services and utilities as necessary. The lowering of services should meet the guidelines set by utility companies and they should be carried out such that there is sufficient cover for pipe work.

The lowering of services needs to be programmed into the works schedule such that onsite delays are minimised.

6.2 Initial Surface Preparation and Milling

In existing pavements a failure of the subgrade is not always apparent and it is suggested, where possible, that the surface of the insitu material be given a light compaction to reveal any irregularities. This light compaction is referred to as proof rolling in some regions of Australia.

Should a weak area of the subgrade be identified, strengthening of this material will be required. The responsibility for this subgrade strengthening should be clearly stated in the tender documents.

Thick-layers of asphalt patching are usually identified from State Road Authorities records or from the pavement management system (PMS). Whilst records indicate that a patch may be 75 mm in thickness, AustStab members note that on most occasions the patch depth is well over the recorded measurement. In some instances where these patches are extensive and structurally sound, it may be prudent to not stabilise the patches.

Where thick asphalt patches are going to be incorporated in the final pavement, the thick layers of asphalt should be milled and blended with granular material or excavated and removed from the site.

6.3 Climatic Restraints

The foamed bitumen stabilisation process can operate in very low and high temperatures without known shortcomings to field performance. However, it is suggested that work does not commence until the pavement temperature at 50 mm below the ground is at least 10°C.

In terms of wet weather, safety of staff and road users is the overriding factor for when stabilisation should commence or be halted due to rain. However, a short-term (say 10 minutes) heavy rain shower sometimes is unlikely to significantly increase the overall moisture content of the pavement material and work may commence immediately after the rain shower has ceased.

6.4 Interruption of Works

Due to the long-term curing characteristics of foamed bitumen, the pavement material may be remixed without the addition of bitumen or supplementary binder for well over one week. However, a conservative approach would be to limit this to 7 days (also refer to Section 10). After this period, further laboratory testing is advised.

6.5 Application of Binder

It has been noted previously that incorporation of the bitumen for foamed bitumen techniques can only be carried out by the use of specially manufactured spray bars located in the mixing hood (see Figure 2).

For bitumen stabilisation, the application rate is the residual bitumen in the pavement material as a measure of kg/m^2, where the area is the stabilised area produced by the reclaimer. This approach is consistent with AustStab recommendations with the spreading and mixing of cementitious binders.

The application rate may be determined from the following equation:

Application rate = (kg/m^2)	Density of compacted soil (kg/m^3) x % of binder required x depth of stabilised layer (m)

For example, if the dry density of the compacted soil is 1.8 t/m^3, the binder content is determined at 2% and the stabilised depth is 200-mm, the application rate is 1800 x 0.02 x 0.2 = 7.2 kg/m^2. This can now be related to tonnage of bitumen in the tanker for a specific run using the following relationship:

Tonnage of bitumen used = Residual bitumen (kg/m^2) x W (m) x L (m) / Bitumen content / 1000

A series of calculations is documented for the determination of residual bitumen applied with temperature correction factors in AustStab Guideline for the *Verification of Bitumen Application Rate* [Ref.4].

Typically the contractor has computer-controlled devices on board the reclaimer that calculates the application rate of the binder as the reclaimer moves along the pavement. In addition, AustStab members

have the equipment set up such that the application width of the sprays can accommodate less than the full width of the reclaimer for work on shoulders.

Dipping in the tanker before and after a run confirms the computer-collected data. For supplementary binders, mats or tray are used at least daily intervals to verify the computer-collected data from calibrated electronic load cells on the spreader. The method to carry out this test is listed in reference 4.

For foamed bitumen operations, two key parameters are specified in clause 6.5.1. The *expansion ratio* is defined as the ratio of the maximum volume of the bitumen in its foamed state to the volume of bitumen once the foaming has completely subsided. In foamed bitumen stabilisation for roads, a suggested minimum expansion ratio of 10 is specified.

The other term used in foamed bitumen stabilisation is *half-life* and this is defined as the time taken (measured in seconds) for the foamed bitumen to settle to one half of the maximum expansion volume (see Figure 5). Experience has shown that the half-life measured in the field and laboratory differ greatly and the half-life has to be measured in the field.

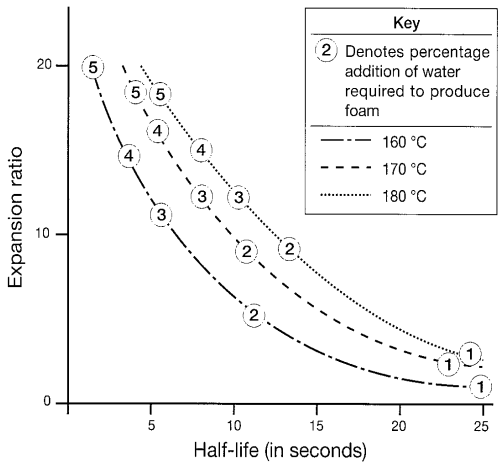

Figure 5. *The half-life and expansion ratio are important characteristics in foamed bitumen stabilisation.*

Both of these parameters are important to foamed bitumen stabilisation to ensure that during the mixing operation there is sufficient time to coat the pavement particles in the mixing chamber. Too short a half-life can create a situation where insufficient bitumen coats the fine particles leading to low strength.

It is noted that the half-life period may need to be longer for laboratory trials as the mixing operations in the field cannot be replicated in the laboratory.

Any supplementary binder is spread over the full width of the working area.

Uniform mixing of the binder is paramount to the success of the stabilised pavement, and therefore, it has been previously noted that specialised machines should only be used in this process. For depths up to 250 mm a 300 kw (400 hp) stabiliser/reclaimer is required to ensure that there is sufficient power in the machine to cope with potential surges in operation due to variable parent material, such as moving from "hard" to "soft" material, and constructing on uphill grades with a bitumen tanker attached the reclaimer. It is also important to have sufficient power to carry out the mixing at a uniform longitudinal rate.

It is also recommended that a minimum 375 kW (500 hp) machine be used for stabilised depths exceeding 250 mm in depth. Where equipment does not meet this minimum engine power requirement, it is suggested that a prepulversing run (ie without bitumen) of the pavement material is carried out at 70% to 90% of the specified depth to ensure that any potential hard spots are negated for the foamed bitumen run.

The construction of multiple layers is uneconomical and impossible with an insitu reclaimer due to the bitumen foaming process.

All AustStab contractors work to a well planned and proven procedure based on their quality manual. Unfortunately, wet weather conditions, plant breakdown or other causes may prevent the binder from being uniformly incorporated into the pavement in accordance with the above procedure. With the use of bitumen it has been found that the material can be reworked for up to 7-days after initial mixing.

6.6 Joints

Mixing generally proceeds in lanes working from one side of the pavement to the other, without intervening lanes of unmixed material. Typically the overlap is 100 to 200 mm and additional binder should not overlap beyond this region, as it may cause pavement cracking. Joints are deemed to be fresh when the pavement materials on both sides of the joint have been stabilised and compacted within the nominated working time.

Where joints are completed the outside 300 mm of material from the first run should be left uncompacted until the adjacent material is mixed.

Joints, other than fresh joints, are formed by cutting back into the previously stabilised and compacted work. The material disturbed during cutting back is re-mixed to full depth and incorporated into the new work. The minimum distances of cutback into previously stabilised material is typically:

(a) longitudinal joints - 75 mm
(b) transverse joints – 2 metres.

The contractor sets a layout of all joints based on the following requirements:

(a) Minimise the number of joints to be formed.
(b) Longitudinal joints should be offset by at least 300 mm from design location of wheel paths
(c) Transverse joints are formed at right angles to the road centreline.
(d) Longitudinal joints are formed on the separation lines of the travel lanes and a minimum of 300 mm outside the edge lines in the shoulder area.
(e) Internal longitudinal joints are formed such that each is at a constant offset to the road centreline.

6.7 Moisture Content

The moisture content of the material immediately after mixing is set at a range of 80% to 100% of the moisture content specified by the client's representative. A contractor has to monitor the moisture content during mixing. An experienced foreman follows the stabiliser and carries out regular testing of the soil mixture by feeling the soil in the palm of the hand using the hand squeeze test.

6.8 Compaction

Compaction of the material in the pavement is best carried out immediately. The slower setting nature of bitumen binders allows more flexibility with compaction times. In colder climates, a "cool" soil may slow the setting and therefore, the use of a supplementary binder, such as lime or GB cement, should be taken into consideration in the design stage.

The minimum compaction is set at 98% (standard) of the maximum dry density to allow a greater scope in the use of marginal materials. With better parent material a higher minimum compaction should be achieved by the contractor.

Selecting the right compaction equipment is typically carried out by the stabilisation contractor.

6.9 Finishing

Two options are provided in this section of the specification, namely to trim to a specified level below the existing kerb and gutter profiles or to a specified crown with cross fall, such as in a rural area.

All final trimming should not be incorporated into the surface and recompacted as studies have shown that the trimmed material becomes an unbonded layer and it is likely to strip under traffic loading. To prevent surface delaminations all trimming should be to "waste". In this instance, "waste" refers to another site before stabilisation or to the side of the road such that it will not affect drainage flows

6.10 Curing

Curing of a bituminous stabilised pavement occurs very slowly and studies have shown that the maximum stiffness may be reached in about 1 year. However, foamed bitumen stabilised materials would normally gain sufficient strength to allow immediate trafficability upon completion of compaction and trimming.

Watering of the pavement surface is not normally required.

7 PRELIMINARY TRIAL

Similar to cementitious binders used in stabilisation, a trial stabilisation run is recommended for foamed bitumen stabilisation in order for the contractor to confirm the effectiveness of the construction process with the specified binders and existing pavement material.

A trial run may consist of the first day's work or 50 to 100 metres of a mixing run. The aim of the trial is to ensure that spreading, bitumen application, compaction and trimming can be achieved. Smoothness is not normally checked with a trial due to the limited distance of the work.

If a trial is carried out in the morning the contractor has only until midday to order materials for the next day's production. Therefore, the timing of the collection of data and its assessment is paramount to reduce the number of days the expensive equipment is held waiting on site.

8 ACCEPTANCE CRITERIA

8.1 Lot Determination

The definition of a lot varies from State to State and this clause is typically tied into the requirements of density.

A lot size is typically a day's production or that area which represents a uniform material type. It is noted that a typical day's production for a two-lane rural highway at 250 mm in thickness is between 2,500 to 4,000 m^2/day. This daily rate does not include milling deep asphalt patches, pulverisation or bringing imported granular material for pavement material depth or grading adjustment.

8.2 Application and spread rate

The specification requires the contractor to regularly check the bitumen application and supplementary binder spread rates. AustStab has developed with industry specific guidelines on how the application of bitumen and spreading of powder binders can be

verified [Refs. 4 & 5]. The construction tolerance is the practical equipment limitation of ±10%.

8.3 Depth

During the mixing operation the pavement material bulks up and the depth of the stabilised layer can be checked by reference levels or after final trimming. Experienced contractors have specific methods to allow for the bulking and trimming thickness.

The construction tolerance has been set at ±20 mm and therefore, the designer should take this into consideration when specifying the target depth of the stabilised layer thickness.

8.4 Density

Density of the stabilisation material is very important to its performance. The attainment of the required density is dependent on the use of suitable rollers and good compaction practices [Ref.6].

Each State Road Authority has a specific method for density measurements based on either individual lot measurements or a rolling mean system to accommodate the fluctuating tolerances in the process. Therefore, this specification requires the lot density testing requirements to be inserted based on the client's QA system.

One of the outcomes of the Dandenong ALF trial in 1996/97 [Ref.7] was to limit the compaction level of stabilised marginal materials at about 95% MDD to ensure that over compaction did not "break-down" the particles leading to lower than anticipated material density.

8.5 Ride Quality

Ride quality limits are frequently included to achieve the desired smoothness. It is noted that the following impediments to ride quality are out of the control of the contractor:

- ☐ a change of pavement materials, such as a lack of fines present in a deep asphalt patch or where large patch of macadam stones are present, creates inconsistencies for the grader operator,
- ☐ in half-road width paving the crown dictates the longitudinal shape of the pavement and hence, the contractor is limited in his outcomes (this is also applicable for existing shoulders),
- ☐ for pavements under traffic the grader operator has limited space to adjust the angle of attack of the blade, and this limits the quality of his work in the confined space, and
- ☐ level control can conflict with roughness.

In the latter case level control is established after primary trimming and roughness measurements made after final compaction and trimming, and before the seal is on the pavement. The latter issue is important as the sealing of the pavement can be several days after final trimming, and subsequent rain and traffic on the pavement will affect the roughness measurement.

8.6 Other Tests

Whilst not included in the specification, in some instances the client may wish to take samples from behind the reclaimer and compact those samples using Marshall or Gyropac devices and determine after 3days of accelerated curing the dry and wet resilient modulus of the samples for each lot when the parent pavement material is likely to change significantly during the course of the project.

Taking these additional tests at the clients expense provides additional information where possible less stiff sections of road may occur over time.

9 MINIMUM FREQUENCY

The specification sets out minimum regular testing requirements for:

- ☐ Bitumen application rate
- ☐ Supplementary binder application rate
- ☐ Density ratio

10 REWORKING

Unlike cementitious binders that form chemical bonds within the first 24 hours of mixing, foamed bitumen stabilisation with lime allows the contractor to rework the pavement material for up to 7 days after initial compaction without compromising optimum density achievement and final material stiffness.

11 MEASUREMENT AND PAYMENT

The pay items have been based on specific tasks in the stabilisation process and notes as:

P1 – supply bitumen and additives to bitumen
P2 – Supply and deliver supplementary binder
P3 - Supply and spread additional granular material
P4 - Supply and spread RAP material
P5 – Pre-pulverisation of existing material
P6 – Spread and mix supplementary binder, and mix and incorporate bitumen
P7 – Compact and trimming
P8 – Density testing
P9 – Rise and fall cost for bitumen
P10 – Ride quality testing

Item P9 allows for the current changing oil prices to be incorporated as the quoted bitumen supply cost at tendering and the cost when purchased for the project may differ by as much as 15%. This rise and fall clause will protect both the client and contractor in the current volatile crude oil market.

References

1. AustStab Construction Tip No.1 *Profilers versus stabilisers* February 2000.
2. *Guide to Stabilisation in Roadworks* Austroads 1998.
3. AustStab National Guidelines *Australian Binders used for the Stabilisation and Road Recycling Industry* Australian Stabilisation Industry Association
4. AustStab National Guidelines *Verification of Bitumen Application Rate* Australian Stabilisation Industry Association.
5. AustStab National Guidelines *Verification of Binder Spread Rate* Australian Stabilisation Industry Association.
6. Mayfield, M, Symons, MG and Collins, JR *Guide to the Selection of Vibratory Rollers for Road Construction* Structural Materials and Assemblies Group, University of South Australia, March, 1994.
7. Moffatt, MA et al *The performance of insitu stabilised marginal sandstone pavements* APRG Report No. 22, May 1998.

NOTES: