

Superseded

Technical Specification

**Transport and Main Roads Specifications
MRTS10 Plant-Mixed Lightly Bound Pavements**

November 2018

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1 Introduction

This Technical Specification applies to the construction of road pavements using plant-mixed lightly bound pavement layers. The intent of this Technical Specification is to produce a lightly bound granular material with an unconfined compressive strength (UCS) of 1.0 to 2.0 MPa. This Technical Specification is applicable to both lightly bound base courses and lightly bound improved layers.

This Technical Specification shall be read in conjunction with MRTS01 *Introduction to Technical Specifications*, MRTS50 *Specific Quality System Requirements* and other Technical Specifications as appropriate.

This Technical Specification forms part of the Transport and Main Roads Specifications Manual.

General

Lightly bound pavement materials are specified with an upper UCS limit of 2.0 MPa to manage the risk of cracking and a lower limit of 1.0 MPa to ensure sufficient strength is developed in the material to meet the load capacity intended through the pavement design.

Lightly Bound Base

Lightly bound base layers have previously been known as “cement modified base” or “CMB” in Queensland. The term ‘lightly bound base’ has been chosen to align with Austroads terminology.

Lightly bound base layers are typically covered with either a thin asphalt or sprayed bituminous treatment, with the lightly bound pavement material forming the main structural pavement layer. These pavements would typically be designed in moderately trafficked pavement applications or where moisture control is required during construction or throughout the service life of the pavement.

To achieve compliance with the requirements of this Technical Specification and deliver these materials at the standard required to meet their design intent, a higher level of control over material constituents and batching may be required compared to what would normally be adopted for traditional unbound and stabilised pavement materials.

Lightly Bound Improved Layer

Lightly bound improved layers have previously been known as “working platform” layers in Queensland. The term ‘lightly bound improved layer’ has been chosen to align with Austroads terminology.

In this application the requirements of this Technical Specification are intended to provide adequate support conditions beneath a pavement during its design life. These requirements may not be sufficient for construction traffic or construction activities themselves, and the Contractor may need to adopt a higher standard to satisfy these requirements.

Where a pavement design includes an unbound granular improved layer, this Technical Specification is not relevant and reference should be made to MRTS05 *Unbound Pavements*.

2 Definition of terms

The terms used in this Technical Specification shall be as defined in Clause 2 of MRTS01 *Introduction to Technical Specifications*. Further definitions are as defined in Table 2.

Table 2 – Definition of terms

Term	Definition
Actual content (of stabilising agent)	The content of stabilising agent in the production mix
APHA	American Public Health Association
Allowable working time	The time within which compaction and trimming of each lightly bound pavement layer shall be completed, measured from the commencement of the incorporation of the stabilising agent (i.e. mixing of the stabilising agent into the material) to completion of compaction and trimming.
Cement Slurry	A semi-liquid mixture of stabilising agent (either a blended cement or a cementitious blend) and water.
Course	A layer or multiple layers of a particular pavement material as reflected in the pavement design. For example, surfacing course, base course, sub-base course or improved layer.
Lightly Bound Base	A course principally intended to directly support the traffic loads, constructed from a mixture of unbound granular pavement materials, cementitious stabilising agent and water.
Lightly Bound Improved Layer	A layer which provides: <ul style="list-style-type: none"> • access for construction • a platform on which to construct the overlying pavement layers, and • protection to the underlying materials Constructed from a mixture of unbound granular pavement materials, cementitious stabilising agent and water.
Mixture	The plant-mixed lightly bound pavement material after incorporation and mixing of the stabilising agent.
Mixing Plant Variability	The Mixing Plant Variability (MPV) is an estimate of the likely variability in stabilising agent content that can be expected during production from the actual mixing plant to be used in the Works. The MPV shall be expressed as a percentage, by dry mass, of unbound pavement material.
Production Result	A tested or measured result obtained from previous operation of the mixing plant to produce cementitiously bound pavement materials. A specific test shall represent an individual result. Alternatively, individual results may be obtained from continuous data collection systems that measure the throughput mass of all constituent materials fed into the plant.
Quarry	A site from which construction materials are won by blasting, ripping or other excavation means for use in their natural state or after processing such as by crushing, screening or combining with other materials. The term quarry also includes pits.
RMS	Roads and Maritime Services, New South Wales
Target Content (of stabilising agent)	The content of stabilising agent nominated by the Contractor based on mix design testing and the historic MPV
UCS _{7-lower}	The 7 day UCS corresponding to a 28 day UCS of 1.0 MPa.

Term	Definition
UCS _{7-upper}	The 7 day UCS corresponding to a 28 day UCS of 2.0 MPa.

3 Referenced documents

Table 3 lists documents referenced in this Technical Specification.

Table 3 – Referenced documents

Reference	Title
AS 1478.1	<i>Chemical admixtures for concrete, mortar and grout - Admixtures for concrete</i>
AS 3582.1	<i>Supplementary cementitious materials – Flyash</i>
AS 3582.2	<i>Supplementary cementitious materials – Slag – Ground granulated iron blast-furnace</i>
AS 3972	<i>General purpose and blended cements</i>

4 Standard test methods

The standard test methods specified in Table 4 will be used in this Technical Specification.

Further details of test numbers and test descriptions are specified in Clause 4 of MRTS01 *Introduction to Technical Specifications*.

Table 4 – Standard test methods

Property to be Tested	Test Method No.
Addition of stabilising agents	Q135A
Ball penetration	AG:PT/T251
Calculation of characteristic value of a lot	Q020
Conductivity (water)	APHA 2510-B
Curing of moulded specimens	Q135B
Deviation from a three metre straight edge	Q712
Determination of the relationship between standard and subsidiary test methods	Q010
Moisture content	AS 1289.2.1.1, AS 1289.2.1.4, AS 1289.2.1.6
Particle Size Distribution (Segregation)	Q103A
pH (water)	APHA 4500-H B
Proof Rolling Test	RMS T198
Relative compaction	Q140A
Road Roughness (Surface Evenness)	Q708B, Q708C, Q708D
Sampling of soils, crushed rock and aggregates	Q060
Selection of sampling or test locations	Q050
Spot Sampling of soils, crushed rock and aggregates	Q061

Property to be Tested	Test Method No.
Stabilising Agent Content – Heat of Neutralisation	Q134
Sulphate content	AS 1289.4.2.1
Unconfined compressive strength (UCS)	Q115
Working time of stabilised materials	Q136

4.1 Supplementary requirements for Test Method AS 1289.2.1.1, AS 1289.2.1.4 and AS 1289.2.1.6

Moisture Content determinations during production shall be undertaken in accordance with Test Method AS 1289.2.1.1, AS 1289.2.1.4 and AS 1289.2.1.6.

Testing to determine the moisture content of the material shall be started as soon as possible, after the commencement of incorporation of stabilising agent into the unbound pavement material. The maximum time between incorporation of stabilising agent into unbound pavement material and the commencement of weighting samples as required by these test methods shall be 30 minutes.

4.2 Supplementary requirements for Test Method Q115

With the exception of testing for mix design purposes (refer Clause 7.3) UCS testing shall be carried out at the sampled moisture content with the specimen compacted to 100% standard compaction.

The sample from which UCS specimens are taken shall also be tested for stabilising agent content and moisture content and the results reported together.

5 Quality system requirements

5.1 Hold Points, Witness Points and Milestones

General requirements for Hold Points, Witness Points and Milestones are specified in Clause 5.2 of MRTS01 *Introduction to Technical Specifications*.

The Hold Points, Witness Points and Milestones applicable to this Technical Specification are summarised in Table 5.1.

Table 5.1 – Hold Points, Witness Points and Milestones

Clause	Hold Point	Witness Point	Milestone
5.2	1. Acceptance of Construction Procedure for lightly bound pavement works		Submit Construction Procedure for lightly bound pavement construction (14 days).
6.1.1	2. Demonstration of unbound pavement material compliance prior to stabilisation		
7.1	3. Acceptance of mix design report		Submission of mix design report (14 days)

Clause	Hold Point	Witness Point	Milestone
8.1	4. Demonstration of ability to manufacture and construct conforming pavement	1. Construction of Trial Pavement	
9.4.9		2. Proof Rolling	
9.5.1	5. Covering a lightly bound pavement layer		
9.5.3	6. Nonconformance of compressive strength or stabilising agent requirements		

5.2 Construction Procedures

The Contractor shall prepare documented procedures for all construction processes as defined in Clause 6 of MRTS50 *Specific Quality System Requirements*.

No lightly bound pavement works shall commence until all relevant construction procedures have been accepted by the Administrator **Hold Point 1**

5.2.1 Lightly Bound Pavement Construction Procedure

For lightly bound pavement materials, the Contractor shall prepare a Construction Procedure, which details at least the following:

- a) details of all plant associated with the works
- b) calibration procedures for the mixing plant
- c) details for all aspects of the pavement works, including:
 - i. location of and management processes for stockpiles
 - ii. location of the mixing plant, and logistics for the operation of the plant in that location
 - iii. the lengths and widths of each paving run
 - iv. the location and type of joints required between each paving run
 - v. slurring procedures, including details of how the slurry will be mixed and spread evenly and safely
 - vi. procedures for the transport, placement, compaction and trimming of the pavement material
 - vii. joint and surface preparation procedures, including methodology and plant proposed to cut-back the surface (refer Clause 8.2.8.2)
 - viii. details for working up to or against to structures, kerbs, road safety barriers, access chambers, drainage gullies and other fixed infrastructure within or adjacent to the pavement, including how the material will be placed and compacted to meet the minimum requirements of this Technical Specification
 - ix. procedure for proof rolling pavement layers
 - x. curing procedures

- d) proposed upper and lower moisture content limits for lightly bound pavement construction (refer Clause 8.2.5)
- e) proposed methodology for verifying the accuracy of the system used to dispense stabilising agent in the mixing plant (refer Clause 9.4.5)
- f) process to provide traceability of unbound pavement materials from stockpiles through to material incorporated into the final pavement.

Where both plant-mixed lightly bound base and improved layers are to be incorporated into the works, the Contractor may prepare a single procedure provided that any differences in construction process are clearly noted.

The Lightly Bound Pavement Construction Procedure shall be submitted to the Administrator at least 14 days prior to the commencement of lightly bound pavement works **Milestone**

6 Materials

6.1 Unbound pavement material

6.1.1 General

Unbound pavement materials to be used for plant-mixed lightly bound pavements shall comply with the requirements of Clause 6.1.2 or 6.1.3 respectively unless otherwise nominated in Clause 1.1 of Annexure MRTS10.1.

The Contractor shall not incorporate unbound pavement material into the works unless it has been demonstrated that the unbound pavement material lot conforms fully to the requirements of this Technical Specification **Hold Point 2** Such conformance results shall be no more than six months old.

Where required in the relevant specification, the unbound pavement material to be stabilised shall be supplied by a quarry registered and operated in accordance with the departments Quarry Registration System requirements. The current Quarry Registration Certificate shall be submitted to the Administrator as part of the mix design report (refer Clause 7.4).

The default requirements of this Technical Specification reflect the expected use of plant-mixed lightly bound bases in moderately trafficked applications. Where the pavement is lightly trafficked or local conditions would support an alternative approach, the Principal may elect to reduce the default requirements of this specification under a risk-based approach.

Lightly bound bases are typically suitable where the average daily ESAs in the design lane in the year of opening are less than 1000. However, following a project specific assessment, lightly bound bases may be adopted where the average daily ESAs in the design lane in the year of opening are up to 3000. In these more heavily trafficked circumstances, a higher standard of unbound granular material may be warranted. Refer to Transport and Main Roads *Pavement Design Supplement* for further guidance on the selection of pavement types.

6.1.2 Unbound pavement material for lightly bound base

Where not specifically nominated in Clause 1.1 of Annexure MRTS10.1 or elsewhere in the design documentation, the unbound pavement material to be incorporated into the lightly bound base shall be as specified in Table 6.1.2 with the additional requirements as specified in Clause 6.1.2.1.

Table 6.1.2 – Unbound pavement materials for lightly bound base

Specification	Permissible Material	Grading Envelope	Testing Frequencies
MRTS05 <i>Unbound Pavements</i>	Subtype 2.1	Grading C	Refer MRTS05

6.1.2.1 Fine component

Additional requirements for the fine component (material passing the AS 0.425 mm sieve) of unbound pavement material to be used in lightly bound bases are specified in Table 6.1.2.1.

Requirements for both plasticity index and linear shrinkage are specified in Table 6.1.2.1. Only one of these requirements shall apply as nominated in Clause 1.2 of Annexure MRTS10.1. Where no property is nominated in Clause 1.2 of Annexure MRTS10.1, the linear shrinkage limit shall apply.

Table 6.1.2.1 - Fines component properties

Property	Value	
	Minimum	Maximum
Plasticity Index (PI)	2	Refer to MRTS05 <i>Unbound Pavements</i>
Linear Shrinkage (LS)	1.5	

The specification of minimum and maximum 'plasticity' requirements is based on TMR's historic experience constructing Cement Modified Base (CMB) pavements in North Queensland. This approach aims to reduce variability in the stiffness of the lightly stabilised base by reducing variability of the constituent materials.

While cement is effective at reducing material plasticity, this process may reduce the cement available to 'bind' the base. For this reason a maximum PI or LS is specified to help ensure sufficient strength is developed and help reduce the potential for material to become excessively friable and prone to break-up after stabilisation.

6.1.3 Unbound pavement material for lightly bound improved layer

Where not specifically nominated in Clause 1.1 of Annexure MRTS10.1 or elsewhere in the design documentation, the Contractor shall nominate in their mix design the standard and grading of unbound pavement material to be incorporated into the lightly bound improved layer.

Where the Contractor nominates an unbound pavement material to be stabilised it shall be one of the permissible types specified in Table 6.1.3.

Table 6.1.3 – Unbound pavement materials for lightly bound improved layers

Specification	Permissible Material	Testing Frequencies
MRTS05 <i>Unbound Pavements</i>	Subtype 2.1, Subtype 2.2 or Subtype 2.3	Refer MRTS05
MRTS35 <i>Recycled Materials for Pavements</i>	RM001, RM002 or RM003	Refer MRTS35

6.1.4 Stockpiling of unbound pavement material

Stockpiles shall be located on clear, even, firm, well-drained ground in a location where they can be clearly identified.

There shall be a separate stockpile for each material with different specification requirements.

Unless otherwise approved by the Administrator, all stockpiles shall be separated from other stockpiles by at least two metres.

For the purpose of testing, each individual stockpile lot shall be clearly delineated by one of the following methods:

- a) a separate stockpile shall be formed for each lot, or
- b) material of the same specification requirements shall be added to a single stockpile incrementally such that a portion representing a lot is added up to the maximum lot tonnage specified for the unbound pavement material, tested and found to be conforming before the next portion, representing the next lot, is added. Nonconforming lots shall be removed from the stockpile prior to the addition of further portions.

6.1.5 Water soluble sulphate content of unbound pavement materials

No unbound pavement material to be stabilised shall have a water soluble sulphate content exceeding 1.9 grams of sulphate (expressed as SO₄) per litre, when tested in accordance with AS 1289.4.2.1.

All unbound pavement material sources shall be tested at a maximum of twelve monthly intervals during the course of supply or when the nature of the source material has changed.

6.2 Stabilising agent

The stabilising agent (binder) type to be used in the works shall comply with the requirements of Table 6.2. The stabilising agent type and supplier to be used shall be nominated by the Contractor as part of their mix design (refer Clause 7.4).

Table 6.2 – Stabilising agent requirements

Stabilising Agent (Binder)	Specification or Standard
Blended cement	Type GB, fly ash blend that complies with AS 3972
Cementitious blend (excluding GP, LH and GB cements)	Portland cement, that complies with AS 3972, blended with one or more of the following: <ul style="list-style-type: none"> • “fine grade” fly ash complying with AS 3582.1 • Ground granulated blast furnace slag (GGBFS) complying with AS 3582.2, or • hydrated lime complying with MRTS23 <i>Supply and Delivery of Quicklime and Hydrated Lime for Road Stabilisation</i>.
Blended lime	Hydrated lime complying with MRTS23 <i>Supply and Delivery of Quicklime and Hydrated Lime for Road Stabilisation</i> , blended with one or more of the following: <ul style="list-style-type: none"> • “fine grade” fly ash complying with AS 3582.1 • Ground granulated blast furnace slag (GGBFS) complying with AS 3582.2.

All of the components of the stabilising agent shall be completely, homogeneously and accurately blended before they are incorporated into the unbound pavement material. At the time of mixing the stabilising agent with the unbound pavement material, each component of the stabilising agent shall:

- a) comply with the relevant Specifications specified in Table 6.2
- b) not be more than three months old, measured from its date of manufacture to the time of blending, unless it has been retested for conformance within one month of use, and
- c) comply with the requirements nominated in the Contractor's mix design (refer Clause 7.4)

6.3 Chemical admixtures

Chemical admixtures used in lightly bound pavements shall be nominated by the Contractor as part of their mix design (refer Clause 7.4). Admixtures shall comply with, and be used in accordance with AS 1478.1.

6.4 Cement slurry

Where required under Clause 8 of this Technical Specification a cement slurry shall be applied to plant-mixed lightly bound pavement layers. In these applications, the slurry shall be as follows:

- The slurry shall have a water/cement ratio of between 0.6 and 0.7
- The cement used in this slurry shall be the same as that being used in the lightly bound pavement material, and
- The application rate shall be approximately 2 kg/m².

Lightly bound pavement material shall be placed onto the slurry immediately after it has been placed, but before the slurry has set. If the slurry sets before placement of the next lightly bound pavement layer, additional slurries shall be placed at the Contractor's expense, until the requirements of this Clause are met.

6.5 Water quality

Water used in lightly bound pavement manufacture and construction shall be free from oil, acids, organic matter and other matter which could be deleterious to the mixture. Unless otherwise accepted by the Administrator, the water shall satisfy the following requirements:

- a) have a pH within the range of 6 to 10, when tested using Test Method APHA 4500-H B or equivalent
- b) have an electrical conductivity not more than 3500 µS/cm when tested using Test Method APHA 2510-B or equivalent, and
- c) have a Sulphate Content of not more than 1.9 grams of sulphate (expressed as SO₄) per litre, when tested in accordance with AS 1289.4.2.1.

Unless otherwise accepted by the Administrator, water sources shall be tested at a maximum of twelve monthly intervals during the course of supply or when the nature of the water source has changed.

Water sources classified by the relevant water authority as 'potable water' shall be exempt from testing.

Electrical conductivity is an indirect measurement of the concentration of salts dissolved in the water.

pH measures the acidity or basicity of the water to assess its corrosiveness.

Where the Contractor can demonstrate a proven history or conformance from a specific water source, such as might be required for ongoing environmental monitoring purposes, the Administrator may waive the requirement for water quality testing of non-potable water sources.

7 Mix Design

7.1 General

The Contractor shall be responsible for undertaking all testing and design required to develop a mix design that consistently conforms with this Technical Specification.

The mix design must satisfy the following requirements:

Table 7.1 – UCS mix design requirements

Material	UCS (Q115)		Time for UCS Test
	Minimum	Maximum	
Lightly Bound Base	1.0 MPa	2.0 MPa	28 days*
Lightly Bound Improved Layer			7 days

* For lightly bound base materials, the Contractor shall prepare duplicate specimens from the same sample for testing after 7 days of curing (refer Clause 7.4).

Using Unconfined Compressive Strength test results and the Mixing Plant Variability, the Contractor shall nominate the Target Content of Stabilising Agent to be used in production.

At least 14 days before mixing operations commence **Milestone**, the Contractor shall submit the mix design report to the Administrator. Construction of lightly bound pavement layers shall not proceed until a conforming mix design (refer Clause 7.4) has been submitted to and accepted by the Administrator. **Hold Point 3**

7.2 Mixing plant variability

The Mixing Plant Variability (MPV) is an estimate of the likely variability in stabilising agent content that can be expected during production for the actual mixing plant to be used in the Works.

The Contractor shall nominate the MPV, expressed as a percentage (by dry mass) of the unbound pavement material to the nearest 0.01%.

Where a minimum of 30 historic production results are available, the nominated MPV shall be as follows:

$$MPV \geq z\sigma$$

where:

$z = 1.28$, representing an 80% confidence interval (for normally distributed data)

σ = the standard deviation of historic production results for the difference between the Target Content and the Actual Content of stabilising agent for the actual mixing plant to be used for the Works, expressed as a percentage (by dry mass) of unbound pavement material.

Where there are no historic production test results available for the mixing plant to be used in the Works, the Contractor shall nominate an interim MPV value. This interim value shall be a minimum of 0.5%. As soon as 30 production tests for additive content have been made, the Contractor shall review this interim value and nominate an MPV value in accordance with this Clause. Where this value differs from the interim value, the Contractor shall resubmit the mix design report in accordance with Clause 7.4.

The Mixing Plant Variability (MPV) to be used for each project will be nominated by the Contractor. The nominated value may be greater than the minimum value obtained by analysing the actual standard deviation of historic production results.

For example, if the standard deviation (σ) of historic production results is 0.18%, the MPV must be greater than or equal to 0.23%. The Contractor may elect, for their processes, to adopt a MPV of any value greater than or equal to 0.23%.

When selecting the MPV, it is important that the Contractor considers both mix design and production compliance requirements:

- Selecting the minimum permitted MPV will increase the acceptable target content range, which will generally allow the Contractor to target a lower stabilising agent content.
- Selecting the minimum permitted MPV will also minimise the allowable tolerances on the actual stabilising agent content in production (refer to Clause 8.3.2).
- Selecting a higher MPV will increase the allowable tolerances which will also reduce the acceptable target content range. This may result in the Contractor needing to use more stabilising agent to achieve the required UCS.

7.3 Determining target content of stabilising agent

Using the proposed unbound pavement material and stabilising agent to be incorporated into the works, the Contractor shall undertake a minimum of three UCS tests at three different stabilising agent contents such that the required stabilising agent content can be plotted across the full UCS range specified in Table 7.1.

Throughout this Technical Specification, one UCS test result is the average of three specimens.

For the purposes of undertaking the design process, UCS testing shall be undertaken on specimens compacted at (Standard) Optimum Moisture Content, and Maximum Dry Density.

These results shall be used by the Contractor to determine the target content of stabilising agent in accordance with this clause.

To undertake the mix design, it is the Contractors responsibility to undertake sufficient UCS testing to fully identify the stabilising agent content required to achieve UCS results across the range of 1.0 - 2.0 MPa. To achieve this, the Contractor may need to undertake more than three tests at different stabilising agent contents.

7.3.1 Acceptable range for target content of stabilising agent

The Contractor shall use the MPV nominated in accordance with Clause 7.2 and UCS test results to determine the acceptable range for the Target Content of Stabilising Agent in accordance with the following requirements:

- a) The UCS at the Maximum Target Content plus MPV shall be ≤ 2.0 MPa, and
- b) The UCS at the Minimum Target Content minus MPV shall be ≥ 1.0 MPa.

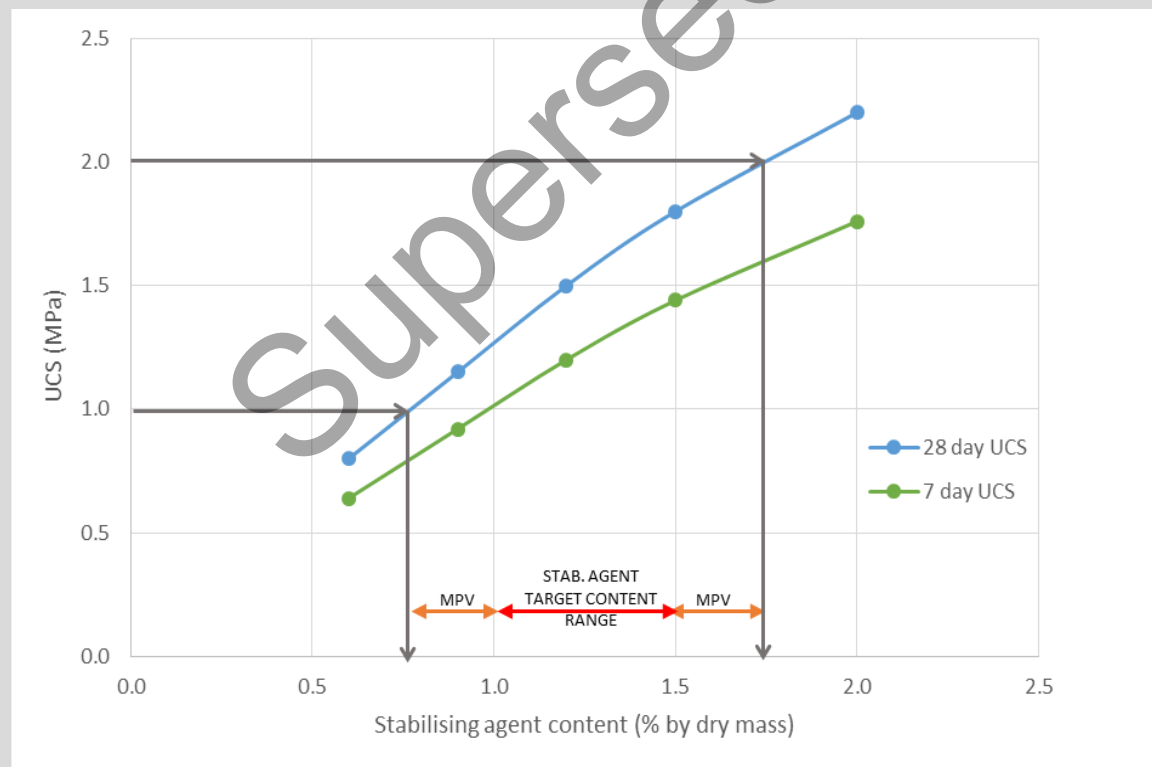
Interpolation between data points is permitted in checking compliance with the above limits. However, extrapolation beyond the range of test results is not permitted, and further testing must be undertaken if the above range of UCS limits is not covered.

To assess compliance with these UCS requirement, testing shall be undertaken after each prepared specimen has been cured for the time specified in Table 7.1.

Example determination of target stabilising agent content from UCS test results

Based on example UCS test results and a MPV of 0.25%, the acceptable stabilising agent target range is shown in Figure 7.3.1. In this example the range that a target content may be nominated between is 1.0% – 1.5%.

Figure 7.3.1 – Mix design example (lightly bound base)



7.3.2 Nominated Target Content of Stabilising Agent

Based on the acceptable target content range determined through UCS testing, the Contractor shall nominate a specific Target Content of Stabilising Agent to be adopted in the production of each lightly bound pavement material, expressed as a percentage (by dry mass) of unbound pavement material.

7.4 Mix design Report

For each plant-mixed lightly bound pavement material to be used in the works, the Contractor shall submit a mix design report to the Administrator. The report shall include as a minimum:

- a) A report on the unbound pavement material proposed to be used in the works including:
 - i. The material type proposed to be used
 - ii. A statement certifying that the unbound pavement materials conform in all regards with the requirements of the applicable Specifications
 - iii. Details of the properties of the material including source information (refer Clause 6.1)
 - iv. Test results for the unbound pavement material including particle size distribution, liquid limit and, plasticity index/linear shrinkage of the material used in the mix design (refer Clause 6 and Clause 9)
 - v. Transport and Main Roads Quarry Registration Certificate for the quarry source supplying each unbound pavement material to be used (refer Clause 6.1)
- b) The nominated stabilising agent and any chemical admixtures to be used, with written certification from the stabilising agent and chemical admixture supplier, supported by test results, confirming that the material proposed conforms to the requirements of this Technical Specification (refer Clause 6.2 and Clause 6.3). Where the stabilising agent is a blend, the Contractor shall also certify that the proportions of the blend used in the mix design testing comply with that nominated in the mix design report
- c) The MPV requirements (refer Clause 7.2), including:
 - i. The Contractor's nominated MPV
 - ii. Details of the proposed mixing equipment and controls to be adopted
 - iii. Historic production results summarised in a Table with the following columns: Test ID, Test Date, Stabilising Agent Type, Actual Content of Stabilising Agent (Production Mix), Target Content of Stabilising Agent, Difference between Actual Content and Target Content
 - iv. All test certificates for the historic production test results
 - v. A statistical analysis of the difference between the Actual Content and Target Content for the historic production test results, and
 - vi. Other relevant supporting information.
- d) The acceptable target content range and the Contractor's nominated Target Content of stabilising agent (refer Clauses 7.3.1 and 7.3.2)
- e) 7 and 28 day (where required) UCS test results for the range 1.0 – 2.0 MPa (refer Clause 7.3)
- f) Interpolated or tested UCS result at the nominated Target Content of stabilising agent;
- g) For lightly bound base materials, the relationship (based on test results) between 7 and 28 day UCS results to define $UCS_{7-lower}$ and $UCS_{7-upper}$ where:
 - i. $UCS_{7-lower}$ is the 7 day UCS corresponding to a 28 day UCS of 1.0 MPa, and
 - ii. $UCS_{7-upper}$ is the 7 day UCS corresponding to a 28 day UCS of 2.0 MPa.

- h) The allowable working time for the material, determined in accordance with Clause 8.2.3, with supporting test results.

All test results used in the mix design shall be less than 12 months old unless otherwise approved by the Administrator.

Where a mix design is otherwise conforming, but uses test results that are more than 12 months old, the mix design would normally be considered suitable if the following additional requirements have been satisfied within the last 12 months:

- There has been no substantial change to any of the constituent materials used in the mix design
- There has been no significant change to the mixing plant, and
- The Contractor can demonstrate consistent conformance with this Technical Specification.

Unless otherwise approved by the Administrator, where there are any changes to the constituent materials used in the production of the lightly bound pavement materials, including changes to the unbound pavement materials and stabilising agent, the Contractor shall resubmit the mix design report with test results based on the revised material.

Where the Contractor believes a material change is minor in nature and will not have a significant effect on the mix design, the Contractor may request approval from the Administrator to resubmit the mix design report based on 7 day UCS results only. However, if these UCS results show a change in the mix properties that is greater than the mixing plant variability, the Contractor will need to resubmit the mix design in full.

8 Construction

To comply with all requirements of this specification and in particular the requirements for surface finish, it may be necessary for the Contractor to develop a set of secondary requirements which comply with the specific material and construction requirements but, where necessary, are more stringent.

8.1 Trial pavement

Unless otherwise agreed by the Administrator, a trial of the manufacturing and laying operations is required for each different plant-mixed lightly bound pavement material prior to commencement of the work involving that material. **Witness Point 1**

The trial pavement must be more than 1000 m². Subject to the Administrator's approval, the trial may be incorporated into the permanent works.

The purpose of the trial is to determine:

- a) The suitability of the Contractor's nominated upper and lower moisture content limits and the ability of the lightly bound pavement layer to comply with the requirements of Clause 8.2.5

- b) Based on the characteristics of the material, its ability to be handled, spread, and compacted to achieve the surface finish requirements of Clause 8.2.8.1
- c) The adequacy of the joint and surface preparation procedures (including slurring and the ability to cut-back the surface as specified in Clause 8.2.8.2)
- d) The rolling pattern and the number of passes of the rollers required to produce an acceptable compacted layer, and
- e) The adequacy or otherwise of the manufacturing and construction plant proposed for the work.

The Contractor shall carry out material and construction compliance tests in accordance with Clause 9 to confirm the trial complies with the requirements of this Technical Specification. Prior to continuing works after completion of the trial, the Contractor shall submit to the Administrator, for their acceptance, records which demonstrate this compliance **Hold Point 4** If the trial does not conform in full to the requirements of this Technical Specification, the Contractor shall review their construction procedure and mix design and a further trial shall be undertaken.

Where minor nonconformances occur in a trial, and the Administrator accepts to incorporate the lot into the permanent works (either at a reduced level of service or otherwise), the Administrator, at their sole discretion may elect to waive the requirement for a further trial to be undertaken.

However where more significant nonconformances occur, and these or other nonconformances occur again after a further trial, the Contractor should substantially review their construction procedure or retest their mix design, and resubmit the mix design report.

8.2 Process requirements

8.2.1 Equipment

Equipment capable of efficiently carrying out the following functions shall be continuously available to the Site:

- a) transporting, transferring and storing of mix constituents
- b) mixing
- c) delivery of the mixture
- d) paving
- e) compaction
- f) preparation of the edges and surfaces, and
- g) water curing.

To achieve the minimum compaction standard specified, the Contractor may need to employ larger rollers than may normally be used.

Particularly where layer thickness are towards the maximum allowable limit, not less than one 21 tonne (minimum weight) vibrating steel drum roller should be used to compact plant-mixed lightly bound pavements, unless the Contractor can demonstrate that the required standards can be achieved with a smaller roller.

Additional rollers, including pneumatic tyred rollers, may also be used.

8.2.1.1 Equipment used to transport, transfer and store stabilising agent

The stabilising agent shall be transported, transferred and stored in a way that is both waterproof and watertight. These vessels and the associated apparatus shall be emptied and cleaned prior to the introduction of each type of material to be used in the works to ensure no contamination occurs.

8.2.1.2 Mixing equipment

Mixing equipment shall comprise at least the following:

- a) a stationary, driven pugmill
- b) a storage silo for the stabilising agent
- c) storage facilities for water as required
- d) calibrated and controlled metering systems for the addition of the stabilising agent and water, and
- e) the necessary conveyors, source of power and controls.

The mixing equipment shall also:

1. have a control system with a metered and variable feed rate for each mix constituent
2. have displays that allow continuous monitoring of each mix constituent
3. be capable of producing plant-mixed lightly bound pavement materials complying with this Technical Specification
4. be capable of uniformly incorporating the stabilising agent and water into the unbound pavement materials
5. be capable of producing a consistent material that is free from segregation, and
6. be capable of continuously producing plant-mixed lightly bound pavement materials complying with this Technical Specification at a rate of 150 tonnes per hour or the Contractor's placing rate, whichever is the greater.

8.2.1.3 Delivery equipment

Vehicles used for the delivery of the mix shall be open-body trucks, or equivalent, equipped with adequate covers. These vehicles shall be capable of transporting and discharging the mixture without segregation. If discharging into the hopper of a self-propelled spreading machine, the vehicles shall be designed or equipped with the capacity to efficiently discharge into the hopper consistently and without spillage.

Sufficient delivery vehicles shall be made available so that the mixture can be continuously delivered to ensure placement is essentially continuous throughout a construction lot.

8.2.1.4 Paving equipment

Unless nominated otherwise in Clause 2.1 of Annexure MRTS10.1, plant-mixed lightly bound base shall be constructed using a self-propelled spreading machine purpose-built for this work (that is, a paver). Such machines have the capacity to either:

- a) receive the material in a hopper and place and spread the mixture on the prepared surface to the required uncompacted layer thickness, width and shape in one pass, or
- b) spread previously placed windrows of the mixture to the required uncompacted layer thickness, width and shape in one pass.

Where the heavily bound material is being placed adjacent to a fixed edge or the width of the layer varies, the paver shall be fitted with a variable width screed.

The Administrator may approve other methods of paving (for example, using a grader) in areas where the pavement width is such that the use of a paver is not practical.

Plant-mixed lightly bound improved layers are not required to be placed by a self-propelled spreading machine.

Irrespective of what equipment is used, the mix shall be placed and spread such that there is no segregation of the mixture.

8.2.1.5 Equipment for water curing

The equipment used for water curing shall have the capacity to store at least 6000 litres of water and be able to discharge the water in a fine and even mist over the layer being cured in a manner that avoids slurring of the surface and does not result in pavement instability, erosion, or leeching of the stabilising agent.

8.2.1.6 Equipment for preparation of the layer edges and surfaces

The equipment used for the preparation of the layer edges shall be capable of cleanly cutting the edges and removing all the cut material from the formation.

The equipment used for the preparation of the surface of each layer shall include:

- a machine capable of sweeping the surface, and
- equipment capable of evenly distributing the cement slurry at the specified rate on the layer's surface and edges.

8.2.2 Stockpiling of lightly bound pavement material

Lightly bound pavement material shall not be stockpiled unless otherwise approved by the Administrator.

In general, lightly bound pavement material should not be stockpiled unless there are specific construction requirements. An example of this might be when lightly bound pavement materials are required to be produced in the afternoon for use during night works (such as in an urban area when a pug mill is unable to operate at night). In this circumstance the Administrator may approve the material to be stockpiled provided the mix incorporated a set-retarder to provide a suitable increase in working time (refer Clause 8.2.3 for further information).

8.2.3 Allowable working time

The time between the commencement of mixing the stabilising agent into the unbound pavement material and the completion of compaction of a single layer shall be less than the allowable working time.

Unless otherwise approved by the Administrator, the allowable working time for each plant-mixed lightly bound pavement material shall be the lesser of:

- a) The working time determined in accordance with Test Method Q136, and
- b) four hours.

Increasing the working time beyond four hours would not generally be approved unless significant constraints exist. Such examples might include:

- Night works in urban areas requiring the mixing of materials at times when the pug mill is unable to operate (for example, due to noise restrictions), or
- Where no suppliers are available locally, and extended travel times would significantly restrict the ability to construct the pavement within the working time.

In these circumstances, the Contractor should provide justification as to the reason for any proposed increase in allowable working time and provide results to the Administrator that demonstrate the working time in accordance with Test Method Q136.

Under such circumstances the Contractor may propose to incorporate a set-retarder into the mix design to achieve the desired working time.

8.2.4 Weather conditions for construction

Lightly bound pavements shall not be manufactured (by blended the stabilising agent with the unbound pavement material) or constructed:

- a) when the air temperature is less than 10°C or greater than 40°C
- b) during rain or when rain is likely to fall during placement, or
- c) when the evaporation rate due to the combined effect of air temperature, wind and relative humidity may result in excessive drying of the lightly bound pavement layers surface.

8.2.5 Moisture content of the mixture

The Contractor shall nominate upper and lower moisture content limits as part of their construction procedures that will ensure:

- a) there is adequate moisture to achieve the specified compaction standard
- b) the constructed lightly bound pavement layer is able to be trafficked without shoving or ravelling on the completion of compaction, and
- c) the pavement does not exceed the optimum moisture content (OMC) of the unbound pavement material, determined in accordance with Test Method Q142A.

Moisture must be uniformly distributed within each layer at the time of compaction. At all times the moisture content of the material must be within the Contractor's nominated upper and lower moisture content limits.

8.2.6 Paving

Lightly bound pavements shall be constructed such that each individual layer is laid in one pass that meets the requirements of this Technical Specification without the addition of extra material except as detailed below.

The material laid ready for compaction shall not have any visible areas of segregation. Any segregated areas are to be removed and replaced with fresh mix prior to the commencement of compaction of the lot. Material removed for this reason shall be disposed of in accordance with Clause 10 of MRTS01 *Introduction to Technical Specifications* and shall trigger a nonconformance, under which the Contractor must identify the cause of the segregation and propose preventative action to prevent reoccurrence **Nonconformance**

8.2.7 Layer thicknesses

Individual compacted layer thicknesses shall be chosen to suit the construction process and the requirements of the Contract. Unless otherwise approved by the Administrator, the completed layer thicknesses (after compaction and surface preparation) shall be in accordance with Table 8.2.7.

Table 8.2.7 – Layer thickness requirements

Material	Minimum Value	Maximum Value
Lightly Bound Pavement Materials	125 mm	250 mm

Where multiple layers of the same lightly bound pavement material are placed together in a single course each layer shall be of equal thickness.

To achieve the minimum compaction standard specified, the Contractor may need to employ larger rollers than may normally be used.

Particularly where layer thickness are towards the maximum allowable limit, not less than one 21 tonne (minimum weight) vibrating steel drum roller should be used to compact plant-mixed lightly bound pavements, unless the Contractor can demonstrate that the required standards can be achieved with a smaller roller.

Additional rollers, including pneumatic tyred rollers, may also be used.

8.2.8 Surface finish

8.2.8.1 General

The finished surface of any lightly bound pavement layer shall:

- be hard and homogenous in appearance
- not be friable when subject to mechanical brooming

- not have transverse shrinkage cracks
- not have any loose, segregated or contaminated areas
- have the course particles slightly exposed
- not be affected by delamination
- not show signs of water pumping, and
- not visibly deflect under load when proof rolled in accordance with Clause 9.4.9.

For layers that are to be covered by a sprayed bituminous treatment, the surface shall have a maximum ball penetration value of 3.0 mm when tested in accordance with Clause 9.4.10.

It is intended that these requirements apply to the condition of the pavement surface immediately prior to application of the surfacing treatment/ layer. The Contractor may need to undertake additional controls beyond the basic construction activities (compaction, trimming and so on) to ensure these requirements are satisfied.

Where a lightly bound pavement layer is required to be covered by a sprayed bituminous treatment, particular attention needs to be given to the surface finish of the lightly bound pavement layer in order to ensure good adhesion. This is particularly relevant when the treatment includes polymer modified bitumen.

The following factors are important to ensure the successful adhesion of a sprayed bituminous treatment:

- All dust must be removed from the pavement immediately before spraying
- Compaction of the lightly bound pavement material may form a thin lens of dried slurry on the surface of the pavement. This can appear hard, however may be prone to 'shattering' or delamination and should be removed before spraying
- Variation in the surface 'tightness' may warrant the specification of either an AMC0 or AMC00 prime (or an equivalent emulsion prime accepted by the Administrator). The effectiveness of any prime should be assessed in field trials.

Inadequate curing can lead to an excessively dusty surface, which may be difficult to prepare. To address this, curing should be undertaken to ensure the pavement remains continuously damp.

8.2.8.2 Preparation of a lightly bound layer prior to placing the next lightly bound layer

Where a lightly bound pavement layer is to be overlaid directly with another lightly bound pavement layer, the finished surface shall be cut-back:

- after the completion of compaction, and
- within the same work shift as the material was placed

Cutting back the surface shall uniformly remove a lens of material across the full width of the lightly bound pavement layer to produce a roughly textured surface. Scratching or marking the surface is not sufficient.

The Contractor will nominate in their Construction Procedure the proposed methodology to cut back the pavement. This may be undertaken using a grader or other plant dependent on the nature of the project and what equipment is available onsite for other processes.

Unless the overlying layer is being constructed in the same work shift, a cement slurry (refer Clause 6.4) shall be applied to the cut-back surface prior to placing the next lightly bound pavement layer.

The surface shall be thoroughly swept with a road broom immediately prior to placement of the slurry or overlying layer. All foreign and loose material, including lenses of pavement material, shall be removed from the surface.

The report Cement Slurry Applications to CTB Layer Bonding (Main Roads, 1988), describes methods that have been successfully used in the past for cutting back and slurring between heavily bound pavement layers.

All cut back material shall be disposed of in accordance with Clause 10 of MRTS01 *Introduction to Technical Specifications*.

8.2.9 Curing and covering of constructed layers

Unless otherwise approved by the Administrator, each layer of lightly bound pavement shall be covered with the next layer and/or a bituminous surfacing within seven days of placement.

At the completion of its construction, the surface of any layer shall be water cured until placement of the next layer of lightly bound pavement or the first layer of a bituminous surfacing is applied.

Unless otherwise approved by the Administrator, water curing shall be completed in accordance with Clause 8.2.1.5.

The number of applications of water shall be such that the surface remains continuously damp.

8.2.10 Construction joints between adjacent paving runs

To the extent practical, the Contractor shall spread the lightly bound pavement material in a manner that minimises the number of joints.

Joints shall be constructed such that the material at the joints comply in all ways with the requirements of this Technical Specification.

Longitudinal joints must comply with the following requirements unless otherwise approved by the Administrator:

- a) Joints shall be offset by a minimum of 150 mm from joints in the underlying layers, except where required otherwise to achieve the design shape (for example to construct a crowned pavement), and
- b) Joints in the final (uppermost) layer of lightly bound bases shall be located within 300 mm of the planned position of the final traffic lane marking.

Transverse joints must be offset by a minimum of 2.0 m from a joint in any underlying layer, unless otherwise approved by the Administrator.

The Administrator may approve pavement joints to be constructed away from lane markings where this represents the best outcome to achieve the pavement design intent. For example, when paving a single lane ramp with wide shoulders, the Administrator may allow the Contractor to form a single longitudinal joint along the centre of the ramp rather than paving the ramp lane between the edge line marking and the subsequently paving narrow shoulders on either side.

8.2.10.1 Fresh joints

A construction joint shall be deemed 'fresh' when the material on each side of the joint has been stabilised, placed and compacted within the allowable working time (refer Clause 8.2.2) of the material that was laid first.

To construct a fresh joint between adjoining or adjacent runs, the outside 300 mm of material from the first run shall be left uncompacted until the adjacent material is ready for compaction.

When compacting the fresh mix against the face of the existing layer, the roller shall be partly supported on the previously compacted portion of the layer that was laid first.

8.2.10.2 Other joints

Joints that are not fresh shall have the edge of the existing layer cut back to form a neat, clean, vertical face. The cut back distance shall be the greater of:

- a) The distance required to cut back into the area of existing material that is compacted to the standard specified in Clause 8.3.4, or
- b) 150 mm.

Unless otherwise approved by the Administrator, immediately before placing an adjoining or adjacent layer, the cut back edge of the existing layer shall have a cement slurry applied (refer Clause 6.4).

All cut back material shall be disposed of in accordance with Clause 10 of MRTS01 *Introduction to Technical Specifications*.

8.2.11 Trafficking during construction

Unless approved otherwise by the Administrator, the following requirements shall apply:

- a) Lightly bound pavement layers may be trafficked for the purpose of constructing the overlying pavement and bituminous surfacings (limited to the immediate area of placement and 500 m either side of that area)
- b) Lightly bound base layers, other than the final (upper most) layer, shall not be opened to general traffic, and
- c) The final (upper most) lightly bound base layer shall not be opened to general traffic:
 - i. Within 24 hours after placement, and
 - ii. Until the initial bituminous surfacing treatment (ie prime and seal, or initial seal/primerseal) is applied.

The Administrator may permit the lightly bound base to be trafficked by general traffic where it is not practical to otherwise restrict doing so. For example, on a two-lane two-way road where side-tracking is not practical and the works are required to be built 'under traffic'.

In such circumstances, it would be expected the Contractor seeks clarification at the time of tender if this requirement can be varied.

Where the lightly bound base is permitted to be traffic, the requirements for curing as per this Technical Specification must still be complied with, and the pavement kept continuously damp regardless.

8.2.12 Contractor's responsibilities

The Contractor shall maintain each layer such that it complies with all aspects of this Technical Specification until it has been overlaid with another pavement layer or surfaced with the final wearing surface, and then until the end of the defect liability period or as otherwise required under the Contract.

8.3 Product standards

8.3.1 Segregation

Segregation is the uneven distribution of particle sizes. The construction process shall control segregation so that the particle size distribution of the lightly bound pavement material complies with the particle size distribution requirements of the specified unbound pavement material prior to the commencement of compaction.

Where there are visible signs of segregation in any lot prior to the commencement of compaction, the Administrator may direct the area to be tested for conformance with the above requirements.

As the addition of stabilising agents is intended to bind unbound pavement materials, care needs to be taken in determining if a mix has in fact segregated. Typically if segregation testing is undertaken for lightly bound pavement materials, the proportion of the grading passing the 2.36 mm sieve would be disregarded.

8.3.2 Actual content of stabilising agent

The actual content of stabilising agent during production shall comply with the requirements specified in Table 8.3.2.

The target content of stabilising agent shall be as per Clause 7.3.2.

Table 8.3.2 – Stabilising agent content requirements

Property	Minimum Value	Maximum Value
Actual stabilising agent content	target content minus MPV	target content plus MPV

8.3.3 Unconfined compressive strength

UCS results for the production of lightly bound pavement materials must comply with the requirements specified in Table 8.3.3.

Table 8.3.3 – UCS requirements

Pavement Type	UCS (7 day)	
	Minimum Value	Maximum Value
Lightly Bound Improved Layer	1.0 MPa	2.0 MPa
Lightly Bound Base	UCS _{7-lower} *	UCS _{7-upper} *

* Refer to Clause 7.4.

28 day UCS testing has been specified for undertaking mix designs for Lightly Bound Bases as longer curing times are more suitable for a wider range of stabilising agents, including slower setting binders that may continue to increase in strength significantly beyond 7 days. This is particularly important for Lightly Bound Bases where any cracking due to over-stiffening may significantly impact on pavement performance. However for production conformance, it is recognised that 28 day testing is impractical, and as such the relationship between 7 and 28 day UCS testing must be determined.

For Lightly Bound Improved Layers, the risk to pavement performance is considered to be much lower due to this layer typically being located beneath a reasonable thickness of overlying pavement materials. Hence, for Lightly Bound Improved Layers, the use of 7 day UCS results for both mix design and production testing is considered acceptable and a more practical approach.

8.3.4 Compaction standard

The characteristic value of relative compaction must comply with the requirements specified in Table 8.3.4.

Table 8.3.4 – Compaction requirements

Material	Minimum Value
Upper most layer of lightly bound base	102% (Standard Compaction)
All other cases	100% (Standard Compaction)

8.3.5 Geometrics

8.3.5.1 General

The pavement shall be constructed so as not to depart from the widths, length, height and shape specified in the design documentation by more than the tolerances stated in this clause.

The widths and heights of the surface of layers other than the final layer shall be calculated by the Contractor using the widths, heights and shapes for the completed pavement, and the depth to the surface of the particular layer within the pavement as described in the design documentation.

The location of longitudinal joints in paving runs must also comply with the requirements of Clause 8.2.10.

8.3.5.2 Geometrics, horizontal tolerances

The horizontal location of any point on the pavement shall not differ from the corresponding point shown in the design documentation, or the point calculated as described in Clause 8.3.5.1, by more than ± 50 mm except for the following situations:

- a) For pavement edges not adjacent to any other part of the pavement and not adjacent to any fixed infrastructure or adjoining road, the transverse tolerance shall be $- 50$ mm, $+ 250$ mm (where the $+$ tolerance is in the direction which increases the width of the pavement), and
- b) where alignment of the pavement with an existing pavement or piece of fixed infrastructure is necessary, the new work shall be joined neatly to the existing work in a smooth manner as shown on the drawings, or if this is not shown, in a manner approved by the Administrator.

8.3.5.3 Geometrics, vertical tolerances

The vertical tolerances specified in Table 8.3.5.3 shall apply for:

- The surface level (height) measured at any point on the surface of any layer, and
- The average total thickness of the constructed course (which may comprise multiple layers of the same lightly bound pavement material) compared to the specified (designed) total thickness.

Table 8.3.5.3 – Primary geometric tolerances

Property	Value
Surface level / height (individual)	± 10 mm
Total thickness (average)	$- 20$ mm / $+$ unspecified

Where the pavement is required to be prepared as specified in Clause 8.2.8.2, these tolerances shall apply after the pavement has been cut back and prepared ready for construction of the overlying layer.

8.3.5.4 Crossfall

For the final (uppermost) layer of a lightly bound base to be constructed under the Contract, the crossfall shall not depart from the design crossfall by more than 0.5% absolute.

The crossfall shall be measured:

- a) between any two points more than two metres apart (excluding where the overall width of a single crossfall is less than two metres wide). For crossfalls less than two metres wide, the measurement shall be made between the extreme edges of the crossfall as shown in the design documentation
- b) transverse to the centre line, and
- c) within the boundaries of a cross-section element which has a constant crossfall as shown in the design documentation.

8.3.6 Deviation from a straight-edge

The deviation from a 3 metre long straight-edge placed anywhere on the surface of the final (uppermost) layer of a lightly bound base to be constructed under the Contract, shall be in accordance with the requirements of Table 8.3.6 with due allowance being made for design shape, where relevant.

These requirements shall also be applied to other layers where stated in Clause 2.2 of Annexure MRTS10.1.

Table 8.3.6 – Requirements for deviation from a straight-edge

Property	Maximum Value
Deviation from a straight edge	5 mm

8.3.7 Road roughness (surface evenness)

Unless otherwise specified in Clause 2.3 of Annexure MRTS10.1, for lightly bound bases the road roughness of the final (uppermost) layer to be constructed under the Contract, shall be in accordance with the requirements of Table 8.3.7.

Surface evenness testing is not required to be undertaken on lightly bound improved layers.

Table 8.3.7 – Road roughness requirements for lightly bound bases

Property	Maximum Value
Road roughness (Rs) (m/km)	2.31

The Administrator may waive the requirement for roughness testing when the lightly bound base will be overlaid with asphalt or another pavement material within the same contract, and there is a roughness requirement specified elsewhere in the contract for the overlying layer.

Calculation of road roughness should accurately represent the ride quality of the complete pavement. It is generally accepted that the inclusion of other road features within the pavement are likely to reduce ride quality.

In accordance with the test method adopted, these features are required to be noted during roughness testing. The following features are typically allowed to be excluded from the ride quality assessment:

- roundabouts
- railway lines
- bridge joints, and
- inspection pit covers (for example, drainage manholes).

The Contractor should nominate a methodology and provide calculations on ride quality for the Administrators acceptance, showing how each feature has been excluded from the assessment and the subsequent lot structure.

Under no circumstances should pavement features (including joints) or signalised/unsignalised intersections (other than roundabouts) be excluded from the ride quality assessment without the express agreement of the Administrator.

9 Compliance testing

9.1 General

Compliance testing of plant-mixed lightly bound pavements shall be undertaken on a lot basis in accordance with MRTS01 *Introduction to Technical Specifications*.

For each lot, the Contractor is responsible for performing sufficient tests to ensure that the pavement complies in all regards with the requirements of this Technical Specification. As a minimum the Contractor's testing program shall not be less than that specified in this clause.

The Contractor shall ensure that sufficient, clearly documented construction compliance records are provided to the Administrator to ensure that traceability of unbound pavement materials is provided from their source (for example, quarry face) to the constructed pavement.

Maximum lot sizes, minimum test frequencies and the minimum number of tests required are specified in Appendix A.

Where testing frequencies are specified as a number of tests per a quantity, the tests should be representative of the quantity of materials nominated, or part thereof.

For example, if a frequency of 1 test per 1000 m² is nominated, and a lot includes 2500 m² of that material a minimum of 3 tests would be required.

9.2 Test locations

Locations for compliance testing shall be selected by random stratified sampling as specified in Test Method Q050. Representative sampling shall be undertaken as detailed in Test Method Q060. Spot sampling shall be undertaken as detailed in Test Method Q061.

9.3 Maximum lot sizes

The maximum lot sizes for plant-mixed lightly bound pavement works shall be as specified in Table A1 of Appendix A.

9.4 Compliance testing requirements

9.4.1 Segregation

Minimum testing frequencies for segregation shall be as specified in Table A3 of Appendix A.

The Administrator may direct additional testing of any areas which show visible signs of segregation during construction.

9.4.2 Compaction

Minimum testing frequencies for compaction shall be as specified in Table A3 of Appendix A.

The compaction standard for each lot shall be represented by the minimum characteristic value of relative compaction. The characteristic value shall be calculated in accordance with Test Method Q020 using the individual relative compaction results reported for each lot.

9.4.3 Stabilising agent & chemical admixture certification

For each lightly bound pavement lot, the Contractor shall provide written certification from the stabilising agent and chemical admixture supplier, with supporting test results, confirming that the material delivered conforms to the requirements of Clause 6.2 and Clause 6.3.

Where the stabilising agent is a blend, the Contractor shall also certify for each lightly bound pavement lot that the proportions of the blend comply with that nominated in the mix design report (refer Clause 7.4)

9.4.4 Cement slurry

For each lot where a cement slurry is incorporated into the works, the Contractor shall report the average spread rate of the slurry by reconciling the amount of slurry spread (measured by mass) over the area treated.

9.4.5 Stabilising agent content

Minimum testing frequencies for stabilising agent content shall be as specified in Table A2 of Appendix A.

The actual content of stabilising agent for each lot shall be represented by both the:

- a) minimum characteristic value of the actual content of stabilising agent, and
- b) maximum characteristic value of the actual content of stabilising agent.

When UCS tests are being undertaken, the sample being used must also be tested for stabilising agent content and moisture content.

9.4.6 Mixing plant variability

Minimum testing frequencies for mixing plant variability shall be as specified in Table A2 of Appendix A.

For each lot, the accuracy of the system used to dispense stabilising agent shall be verified by reconciliation between:

- a) *The stabilising agent used*

The actual (measured) amount of stabilising agent added to the pug mill (refer Clause 8.2.1.2) to produce the lot, and

- b) *The amount of unbound pavement material used*

The amount of unbound pavement material used in the lightly bound pavement material shall be established based on the wet mass of mixture, as shown on weighbridge records, adjusted to a dry mass (using the average measured moisture content of the mixture for the Lot), minus the mass of stabilising agent used.

The average stabilising agent content can then be calculated as a percentage by dry mass of the unbound pavement material.

Alternatively, for assessment of the accuracy of the system, the Contractor may propose an alternative compliance method, such as one that includes a continuous (real time) data collection system of the throughput mass of all constituent materials. Any proposed alternative must be approved by the Administrator prior to use.

Example of approach to calculate average stabilising agent content:

The stabilising agent used

- production records shown 3 tonnes of stabilising agent was added to the pug-mill to produce a lot

The amount of lightly bound pavement material produced

- Weight bridge records show a total of 200 tonnes of lightly bound pavement materials was produced in the same lot
- Moisture content testing for the lot returned an average result of 7.5%
- The equivalent dry tonnage of the mixture would therefore be calculated as 185 tonnes
- The equivalent dry tonnage of unbound pavement material used would be 182 tonnes
- The average stabilising agent content is therefore 1.65%

Testing for mixing plant variability is not intended to assess the plant performance during production against the MPV nominated in the mix design process. Rather this requirement is specified as a means of validating process control measures undertaken in the plant and may be a lead indicator that UCS results may be nonconforming in a lot.

While there is no specific specification limit for this property, excessive variation in the actual mixing plant variability during production should be investigated by the Contractor, and consideration given to reviewing process controls accordingly.

9.4.7 Moisture content

Minimum testing frequencies for moisture content testing shall be as specified in Table A2 of Appendix A.

The moisture content of each lot shall be represented by the individual moisture content results.

9.4.8 Unconfined compressive strength

Minimum testing frequencies for unconfined compressive strength (UCS) testing shall be as specified in Table A2 of Appendix A.

Conformance testing for UCS, moisture content and stabilising agent content must be undertaken in accordance with the time requirements given in the respective Test Methods. Under normal circumstances, these tests would all be undertaken on samples taken from material being discharged directly from the pug mill. These results would therefore represent material properties at the point of production.

Material properties at the point of placement are controlled by ensuring materials are placed within the allowable working time, which allows a reduction in both the UCS and maximum dry density of the material as detailed in Test Method Q136. However there is no specific requirements that the material is tested for conformance in this regard.

9.4.9 Proof rolling

Each lightly bound pavement layer shall be tested for perceptible surface deformation by 'proof rolling' the pavement, in the presence of the Administrator **Witness Point 2** All areas of lightly bound pavements shall be 'proof rolled', including all trafficked lanes, shoulders and other areas.

Testing shall be in accordance with RMS Test Method T198 unless otherwise approved by the Administrator. Testing for perceptible surface deformation is exempt from the requirement for NATA accreditation or Construction Material Testing (CMT) registration.

In areas where perceptible surface deformation is observed, the Contractor shall remove and replace the affected section, or take other corrective action to the satisfaction of the Administrator. In doing so, the Administrator may require the Contractor to carry out additional compliance testing to ensure that the affected section of pavement complies with Clause 8.2.5 and 8.3.4. No additional payment will be made by the Principal for any such additional testing.

The proof rolling result reported for any lot shall be representative of the condition of the lot immediately prior to it being covered by another pavement layer. If the pavement lot has been subjected to rainfall or moisture ingress in any way since proof rolling was undertaken, the Administrator may direct the Contractor to retest the lot to prove conformance. If the retested results do not comply with the requirements of this Technical Specification, the Contractor shall dry back and/or reprepare the pavement such that it complies with the requirements of this Technical Specification. No additional payment will be made by the Principal for any such additional efforts.

RMS Test Method T198 provides a method for using either a pneumatic-tyred static roller or a 10,000 L loaded water tanker for proof rolling.

9.4.10 Ball penetration testing

For lightly bound pavement layers that are to be covered by a sprayed bituminous treatment, the Contractor shall undertake ball penetration testing in accordance with Test Method AG:PT/T251 on the completed layer prior to undertaking the sprayed bituminous treatment.

Minimum testing frequencies for ball penetration testing shall be as specified in Table A3 of Appendix A.

In accordance with Test Method AG:PT/T251, ball penetration results shall be reported as both individual and average values.

For the average value to be adopted for lot conformance and seal design purposes, the results must be representative of a homogeneous section of pavement. Any areas represented by excessively low or high individual values should be considered for sub-lotting, and may require additional construction or testing actions before they can be incorporated into the final works. Any such works shall be undertaken by the Contractor at no cost to the Principal.

The ball penetration result reported for any lot shall be representative of the condition of the lot immediately prior to it being covered. If the pavement lot has been subjected to rainfall or moisture ingress in any way since ball penetration testing was undertaken, the Administrator may direct the Contractor to retest the lot to prove conformance. If the retested results do not comply with the requirements of this Technical Specification, the Contractor shall dry back and/or reprepare the pavement such that it complies with the requirements of this Technical Specification. No additional payment will be made by the Principal for any such additional efforts.

9.4.11 Geometrics & deviation from a straight edge

Minimum testing frequencies for geometric tolerances and deviation from a straight edge shall be as specified in Table A4 of Appendix A.

Horizontal position, vertical levels, crossfall and layer thickness shall be determined by survey unless otherwise agreed by the Administrator.

9.4.12 Road roughness (surface evenness)

The road roughness of the final (uppermost) layer of all lightly bound bases shall be measured by Test Methods Q708B, Q708C or Q708D.

For road roughness testing, a lot shall not be less than 100 m or greater than 500 m in length, unless otherwise approved by the Administrator. Areas of pavement affected by roundabouts, railway lines, bridge joints and inspection pit covers may be excluded from ride quality assessment.

Road roughness testing is not required to be undertaken on lightly bound improved layers.

9.5 Compliance testing results

9.5.1 Acceptance of lots

Unless otherwise approved by the Administrator, no layer of lightly bound pavement shall be covered by a subsequent layer of pavement or by a surfacing until **Hold Point 5**:

- a) all testing has been completed (other than UCS testing)
- b) the surface finish of the layer complies with the requirements of Clause 8.2.7
- c) all test results (other than UCS testing) comply with the requirements of this Technical Specification, or any non-conformances have been submitted, with corrective actions proposed by the Contractor, and accepted by the Administrator, and
- d) all (production) UCS test results for preceding lightly bound pavement lots constructed more than 10 working days prior comply with the requirements of this Technical Specification, or any non-conformances have been submitted, with corrective actions proposed by the Contractor, and accepted by the Administrator.

9.5.2 Recurring nonconformances

A nonconformance is considered recurring when more than 5 out of the most recent 20 test results for the following properties are nonconforming:

- a) unbound pavement material properties
- b) unconfined compressive strength, or
- c) actual stabilising agent content.

Where a recurring nonconformance occurs, the Contractor shall cease using the mix, retest the plant-mixed lightly bound pavement material and resubmit the mix design report in accordance with Clause 7.4.

9.5.3 Nonconformances with compressive strength or stabilising agent requirements

Where the UCS or Actual Content of Stabilising Agent test results for any lot do not comply with the requirements of this Technical Specification, the Contractor shall cease using the mix, review the mix design, and propose to the Administrator how the mix design will be adjusted to ensure compliance with this Technical Specification **Nonconformance**

Works shall not continue until the proposed actions outlined in the NCR are accepted by the Administrator **Hold Point 6**

Unless a recurring nonconformance has been triggered, the mix is not required to be retested or the mix design resubmitted.

Where UCS results are nonconforming the lot must be assessed for its suitability to be incorporated into the permanent works. This should be done by the RPEQ Pavement Designer responsible for the project.

For lightly bound base layers, in all cases specific consideration should be given to the effect of the nonconformance on the long-term performance of the pavements

For lightly bound improved layers, lots which exceed the upper limits for stabilising agent content and/or UCS requirement would normally be accepted to be incorporated into the works provided:

- a) The nonconformance is not recurring
- b) The Contractor has raised a NCR and detailed the actions being taken to prevent recurrence
- c) All other requirements of this Technical Specification have been met
- d) There are no cracks, other than transverse cracks with a maximum width of 5 mm, in the surface of the lightly bound improved layer at any time prior to placement of the overlying pavement
- e) The maximum characteristic value of the actual content of stabilising agent is less than or equal to the target content plus 1.5 times MPV
- f) Previous nonconformances have been satisfactorily addressed by the Contractor, and
- g) The Administrator is satisfied that the long term performance of the pavement will not be adversely affected

In these circumstances, the following corrective actions should apply at no cost to the Principal.

- i. Apply a 14 mm SAMI seal to the final surface of the improved layer, and
- ii. Application of this SAMI shall be undertaken not more than 3 days prior to commencement of the overlying pavement.

10 Supplementary requirements

The requirements of MRTS10 *Plant-Mixed Lightly Bound Pavements* are varied by the supplementary requirements specified in Clause 3 of Annexure MRTS10.1.

Superseded

Appendix A: Maximum lot sizes and minimum testing frequencies

Table A1 – Maximum lot size requirements

Construction Activity	Maximum Lot Size
Supply of unbound pavement materials	Refer to the relevant Technical Specification for unbound pavement material. (For further information refer to Clause 6.1 of MRTS10).
Construction of lightly bound pavements	A continuous single layer constructed in 1 day's production
Road roughness testing	500 m

Superseded

Table A2 – Lightly bound pavement materials - product testing

Property	Test Method	Normal Testing Level		Reduced Testing Level	
		Minimum Testing Frequency	Minimum No. of Tests	Minimum Testing Frequency	Minimum No. of Tests
pH (water)	APHA 4500-H B	12 month intervals	-	12 month intervals	-
Conductivity (water)	APHA 2510-B				
Sulphate content (unbound pavement material and water)	AS 1289.4.2.1				
Stabilising Agent Content (heat of neutralisation)	Q134	1 per 500t	2 per lot	1 per 1000t	2 per lot
Stabilising Agent Content (mixing plant variability)	Refer Clause 9.4.6	-	1 per lot	-	1 per lot
Moisture Content	AS 1289.2.1.1, AS 1289.2.1.4 or AS 1289.2.1.6	1 per 500t	2 per lot	1 per 1000t	2 per lot
Unconfined Compressive Strength (7 day)	Q115	1 per 1000t*	-	1 per 1000t*	-

Notes:

* 1 test is the average of 3 individual UCS specimens.

Table A3 – Construction standard testing

Property	Test Method	Normal Testing Level		Reduced Testing Level	
		Minimum Testing Frequency	Minimum No. of Tests	Minimum Testing Frequency	Minimum No. of Tests
Segregation	Q103A	1 per lot (Additional testing as directed by the Administrator)			
Compaction	Q140A	1 per 500 m ²	4 per lot	1 per 1000 m ²	4 per lot
Proof Rolling	T198	Refer Clause 9.4.9			
Ball Penetration Testing	AG:PT/T251	<p>For lightly bound pavement layers where the final surfacing (to be trafficked) is a sprayed bituminous treatment:</p> <ul style="list-style-type: none"> • 5 test chainages per lot • Test chainages (longitudinal coordinates) determined in accordance with Test Method Q050 – random stratified • At each test location an individual test must be undertaken in both the inner and outer wheel path for each traffic lane in the lot at that location. <p>For lightly bound pavement layers where the final surfacing (to be trafficked) is not a sprayed bituminous treatment (ie. the sprayed bituminous treatment will be covered by asphalt):</p> <ul style="list-style-type: none"> • 5 test chainages per lot • Test chainages (longitudinal coordinates) determined in accordance with Test Method Q050 – random stratified • At each test location an individual test must be undertaken at the offset (lateral coordinate) determined in accordance with Test Method Q050 – random stratified. 			

Table A4 – Geometrics testing

Property	Test Method	Normal Testing Level	Reduced Testing Level
Layer Thickness	Survey	1 per 20 linear m	1 per 50 linear m
Horizontal Position & Vertical Levels	Survey	Each 20 linear metres [^] - measured at all shoulder edges, lane lines and other changes in grade across the pavement	
Deviation from a straight edge	Q712	<p>a) within lane: 1 per 20 linear metres[^] along each paving run, unless otherwise approved by the Administrator. Measurements shall be taken in both the transverse and longitudinal directions.</p> <p>b) longitudinal joint: 1 per 20 linear metres[^] along each joint, unless otherwise approved by the Administrator.</p> <p>c) transverse joint: 1 measurement per joint in each wheel path in each lane.</p> <p>For the measurement of joints, place the straightedge on the completed layer, perpendicular to the joint. With the end of the straightedge directly over the joint, gradually move the straightedge across the joint for its full length and identify the point on the layer that produces the largest deviation under the straightedge (between two points of contact). Record the deviation at this point.</p> <p>For all joints that tie the new works to existing pavement (not constructed under the Contract), place the straightedge on the road surface perpendicular to the joint. With the end of the straightedge directly over the joint and the other end located within the works, record the largest deviation under the straightedge (between two points of contact).</p>	
Crossfall	Survey	1 per 20 linear metres [^] – measured for all crossfalls shown in the design documentation at the point of testing	
Road Roughness	Q708B, Q708C or Q708D	Refer Clause 9.4.12	

[^] The Administrator may approved the adoption of a reduced testing frequency of 1 per 50 m in 'mid-block' applications (that is, areas of pavement not located in the vicinity of intersections, roundabouts, steep grades and/or sharp curves).

Superseded