

Superseded

Technical Specification

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

November 2019

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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 lightly bound bases, subbases and 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.

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.

To achieve the requirements of this Technical Specification, collaboration is required between Contractors and Suppliers.

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 specified in moderately trafficked pavement applications or where moisture control is required during construction or throughout the service life of the pavement.

Lightly Bound Subbase

Lightly bound subbase would typically be specified where additional moisture control is required in the subbase course.

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	<p>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.</p> <p>The following activities are not required to be completed in the allowable working time:</p> <ul style="list-style-type: none"> • cut-back of the surface prior to placing another lightly bound layer • static rolling to prepare the surface for sealing, and • proof rolling.
Cement Slurry	A semi-liquid mixture of stabilising agent (either a blended cement or a cementitious blend) and water.
Control Charts	A graph used to show how a material property changes over time. Test results are plotted chronologically.
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	<p>A layer which provides:</p> <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 <p>Constructed from a mixture of unbound granular pavement materials, cementitious stabilising agent and water.</p>
Lightly Bound Subbase	A lightly bound course constructed beneath a base course, 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.

Term	Definition
Mixing Plant Variability	The Mixing Plant Variability (MPV) is an estimate of the likely variability in stabilising agent content 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 and natural deposits such as sand sources.
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.
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 1289.2.1.1	<i>Methods of testing soils for engineering purposes Soil moisture content tests – Determination of the moisture content of a soil – Oven drying method (standard method)</i>
AS 1289.2.1.4	<i>Methods of testing soils for engineering purposes Soil moisture content tests – Determination of the moisture content of a soil – Microwave-oven drying method (subsidiary method)</i>
AS 1289.2.1.6	<i>Methods of testing soils for engineering purposes Soil moisture content tests - Determination of the moisture content of a soil – Hotplate drying method</i>
AS 1289.2.3.1	<i>Methods of testing soils for engineering purposes - Soil moisture content tests - Establishment of correlation - Subsidiary method and the standard method</i>
AS 1289.4.2.1	<i>Methods of testing soils for engineering purposes Soil chemical tests— Determination of the sulfate content of a natural soil and the sulfate content of the groundwater—Normal method</i>
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>

Reference	Title
MRTS01	<i>Introduction to Technical Specifications</i>
MRTS05	<i>Unbound Pavements</i>
MRTS23	<i>Supply and Delivery of Quicklime and Hydrated Lime for Road Stabilisation</i>
MRTS35	<i>Recycled Materials for Pavements</i>
MRTS50	<i>Specific Quality System Requirements</i>
-	<i>Pavement Design Supplement, Transport and Main Roads</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
Moisture content	AS 1289.2.1.1, AS 1289.2.1.4, AS 1289.2.1.6
Moisture content test - Establishment of correlation for subsidiary methods (AS 1289.2.1.4 or AS 1289.2.1.6)	AS 1289.2.3.1
Particle Size Distribution (Segregation)	Q103A
pH (water)	APHA 4500-H B
Proof Rolling Test	Q723
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
Stabilising Agent Content – Heat of Neutralisation	Q134
Sulfate content	AS 1289.4.2.1, other published or validated classical chemistry technique or instrumentation technique#
Unconfined compressive strength (UCS)	Q115

Property to be Tested	Test Method No.
Working time of stabilised materials	Q136A

Note

Instrumentation techniques may include Ion Chromatography / Inductively Coupled Plasma / Discrete Analyser and so on. NATA endorsed test results are evidence of a validated technique.

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 or AS 1289.2.1.6. If one of the subsidiary methods (AS 1289.2.1.4 or AS 1289.2.1.6) are used, a correlation using AS 1289.2.3.1 must be applied.

Testing to determine the moisture content of the material at the point of production 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 the 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

The sample from which production 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
8.1	4. Demonstration of ability to manufacture and construct conforming pavement	1. Construction of Trial Pavement	

Clause	Hold Point	Witness Point	Milestone
9.4.9		2. Proof Rolling	
9.5.1	5. Covering a lightly bound pavement layer		
9.5.3	6. Mix design review		

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) procedures to demonstrate the accuracy of the mixing plant (including calibration procedures for load cells where applicable)
- 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. procedures for the transport, placement, compaction and trimming of the pavement material
 - vi. the proposed rolling pattern and number of passes needed to achieve the specified compaction standard for each layer thickness and support condition (to be validated during the placement trial)
 - vii. procedures and equipment to prepare joints (refer Clause 8.2.10) prior to placing an adjacent layer of lightly bound material
 - viii. procedures and equipment to cut-back the surface (refer Clause 8.2.8.2) prior to placing an overlying layer of lightly bound material
 - ix. slurring procedures, including details of how the slurry will be mixed and spread evenly and safely to the cut-back joint edges and the cut-back surfaces
 - x. 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
 - xi. procedure and equipment proposed for proof rolling pavement layers

- xii. curing procedures
- xiii. procedure and equipment to prepare the surface prior to sealing (refer Clause 8.2.8.1)
- 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 more than one type of plant-mixed lightly bound material is 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 as applicable.

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

The unbound pavement material to be incorporated into the lightly bound base shall be as specified in Table 6.1.2.

Table 6.1.2 – Unbound pavement materials for lightly bound base

Specification	Permissible Material	Testing Frequencies
MRTS05 <i>Unbound Pavements</i>	Subtype 2.1	Refer to MRTS05

6.1.3 Unbound pavement material for lightly bound subbase and improved layer

The Contractor shall nominate in their mix design the standard of unbound pavement material to be incorporated into the lightly bound subbase or improved layer.

The unbound material shall be one of the permissible types specified in Table 6.1.3.

Table 6.1.3 – Unbound pavement materials for lightly bound subbase and 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

6.2 Stabilising agent

The constituents incorporated into the stabilising agent (binder) to be used in the works shall comply with the requirements of Clause 6.2.1 through 6.2.4. The stabilising agent type, the proportion of each constituent and the supplier to be used shall be nominated by the Contractor as part of their mix design (refer Clause 7.4).

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) 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
- b) comply with the requirements nominated in the Contractor's mix design (refer Clause 7.4)

6.2.1 Cement

All cement used shall comply with AS 3972. The type of cement used shall be Type GP or Type GB.

6.2.2 Fly ash

Fly ash used shall comply with AS/NZS 3582.1 and be Special Grade or Grade 1.

6.2.3 Slag – ground granulated iron blast-furnace

Slag shall comply with AS 3582.2.

6.2.4 Hydrated lime

Hydrated lime shall comply with MRTS23 *Supply and Delivery of Quicklime and Hydrated Lime for Road Stabilisation*.

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 between 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, and
- the application rate shall be approximately equivalent to 2 kg/m² of cement (stabilising agent)

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.

The maximum time between mixing the slurry and covering the slurry with lightly bound material shall be:

- three hours, or
- the working time determined for the lightly bound material using Test Method Q136A without the use of a set retarder, where the same stabilised agent is used in the slurry as in the lightly bound material.

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 Sulfate Content of not more than 1.9 grams of sulfate (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 requirements specified in Table 7.1.

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 Subbase			
Lightly Bound Improved Layer			7 days

Note

* For lightly bound base and subbase 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 rounded up to the nearest 0.1%.

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

$$MPV \geq z\sigma$$

where:

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

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 is higher than 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% and rounded up to the nearest 0.1%. The Contractor may elect, for their processes, to adopt a MPV of any value greater than or equal to 0.3%.

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 Mix design testing

Using the proposed unbound pavement material and stabilising agent to be incorporated into the works, the Contractor shall undertake:

- testing which demonstrates the unbound pavement material used in the mix design tests conforms to the relevant specification,
- 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 with at least one UCS test result falling between the Minimum and Maximum UCS values specified in Table 7.1, and
- working time testing

For the purposes of undertaking the mix design process, all testing shall be undertaken on specimens taken from the same unbound material bulk sample. UCS tests shall be compacted at (Standard) Optimum Moisture Content, and Maximum Dry Density.

UCS test 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 from the same unbound material bulk sample 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.

The Administrator may accept UCS tests from different bulk samples if there are minimal differences in the unbound materials properties between samples.

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. Unless otherwise accepted by the Administrator, 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.

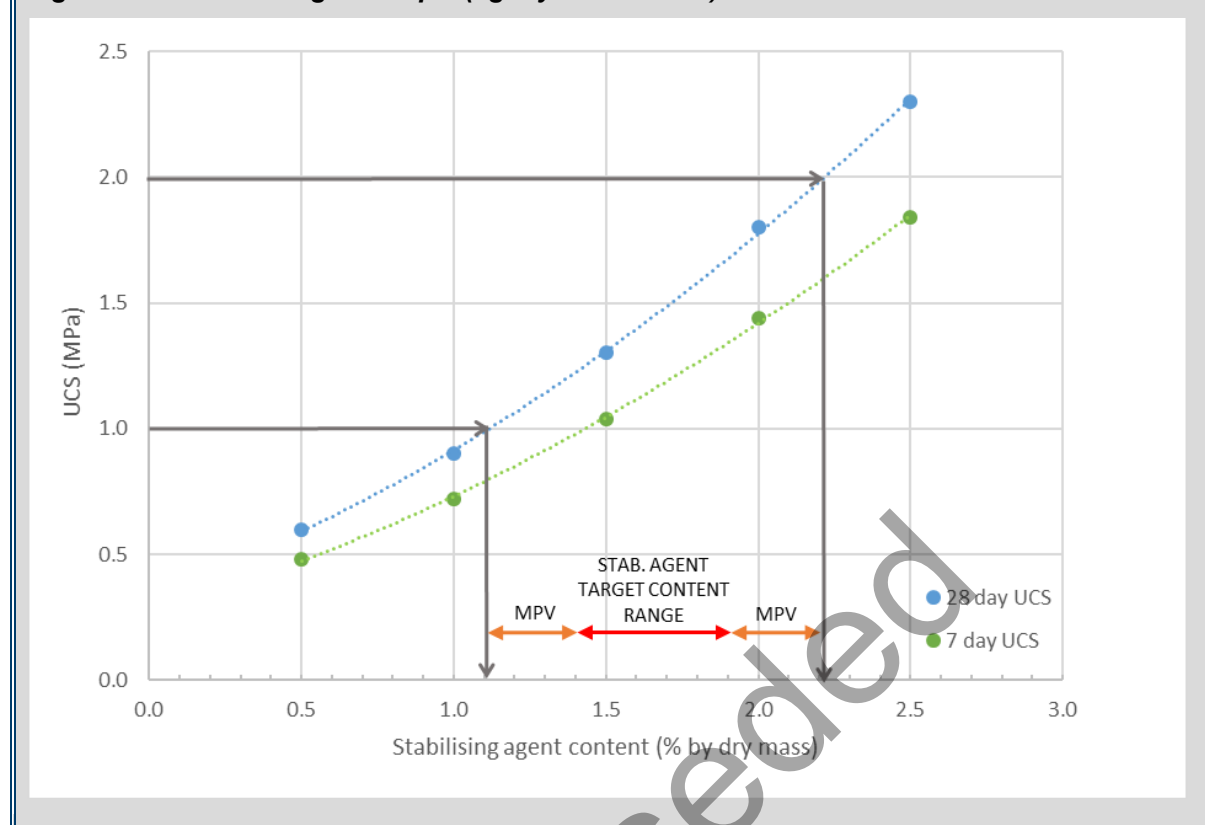
To assess compliance with these UCS requirement, testing shall be undertaken after each prepared specimen has been cured for the time specified in Table 7.1.

The equation used to interpolate between data points is not specified.

When preparing the mix design, the Contractor shall determine the most appropriate trendline to be used. The R^2 value of the trendline should be as close to 1 as possible.

Example determination of target stabilising agent content from UCS test results

Based on example UCS test results and a MPV of 0.3%, 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 1.4% – 1.9%.

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.

7.3.3 Working time

Working time testing shall be carried out using Test Method Q136A, at a stabilising agent content within the acceptable target content range (refer Clause 7.3.1)

Where a chemical admixture is proposed to be used in the Works, the same chemical admixture and dose rate shall be used to determine the working time.

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. Details of the source of the material (refer Clause 6.1.1) – including the Transport and Main Roads Quarry Registration Certificate, where required
 - iii. Test results for the unbound pavement material used in the UCS testing, which demonstrates it complies in full with the relevant specification (refer Clause 6 and Clause 7.3)

- b) Details of the stabilising agent to be used in the works including:
 - i. The type of stabilising agent, with written certification from the stabilising agent supplier, supported by test results, confirming that the material proposed conforms to the requirements of this Technical Specification (refer Clause 6.2). The stabilising agent type and supplier proposed shall be the same as that used in the mix design testing.
 - ii. The proportions of each constituent to be used in the stabilising agent (refer Clause 6.2)
 - iii. The ATIC registration number (where available) of the stabilising agent used in the mix design (and proposed to be used in the Works)
- c) Details of any chemical admixtures to be used, including the nominated dosage rate (refer Clause 6.3)
- d) 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 test 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. Any other relevant supporting information.
- e) The acceptable target content range and the Contractor's nominated Target Content of stabilising agent (refer Clauses 7.3.1 and 7.3.2)
- f) 7 and 28 day (where required) UCS test results for the range 1.0 – 2.0 MPa (refer Clause 7.3)
- g) Interpolated or tested UCS result at the nominated Target Content of stabilising agent;
- h) For lightly bound base and subbase 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 rounded to the nearest 0.1 MPa, and
 - ii. $UCS_{7-upper}$ is the 7 day UCS corresponding to a 28 day UCS of 2.0 MPa and rounded to the nearest 0.1 MPa.
- i) The allowable working time for the material, determined in accordance with Clause 7.3.3, 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.

8 Construction

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 shall not commence until the Administrator has accepted the lightly bound pavement construction procedure and released Hold Point 1 as specified in Clause 5.2.

Unless otherwise approved by the Administrator, 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 and/or mix design prior to undertaking a subsequent trial.

8.2 Process requirements

8.2.1 Equipment

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 shall be carried out using a mechanically driven pugmill.

The mixing equipment shall:

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. produce plant-mixed lightly bound pavement materials complying with this Technical Specification
4. uniformly incorporate the stabilising agent and water into the unbound pavement materials
5. produce 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 directly 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

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

Lightly Bound Base

Unless nominated otherwise in Clause 1.1 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 lightly 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. In these instances, the Contractor shall document the paving equipment to be used and the proposed construction methodology in their Construction Procedure.

Where a paver is not required as per Clause 1.1 of Annexure MRTS10.1, the plant-mixed lightly bound base shall be constructed using a grader.

Lightly Bound Subbase

Lightly bound subbase shall be constructed by either using a paver (in accordance with the paving equipment requirements for lightly bound base) or with a grader, unless specified plant is nominated in Clause 1.2 of Annexure MRTS10.1.

Lightly Bound Improved Layers

The Contractor may choose to construct lightly bound improved layers using either a paver (in accordance with the paving equipment requirements for lightly bound base) or with a grader.

General

The Administrator may approve other methods of paving (for example, using small plant) in areas where the use of a paver or grader is not practical (for example, at turnouts or other isolated areas). In these instances, the Contractor shall document the paving equipment to be used and the proposed construction methodology in their Construction Procedure.

8.2.1.5 Equipment for water curing

The equipment used for water curing shall be able to discharge 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 leaching 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 prior to placing another layer of lightly bound layer shall include:

- a machine capable of roughening the surface of the layer

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

The equipment used for the general preparation of the surface shall include:

- a static three-point roller or pneumatic (multi-tyred) roller, and
- a machine capable of sweeping the surface.

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.

The following activities are not required to be completed in the allowable working time:

- cut-back of the surface prior to placing another lightly bound layer
- static rolling to prepare the surface for sealing, and
- proof rolling.

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 Q136A (refer Clause 7.3.3), 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, unless otherwise approved by the Administrator
- 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.

The default temperature requirements specified represent the preferred conditions to place lightly bound materials. When assessing a proposal to place lightly bound materials outside of these requirements the Administrator should consider the following:

- When the air temperature is greater than 40°C, the allowable working time may need to be reduced below the normal specification requirements.
- When the air temperature is less than 10°C, the material may take significantly longer to set-up requiring an extended time prior to being trafficked.

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 trafficked in accordance with requirements of Clause 8.2.11, 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 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, unless otherwise approved by the Administrator.

Constructing multiple layers in a single course to the same thickness is intended to promote uniformity of each layer. However, there may be circumstances where this requirement is not able to be satisfied, such as where kerb and channel is being constructed. In such instances the Administrator may allow this requirement to be relaxed.

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 (multi-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 that complies with Clause 8.3.8.

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 (within the same course or not), the finished surface shall be cut-back:

- after the completion of compaction, and
- within the same work shift as the material was placed unless otherwise approved by the Administrator.

Cutting back the surface shall uniformly roughen the surface across the full width of the layer. Scratching or marking the surface is not sufficient.

The Contractor will nominate in their Construction Procedure the proposed methodology to cut back the pavement. The cut back may be undertaken using a grader (with a straight blade, serrated blade or toothed blade), by heavy brooming or with other plant. The nominated cut back process should be assessed as part of the paving trial.

Where the construction process does not allow the lightly bound pavement layer to be cut back within the same work shift as the material was placed, the Administrator may approve the Contractor to delay the cut-back process provided the Contractor can demonstrate that their nominated process will achieve an acceptable surface. The longer a lightly bound material is left prior to cut-back, the more effort will be needed to cut back the surface and the more chance there is of damaging the pavement if inappropriate equipment is chosen (e.g. using a grader with straight blade to cut back cured lightly bound pavement).

Figure 8.2.8.2 – Example of acceptable cut-back surface



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.

Unless otherwise approved by the Administrator, lightly bound layers must not be covered with a sprayed seal (including a prime) within 48 hours of placement or rainfall.

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 otherwise specified in Clause 2 of Annexure MRTS10.1 or approved otherwise by the Administrator, lightly bound pavement layers shall not be opened to either construction traffic (other than needed to construct the lot) or general traffic until the lot has been tested for, and passes proof rolling in accordance with Clause 9.4.9.

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

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 (determined using Test Method Q134) 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 (Report Only)

The Contractor shall undertake testing to determine the UCS of lightly bound pavement materials during production, with the results reported to the Administrator for each lot.

Target production UCS requirements for the production of lightly bound pavement materials are specified in Table 8.3.3.

Table 8.3.3 – UCS reporting requirements

Pavement Type	Target Production UCS		Time for UCS Test	Compliance Requirement
	Minimum Value	Maximum Value		
Lightly Bound Improved Layer	1.0 MPa	2.0 MPa	7 days	Report Only
Lightly Bound Base & Lightly Bound Subbase	UCS _{7-lower} *	UCS _{7-upper} *	7 days	
	1.0 MPa	2.0 MPa	28 days	

* Refer to Clause 7.4.

UCS test results are to be reported for each lot as follows:

- 7 day UCS for Lightly Bound Improved Layers, and
- 7 and 28 day UCSs for Lightly Bound Bases and Subbases

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)	Where the layer has been cut back in accordance with Clause 8.2.8.2	± 15 mm
	All other layers	± 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 three 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 1.3 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 1.4 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 subbases and 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 of the lightly bound base 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.

8.3.8 Ball penetration

For lightly bound layers that are to be covered by a sprayed bituminous treatment, the surface shall have a maximum ball penetration value that complies with the requirements specified in Table 8.3.8.

Table 8.3.8 – Road roughness requirements for lightly bound bases

Property	Maximum Value
Ball Penetration	3 mm

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 determined using Test Method Q134 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.

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 186 tonnes
- the equivalent dry tonnage of unbound pavement material used would be 183 tonnes
- the average stabilising agent content is therefore 1.64%

Testing for mixing plant variability is not intended to assess the plant performance during production against the MPV nominated in the mix design process.

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 and Table A3 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.

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

Conformance testing for UCS 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 Q136A. 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 undertaken in accordance with Test Method Q723. 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.

Test Method Q723 provides a method for using either a 7,000 L single rear axle or 10,000 L tandem rear axle loaded water tanker for proof rolling.

9.4.10 Ball penetration

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 subbases and 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, and
- c) all test results 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 Control charts

For each lightly bound pavement lot, the Contractor shall submit control charts which show the following properties for that lot and all previous lots of the same lightly bound material produced under the Contract:

- Liquid limit
- Linear shrinkage
- UCS
- Stabilising agent content
- Actual moisture content (sampled at plant).

9.5.3 Mix design review

When more than five out of the most recent 20 (or less) production UCS test results are outside of the target limits specified in Table 8.3.3, the Contractor shall review the mix design, using the control charts, to validate that the intent of the mix design specified in Clause 7 is being achieved.

Within seven days of triggering this clause the Contractor shall submit a proposal, to the satisfaction of the Administrator, to:

- address the root cause, and
- bring the production UCS result back in line with the target requirements specified in Table 8.3.3.

In addition to the Administrator, on Transport and Main Roads projects the proposal shall be submitted to the Principal Engineer (Pavements and Materials Development) of the Transport and Main Roads, Engineering and Technology Branch.

When more than 12 of the most recent 40 (or less) production UCS test results are outside of the target limits specified in Table 8.3.3, the Contractor shall cease using the mix, revise the mix design (supported with testing as required), and resubmit the mix design report in accordance with Clause 7.4

Hold Point 6

Where the process control charts show production UCSs trending towards the lower or upper side of the target range, the Contractor should increase or decrease the nominated target content of stabilising agent.

Where the nominated target content of stabilising agent needs to be decreased, but the required target content cannot be effectively blended, the Contractor should revise the mix design to use an alternative stabilising agent.

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	Lot Size	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	–	Before use and then at 12 month intervals			
Conductivity (water)	APHA 2510-B					
Sulphate content (water)	AS 1289.4.2.1#					
Stabilising Agent Content (heat of neutralisation)	Q134	≤ 100 t	–	1 per lot	–	1 per lot
		> 100 t	1 per 300t	2 per lot	1 per 500t	2 per lot
Stabilising Agent Content (mixing plant variability)	Refer Clause 9.4.6	Any	–	1 per lot	–	1 per lot
Moisture Content (sampled at plant)	AS 1289.2.1.1, AS 1289.2.1.4 or AS 1289.2.1.6	≤ 100 t	–	1 per lot	–	1 per lot
		> 100 t	1 per 300t	2 per lot	1 per 500t	2 per lot
	AS 1289.2.3.1	–	1 per material type if subsidiary methods used			
Unconfined Compressive Strength (7 day) (all materials)	Q115	≤ 200 t	–	–	–	–
Unconfined Compressive Strength (28 day) (lightly bound base and lightly bound subbase only)		> 200 t	1 per 1000t*	1 per lot	1 per 1000t*	1 per lot

Notes:

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

Or other published or validated classical chemistry technique or instrumentation technique.

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)			
Moisture Content (sampled in field prior to compaction)	AS 1289.2.1.1, AS 1289.2.1.4 or AS 1289.2.1.6	1 per 500 m ²	4 per lot	1 per 1000 m ²	4 per lot
	AS 1289.2.3.1	1 per material type if subsidiary methods used			
Compaction	Q140A	1 per 500 m ²	4 per lot	1 per 1000 m ²	4 per lot
Proof Rolling	Q723	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