Technical Specification

MRTS05 Unbound Pavements

March 2022

Queensland Government

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1 Introduction

This Technical Specification applies to the supply and construction of unbound granular pavements. Material from natural, quarried and recycled sources, or a combination of these, can all be used.

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.

The requirements of this Technical Specification are designed to provide a high probability of a satisfactory pavement being produced. However, it is acknowledged that alternative or supplementary requirements specific to local conditions and the known performance of local materials may be incorporated through project-specific supplementary requirements.

This Technical Specification assumes that the pavement is not excessively exposed to water and that protective measures are taken to assure this. Where exposure to moisture is expected, additional controls over and above the requirements of this Technical Specification may be warranted or the use of bound pavement materials should be considered in the pavement design.

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
acid igneous rock	An igneous rock containing more than 65% SiO2 typically consisting of quartz, feldspar, biotite. Includes Rhyolite, Rhyodacite, Dacite, Tuffs (of same composition), Granite, Adamellite and Granodiorite.
adamellite	A granitoid igneous rock consisting of between 5% to 20% quartz and with alkali feldspar representing between 33% and 66% of the total feldspar. Typical mafic minerals are hornblende and biotite.
base	A course or courses principally intended to directly support the traffic loads.
basic igneous rock	An igneous rock containing between 44% and 54% SiO2 typically consisting of plagioclase, pyroxene, olivine and quartz free. Includes Basalt, Dolerite and Gabbro.
brick	A block of clay hardened in a kiln and suitable for use under the Building Code of Australia as a building material in domestic housing or industrial building construction. Recycled bricks may have mortar attached.
coarse component	The fraction of the material which does not pass the 0.425 mm test sieve.
duricrust	A layer formed on the surface of rock or soil by the natural accumulation of silica, calcium or iron oxides resulting in the formation of a hard rock like layer. Includes Silcrete, Calcrete and Ferricrete.
fines component	The fraction of the material passing the 0.425 mm test sieve.

Term	Definition
fines ratio	The ratio of the percentage of the material passing the 0.075 mm test sieve and the percentage of the material passing the 0.425 mm test sieve.
Intelligent Construction (IC) Roller	A single (smooth) drum roller that incorporates equipment to measure the stiffness of compacted layers, while simultaneously tracking the position and number of passes using a global positioning system (GPS). Stiffness, position and coverage results are displayed in real time to the plant operator and the data can be exported to provide a complete record of compaction and undertake further analysis with Veta.
intermediate igneous rock	An igneous rock containing between 54% and 65% SiO2 typically consisting of plagioclase, amphibole, pyroxene and nil or minor quartz. Including Trachyte, Trachyandesite, Andesite, Tuffs (of same composition), Syenite and Diorite.
marine water	Water derived from an oceanic source or a source directly attached to an oceanic source and subject to tidal influences.
material group	A unique category selected on the basis of material classification, geological processes and material properties. Materials of one group may grade into another in the one quarry site, however each source will be classified based on the predominant material group.
metamorphic rock	A rock derived from a pre-existing rock by mineralogical, or structural changes in response to changes in the temperature and/or pressure. Including Hornfels, Quartzite, Metagreywacke, Greenstone, Slate and Amphibolite.
natural gravel or natural material	Naturally occurring granular alluvial, colluvial or residual deposits. Natural material may be used as a supplementary material, as an unbound material in its own right, or blended with recycled materials to produce an unbound granular pavement material.
pavement	The portion of the road placed above the subgrade for the support of, and to form a running surface for, vehicular traffic.
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. When used in relation to Transport and Main Roads quarry registration system, a quarry may also include a material recycler.
Reclaimed asphalt pavement (RAP)	Asphalt that has been milled or excavated from existing pavements, or unused asphalt returned from job sites. RAP used in unbound pavement material may also contain a small proportion of other materials (such as granular material or subgrade) that is picked up during milling or excavation.
Recycled brick	Brick that is crushed and processed for use as an aggregate. Recycled bricks may have mortar attached.
Recycled concrete	Concrete that is crushed and processed for use as an aggregate. May include construction and demolition waste, concrete washout or returned concrete.
Recycled glass	Glass that is crushed and processed into an aggregate and complies with MRTS36 *Recycled Glass Aggregate.*
Recycled material	Recycled concrete, brick, glass or RAP that complies with the requirements of this specification.

Term	Definition
Recycled material blend	A granular material blend produced from the crushing and/or processing of recycled materials within the proportions permitted by this Technical Specification. A recycled material blend contains a minimum of 70% (by mass) recycled materials and may contain up to 30% (by mass) of natural or quarried material.
sedimentary rocks	A rock formed from loose sediments or by biological activity which have, via the process of lithification been transformed into rock. Including Limestone, Mudstone, Sandstone, Arenite, Chert.
subbase course	A course or courses principally intended to distribute to the subgrade the loads from overlying course(s).
supplementary material	A generally fine-grained material which is blended into an unbound material, at a low concentration, to adjust the grading and/or plastic properties to ensure specification compliance. Supplementary materials shall be sourced from a registered site, but does not necessarily need to be sourced from the quarry providing the bulk of the material.
surfacing	The upper layer of the pavement which is directly trafficked (e.g. a sprayed bituminous treatment or asphalt surfacing).
Veta	A map-based software tool for Contractors and Administrators to standardise, display, analyse and report data collected by intelligent compaction (IC) and paver-mounted thermal profiling (PMTP) technologies during construction. Veta can import data from various IC machines and PMTP to perform editing, filtering, spot test correlation, and statistical analysis as a post-processing tool.

3 Referenced documents

The requirements of the referenced documents listed in Table 3 below apply to this Technical Specification. Where there are inconsistencies between this Technical Specification and the referenced documents, the requirements specified in this Technical Specification shall take precedence.

Table 3 – Referenced documents

Reference	Title
MRTS01	*Introduction to Technical Specifications*
MRTS36	*Recycled Glass Aggregate*
MRTS50	*Specific Quality System Requirements*
MRTS51	*Environmental Management*
MRTS56	*Construction Surveying*
MTM	*Materials Testing Manual*, Transport and Main Roads
Pavement Design Supplement	*Pavement Design Supplement*, Transport and Main Roads
Quarry Registration System QRS1 to QRS6	*Quarry Registration System,* Transport and Main Roads
TN140	*Source Material Assessment for Subtype 2.5, Subtype 3.5 and Type 4 Unbound Pavement Materials*
TN171	*Use of High Standard Granular (HSG) Bases in Heavy Duty Unbound Granular Pavements*

4 Standard test methods

The standard test methods specified in Table 4 are referenced in this Technical Specification.

Further details of test numbers and test descriptions are detailed in the *Materials Testing Manual* (MTM) and in Clause 4 of MRTS01 *Introduction to Technical Specifications*.

Table 4 – Standard test methods

Property to be Tested	Method No.
Ball penetration	AG:PT/T251
Calculation of characteristic value of a lot	Q020
California bearing ratio	Q113A, Q113C
Conductivity (water)	APHA 2510-B
Crushed particles	AS 1141.18
Degradation factor	Q208B
Degree of saturation	Q146
Deviation from a three-metre straight edge	Q712
Dry strength	AS 1141.22
Flakiness index	Q201
Foreign materials	Q477
Light particles (%)	AS 1141.31
Linear shrinkage, Weighted linear shrinkage	Q106
Liquid limit	Q104A
Moisture content	AS 1289.2.1.1, AS 1289.2.1.4, AS 1289.2.1.6, Q141A
Organic content (%)	Q120B
Particle size distribution and fines ratio	Q103A
Permanent deformation and resilient modulus	Q137
Petrographic assessment of aggregates	Q188
pH (water)	APHA 4500-H B
pH (Type 2 material containing recycled concrete)	AS 1289.4.3.1
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 and testing location	Q050
Spot sampling of soils, crushed rock and aggregate	Q061
Texture depth	AG:PT/T250

Property to be Tested	Method No.
Unconfined compressive strength	Q115
Water absorption	AS 1141.6.1
Wet strength	AS 1141.22
Wet / dry strength variation	AS 1141.22

4.1 Supplementary requirements for Test Method Q113A and Q113C

4.1.1 Q113A

No California Bearing Ratio (CBR) testing is required for materials that are to be compacted to 100% modified compaction.

Where CBR testing using standard compaction is required, the test result shall be reported at the maximum dry density and optimum moisture content as defined by the relevant test method.

4.1.2 Q113C

For Type 4 materials where a moisture content other than OMC is specified in Clause 2.3.2 of Annexure MRTS05.1, the CBR shall be determined from one single-point test, in accordance with Test Method Q113C.

This test shall be carried out at the maximum dry density of the material and at the relative moisture content specified in Clause 2.2.2 of Annexure MRTS05.1.

Where a soaked CBR is specified, the soaking period shall be four days unless otherwise nominated in the design documents.

4.2 Supplementary requirements for Test Method Q115

Unconfined compressive strength testing shall be undertaken at the optimum moisture content and maximum dry density determined using standard compaction.

4.3 Supplementary requirements for Test Method AS 1141.22

The Wet Strength and the Wet / Dry Strength Variation tests shall both be carried out on the fraction of the coarse component passing the 13.2 mm test sieve, but retained on the 9.5 mm test sieve.

The wet strength and the wet / dry strength variation tests must not be undertaken on other fractions.

The Wet Strength and the Wet / Dry Strength Variation tests are known to be sensitive to the fraction size tested.

Generally:

- the apparent wet strength will increase as the size of the fraction tested decreases, and
- the wet / dry strength variation will decrease as the size of the fraction tested decreases.

As such a standard particle size range is tested even if this constitutes only a small proportion of the material.

5 Quality system requirements

5.1 Hold Points, Witness Points and Milestones

General requirements for Hold Points, Witness Points and Milestones are stated 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	1. Acceptance of Construction Procedures for unbound pavement Works		
5.2.2			Submit Construction Procedure for aggregate production (seven days)
5.2.3			Submit Construction Procedure for unbound pavement construction (14 days)
6.1	2. Use of quarry or source		
6.2			Submit Quarry Registration Certificate (seven days)
6.3			Submit Source Material Report (seven days)
8.2	3. Demonstration of ability to manufacture and construct conforming pavement	1. Construction of Trial Pavement	
8.3.4.1	4. Increase DoS limit – Type 1 materials		
9.1	5. Demonstration of compliance prior to incorporation into pavement		
9.4.7		2. Proof Rolling	
9.5.1	6. Covering a pavement layer		

5.2 Construction procedures

5.2.1 General

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

No unbound pavement Works shall commence until all relevant construction procedures have been accepted by the Administrator. **Hold Point 1**

5.2.2 Material production procedure

For each supplier that will provide material to be used in the Works, the Contractor shall prepare a construction procedure for material production and detail the following for each subtype (or Type 1):

a) for natural gravel and quarried materials – the area (for example, face number, bench number and reduced level) of the quarry from which the material will be won

b) for recycled materials – procedures used to manage the source materials, including:

   i. how source material deliveries are inspected at the point of entry and during tipping

   ii. records that are kept for each delivery

   iii. sorting and stockpiling of source materials

   iv. selection of source material from feed stockpiles, and

   v. detection, management and removal of contaminants and excess foreign materials.

c) production process to be used including methods of winning / sourcing, crushing and blending the material

d) procedures for stockpile management and traceability as part of lot control and, as applicable, stockpile sub-lot control, and

e) quality control procedures.

The Material Production Procedures shall be submitted to the Administrator at least seven days prior to the commencement of material production for the Works. **Milestone**

5.2.3 Unbound pavement construction procedure

For unbound pavement materials to be used in the Works, the Contactor shall prepare a Construction Procedure, which details at least the following:

a) details of all plant associated with the Works, including the proposed paving plant (refer Clause 8.3.1)

b) details for all aspects of the pavement works, including:

   i. location of and management processes for stockpiles

   ii. location of unbound pavement material production / processing and logistics for operation of and the transport of materials from this location

   iii. the lengths and widths of each paving run

   iv. the location and detail of joints required between each paving run

   v. procedures for joint preparation

   vi. procedures for the transport, placement, compaction and trimming of the pavement material

   vii. 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)

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 and equipment proposed for proof rolling pavement layers

x. procedures and equipment to cut-back Type 1 layers prior to placing the next layer (refer Clause 8.3.1.2 and Clause 8.3.5.2) if applicable, and

xi. procedure and equipment to prepare the surface prior to sealing (refer Clause 8.3.1.2 and Clause 8.3.5.1).

c) process to provide traceability of unbound pavement materials from source through to material incorporated into the final pavement.

Where multiple unbound pavement materials are to be incorporated into the Works, the Contractor may prepare a single procedure provided that any differences in construction process for each material are clearly detailed.

The Unbound Pavement Construction Procedure shall be submitted to the Administrator at least 14 days prior to the commencement of unbound pavement Works. **Milestone**

6 Supplier registration and source material assessment

6.1 General

The written permission of the Administrator is required prior to material being supplied to or used in the Works from any source. **Hold Point 2**

6.2 Type 1, Type 2 and Type 3 (excluding Subtypes 2.5 and 3.5)

Type 1, Type 2 and Type 3 materials (including those sourced from recycled materials, but excluding Subtype 2.5 and Subtype 3.5) shall be provided by a supplier registered and operated in accordance with the Transport and Main Roads Quarry Registration System requirements. The supplier must be registered to supply the appropriate material subtype.

The coarse component shall be manufactured from source material from a supplier which has a current Transport and Main Roads Quarry Registration Certificate. Suppliers producing Type 2 materials containing more than 30% recycled materials, shall be registered as a Recycled Material Site in accordance with the Transport and Main Roads Quarry Registration System.

Supplementary material can be imported for use in these materials, provided it is also from a source registered and operated in accordance with the Transport and Main Roads Quarry Registration System requirements.

The current Transport and Main Roads Quarry Registration Certificates for all sources (including natural, quarried and recycled materials), shall be submitted to the Administrator at least seven days before a material's supply or use. **Milestone**

6.3 Subtype 2.5, Subtype 3.5 and Type 4

Subtypes 2.5, 3.5 and Type 4 materials may be provided from a supplier registered under the Transport and Main Roads Quarry Registration System in accordance with the requirements of Clause 6.

Where a Subtype 2.5, 3.5 or Type 4 material is not sourced from a supplier registered under the Transport and Main Roads Quarry Registration System, a source material assessment shall be undertaken in accordance with TN140 *Source Material Assessment for Subtype 2.5, Subtype 3.5 and Type 4 Unbound Pavement Materials* for the material source from which the Subtype 2.5, Subtype 3.5 or Type 4 unbound pavement material is to be supplied. A copy of the Source Material Assessment Report shall be submitted to the Administrator at least seven days before supply or use. **Milestone**

6.4 Supplementary material

Supplementary materials shall be supplied from a source registered and operated in accordance with the Transport and Main Roads Quarry Registration System requirements.

7 Material

Unbound pavement materials specified in accordance with this Technical Specification have the following attributes:

Type 1 – High Standard Granular (HSG)

- A premium unbound granular pavement material, for use in the base course of heavy duty unbound pavements to produce a hard, durable and uniform material that enables a dense and homogeneous pavement to be constructed.
- Typically covered with a sprayed bituminous treatment or thin asphalt surfacing.
- Relies principally on the mobilisation of internal frictional forces to resist the applied load.
- Potentially highly permeable. Requires protection from moisture as soon as possible after construction. Will deteriorate rapidly if the surfacing fails.
- Permeability is reduced by specifying a higher minimum linear shrinkage requirement.
- A high compaction standard specified to provide some reduction in permeability as well as increased stiffness.
- Type 1 materials typically have a very low unconfined strength. Consequently, a single coat seal may not provide adequate confinement, particularly under heavy traffic and at least a double / double polymer modified seal or asphalt surfacing should be applied.
- Must not be subject to traffic without a surfacing and should be subject to traffic only for a very short period of time, if it is covered by a prime only.
- No direct strength test (CBR) is specified as optimum property limits are specified.
- Because of the extensive range of properties chosen to specify this material and because optimum property limits have been specified, Type 1 materials provide the highest probability of obtaining a consistently high-quality pavement material.
- Further information regarding the use of Type 1 (HSG) pavements materials is provided in TN171 *Use of High Standard Granular (HSG) Bases in Heavy Duty Unbound Granular Pavements.*

Type 2 – Standard Material

- A high quality unbound granular pavement material, for use in base, subbase and lower pavement layers.
- Relies principally on the mobilisation of internal frictional forces and/or cohesion to resist the applied load.
- If a sprayed bituminous treatment or asphalt surfacing is not provided, consideration should be given to specifying a higher minimum linear shrinkage requirement.
- To comply with the CBR requirements (where specified), the Contractor may have to apply more stringent target properties to the material within the limits given in this Technical Specification.
- Commonly used in wet environments, hence the requirement for a soaked CBR (where specified) and more stringent durability requirements (compared to Type 3 materials).
- Type 2 material may be produced from either natural, quarried or recycled material.

Type 3 – Standard Material

- Attributes are as per Type 2, except intended for use in relatively dry environments, only where the pavement equilibrium moisture content is low, hence the requirement for an unsoaked CBR (where specified). Similarly, only the wet strength and the flakiness index properties for the coarse component are specified and the fines standards are less stringent than the values specified for Type 2 materials.
- Type 2 material of the same subtype produced from either natural, quarried or recycled material may be used where a Type 3 material is specified.

Type 4 – Non-standard material

- Relies principally on cohesion, but may also utilise the mobilisation of internal frictional forces to resist the applied load.
- The only default property specified for Type 4 materials is unsoaked CBR, to provide a hierarchy of the respective subtypes.
- To utilise a Type 4 material, the designer must develop the standards and requirements relevant to the particular material and include these in Annexure MRTS05.1.
- The use of a standard Type 2 or Type 3 material may not be suitable where a Type 4 material has been specified.

Typical applications for each material subtype are given in the Transport and Main Roads *Pavement Design Supplement*.

7.1 Type 1 unbound material – High Standard Granular (HSG)

7.1.1 General

Type 1 (HSG) material shall be hard, sound, durable and not breakdown in service.

The locations in which Type 1 (HSG) material is to be used, shall be shown in the design documentation or specified in Clause 2.1 of Annexure MRTS05.1.

When properly constructed, a Type 1 (HSG) base provides a dense, relatively low-permeability structural layer, with increased durability. The Type 1 (HSG) requirements of this Technical Specification are based on historically specified Subtype 1.1 materials, modified to help ensure that this higher standard of pavement is able to be consistently achieved.

The use of Type 1 (HSG) materials in accordance with this Technical Specification has a number of specific requirements, including:

- material properties as specified in this Clause
- use of specific paving equipment and tighter process controls for adding moisture
- tighter controls on layer thickness and DoS
- texturing of the surface between layers, and
- checking of post-compaction gradings and assessment of compaction using modified compaction.

7.1.2 Coarse component

The coarse component properties for Type 1 (HSG) materials are specified in Table 7.1.2.

Table 7.1.2 – Coarse component properties – Type 1 (HSG)

Property	Material Group†			
	Acid Igneous	**Basic Igneous**	**Intermediate Igneous and Metamorphic**	**Sedimentary Duricrust**
Wet strength (kN)	≥ 130‡ *	≥ 150‡	≥ 140‡	≥ 130‡
Wet / Dry strength variation (%)	≤ 40‡	≤ 30‡	≤ 35‡	≤ 40‡
Degradation factor	≥ 40	≥ 50	≥ 45	–
Flakiness index (%)	≤ 35	≤ 35	≤ 35	≤ 35
Crushed particles (%)	≥ 70	≥ 70	≥ 70	≥ 70
Water absorption (%)	≤ 2.0	≤ 2.0	≤ 2.0	≤ 2.0

† Materials are to be classified into a material group on the basis of the lithology of the major granular component, except where two or more components each constitute over 30% of the total, then the most stringent properties of these materials group shall be applied.

‡ If the material does not comply with the specified maximum Wet / Dry strength variation limits, the Wet / Dry strength variation requirement may be waived if the Wet Strength is at least 60 kN above the relevant specified minimum value.

* For Adamellite source material only (Acid Igneous Group), the minimum Wet Strength shall be 115 kN.

Material tests are specified to assess the following properties:

- Wet Strength: strength.
- Wet / Dry Strength variation: indirect measure of durability.
- Degradation factor: indirect measure of durability by measuring the amount of secondary minerals in the aggregate.
- Crushed particles: indirect measure of aggregate surface roughness that generates internal friction. This property is particularly important for Type 1 (HSG) materials. For material manufactured exclusively from crushed quarry products, the Administrator may elect to waive the requirement to test for this property.
- Flakiness index: measures the amount of aggregate particles that are elongated and/or flat. 'Flaky' particles reduce workability and are prone to breakdown during compaction and in service.
- Water absorption: a complementary test to degradation factor to assess material durability. Also specified as a way of controlling the amount of moisture that aggregates can absorb during construction, which may later be released as pore water and lead to DoS issues.

7.1.3 Fines component

The fines component of Type 1 (HSG) material shall comply with the properties as specified in Table 7.1.3.

Table 7.1.3 – Fines component properties – Type 1 (HSG)

Property	Value
Liquid Limit	≤ 25
Linear Shrinkage (%)	1.5 – 3.5

Linear Shrinkage (LS) limits are specified for Type 1 (HSG) materials to control the content of plastic (that is, clay) materials. In Type 1 (HSG) materials, which are materials designed to carry load primarily through internal frictional forces (particle interlock), excess clay must be controlled as this may lead to a potential loss of stability of the material, due to the softening of the clay component from wetting up of the pavements.

Minimum LS limits are specified to enhance the performance of these unbound pavement materials by improving workability, providing some degree of cohesion and reducing permeability.

7.1.4 Particle size distribution (grading)

The particle size distribution requirement is specified in Table 7.1.4(a). The Contractor shall aim to produce material conforming to the target grading. The maximum and minimum limits define an acceptable zone of departure from this target grading for any sample taken prior to the construction of the pavement layer.

Table 7.1.4(a) – Grading – Type 1 (HSG)

Test Sieve Size (mm)	Percent Passing by Mass		
	Target	Minimum	Maximum
37.5	100	100	100
26.5	100	100	100
19.0	100	95	100
13.2	85	78	92
9.5	73	63	83
4.75	54	44	64
2.36	39	30	48
0.425	18	14	22
0.075	9	7	11

In addition to the requirements for particle size distribution specified in Table 7.1.4(a), the fines ratio shall be between the limits specified in Table 7.1.4(b).

Table 7.1.4(b) – Ratio of 0.075 mm material to 0.425 mm material – Type 1 (HSG)

Material	Fines Ratio
Type 1	0.3 – 0.55

The fines ratio can be related to unbound pavement material performance as follows:

- higher ratio – leads to a reduction in stability and strength, and
- lower ratio – increases permeability, leads to poorer surface finish and reduces surface stability.

7.2 Type 2 unbound material

7.2.1 General

Type 2 materials may be produced from either natural gravel, quarried or recycled materials (or combination of these).

The allowable constituents for each subtype are given in Table 7.2.1(a).

Table 7.2.1(a) – Constituents in Type 2 materials

Subtype	Maximum Limit of each Constituent (percent by mass)				
	Natural gravel or quarried material	Recycled materials			
		Recycled concrete	RAP	Recycled brick	Recycled glass ^
2.1	100	100	0	0	0
2.2	100		15	15	0
2.3	100		20	20	20
2.4	100			45	
2.5	100		45		

^ Recycled glass shall comply with the requirements of MRTS36 *Recycled Glass Aggregate*.

In addition to the requirements for allowable constituents specified in Table 7.2.1(a), Type 2 materials are classified into two categories as specified in Table 7.2.1(b).

Table 7.2.1(b) – Material categories of Type 2 materials

Material category	Limit of Constituents (percent by mass)	
	Natural gravel or quarried material	Recycled materials
General material	> 30%	< 70%
Recycled material blend	≤ 30%	≥ 70%

Where applicable, different requirements have been specified for general materials (which contain < 70% recycled materials) and recycled material blends (which contain ≥ 70% recycled materials).

For any requirement where no distinction is made between general materials and recycled material blends, the requirements shall apply to both.

Recycled materials may be used in base layers when:

- the average daily traffic in the design lane in year of opening is less than 500 Equivalent Standard Axles (ESAs), (the average daily traffic in the design lane in year of opening is given in Clause 2.2 of Annexure MRTS05.1), and
- an asphalt surfacing is provided over the base.

There are no restrictions to the use of recycled materials in other applications, for example non-trafficked shoulders, sub-bases, improved layers, or subgrade treatments.

Transport and Main Roads supports the use of recycled materials based on their highest and best use. The reuse of RAP in asphalt maximises the value of its high quality aggregates and residual binder.

Where RAP is not suitable for reuse in asphalt (for example, other material has been mixed with it during removal or handling) this second class material may be recycled by incorporating it into unbound pavement materials.

The locations in which material of a specific subtype is to be used, shall be shown in the design documentation or specified in Clause 2.1 of Annexure MRTS05.1.

7.2.2 Coarse component

The coarse component properties for Type 2 material are specified in Table 7.2.2.

Table 7.2.2(a) – Coarse component properties – Type 2

Property	Subtype	Material Group‡				
		Acid Igneous	**Basic Igneous**	**Intermediate Igneous and Metamorphic**	**Sedimentary Duricrust**	**Recycled Material Blend**
Wet strength (kN)	2.1 2.2 2.3 2.4 2.5	≥ 115† ≥ 100† ≥ 85† ≥ 70† –	≥ 135† ≥ 115† ≥ 100† ≥ 85† –	≥ 125† ≥ 105† ≥ 90† ≥ 80† –	≥ 115† ≥ 100† ≥ 85† ≥ 70† –	≥ 85 ≥ 85 ≥ 70 ≥ 70 –
Wet / Dry strength variation (%)	2.1 2.2 2.3 2.4 2.5	≤ 40† ≤ 40† ≤ 45† ≤ 45† –	≤ 30† ≤ 30† ≤ 35† ≤ 35† –	≤ 35† ≤ 35† ≤ 40† ≤ 40† –	≤ 40† ≤ 40† ≤ 45† ≤ 45† –	≤ 35 ≤ 40 ≤ 40 ≤ 45 –
Degradation factor	2.1, 2.2 2.3, 2.4 2.5	≥ 40 ≥ 30 –	≥ 50 ≥ 40 –	≥ 45 ≥ 35 –	–	–
Flakiness index (%)	2.1, 2.2 2.3, 2.4 2.5	≤ 35 ≤ 40 –	≤ 35 ≤ 40 –	≤ 35 ≤ 40 –	≤ 35 ≤ 40 –	≤ 35 ≤ 40 –
Water absorption (%)	2.1, 2.2 2.3, 2.4 2.5	≤ 2.0 ≤ 2.5 –	≤ 2.0* ≤ 2.5* –	≤ 2.0 ≤ 2.5 –	≤ 2.0 ≤ 2.5 –	–

‡ Materials are to be classified into a material group on the basis of the lithology of the major granular component unless, where two components each constitute over 30% of the total, then the most stringent properties of either materials group for that subtype shall be applied.

† If the material does not comply with the specified maximum Wet / Dry Strength Variation limits, the Wet / Dry strength variation requirement may be waived if the Wet Strength is at least 60 kN above the relevant specified minimum value.

* Where the Transport and Main Roads Quarry Registration Certificate states the rock / material type is 'undersaturated glassy basalt' or
'oversaturated glassy basalt', the water absorption values specified in Table 7.2.2(b) shall apply.

Table 7.2.2(b) – Water absorption values for Glassy Basalts

Property	Subtype	Undersaturated Glassy Basalt	Oversaturated Glassy Basalt
Water absorption (%)	2.1 & 2.2 2.3 & 2.4	≤ 3.0 ≤ 3.5	≤ 4.0 ≤ 4.5

Material tests are specified to assess the following properties:

- Wet Strength: strength.
- Wet / Dry Strength Variation: indirect measure of durability.
- Degradation factor: indirect measure of durability by measuring the amount of secondary minerals in the aggregate.
- Flakiness index: measures the amount of aggregate particles that are elongated and/or flat. 'Flaky' particles reduce workability and are prone to breakdown during compaction and in service.
- Water absorption: a complementary test to degradation factor to assess material durability. Also specified as a way of controlling the amount of moisture that aggregates can absorb during construction, which may later be released as pore water and lead to DoS issues.

7.2.3 Fines component

The fines component properties for Type 2 material are specified in Table 7.2.3(a) and Table 7.2.3(b).

Table 7.2.3(a) – Fines component properties – Type 2 – General Materials (containing < 70% recycled materials)

Property	Subtype				
	2.1	**2.2**	**2.3**	**2.4**	**2.5**
Liquid Limit (LL) (%)	≤ 25 *	≤ 25 *	≤ 28 *	≤ 35	≤ 40
Linear Shrinkage (LS) (%)	1.0 – 3.5	1.0 – 3.5	1.5 – 4.5	1.5 – 6.5	1.5 – 7.5
Weighted Linear Shrinkage (WLS)	≤ 85	≤ 85	≤ 110	≤ 195	–

* Where the Transport and Main Roads Quarry Registration Certificate states that the rock / material type is 'oversaturated glassy basalt', the following Liquid Limit values shall apply:

– Subtype 2.1 & 2.2 materials, LL ≤ 28%

– Subtype 2.3 materials, LL ≤ 30%

Table 7.2.3(b) – Fines component properties – Type 2 Recycled Material Blends (containing ≥ 70% recycled materials)

Property	Subtype				
	2.1	**2.2**	**2.3**	**2.4**	**2.5**
Liquid Limit (LL) (%)	≤ 35	≤ 35	≤ 35	≤ 40	≤ 40
Linear Shrinkage (LS) (%)	1.0 – 3.5	1.0 – 3.5	1.5 – 4.5	1.5 – 6.5	1.5 – 7.5
Weighted Linear Shrinkage (WLS)	≤ 85	≤ 85	≤ 110	≤ 195	–

7.2.4 Particle size distribution (grading)

The grading envelopes for Type 2 materials are specified in Table 7.2.4(a) and Table 7.2.4(b).

Table 7.2.4(a) – Grading envelopes – Type 2 – General Materials (containing < 70% recycled materials)

Subtypes	2.1 and 2.2	2.3 and 2.4	2.5
Test Sieve Size (mm)	**Percent Passing by Mass**		
75.0	100	100	100
37.5	100	90 – 100	85 – 100
19.0	87 – 100	80 – 100	–
9.5	67 – 87	60 – 90	55 – 95
4.75	50 – 70	42 – 76	–
2.36	36 – 52	30 – 60	30 – 80
0.425	14 – 24	14 – 28	14 – 60
0.075	7 – 16	7 – 16	7 – 30

Table 7.2.4(b) – Grading envelopes – Type 2 – Recycled Material Blends (containing ≥ 70% recycled materials)

Subtypes	2.1 and 2.2	2.3 and 2.4	2.5
Test Sieve Size (mm)	**Percent Passing by Mass**		
26.5	100	100	100
19.0	95 – 100	95 – 100	84 – 100
13.2	78 – 92	75 – 95	69 – 95
9.5	63 – 83	60 – 90	56 – 90
4.75	44 – 64	42 – 76	37 – 77
2.36	30 – 48	28 – 60	23 – 63
0.425	13 – 21	10 – 28	8 – 30
0.075	5 – 11	3 – 11	2 – 14

In addition to the requirements of Table 7.2.4(a) and Table 7.2.4(b), the grading curve for the material shall be smooth. For Subtype 2.5, the grading between adjacent sieves, shall not vary from one outer third of the grading limits of one sieve to the opposite outer third of the grading limits of the next sieve.

The specified gradings reflect the typical applications that each material subtype will be used in as per the Transport and Main Roads *Pavement Design Supplement*. For example:

- 2.1 and 2.2 materials are typically used in base courses.
- 2.3 and 2.4 materials are typically used in subbase courses, and
- 2.5 materials are typically used in lower subbases or subgrade.

Where a materials subtype is to be used in a different application, the designer may choose to specify an alternative grading.

7.2.5 California bearing ratio

The California Bearing Ratio requirements for Type 2 material are specified in Table 7.2.5.

Table 7.2.5 – California bearing ratio requirements – Type 2

Property	Subtype						
	2.1		2.2		2.3	2.4	2.5
Compaction standard (refer Clause 8.4.3)	Modified	Standard	Modified	Standard	Standard	Standard	Standard
CBR (4 day soaked)	Not specified	≥ 80	Not specified	≥ 60	≥ 45	≥ 35	≥ 15

Where specified, the strength of Type 2 material is principally assessed by the soaked California Bearing Ratio (CBR) test. To consistently comply with all of the relevant specification requirements, it may be necessary for the Contractor to develop a set of secondary requirements which comply with the list of primary requirements specified in Clauses 7.2.3 and 7.2.4 but, where necessary, are more stringent so that the specified CBR is achieved.

Where unbound materials conform with the coarse and fine material requirements of this Technical Specification and are compacted to 100% modified compaction or greater, experience has shown that the necessary CBR limit is readily achievable. As a result, the Technical Specification does not require CBR testing for materials where 100% modified compaction is both specified and achieved during construction and all other material properties are conforming.

7.2.6 Type 2 materials containing Recycled materials

7.2.6.1 pH

Where the recycled material blend is to be in direct contact with galvanised or aluminium components, the pH value of the recycled material blend shall comply with the requirements specified in Table 7.2.6.1.

Alternatively, the components shall be adequately protected from contact with the material to the satisfaction of the Administrator.

Table 7.2.6.1 – pH of Type 2 material containing recycled concrete in direct contact with galvanised or aluminium components

Property	Maximum Value
pH	11

7.2.6.2 Unconfined Compressive Strength

Where a subtype includes recycled concrete, the Unconfined Compressive Strength (UCS) of the combined material shall comply with the requirements specified in Table 7.2.6.2.

Table 7.2.6.2 – Unconfined compressive strength of Type 2 material containing recycled concrete

Property	Maximum Value	Time for UCS Test
UCS	0.7 MPa	7 days

7.2.6.3 Foreign Material

Unless otherwise approved by the Administrator, where a subtype includes recycled materials, the foreign material shall comply with the limits specified in Table 7.2.6.3.

Table 7.2.6.3 – Limits of foreign materials in Type 2 material containing recycled materials

Foreign Material	Test Method	Subtype	Maximum Percent in Mix (% by Mass)
Brick	Q477	2.1	1
Asphalt		2.1	1
Metal, ceramics and slag (other than blast furnace slag)		All	3
Plaster, clay lumps and other friable material		All	1
Rubber, plastic, bitumen not part of asphalt, paper, cloth, paint, wood and other vegetable matter		All	0.2
Asbestos	Not permitted		

The Administrator may consider relaxing the requirement for foreign material testing where the source of the recycled material is very well controlled. For example concrete washout / returned concrete that is sent directly from a concrete batch plant to a quarry for blending with natural or quarried material.

This requirement should not be waived where the recycled material is sourced from any construction and demolition waste.

7.3 Type 3 unbound material

7.3.1 General

The locations in which material of a specific subtype is to be used shall be shown in the design documentation or specified in Clause 2.1 of Annexure MRTS05.1.

Where a Type 3 material is specified, a Type 2 material of the same subtype may be used in its place.

The requirements for a Type 2 recycled material blend are also suitable for use as a Type 3 material.

7.3.2 Coarse component

The coarse component properties for Type 3 material are specified in Table 7.3.2.

Table 7.3.2 – Coarse component properties – Type 3

Property	Subtype	Material Group ‡			
		Acid Igneous	**Basic Igneous**	**Intermediate Igneous and Metamorphic**	**Sedimentary Duricrust**
Wet strength (kN)	3.1	≥ 100	≥ 115	≥ 105	≥ 100
	3.2	≥ 80 ‡	≥ 95	≥ 90‡	≥ 80‡
	3.3	≥ 70 ‡	≥ 85‡	≥ 80‡	≥ 70‡
	3.4	≥ 60 ‡	≥ 70‡	≥ 65‡	≥ 60‡
	3.5	–	–	–	–
Flakiness index (%)	3.1, 3.2	≤ 35	≤ 35	≤ 35	≤ 35
	3.3, 3.4	≤ 40	≤ 40	≤ 40	≤ 40
	3.5	–	–	–	–

‡ Materials are to be classified into a material group on the basis of the lithology of the major granular component, unless where two or more components each constitute over 30% of the total, then the most stringent properties of the various materials group shall be applied.

Material tests are specified to assess the following properties:

- Wet Strength: strength.
- Flakiness Index: measures the amount of aggregate particles that are elongated and/or flat. ‘Flaky’ particles reduce workability and are prone to breakdown during compaction and in service.

7.3.3 Fines component

The fines component properties for Type 3 material are specified in Table 7.3.3.

Table 7.3.3 – Fines component properties – Type 3

Property	Subtype				
	3.1	**3.2**	**3.3**	**3.4**	**3.5**
Liquid Limit (LL) (%)	≤ 25 *	≤ 28 *	≤ 35 *	≤ 35	≤ 40
Linear Shrinkage (LS) (%)	1.0 – 3.5	1.0 – 4.5	1.5 – 6.5	1.5 – 6.5	1.5 – 7.5
Weighted Linear Shrinkage (WLS)	≤ 85	≤ 110	≤ 195	–	–

* Where the Transport and Main Roads Quarry Registration Certificate states that the rock / material type is 'oversaturated glassy basalt', the following Liquid Limit values shall apply:

– Subtype 3.1 materials, LL ≤ 28%

– Subtype 3.2 materials, LL ≤ 30%

7.3.4 Particle size distribution (grading)

The grading enveloped for Type 3 materials are specified in Table 7.3.4.

Table 7.3.4 – Grading envelopes – Type 3

Subtypes	**3.1 and 3.2**	**3.3 and 3.4**	**3.5**
Test Sieve Size (mm)	**Percent Passing by Mass**		
75.0	100	100	100
37.5	100	90 – 100	85 – 100
19.0	87 – 100	80 – 100	–
9.5	67 – 87	60 – 90	55 – 95
4.75	50 – 70	42 – 76	–
2.36	36 – 52	30 – 60	30 – 80
0.425	14 – 24	14 – 28	14 – 60
0.075	7 – 16	7 – 16	8 – 30

In addition to the requirements of Table 7.3.4, the grading curve for the material shall be smooth. For Subtype 3.5, the grading between adjacent sieves, shall not vary from one outer third of the grading limits of one sieve to the opposite outer third of the grading limits of the next sieve.

The specified gradings reflect the typical applications that each material subtype will be used in, as per the Transport and Main Roads *Pavement Design Supplement*. For example:

- 3.1 and 3.2 materials are typically used in base courses
- 3.3 and 3.4 materials are typically used in subbase courses, and
- 3.5 materials are typically used in lower subbases or subgrade.

Where a materials subtype is to be used in a different application, the designer may choose to specify an alternative grading.

7.3.5 California bearing ratio

The California Bearing Ratio requirements for Type 3 material are specified in Table 7.3.5.

Table 7.3.5 – California bearing ratio requirements – Type 3

Property	Subtype						
	3.1		3.2		3.3	3.4	3.5
Compaction standard (refer Clause 8.4.3)	Modified	Standard	Modified	Standard	Standard	Standard	Standard
CBR (unsoaked)	Not specified	≥ 80	Not specified	≥ 60	≥ 45	≥ 35	≥ 15

Where specified, the strength of Type 3 material is principally assessed by the soaked CBR test. To consistently comply with all of the relevant Technical Specification requirements, it may be necessary for the Contractor to develop a set of secondary requirements which comply with the list of primary requirements specified in Clause 7.3.3 and 7.3.4 but, where necessary, are more stringent so that the specified CBR is achieved.

Where unbound materials conform with the coarse and fine material requirements of this Technical Specification and are compacted to 100% modified compaction or greater, experience has shown that the necessary CBR limit is readily achievable. As a result, the specification does not require CBR testing for materials where 100% modified compaction is both specified and achieved during construction and all other material properties are conforming.

7.4 Type 4 unbound material

Type 4 material is specified by its unsoaked CBR and any additional requirements specified in Clause 2.3.1 of Annexure MRTS05.1.

The California Bearing Ratio requirements are specified in Table 7.4.

Table 7.4 – California bearing ratio requirements – Type 4

Property	Subtype				
	4.1	4.2	4.3	4.4	4.5
Compaction standard	Standard	Standard	Standard	Standard	Standard
CBR (unsoaked)	≥ 80	≥ 60	≥ 45	≥ 35	≥ 15

The moisture content at which the CBR result is to be reported, may vary from OMC for Type 4 materials when specified in Clause 2.3.2 of Annexure MRTS05.1. However, if no alternative is specified, the CBR shall be reported at OMC.

7.5 All unbound materials

All pavement material incorporated into the finished pavement shall be free from sticks, organic matter, clay lumps and other deleterious material or contamination. Visual inspection of the material, during and after placement, shall be undertaken to ensure compliance with this clause.

The constituent materials shall be blended using procedures that:

a) are controlled to ensure uniformity of the blended material (including moisture)

b) ensure that the blended material is processed to a well graded, free flowing and consistent state, and

c) consistently achieve the requirements specified in this Technical Specification.

7.6 Supplementary materials

Supplementary materials may be used in the production of Type 1, Type 2 and Type 3 materials to meet the material requirements specified in Clause 7.1, 7.2 and 7.3.

Where the Contractor elects to use a supplementary material, it shall:

a) be derived from sound and durable material

b) not be self-cementing or cementitious in nature (with the exception of recycled hardened concrete which may include some unhydrated cement resulting from the crushing of the concrete, but not added, but must comply with the UCS requirements specified)

c) be free of vegetable matter, lumps and balls of clay and oversize particles of rock

d) be sized so that it can be effectively and uniformly distributed throughout the crushed rock

e) be kept sufficiently dry to facilitate blending, and

f) be uniformly blended into the product using a mixing system approved by the Administrator.

The properties of supplementary material shall meet the requirements of Table 7.6 prior to blending.

Table 7.6 – Supplementary material properties

Property	Value
% passing 9.5 mm test sieve	100
% passing 4.75 mm test sieve	90 – 100
Liquid limit (%)	≤ 40
Linear shrinkage (%)	≤ 10
Light particles (%)	≤ 10
Organic content (%)	≤ 5

The selection of supplementary materials to be used in an unbound pavement material to meet the specified product requirements, is highly dependent on the nature of the material that it is being blended with.

The above limits have been included to give the widest possible range of potential supplementary materials, however materials with properties approaching the upper limits of these properties, will not be appropriate in every case. The required properties of supplementary materials should be assessed on a case by case basis and continually checked through material testing.

It would be expected that the proportion of supplementary material used would be less than 10% of the total product, but no upper limit has been defined in this Technical Specification.

Recycled, natural and quarried materials (or a combination of these) may all be used as supplementary materials.

7.7 Stockpiling of materials

Stockpiles of unbound pavement materials shall be positioned as specified in Clause 2.4 of Annexure MRTS05.1. If no position is specified in the Annexure, the Contractor shall nominate the stockpile location as part of their Unbound Pavement Construction Procedure and the stockpile shall be located on clear, even, firm, well-drained ground in a location where it 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 so that a portion representing a lot is added up to the maximum lot tonnage specified in Appendix A, 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.

7.8 Water Quality

Water used in unbound 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 six to ten, 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) marine water shall not be used.

Unless otherwise accepted by the Administrator, water sources shall be tested at a maximum of 12 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.

8 Construction

8.1 General

The locations in which specific pavement materials are to be used, shall be shown in the design documentation or specified in Clause 2.1 of Annexure MRTS05.1.

8.2 Trial pavement

Unless otherwise agreed by the Administrator, for Type 1 (HSG) materials, a trial of the manufacturing and laying operations is required prior to commencement of the work. **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) based on the characteristics of the material, its ability to be handled, spread and compacted to achieve the surface finish requirements of Clause 8.3.5

b) the adequacy of the joint and surface preparation procedures (including the ability to achieve the surface texture requirement specified in Clause 8.3.5.2

c) the rolling pattern and the number of passes of the rollers required to produce an acceptable compacted layer

d) the adequacy or otherwise of the manufacturing and construction plant proposed for the work, and

e) the ability for the material to comply with the specified post compaction grading requirements (refer Clause 8.4.2).

The Contractor shall carry out material and construction compliance tests in accordance with Clause 9, to confirm that 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 3** If the trial does not conform in full to the requirements of this Technical Specification, the Contractor shall review their construction procedure and the properties of the proposed unbound materials 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.

8.3 Process requirements

8.3.1 Equipment

8.3.1.1 Paving Equipment

8.3.1.1.1 General

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

8.3.1.1.2 Paving Type 1 (HSG) material

Pavements layers incorporating Type 1 (HSG) materials shall be constructed using a self-propelled spreading machine purpose-built for this work (that is, a paver). Such machines shall have the capacity to either:

a) receive the material in a hopper and place and spread the material on the prepared surface to the required uncompacted layer thickness, width and shape in one pass, or

b) spread previously placed windrows of the material to the required uncompacted layer thickness, width and shape in one pass.

Where the 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 Unbound Pavement Construction Procedure.

8.3.1.1.3 Paving Type 2, 3 or 4 materials

Pavement layers incorporating Type 2, 3 or 4 materials shall be constructed by either using a paver (in accordance with the requirements of Clause 8.3.1.2) or with a grader, unless specific plant is specified in Clause 3.1.1 of Annexure MRTS05.1.

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 Unbound Pavement Construction Procedure.

8.3.1.2 Equipment for preparation of surfaces

The equipment used for the preparation of a surface to be covered by a sprayed bituminous treatment shall include:

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

The use of drag broom in conjunction with the three-point or multi-tyred roller is recommended.

The equipment used for the preparation of a Type 1 layer prior to placing the next layer shall include:

- a machine capable of roughening the surface of the layer, and
- a machine capable of sweeping the surface.

8.3.1.3 Intelligent Construction Rollers

Intelligent Construction (IC) rollers shall be used to compact unbound pavement material where specified in Clause 3.1.2 of Annexure MRTS05.1.

The IC rollers shall meet the following requirements:

a) IC rollers shall be self-propelled, single smooth drum vibratory rollers equipped to measure the stiffness of the layer being compacted.

b) IC rollers shall be capable of recording and displaying:

   i. real-time, colour-coded maps of the roller position, coverage and stiffness of the compacted layer

   ii. number of roller passes

   iii. roller speeds, and

   iv. vibration frequency and amplitude of the roller drums.

c) The data output from the IC roller shall be compatible with Veta.

To comply with this Clause, all single smooth drum rollers shall be IC rollers.

8.3.2 Paving

Unbound pavements shall be constructed so 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**

8.3.3 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 8.3.3. Where multiple layers of the same material are placed in a single course, each layer shall be of equal thickness unless otherwise approved by the Administrator.

Table 8.3.3 – Layer thickness requirements

Material	Minimum Value	Maximum Value
Type 1 (HSG)	100 mm	150 mm
All other Subtypes	75 mm	250 mm

Except in batters, each layer shall be constructed in a uniform 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.

The Contractor should consider the vibration requirements specified in MRTS51 *Environmental Management* in determining the size of compaction equipment used and the thickness of the layer in which the material is compacted.

8.3.4 Moisture content

8.3.4.1 Degree of saturation

The pavement layer shall have a moisture content so that the degree of saturation is less than the relevant limit specified in Table 8.3.4.1 at the time that it is covered by another pavement layer or surfacing. Unless otherwise accepted by the Administrator, these requirements shall also apply to trafficking unbound pavement layers.

Table 8.3.4.1 – Maximum degree of saturation

Material	Maximum Degree of Saturation (%)	
Compaction standard	Modified	Standard
Type 1 (HSG)	60 *	Not applicable
Type 2	70	65
Type 3	70	65
Type 4	Not applicable	65

* For Type 1 material, the Administrator may accept a higher degree of saturation limit (up to a maximum of 70%) when the Contractor **Hold Point 4**:

a) confirms the use of a higher moisture content limit will not impact on achieving the surface finish requirements stated in Clause 8.3.5, and

b) demonstrates adequate resistance to deformation at a higher DoS level. This demonstration shall at least include RLT testing in accordance with Test Method Q137 where the maximum DoS at the time of sealing shall be the maximum value providing:

   i. less than 1.5% permanent strain after 1000 cycles

   ii. less than 4.0% strain at 50,000 cycles, and

iii. RLT test results shall be undertaken on the manufactured pavement material not more than 12 months prior to its intended incorporation into the Works.

A common factor affecting the premature failure of newly constructed unbound granular pavements, has been the presence of excess moisture within the pavement base prior to the application of the bituminous surfacing. A DoS above the specified limits can lead to:

- rapid failure including blow-outs and rutting of an unbound pavement layer due to shear failures
- lifting of the surfacing due to positive pore pressure, and
- embedment of cover aggregate due to the softness of the base.

8.3.4.2 Moisture content during construction

The unbound pavement material may have a moisture content greater than that represented by the relevant DoS limit specified in Clause 8.3.4.1 for the purpose of construction only, provided that the section of pavement is dried back to meet the requirements of Clause 8.3.4.1 at the time it is covered by another pavement or surfacing layer.

For Type 1 (HSG) material, water shall only be added to the unbound pavement material via a controlled and measured process and be uniformly mixed through the material using a pugmill (or equivalent mechanical process).

Water shall not drain freely from the pavement material during production, handling, transport or construction.

Sufficient moisture must be added to unbound pavement material to allow adequate lubrication of the particles to achieve compaction. Generally, unbound materials should be compacted near the relevant OMC to achieve maximum density; however, materials are often compacted slightly dry of OMC to reduce the time required to achieve dry back.

Developing optimum moisture content and density graphs for the material can be useful to characterise the material, indicate sensitivity to moisture content and inform compaction procedures. However, the required moisture content for field compaction will depend largely on the conditions onsite and must be chosen to align with the material's characteristics and the compaction equipment to be used.

Uniformity of moisture content in the material is important, as variations will likely affect compactability, leading to unsatisfactory variations in density.

Moisture conditioning unbound pavement materials prior to delivery to the roadbed, will assist in minimising segregation during the spreading stage. However, the type and capacity of the pugmill will determine the length of the mixing time. Too short a mixing time in the pugmill will result in uneven moisture content throughout the product and will adversely impact on the ability to readily achieve the required compaction result.

8.3.5 Surface finish

8.3.5.1 General

From when the layer is presented to the Administrator for inspection (refer Hold Point 5), until immediately prior to covering, the finished surface of any unbound pavement layer shall:

- be hard and homogenous in appearance
- not have any loose, segregated or contaminated areas
- have the coarse 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 9.4.7.

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 8.4.7.

As necessary, the Contractor shall trim, lightly water, broom and roll the pavement to achieve the above finish to the satisfaction of the Administrator.

8.3.5.2 Preparation of Type 1 (HSG) layers prior to placing the next layer

Where a Type 1 (HSG) layer is to be overlaid directly with another layer of Type 1 (HSG) material, the finished surface shall be prepared so that it has a hard-rough surface with a texture depth not less than 1 mm (when testing in accordance with Test Method AG:PT/T250) without reducing the density of the layer or compromising the integrity of the surface.

> The Contractor will nominate in their Construction Procedure, the proposed methodology to prepare the pavement. This may be undertaken by hard brooming using a drag broom, however other plant may be used dependent on the nature of the project and what equipment is available onsite for other processes.

Unless otherwise approved by the Administrator, the overlying layer of Type 1 (HSG) material must be constructed within three days of the construction of the underlying layer unless additional time is required to meet the DoS limit for the underlying layer. Where additional time is needed to dry back the underlying layer, the overlying layer shall be constructed as soon as the required DoS has been reached.

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

8.3.6 Construction joints between adjacent paving runs

To the extent practical, the Contractor shall spread the unbound 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 a joint in the underlying layers, except where required, otherwise to achieve the design shape (for example to construct a crowned pavement)

b) joints shall be located away from trafficked wheel paths, and

c) joints in the final (uppermost) layer of unbound pavement bases shall coincide with the final traffic lane markings and/or line of change in crossfall (for example, crown of the pavement).

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 longitudinal joints in the final (uppermost) layer of the base course to be constructed away from lane marking 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 shoulders on either side.

8.3.7 Contractor's responsibilities

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

8.3.8 Dust management

Unbound pavement material shall be transported in covered vehicles and delivered with sufficient moisture to control dust. Materials shall not be worked dry, but rather with sufficient moisture to minimise dust.

The moisture content required to manage dust will vary from material to material, however, would generally be less than that required to place and compact the material as a conforming pavement layer.

8.4 Product standards

8.4.1 Segregation

Segregation is the uneven distribution of particle sizes. The construction process shall control segregation so that the particle size distribution of the unbound pavement material complies with the particle size distribution requirements in Clause 7 (for the relevant subtype and grading) 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.

8.4.2 Post compaction grading of Type 1 (HSG) material

For Type 1 (HSG) materials, material breakdown (and segregation) shall be assessed against the post-compaction grading requirements specified in Table 8.4.2.

Table 8.4.2 – Post compaction grading for Type 1 (HSG)

Test Sieve Size (mm)	Percent Passing by Mass	
	Minimum	Maximum
26.5	100	100
19.0	95	100
13.2	78	92
9.50	63	83
4.75	44	64
2.36	30	49
0.425	14	23
0.075	6	12

8.4.3 Compaction standard

The characteristic value of relative compaction for unbound pavements must comply with the requirements specified in Table 8.4.3(a).

Table 8.4.3(a) – Compaction requirements

Material	Location	Minimum Value
Type 1 (HSG)	All	100% (Modified Compaction)
Subtype 2.1 and 2.2	Base course	
Subtype 3.1 and 3.2		
Subtype 2.1 and 2.2	Other than base course	100% (Standard Compaction)
Subtype 3.1 and 3.2		
Subtype 2.3, 2.4 and 2.5	All	
Subtype 3.3, 3.4 and 3.5		
Type 4		

The base course would typically be shown on the drawings. Where the base course is not specifically shown on the drawings, the thickness of the base course may be determined in accordance with Figure 8.4 of the Austroads *Guide to Pavement Technology (Part 2: Pavement Structural Design)*.

Where unbound pavement materials are used in other applications (for example stabilised pavements) the compaction requirements of the relevant Technical Specification shall apply.

Where the use of IC Rollers is specified in Clause 3.1.2 of Annexure MRTS05.1, the lot coverage must comply with the requirements specified in Table 8.4.3(b).

Coverage shall be calculated as:

1. the area of the lot (that is to be incorporated into the Works) which has achieved the minimum number of roller passes nominated in the Unbound Pavement Construction Procedure, divided by
2. the total area of the lot that is to be incorporated into the Works.

Table 8.4.3(b) – IC Roller Coverage

Property	Minimum Value
IC Roller coverage	90%

The intent of this Technical Specification is that all high standard and standard quality unbound base materials (that is, Type 1 (HSG), Subtypes 2.1, 2.2, 3.1, and 3.2) are to be compacted to 100% modified compaction. This higher standard of compaction has a number or advantages, including:

1. reduced permeability
2. increased strength of the unbound base, and
3. improved fatigue life of thin asphalt surfacings.

All other unbound materials (that is, Subtypes 2.3, 2.4, 2.5, 3.3, 3.4, 3.5, and Type 4) are intended to be used in lower trafficked applications or in lower pavement layers. Accordingly, these materials are intended to be compacted to 100% standard compaction in most applications. These materials may not be suitable for compaction to 100% modified compaction as follows:

a) lower strength materials may be prone to breakdown during compaction. This is particularly likely where the wet strength is ≤ 90kN, and/or

b) the underlying materials may not provide adequate support for compaction.

8.4.4 Geometrics

8.4.4.1 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 joins in paving runs must also comply with the requirements of Clause 8.3.6.

8.4.4.2 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 8.4.4.1, 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.

8.4.4.3 Geometrics, vertical tolerances

The vertical tolerances as specified in Table 8.4.4.3 shall apply for:

- the surface level (height) measured at any point on the surface of any layer, and
- the average total thickness of the unbound pavement constructed under the Contract in accordance with this Technical Specification. Assessed as either:
  - where the pavement contains only a single unbound pavement layer – the total thickness of that individual layer, or
  - where the pavement contains multiple unbound pavement, layers constructed immediately over on another in accordance with this Technical Specification – the total thickness of the overall unbound pavement material (which may include different unbound pavement material types).

The tolerance (alternative) that will apply to Type 2, 3 and 4 materials shall be as nominated in Clause 3.2.1 of Annexure MRTS05.1. Where not specifically nominated, Alternative A shall apply.

Table 8.4.4.3 – Primary geometric tolerances

Material [Tolerance Alternative]	**Surface Level / Height (Individual)**		**Total Thickness (Average)**
	When Covered with Asphalt Surfacing ≤ 50 mm Thick	All Other Cases	
Type 1 (HSG)	± 10 mm *		- 20 mm * + unspecified
Type 2, 3 and 4 [Alternative A]	± 10 mm	± 15 mm	- 20 mm + unspecified
Type 2, 3 and 4 [Alternative B]	not suitable	± 25 mm	- 20 mm

* Where the pavement is required to be prepared as specified in Clause 8.3.5.2, these tolerances shall apply after the pavement has been prepared ready for construction of the overlying layer.

At all times, the Contractor shall target construction at the mid-point of the surface level tolerances.

8.4.4.4 Crossfall

For the final (uppermost) layer of unbound pavement to be constructed under the Contract, the crossfall shall not depart from the design crossfall by more than 0.5% absolute. These requirements shall also be applied to other layers where stated in Clause 3.2.3 of Annexure MRTS05.1.

This 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.

8.4.5 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 unbound pavement, to be constructed under the Contract, shall be in accordance with the requirements of Table 8.4.5 with due allowance being made for design shape, where relevant. These requirements shall also be applied to other layers where stated in Clause 3.2.3 of Annexure MRTS05.1.

The tolerance (alternative) that will apply to Type 2, 3 and 4 materials shall be as nominated in Clause 3.2.2 of Annexure MRTS05.1. Where not specifically nominated, Alternative C shall apply.

Table 8.4.5 – Requirements for deviation from a straight-edge

Material [Tolerance Alternative]	Maximum Value
Type 1 (HSG)	5 mm
Type 2, 3 and 4 [Alternative C]	5 mm
Type 2, 3 and 4 [Alternative D]	8 mm

8.4.6 Road roughness (surface evenness)

Unless otherwise specified in Clause 3.2.4 of Annexure MRTS05.1, the road roughness of the final (uppermost) layer of an unbound pavement to be constructed under the Contract, shall be in accordance with the requirements of Table 8.4.6.

Table 8.4.6 – Road roughness requirements

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

The roughness of the following features is required to be noted during roughness testing, but shall be excluded from the ride quality assessment:

- roundabouts
- railway crossing and grids

- bridge joints, and
- inspection pit covers (for example, drainage access chambers).

The Contractor shall 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.

Pavement features (including joints) or signalised / unsignalized intersections (other than roundabouts) shall not be excluded from the ride quality assessment unless agreed by the Administrator.

The Administrator may waive the requirement for roughness testing where the unbound pavement will be overlayed 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.

8.4.7 Ball penetration

For layers that are to be covered be a sprayed bituminous treatment, the surface shall have a maximum ball penetration value that complies with the requirements specified in Table 8.4.7.

Table 8.4.7 – Ball penetration requirement

Property	Maximum Value
Ball penetration	3 mm

9 Compliance testing

9.1 General

Compliance testing of unbound pavements shall be undertaken on a lot basis in accordance with MRTS01 *Introduction to Technical Specifications*. A lot shall include only material of the same subtype.

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.

The Contractor shall not incorporate materials into the work, unless it has demonstrated that the material complies fully with the requirements of this Technical Specification before delivery of the material to site. **Hold Point 5** Such conformance results shall be no more than 18 months old, unless otherwise agreed by the Administrator.

When test results are more than six months old, where requested by the Administrator, the Contractor shall undertake audit testing prior to submitting **[refer Hold Point 6]** to demonstrate the material still complies with the requirement of this Technical Specification.

The requirements for audit testing of stockpiles greater than six months, old would typically involve undertaken grading, liquid limit and linear shrinkage testing.

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 one test per 1000 m² is nominated and a lot includes 2500 m² of that material, a minimum of three tests would be required.

9.2 Test locations

Unless indicated otherwise in Clause 1 of Annexure MRTS05.1, or elsewhere in this Technical Specification, samples for material compliance testing shall be taken from the stockpile.

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 unbound pavements shall be as specified in Table A1 of Appendix A.

The material used in a small construction lot would generally be sourced from a larger material stockpile (supply of unbound material) lot that has been tested as a whole for conformance with this Technical Specification. Accordingly, the test results from a single material stockpile may be applicable to multiple construction lots.

9.4 Compliance testing requirements

9.4.1 Unbound pavement materials

Minimum testing frequencies for unbound pavement material source and product testing, shall be as specified in Table A2 of Appendix A.

9.4.2 Testing under Transport and Main Roads Quarry Registration System.

Source material testing frequencies are controlled by Transport and Main Roads Quarry Registration System (QRS).

For project conformance, the Contractor shall provide test results, undertaken in line with the QRS requirements, which represent the unbound pavement material supplied to the Works. These test results need to be provided to the Administrator as part of each applicable construction lot.

9.4.3 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.

9.4.4 Post compaction grading of Type 1 (HSG) materials

Minimum testing frequencies for post compaction grading of Type 1 (HSG) materials shall be as specified in Table A3 of Appendix A.

Breakdown (as well as segregation) of Type 1 material shall be assessed based on its post-compaction grading. The specimen to be tested shall:

a) be sampled from the compacted pavement

b) be sampled using Q061 Spot Sampling of Soils, Crushed Rock and Aggregates, and

c) be sampled at a location adjacent to the location of sampling for the Relative Compaction testing.

9.4.5 Degree of saturation

9.4.5.1 General

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

The degree of saturation for each lot, shall be represented by the maximum characteristic value of the degree of saturation of the individual samples taken from the lot. The characteristic value shall be calculated in accordance with Test Method Q020.

The degree of saturation result reported for any lot, shall be representative of the condition of the lot immediately prior to it being covered by another pavement layer. Should the pavement lot have been subjected to rainfall or moisture ingress in any way since degree of saturation testing was undertaken, the Administrator may direct the Contractor to retest the lot in accordance with Clause 9.4.5.2 to prove conformance.

9.4.5.2 Retesting degree of saturation

Retesting of the Degree of Saturation shall include the measurement of both the compacted density, and the moisture content.

If the retested results do not comply with the requirements of this Technical Specification, the Contractor shall dry back and/or reprepare the pavement so that it complies with the requirements of this Technical Specification, prior to covering the lot.

9.4.6 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.

For each lot where IC is used, the Contractor shall use Veta to analyse the IC data for coverage.

The Contractor shall provide to the Administrator, all input files necessary to analyse the data in Veta and a report of the Veta analysis (which has been output directly from Veta). The Veta report shall include the locations and values of all individual compaction compliance test results.

All data and files must be clearly linked to the construction lot which they relate to.

The Veta software is freely available on the website *https://www.intelligentconstruction.com/*

9.4.7 Proof rolling

Each unbound 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 unbound pavements shall be 'proof rolled', including all trafficked lanes, shoulders and other areas.

Testing shall be in accordance with Test Method Q723, 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 8.3.4 and 8.4.3. 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 so that it complies with the requirements of this Technical Specification. No addition payment will be made by the Principal for any such additional efforts.

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

9.4.8 Ball penetration testing

For unbound 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 are to 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 work is to 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 so that it complies with the requirements of this Technical Specification. No additional payment will be made by the Principal for any such additional efforts.

9.4.9 Geometrics and 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, cross-fall and layer thickness, shall be determined by survey unless otherwise agreed by the Administrator.

9.4.10 Road roughness (surface evenness)

The road roughness of the final (uppermost) layer of unbound pavement, 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.

> The Administrator may waive the requirement for roughness testing where the unbound pavement will be overlayed 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.

9.5 Compliance testing results

9.5.1 Acceptance of lots

Unless otherwise approved by the Administrator, no unbound pavement layer shall be covered by a subsequent layer of pavement or by a surfacing until **Hold Point 6**:

a) all testing has been completed

b) the surface finish of the layer complies with the requirements of Clause 8.3.5

c) all test results comply with the requirements of this Technical Specification, or any nonconformances have been submitted, with corrective actions proposed by the Contractor, and accepted by the Administrator

d) the layer has been presented to the Administrator for inspection, and

e) the As Constructed Survey requirements of the lot have been met, as specified in MRTS56 *Construction Surveying* and notice of such Works has been provided to the Administrator.

9.5.2 Reworking of unbound pavement lots

Where the Administrator permits an unbound pavement lot to be reworked to achieve compliance with the specified requirements, the Contractor shall ensure that the material still meets with the requirements of this Technical Specification – including the requirements for particle size distribution prior to compaction.

10 Supplementary requirements

The requirements of this Technical Specification are varied by the supplementary requirements specified in Clause 4 of Annexure MRTS05.1.

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	5000 tonnes
Supply of supplementary material (prior to blending)	1000 tonnes
Construction of unbound pavements	A continuous single layer constructed in one day's production
Road roughness testing	500 m

The default testing frequencies provided in this Appendix have been developed for use on typical Transport and Main Roads projects. Where projects warrant specific testing frequencies, these are to be specified using Annexure MRTS05.1.

Table A2 – Unbound pavement materials – source and 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
Source Testing					
Default source testing frequencies are given below. A lesser minimum testing frequency is permitted for specific properties, where stated on the Transport and Main Roads Quarry Registration Certificate – Testing Frequency Schedule					
Petrographic assessment of aggregates	Q188	6 monthly	-	-	-
Wet strength	AS 1141.22	1 per 2500t	2 per lot	-	-
Wet / dry strength variation	AS 1141.22	1 per 2500t	2 per lot	-	-
Water absorption	AS 1141.6.1	1 per 2500t	2 per lot	-	-
Degradation factor	Q208B	1 per 2500t	2 per lot	-	-
Product Testing					
Crushed particles (Type 1 materials)	AS 1141.18	–	1 per lot	–	1 per lot
Flakiness index	Q201	1 per 2500t	2 per lot	–	1 per lot
California Bearing Ratio*	Q113A or Q113C	1 per 2500t	2 per lot	–	1 per lot
Grading	Q103A	1 per 1000t	–	1 per 2500t	–
Fines ratio	Q103A	1 per 1000t	–	1 per 2500t	–
Liquid limit	Q104A	1 per 1000t	–	1 per 2500t	–
Linear shrinkage	Q106	1 per 1000t	–	1 per 2500t	–
UCS (Type 2 materials containing recycled concrete)	Q115	–	1 per lot	–	1 per lot
Foreign material (Type 2 materials containing recycled material)	Q477	1 per 2500t	2 per lot	–	1 per lot

Property	Test Method	Normal Testing Level		Reduced Testing Level	
		Minimum Testing Frequency	Minimum No. of Tests	Minimum Testing Frequency	Minimum No. of Tests
pH (Type 2 material containing recycled concrete)	AS 1289.4.3.1	bi-monthly	–	Monthly	–
pH (water)	APHA 4500-H B	12 month intervals	–	12 month intervals	–
Conductivity (water) #	APHA 2510-B	12 month intervals	–	12 month intervals	–
Supplementary Material Testing					
Grading	Q103A	Refer to Clause 8.1.1 of MRTS50 *Quality System Requirements*			
Liquid limit	Q104A				
Linear shrinkage	Q106				
Light particles	AS 1141.31				
Organic content	Q120B				

* CBR testing is not required for Type 1 materials or for Type 2 or 3 materials where the requirements of Clause 7.2.5 are satisfied.

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

Transport and Main Roads Quarry Registration System (QRS) assesses the suitability of the source material at quarries to produce materials that comply with the various Transport and Main Roads Technical Specifications.

Being registered under QRS does not guarantee a quarry's ability to produce conforming material.

Quarries are not required to submit conformance tests directly to QRS during production (however these results may be included in registration renewals from time to time). For this reason, it is important that all conformance tests specified in Table A2 are provided to the Administrator as part of each applicable construction lot.

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)			
Post compaction grading (Type 1 materials only)	Q103A	1 per 2,500 m²	2 per lot	1 per 2,500 m²	2 per lot
Degree of saturation	Q146	1 per 500 m²	4 per lot	1 per 1000 m²	4 per lot
Compaction	Q140A	1 per 500 m²	4 per lot	1 per 1000 m²	4 per lot
Proof rolling	Q723	Refer Clause 9.4.7			
Ball penetration testing	AG:PT/T251	**For unbound pavement layers where the final surfacing (to be trafficked) is a sprayed bituminous treatment:** • 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. **For unbound pavement layers where the final surfacing (to be trafficked) is not a sprayed bituminous treatment (that is, the sprayed bituminous treatment will be covered by asphalt):** • 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 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 and 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	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. b) **Longitudinal joint**: 1 per 20 linear metres^ along each joint, unless otherwise approved by the Administrator. c) **Transverse joint**: 1 measurement per joint in each wheel path in each lane. 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. 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).	
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 and Q708D	Refer Clause 8.4.6 and 9.4.10	

^ The Administrator may approve 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).