



ACT
Government

SEGMENTAL PAVING 07

MUNICIPAL
INFRASTRUCTURE
TECHNICAL
SPECIFICATION
07 - SEGMENTAL PAVING

Transport Canberra and
City Services

July 2019



Publication Number:	MITS 07 Edition 1 Revision 0
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Date of Effect:	July 2019
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Supersedes: Standard Specification for Urban Infrastructure Works Section 12
Edition 1 Revision 0 September 2002

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Document Information

Document	Key Information
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Document Title MITS 07 Segmental Paving

Next review date	
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Key words

AUS-SPEC Base Document	0161Quality (construction) 1145 Segmental pavers – road construction
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Revision Register

Edition/ Revision Number	Clause Number	Description of Revision	Authorised By	Date
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1 SEGMENTAL PAVING

1.1 General

General: This Specification comprises the supply, placement and compaction of segmental pavers, including the provision of a sand bedding course and joint filling sand over various types of base and/or subbase layers.

Requirement: Provide the following paving systems for pedestrian or vehicular traffic:

- > External paving in clay, stone, tactile paving, porphyry stone paving, porphyry setts paving and manufactured cementitious pavers on a cement mortar bed and adhesive bed to concrete substrates; or
- > Supply and placement of concrete segmental paving on mortar or adhesive bed on a concrete pavement for use in vehicular pavements and paths; or
- > Supply, placement and compaction of proprietary clay and concrete segmental paving on sand bedding for use in vehicular pavements, medians, traffic islands, driveways, paths and landscaped areas, over unbound base and/or subbase layer/s.

Exclusions: This Specification does not include paving fixed to substrates subject to vibration.

Driveways: Segmental pavers may be used for vehicle accesses subject to the requirements of this Specification. Note that following repair or maintenance work in the verge, TCCS are only able to match plain concrete or asphalt surfaces.

1.1.1 Responsibilities

1.1.1.1 General

Requirement: Provide segmental paving, as documented and as follows:

- > Consistent in colour and finish as appropriate to the land use.
- > Resistant to expected impacts in use.
- > Set out with joints accurately aligned in both directions.
- > Set out around existing structures and trees.
- > In conformance with the level tolerances specified.

Requirement: In addition, provide segmental paving with a mortar or adhesive bed, as documented and as follows:

- > Firmly bonded to substrates for the expected life of the installation.
- > To direct all water flowing from supply points to drainage outlets without leakage to the substrate or adjacent areas.

1.1.2 Cross references

General: The following documents are related to this Specification:

1.1.2.1 ACT Legislation

Road Transport (General) Act

Road Transport (Safety and Traffic Management) Act

Road Transport (Mass, Dimensions and Loading) Act

Road Transport (Safety and Traffic Management) Regulation

Territory Plan and related Codes

Public Roads Act

1.1.2.2 Specifications

Requirement: Conform to the following:

MITS 00 Preliminaries

MITS 01 Roadwork

MITS 02 Earthworks

MITS 03 Underground services

MITS 04 Flexible pavement construction

MITS 06 Concrete kerbs, footpaths and minor works

MITS 10 Major concrete works

TRITS 05 Rigid pavement construction

1.1.2.3 Design Standards

General: The following Design Standards are related to this Specification

MIS 07 Driveways

Attachment B Design acceptance requirements

Canberra Central Design Manual

1.1.2.4 TCCS Reference Documents

General: The following TCCS reference documents are related to this specification:

Reference document 04 Protection of public landscape assets

Reference document 07 Operational acceptance submissions

Reference document 08 Works as executed quality records

Reference document 09 Final acceptance submissions

Reference document 10 Landscape consolidation

Reference document 11 Drafting Standard for Civil and Landscape works

1.1.3 Referenced documents

General: The following documents are incorporated into this Specification by reference:

1.1.3.1 Standards

Australian standards

AS 1141	Methods for sampling and testing aggregates
AS 1141.11.1	Particle size distribution — Sieving method
AS 1289	Methods of testing soils for engineering purposes
AS 1379	Specification and supply of concrete
AS/NZS 1428	Design for access and mobility
AS/NZS 1428.2	Design for access and mobility – Enhanced additional requirements – Buildings and facilities
AS/NZS 1428.4	Design for access and mobility - Tactile ground surface indicators for the orientation of people with vision impairment
AS/NZS 1428.4.1	Means to assist the orientation of people with vision impairment - Tactile ground surface indicators
AS 1478	Chemical admixtures for concrete, mortar and grout
AS 1478.1	Admixtures for concrete
AS 1604	Specification for preservative treatment
AS 1604.1	Sawn and round timber
AS 1672	Limes and limestones
AS 1672.1	Limes for building
AS 2358	Adhesives - For fixing ceramic tiles
AS 2758	Aggregates and rock for engineering purposes
AS 2758	Concrete aggregates
AS 2876	Concrete kerbs and channels (gutters) – Manually or machine placed.
AS 3582	Supplementary cementitious materials for use with portland and blended cement
AS 3582.1	Fly ash
AS 3705	Geotextiles - Identification, marking and general data
AS 3818	Timber - Heavy structural products - Visually graded
AS 3818.2	Railway track timbers
AS 3958	Ceramic tiles
AS 3958.1	Guide to the installation of ceramic tiles
AS 3972	General purpose and blended cements
AS/NZS 4455	Masonry units, pavers, flags and segmental retaining wall units
AS/NZS 4455.2	Pavers and flags
AS/NZS 4456	Masonry units and segmental pavers — Methods of test
AS/NZS 4456.2	Assessment of mean and standard deviation

AS/NZS 4456.3	Determining dimensions
AS/NZS 4456.5	Determining the breaking load of segmental pavers and flags
AS/NZS 4456.9	Determining abrasion resistance
AS/NZS 4456.10	Determining resistance to salt attack
AS/NZS 4456.13	Determining pitting due to lime particles
AS 4586	Slip resistance classification of new pedestrian surface materials
AS 4663	Slip resistance measurement of existing pedestrian surfaces
AS ISO 13007	Ceramic tiles
AS ISO 13007.1	Grouts and adhesives - Terms, definitions and specifications for adhesives

British Standards

BS EN 12878	Pigments for the colouring of building materials based on cement and/or lime.
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1.1.3.2 Other publications

Proprietary products: To *TCCS Products previously considered for use list*

Austroads

AGPT	Austroads Guide to Pavement Technology
AGPT04G	Part 4G: Geotextiles and geogrids

Concrete Masonry Association of Australia

CMAA PA01	Concrete segmental pavements - Detailing guide
CMAA PA02	Concrete segmental pavements - Design guide for residential access ways and roads
CMAA PA03	Concrete segmental pavements - Specifying guide
CMAA PE01	Permeable interlocking concrete pavements - Design and construction guide

Clay Brick and Paver Institute

CBPI Manual 1	Clay paving design and construction
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1.1.4 Interpretation

1.1.4.1 Abbreviations

General: For the purposes of this Specification the following abbreviations apply:

CBPI:	Clay Brick and Paver Institute, now known as Think Brick Australia.
CMAA:	Concrete Masonry Association of Australia.
ITP:	Inspection and Test plan.
NATA:	National Association of Testing Authorities.
RMS:	NSW Roads and Maritime Services
TCCS:	Territory and Municipal Services.
TGSI:	Tactile Ground Surface Indicator.

1.1.4.2 Definitions

General: For the purposes of this Specification the following definitions apply:

Absolute level tolerance: Maximum deviation from design levels.

Adhesive bedding: Paving adhered by a cementitious adhesives bed.

Authorised Person: The Authorised Person as defined by the contract.

Base: One or more layers of material usually constituting the uppermost structural element of a pavement on which the surfacing may be placed and which may be composed of fine crushed rock, natural gravel, broken stone, stabilised material, asphalt or concrete.

Bedding: Mixtures of materials which are applied to substrates in a plastic state and dry and cure to adhere pavers to substrates.

Cementitious adhesives (C): Adhesives in which the binders are hydraulic, e.g. Portland cement, with aggregates and organic additives.

Clay pavers: Manufactured from clay, shale or argillaceous materials which may be mixed with additives. Clay pavers may have square, bevelled (chamfered), rounded or rumbled edges. They are generally rectangular in shape, with the length twice the width, plus 2 mm.

Concrete segmental pavers: Units of not more than 0.10 square metres in gross plan area, manufactured from concrete, with top and bottom faces parallel, with or without chamfered edges and identified by the following shape types:

- > **Shape Type A:** Dentated chamfered units which key into each other on four sides, are capable of being laid in herringbone bond, and by plan geometry, when interlocked, resist the spread of joints parallel to both the longitudinal and transverse axes of the units.
- > **Shape Type B:** Dentated units which key into each other on two sides, are not (usually) laid in herringbone bond, and by plan geometry, when keyed together, resist the spread of joints parallel to the longitudinal axes of the units and rely on dimensional accuracy and accuracy of laying to interlock on the other faces.
- > **Shape Type C:** Units which do not key together rely on dimensional accuracy and accuracy of laying to develop interlock.

Domestic driveway: Has the same meaning as in *AS 2890.1*; namely a driveway serving from 1 to 3 dwelling units in residential zones and designed for light vehicle traffic only.

Edge restraint: An existing or constructed element forming a boundary to the paved area.

Flag: Large format, solid (non cored) paver with a gross plan area $\geq 0.08\text{m}^2$.

Frogs: Frogs are depressions in pavers, usually located on one bed surface as a result of the manufacturing process.

Gross plan area: The plan area of the paving unit including the chamfer or radius.

Header course: A course of whole or trimmed rectangular pavers at the pavement restraint edge. Also known as a Soldier course.

Heavy Duty Driveway: Is a commercial or industrial driveway, or a residential driveway other than a domestic driveway, designed in accordance with AS 2890.2.

Laying face: The working edge of the pavement, that is, where pavers are being laid during construction.

Laying patterns: Herringbone, basketweave, stretcher, or zig zag running bond. Refer to the **Laying patterns figure** for laying patterns examples.

Lippage: Height deviation between adjacent pavers or other surface features.

Mortar bedding: Paving adhered in a cementitious mortar bed.

Net Area: The plan area of the top surface of the paving unit bounded by the chamfer or radius.

Pavers: Units made from clays, stone, concrete and/or other inorganic raw materials generally over 20mm thick used as coverings for floors and supported over continuous substrates. Solid unit with a gross plan area $\leq 0.08\text{m}^2$.

Relative level tolerance: Maximum deviation from a 3m straightedge laid on the surface.

Subbase: The material laid on the subgrade below the base either for the purpose of making up additional pavement thickness required over the subgrade, or to prevent intrusion of the subgrade into the base, or to provide a working platform.

Substrates: The surface to which a material or product is applied.

Soldier course: A course of whole or trimmed rectangular pavers at the pavement restraint edge. Also known as a Header course.

Threshold treatment: A section of a lane with changed pavement marking or surfacing, to indicate a change in speed environment.

Unit: A single paver.

1.1.5 Submissions

1.1.5.1 General

Conform to Hold points and witness points.

Drawings: Prepare drawings or other documentation to record extent and constitution of final works in accordance with Requirements for Works as Executed quality records, TCCS.

Margins: If it appears that minor variations in joint widths or overall dimensions will avoid cut pavers, submit a proposal.

1.1.5.2 Samples

Samples: Submit two samples of each different type and/or source of paving for approval by the Authorised Person prior to ordering. Samples are to be indicative of the paver to be supplied for each different type of paving.

Inspection type: **HOLD POINT.**

1.1.6 Hold points and witness points

1.1.6.1 Notice

General: Give written notice to the Authorised person so that the documented inspection and submissions may be made to the **Hold point table** and the **Witness point table**.

Table 7-1 Hold point table

Item	Clause Title	Requirement	Notice for inspection	Release by
General				
7.1	Samples	Submit two samples of each different type and/or source of paving.	5 working days before ordering	Authorised Person
Pre-construction planning				
7.2	Quality plan	Prepare and submit Quality plan including Inspection and Test Plan.	2 weeks before commencing site work	Authorised Person
Materials				
7.3	Nominated materials	For each paver type submit samples and test results stating source and demonstrating conformance.	5 working days before ordering	Authorised Person
Execution				
7.4	Base	Present the finished base and all test/survey results conforming to <i>MITS 04 Flexible pavement construction</i> or <i>MITS 06 Concrete kerbs, footpaths and minor works</i> as appropriate.	1 working day before commencing placement of bedding sand	Authorised Person
7.5	Substrate	Present the finished substrate and all test/survey results demonstrating conformance of material properties, compaction and levels.	1 working day before commencing placement of bedding/adhesive.	Authorised Person

Table 7-2 Witness point table

Item	Clause title	Requirement	Notice for inspection
Execution			
7.1	Laying pavers – mortar and adhesive bed	Complete trial set out for each area	Progressive
7.2	Laying pavers – sand bedding	Complete trial set out for each area	Progressive
7.3	Screeding	Re-inspect screed left more than 1 day	Progressive
7.4	Inspection	Regularly inspect joints after completion	Progressive

1.2 Pre-construction planning

1.2.1 General

1.2.1.1 Traffic management

General: Take all necessary steps to avoid or minimise delays and inconvenience to all users of the road reserve or open space area during the course of the work but without compromise to the safety of the employees and the public or quality of the works.

Plan: Submit a Traffic Management Plan for approval in conformance with *MITS 01 Traffic Management*.

1.2.2 Activity plan

1.2.2.1 Quality plan

Requirements: Prepare and submit a quality plan for the paving construction consistent with the drawings and subject to direction by the Authorised Person. Include the following:

- > A time based program to conform to contract schedule, if required under the contract.
- > Allocation of plant and personnel for the contract period, if required under the contract.
- > The proposed laying technique for each laying pattern.
- > Layout of control joints.
- > Finished levels.
- > Grouting methods and materials.
- > Inspection and Test Plan.
- > Work programming to meet the requirements of the HOLD POINT table and the WITNESS POINT table.

This is a **HOLD POINT**.

1.3 Materials

1.3.1 Nominated materials

1.3.1.1 General

Submissions: Submit details and samples of all proposed segmental paving materials, including the following:

- > Sand: Provide certification of the grading and quality to *AS 1141.11.1*.
- > Segmental pavers: Submit the following type test results from a NATA registered laboratory:
 - > Characteristic breaking load and flexural strength: To *AS/NZS 4456.5*.
 - > Dimensional deviations: To *AS/NZS 4456.3*.
 - > Abrasion resistance: To *AS/NZS 4456.9*.
 - > Salt attack resistance grade: To *AS/NZS 4456.10*.
 - > Slip resistance type test: To *AS 4586 Appendix A*.
 - > Slip resistance site test of completed paving: To *AS 4663 Appendix A*, if required by the contract or this Specification.
 - > Adhesive: Classification to *AS ISO 13007.1*.
 - > The source of supply.

Inspection type: **HOLD POINT**.

Recycled materials: Recycled pavers may be used, provided they meet all the criteria set out in this Specification.

Approved palette: Conform to approved paving types and designs for works within Canberra City. Refer to Canberra Central Design Manual.

1.3.2 Marking

1.3.2.1 Identification

General: Deliver materials to the site in the manufacturer's original sealed packaging, legibly marked to show the following:

- > Manufacturer's identification.
- > Product brand name.
- > Product type.
- > Quantity.
- > Product reference code and batch number.
- > Date of manufacture.
- > Material composition and characteristics such as volatility, flash point, light fastness, colour and pattern. Provide technical data sheets if not shown on labels.
- > Handling and installation instructions.
- > Material safety data sheets.

1.3.3 Concrete segmental pavers

1.3.3.1 Properties

Appearance: Concrete paving units shall be sound, firm, dense, dimensionally stable and consistent, with a smooth unblemished upper surface and with unrumpled units having unbroken arrises, chamfered or radiused as specified evenly all round. Units which exhibit cracking, "boniness" or are considered by the Authorised Person to be excessively porous, brittle or friable shall be liable to rejection. Paving unit colours shall be uniform and shall match that of approved sample units over the full area of the pavement.

Requirements: To the **Paving schedule - driveways table**, the **Paving schedule - public footpaths table** and the **Paving schedule - Roads table** when tested to **Nominated materials**.

1.3.3.2 Production

Dry pressed: Concrete paving units shall be manufactured from cohesive concrete (zero slump) placed into block machine moulds. The units shall be mechanically vibrated and extruded after sufficient strength has developed to permit handling without distortion. Concrete shall be constantly cured.

Wet cast: Concrete paving units shall be mechanically vibrated in separate moulds and retained within the mould for 24hrs before stripping. Concrete shall be constantly cured.

1.3.3.3 Standards

General: To *AS/NZS 4455.2* and *MITS 06 Concrete kerbs, footpaths and minor works*.

Requirements:

- > Cement: To *AS 3972*. Colour shall be added to achieve the desired paver colour.
- > Lime: To *AS 1672.1*.
- > Fly ash: To *AS 3582.1*.
- > Pigments: To *BS EN 12878*.
- > Aggregate: To *AS 2758.1*.
- > Admixtures: To *AS 1478.1*.
- > Water: Provide clean water, free from oil, acid, alkali, organic or vegetable matter to *AS 1379*.
- > Dimensions: Maximum chamfer to *AS/NZS 4455.2*.

Permeable interlocking concrete pavers: To *CMAA PE01*.

Concrete segmental paving: To *CMAA PA01*, *CMAA PA02* and *CMAA PA03*.

Dimensional deviations: To *AS/NZS 4455.2 Table 2.2(A)* and *AS/NZS 4455.2 Table 2.2(B)*.

1.3.4 Clay segmental pavers

1.3.4.1 Properties

General: Clay paving units shall be solid units, pressed or extruded, cut or moulded then dried and fired to achieve the specified properties, dimensions and edge treatment. Surface coatings shall not be applied to clay paving units without the prior written approval of the Authorised Person.

Appearance: Clay paving units shall be sound, firm, dense, free of distortion, dimensionally stable and consistent, with a smooth upper surface and with unrumpled units having unbroken arrises, chamfered or radiused as specified evenly all round. Units which exhibit cracking, bloating or are considered by the Authorised Person to be excessively porous, brittle or friable shall be liable to rejection. Paving unit colours shall fall within the colour range of the approved sample units over the full area of the pavement.

Requirements: To the **Paving schedule - driveways table**, the **Paving schedule - public footpaths table** and the **Paving schedule - Roads table** when tested to **Nominated materials**.

Pitting due to lime: maximum Moderated as defined in *AS/NZS 4456.13*.

1.3.4.2 Standards

General: To *AS/NZS 4455.2*.

Clay segmental paving: To *CPBI Manual 1*.

Dimensional deviations: To *AS/NZS 4455.2 Table 2.2(A)* and *AS/NZS 4455.2 Table 2.2(B)*.

1.3.5 Sand

1.3.5.1 General

Quality: Provide well-graded, clean, washed, non-plastic, hard sand, with uncoated grains of uniform quality and free of deleterious material, such as soluble salts or other contaminants which may cause efflorescence.

Storage: Cover sand on site to protect from rain.

Cement: Do not use cement bound material.

1.3.5.2 Bedding sand

General: Crushed gravel, granulated glass or natural sand.

Fines: Do not use single-sized, gap-graded or excessive fine material. Crushed stone such as 'crusher dust' or dolomite is unsuitable. Fatty sands, loams or packing sands are unsuitable.

Moisture content: 4 – 8% and uniform when spread.

Grading: Obtain material from a single source or blend to conform to the **Bedding sand grading table** when tested to *AS 1141.11.1*.

Table 7-3 Bedding sand grading table

AS Sieve	Segmental paving % Passing	Permeable paving % Passing
9.52mm	100	100
4.75mm	95–100	85-100
2.36mm	80–100	10-40
1.18mm	50–85	0-10
600µm	25–60	
300µm	10–30	0-5
150µm	5–15	
75µm	0–10	

1.3.5.3 Joint filling sand

General: Sand used for bedding is not suitable for joint filling.

Grading: Conform to the **Joint filling sand grading table** when tested to *AS 1141.11.1*.

Moisture content: Dry when spread.

Table 7-4 Joint filling sand grading table

AS Sieve	Segmental paving % Passing	Permeable paving % Passing
9.52mm	100	100
4.75mm	100	85-100
2.36mm	100	10-40
1.18mm	90–100	0-10
600µm	60–90	
300µm	30–60	0-5
150µm	15–30	
75µm	5–10	

1.3.6 Adhesives**1.3.6.1 General**

Scope: The inclusion of adhesives in this Specification refers to adhesive fixed pavers on a cementitious topping.

Standard: To *AS 2358* or *AS ISO 13007.1*.

1.3.6.2 Type

General: Provide adhesives compatible with the materials and surfaces to be adhered.

Prohibited uses: Do not provide the following combinations:

- > Organic PVC-based adhesives and organic natural rubber latex adhesives in damp or wet conditions.
- > PVA (polyvinyl acetate) based adhesives in wet areas or externally.

1.3.7 Mortar

1.3.7.1 Materials

Cement: To AS 3972.

- > Type: GP.
- > White cement: Iron salts content \leq 1%.
- > Off-white cement: Iron salts content \leq 2.5%.

Lime: To AS 1672.1.

Sand: Fine aggregate with a low clay content selected for grading, sharp and free from efflorescing salts.

Water: Clean and free from any deleterious matter.

Measurement of volume: Measure binders and sand by volume using buckets or boxes. Do not allow sand to bulk by absorption of water.

1.3.7.2 Bedding mortar

Quality: A mixture of washed sand and fatty sand or fatty sand only may be used depending on the laying technique proposed. If only washed sand is proposed to be used the Contractor shall take other precautions to ensure adhesion of the pavers to the slab.

Proportioning: Select proportions of 1 part cement: 3 parts sand by volume to obtain satisfactory adhesion. Provide minimum water for total hydration of the cement to occur.

Mixing: To AS 3958.1 clause 2.15.

Gauging: Site gauged by volume.

1.3.8 Grout

1.3.8.1 Type

General: Mix portland cement with fine sand. Provide minimum water to achieve workability.

- > Proportion: 1 cement: 3 sand by volume.

Specialist applications: Where joint widths are >5 mm use a proprietary high strength, low shrink grout prepared according to the manufacturer's instructions.

1.3.8.2 Pigments

Pigments for coloured grout: Provide colourfast pigments compatible with the grout material. For cement-based grouts, provide inorganic mineral pigments or lime-proof synthetic metallic oxides compatible with cement.

1.3.8.3 Water

General: Clean and free from any deleterious matter.

1.3.9 Other materials

1.3.9.1 Control joint materials

General: To *MITS 06 Concrete kerbs, footpaths and minor works* unless otherwise specified.

Divider strip: A proprietary expansion joint consisting of a neoprene filler sandwiched between plates with lugs or ribs for mechanical keying. Set flush with the finished surface according to the manufacturer's instructions.

Proprietary slide plate divider strip: An arrangement of interlocking metal plates grouted into pockets formed in the concrete joint edges.

Sealant: Self-levelling, flexible and mould resistant. Finish flush with the paver surface.

Floors: Trafficable, shore hardness more than 35.

Backing rod: Compressible closed cell polyethylene foam with a bond-breaking surface.

1.3.9.2 Stone setts

Description: Igneous stone cubed cobble style setts.

1.3.9.3 Tactile Ground Surface Indicators

Standard: To *AS/NZS 1428.2* and *AS/NZS 1428.4.1*.

1.3.9.4 Sealants, etchants and polishes

General: Apply any sealants, etchants or polishes in accordance with the contract drawings and manufacturers specification.

Site test: Submit slip resistance site test results for completed paving.

1.3.10 Geotextile materials

1.3.10.1 General

Quality: Free of flaws, stabilised against UV radiation, rot proof, chemically stable and with low water absorbency. Filaments resistant to delamination and dimensionally stable.

Standard: To *AS 3705*, *MITS 08 Incidental works* and *AGPT04G*.

Specification: Provide geotextile materials as specified on the drawings.

1.3.11 Concrete for edge restraints

1.3.11.1 Properties

General: To *MITS 06 Concrete kerbs, footpaths and minor works*.

Concrete: To *AS 1379*.

Strength: If not shown on the drawings, or provided by kerb and/or gutter (channel), provide concrete edge restraints for pavers with the following minimum 28-day characteristic compressive strength:

- > Edge restraints for pavers on road pavements: 32MPa.
- > Edge restraints for pavers on medians, traffic islands and driveways: 32MPa.

1.3.12 Selections

General: Provide pavers and flags as specified on the drawings. Refer to the schedules below where information has been omitted.

Table 7-5 Paving schedule – driveways table

Application	Characteristic breaking load ⁽ⁱⁱⁱ⁾ (kN)	Characteristic flexural strength ⁽ⁱⁱⁱ⁾ (MPa)	Min. Thickness (mm)	Shape (type) ^(iv)	Dimensional deviations (Category from AS 4455)	Slip resistance (Class from AS 4586) ^(v)	Abrasion resistance (mean abrasion index)
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Pavers

Domestic ⁽ⁱ⁾	5	2	40	Any	DPA1 or DPB1	P4	7
Heavy Duty ⁽ⁱⁱ⁾	5	3	60	Any	DPA1 or DPB1	P4	7

Flags

Domestic ⁽ⁱ⁾	7	2	50	Any	DPA2 or DPB2	P4	7
Heavy Duty ⁽ⁱⁱ⁾	7	3	60	Any	DPA2 or DPB2	P4	7

Table 7-6 Paving schedule – public footpaths table

Application	Characteristic breaking load ⁽ⁱⁱⁱ⁾ (kN)	Characteristic flexural strength ⁽ⁱⁱⁱ⁾ (MPa)	Min. Thickness (mm)	Shape (type) ^(iv)	Dimensional deviations (Category from AS 4455)	Slip resistance (Class from AS 4586) ^(v)	Abrasion resistance (mean abrasion index)
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Pavers

No vehicle access ^(vii)	3	3	50	Any	DPA2 or DPB2	P4	5.5
Occasional vehicle access	5	3	60	Any	DPA2 or DPB2	P4	3.5

Flags

No vehicle access ^(vii)	7	3	50	Any	DPA2 or DPB2	P4	5.5
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Table 7-7 Paving schedule – Roads table

Traffic Category (TC) ^(vi)	Characteristic breaking load ⁽ⁱⁱⁱ⁾ (kN)	Characteristic flexural strength ⁽ⁱⁱⁱ⁾ (MPa)	Min. Thickness (mm)	Shape (type) ^(iv)	Dimensional deviations (Category from AS 4455)	Slip resistance (Class from AS 4586) ^(v)	Abrasion resistance (mean abrasion index)
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Pavers

Rear lanes & Access streets	6	3	80	Any	DPA2 or DPB2	P4	5
Collector roads	6	3	80	A	DPA2 or DPB2	P4	5
Industrial Zone Pavement (v)	10	4	80	A	DPB3	P4	7

Notes: Paving schedules

- i. Refer to **Definitions** and *MITS 07 Segmental paving*.
- ii. Heavy Duty driveways shall be laid as a rigid pavement on a reinforced base, refer to *MITS 07 Segmental paving*.
- iii. At 28 days for concrete paving units.
- iv. For concrete paving units. Interlocking shapes offer superior performance in road applications.
- v. For level surfaces. Where the finished surface grade is steeper than 1:14 in any direction, the minimum class shall be P5.
- vi. Traffic Categories as defined in the *Estate Development Code*.
- vii. Where vehicles are physically prevented by use of permanent bollards, fences or equivalent.

1.4 Execution

1.4.1 Site establishment

1.4.1.1 Survey

Requirement: Confirm site surface and benchmarks. Conform to *MITS 00 Preliminaries*.

1.4.2 Provision for traffic

1.4.2.1 General

Requirement: Conform to *MITS 01 Traffic Management*.

1.4.3 Subgrade preparation

1.4.3.1 Preparation

Extent: Prepare the subgrade required depth below the finished surface level and to the required profile. Extend to the rear face of the proposed edge restraints or to the face of existing abutting structures.

Subgrade preparation: To *MITS 02 Earthworks*.

Tree root protection: Where tree root control measures have been specified, spread approved root control granules containing dichlobenil at the rate of 1kg per m³ of soil. Mechanically till the subgrade and chemical to provide an intimate mixture to a minimum depth of 100mm.

1.4.3.2 Drainage of subgrade

Subgrade drainage: Prepare piped or channelled stormwater and subsoil drainage to *MITS 03 Underground services*.

Service trenches: Backfill all drainage trenches to *MITS 03 Underground services*.

1.4.4 Subbase

1.4.4.1 Dimensions and specification

Construction: If shown on the drawings, construct subbase, to conform to *MITS 04 Flexible pavement construction* or *MITS 06 Concrete kerbs, footpaths and minor works* as appropriate.

1.4.5 Base

1.4.5.1 Flexible pavements

Construction: To *MITS 04 Flexible pavement construction* or *MITS 06 Concrete kerbs, footpaths and minor works* as appropriate.

Extent: Extend the base course in width below the edge restraint for its full width except at walls or pits.

Base surface drainage: Free without ponding.

Inspection type: **HOLD POINT**.

Remedial work: Do not use sand bedding material as a levelling material to compensate for base finishing outside the tolerance for bedding sand thickness (refer to *MIT S 04 Flexible pavement construction*) If the bedding sand thickness shall exceed the specified tolerance then rework and recompact the base layer to meet allowable tolerances.

1.4.5.2 Rigid pavements

General: Pavers shall be laid on mortar on a rigid concrete base where required by this specification or on the Drawings. Pavers must be laid with movement joints coincident with the contraction or expansion movement joints in the underlying concrete base. Both the joints in the concrete pavement and the overlying movement joints in the pavers must be sealed against water infiltration.

Construction: Base to *MIT S 06 Concrete kerbs, footpaths and minor works* or *TRITS 05 Rigid pavement construction* as appropriate.

1.4.6 Laying pavers

1.4.6.1 Laying Patterns

Laying patterns: Patterns of pavers are identified in the **Laying patterns figure**. A variation of Stretcher is the Zig Zag Running Bond. Each of these may be laid at either 90° or 45° to the line of edge restraints to achieve the required visual orientation of paving units. Concrete and clay pavers for road pavements shall be aligned either parallel or perpendicular to the direction of traffic (refer to the **Traffic directions for laying patterns figure**).

Laying patterns for road pavements: Unless otherwise specified, concrete and clay pavers for road pavements shall be placed in Herringbone laying pattern. Herringbone patterns are preferred because of a greater degree of interlock and the absence of continuous joints.

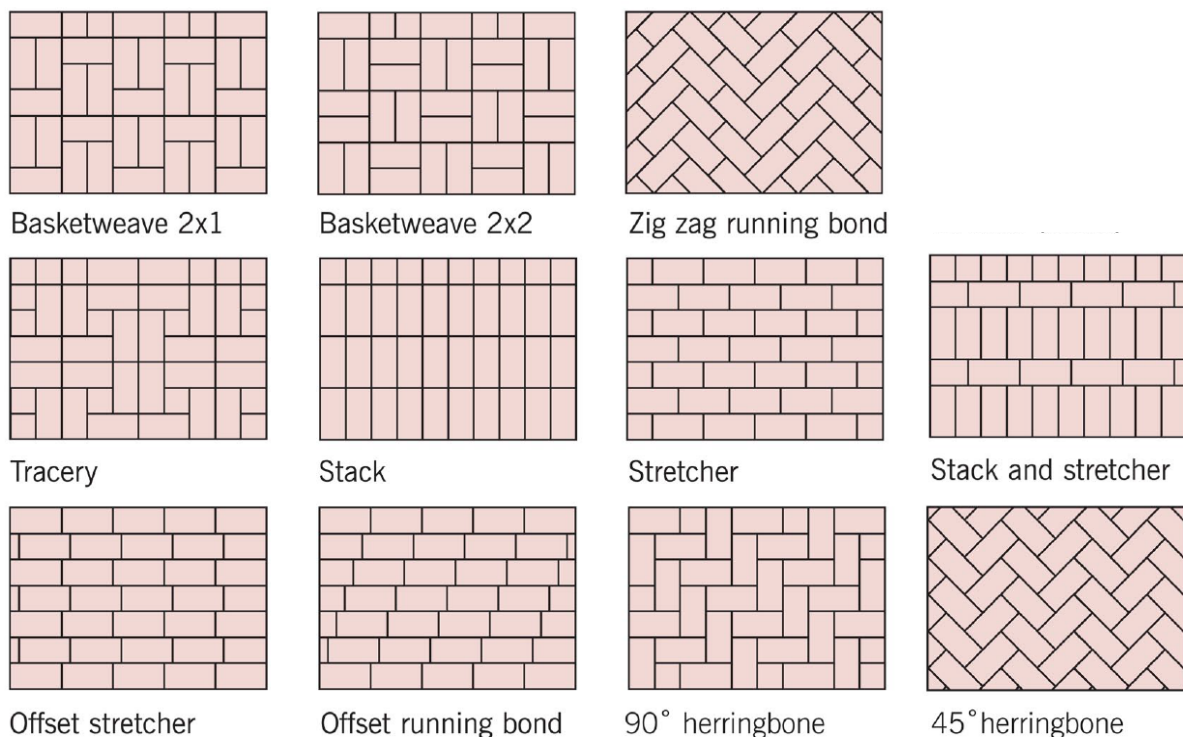


Figure 7-1 Laying patterns figure (courtesy of Think Brick Australia)

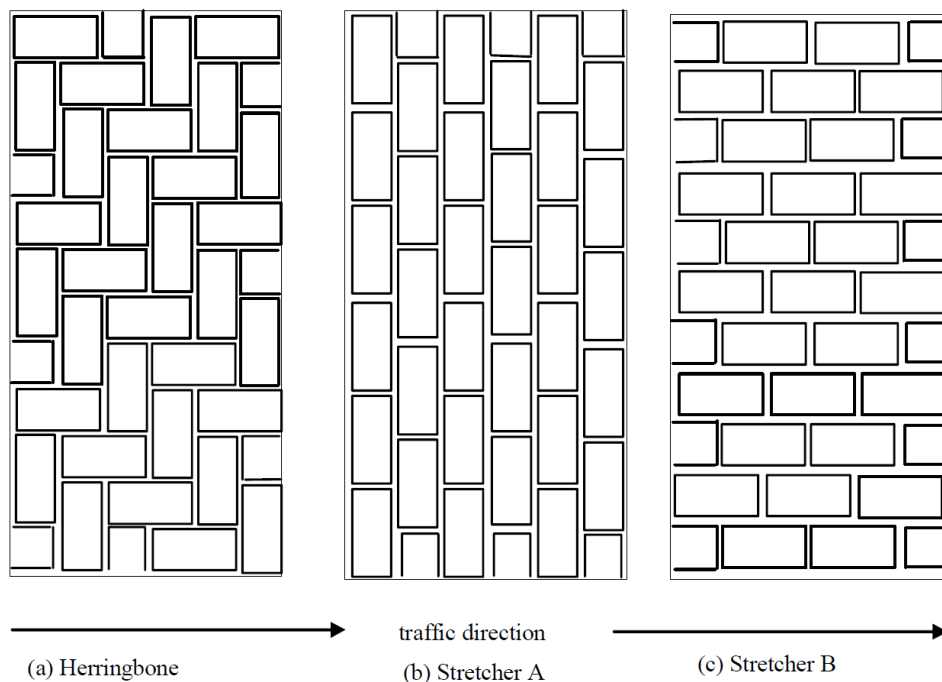


Figure 7-2 Traffic directions for laying patterns figure (courtesy of Think Brick Australia)

1.4.6.2 General

Segmental paving pattern: Lay paving units on the screeded sand bedding to the documented pattern. Prepare a trial set-out for each area to the satisfaction of the Authorised Person.

This is a **HOLD POINT**.

Joints: 2 to 5mm gap after bedding compaction and joint filling operations, unless otherwise shown on the drawings. All joints shall be correctly aligned and no contact shall exist between adjoining paving units.

Control: Control alignment and laying pattern by stringlines or chalked stringlines at every 5m interval.

Sequence: Lay first row next to edge restraint or established straight line. Start laying from the kerbside margin or low point, where applicable.

Cut courses: 50mm minimum plan dimension. On footpaths and other linear elements, use at least two cut courses and maintain symmetry.

Variation: Sequence pallet production and mix the pallets across the Works to evenly distribute colour and size variation between pallets over the paved area.

1.4.6.3 Manual laying

Odd shapes: In each row, first lay the full units and follow with cut closure units. All units are to be wet cut using a power diamond saw unless prior written approval is obtained from the Authorised Person for the use of other means of cutting.

Water management: Cut units in a designated area. Do not allow water to flow into the laying area or into the stormwater system. Discharge water from site in accordance with EPA requirements and *MITS 02 Earthworks*.

Margins: Provide whole or purpose-made pavers at margins where practicable, otherwise set out to give equal margins of cut pavers. If a margin less than half paver width is unavoidable, locate the cut paver where it is least conspicuous. The use of a soldier course adjacent to the edge restraint is recommended. Where margins exist, start layout work from both ends and work towards the middle.

Infill: Use random jointing at right angles to the margin where the laying pattern permits. Minimise the use of slender infill pieces by making local adjustments to the main laying pattern. Infill spaces between 25 to 50mm wide with in situ 32MPa concrete. Infill strips to have a maximum aggregate size of 10mm.

Use infill strips to make a straight area for paving and take up the variable width. Dry packed mortar may be used to infill spaces smaller than 25mm wide. In all cases, the infill is to extend for the full depth of the adjoining paving units. Concrete and mortar shall be coloured to match the paving units, with due allowance being made for the effects of weathering.

Sloping sites: Pave in an uphill direction where possible to avoid downhill creep during laying.

1.4.6.4 Laying around obstacles

Consultation: Obtain clearance or design acceptance from relevant utility authority prior to any work adjacent to utility assets. This shall include any concrete surrounds or proposed level changes to pit covers.

Placement and jointing: Neatly diamond saw cut pavers as required adjacent to edges and obstacles.

Concrete surround: Finish public utility access pits, drainage pits and similar penetrations in the pavement with a concrete surround, conforming to the following:

- > Strength grade: N32.
- > Plan shape: Square or rectangular with a smooth connection with the laying pattern of the pavers.
- > Pit position: Centring not required.
- > Minimum thickness between the pit and paving: 100mm.
- > Colour: Grey.

Pit covers: Obtain relevant approvals to adjust the levels of pit covers before paving around them. Ensure that water drains away from closed pits.

Precast access chamber: Lay pavers to suit specific dimensions of authority access chambers.

Public utility access pits and penetrations: Adjust access covers as required before commencing paving. Make sure water drains away from pits with lids and into surface inlet drainage structures.

Patterns around obstacles: Lay up both sides of the feature from the main or original laying face.

1.4.7 Flexible pavements

1.4.7.1 Edge Restraints

Extent: Provide edge restraints along the perimeter of all segmental paving where not provided by other structures and as shown on the drawings. Make sure the faces of edge restraints abutting pavers are vertical.

Edge restraint support: On compacted base or subbase.

Drainage: Position edge restraint and pavers so that the top of the pavers are slightly above the front edge of the edge restraint.

Backfilling: Backfill at least 3 days after placing concrete unless otherwise directed by the Authorised Person.

Compaction: Backfill behind the edge restraint with earth, compacted in layers not greater than 150mm thick, and complete with topsoil to finished design levels.

Sleeper edging: Fix sleepers in position by spiking with two 13mm diameter galvanized mild steel rods per sleeper, penetrating at least 400mm into the subgrade. Drive the rods flush with the upper surface of the sleeper. Arris the upper exposed sleeper edges to produce a 15mm wide face at 45 to the edges.

Concrete edging or kerb: Fixed form, extrusion or slip forms to *AS 2876* and *MITS 06 Concrete kerbs, footpaths and minor works*. Finish flush with the adjacent finished grass level. Provide contraction joints 20mm deep every 5m. Carry out concrete edge restraints before bedding course. Allow concrete edge restraints to harden before vibration of the surface course.

Brick: Mortared brick or paver unit edging or header courses shall be set on a minimum 10mm thick bed of cement 1:1:6 (cement:lime:sand) mortar haunch. Joints to be 3mm struck flush. Align evenly, free from dips, humps and bends. Wash off mortar progressively.

1.4.7.2 Sand bedding course

Preparation: Remove all loose material from the prepared base.

Storage: Bedding sand shall be covered when stored on site to protect it from rain penetration.

Screeding: Spread the sand bedding course in a single uniform layer and screed in a loose condition to the nominated design profile and levels. Protect against compaction from any cause, including rain both prior to and following screeding.

Progressive screeding: Do not screed in advance of the laying face at the completion of work on any day.

Depressions: Before laying pavers, loosen, rake and re-screed any depressions in the screeding sand exceeding 5mm.

Remediation: If screeded sand left overnight is subject to rain, check for level and re-screed where necessary before pavers are placed.

Inspection type: **WITNESS POINT.**

Bedding course drainage: If water ponding can occur at edge restraint, drain bedding course to existing subsurface drain or drainage pit using geotextile and 20mm diameter PVC-U pipe.

Moisture content: Prepare a trial section to establish the moisture content limits which will allow paver system compaction to be achieved. Maintain sand at a uniform moisture content.

Depth: Prepare a trial section to establish the depth required to achieve 25mm \pm 5 mm after compaction.

Manual placing of pavers: Maintain the bedding sand at a uniform loose density.

Mechanised laying: Provide firm, uniform but not full compaction.

1.4.7.3 Bedding compaction

Compactor: Compact the sand bedding after laying the pavers with not less than two passes of a high frequency low amplitude plate compactor with carpet cover which covers at least 12 units. Continue compaction until the design level is achieved and level differences between units are within tolerance.

Lippage: Maximum 2mm level difference between the adjoining edges of any two pavers.

Damage: Replace any pavers which are damaged during bedding compaction and re-compact the pavement for at least 1m surrounding each replacement unit.

Progressive compaction: Arrange the paving operations as follows:

- > Progressively compact behind the laying face.
- > Complete compaction of laid paving at end of each day.
- > Do not compact within 1m of laying face except where adjacent to edge restraint.

1.4.7.4 Finished levels

Design level: To design drawings.

Finished level of edge restraints and drainage inlets: Minimum 5mm below the finished paving level.

Changes of grade: Ease changes of grade over minimum 3 unit lengths to avoid protuberance of adjoining units.

Final surface drainage: Free without ponding.

1.4.7.5 Filling joints

Timing: Compact all paving units to design levels before starting joint filling. Complete joint filling of laid paving as soon as possible. Protect the works from inclement weather at the end of each day.

Spreading: Spread the joint filling sand over the pavement and fill the joints by brooming.

Compaction: After spreading, make one or more passes of a plate compactor and refill the joints. Repeat the process until the joints are completely filled. For road pavements, or where specified, additional compaction shall then be carried out using between 5 and 10 passes of pneumatic tyred roller or equivalent, having a gross weight of not less than 10 tonnes.

1.4.8 Rigid pavements

1.4.8.1 Substrate Preparation

General: Make sure substrates are as follows:

- > Clean and free of any contaminants or finish which may impair adhesion or location of pavers.
- > Projections are removed and voids and hollows are filled with a cement-sand mix not stronger than the substrate nor weaker than the bedding.
- > Inspection type: **HOLD POINT**.

Absorbent substrates: If suction is excessive, control it by dampening but avoid over-wetting and do not apply mortar bedding to substrates showing surface moisture.

Dense concrete: If not sufficiently rough to provide a mechanical key, roughen by scabbling or the like to remove 3mm of the surface and expose the aggregate then apply a bonding treatment.

Drying and shrinking: Before paving, allow for sufficient time to elapse for curing and initial shrinkage of the substrate in accordance with the design and contract drawings.

Trial set out: Prepare a trial paving set-out to each area as follows to:

- > Maximise the size of equal margins of cut pavers.
- > Locate control joints.
- > Note minor variations in joint widths to eliminate cut pavers at margins.

This is a **WITNESS POINT**.

Ambient temperature: If the ambient temperature is less than 5°C or more than 35°C, do not lay mortar or adhesive bedded pavers.

Fixtures: Before paving make sure that fixtures interrupting the surface are accurately positioned in their designed or optimum locations relative to the paving layout.

1.4.8.2 Mortar bedding

Preparation of pavers: Soak porous pavers in water and then drain until the surface water has disappeared.

Bedding: Use bedding methods and materials which are appropriate to the paver, the substrate, the conditions of service, and which leave the paver firmly and solidly bedded in the bedding material and adhered to the substrate. Form falls integral with the substrate.

Substrate preparation: Either lightly dust the screeded bed surface with dry cement and trowel level until the cement is damp, or spread a thin slurry of neat cement, on to the paver back. Do not provide mortar after initial set has occurred.

Nominal thickness: 20 to 40mm

Quantity: The volume of mixed mortar bedding shall not exceed that required for the area of paving units to be laid in a period of 2 hours. Adequate precautions shall be taken to protect the mortar from adverse weather conditions.

Stone setts dry bed: Lay and tamp setts on to a dry sand and cement mix, compact and moisten as follows:

- > Bed: 1 cement: 3 sand by volume, screeded to the level required to allow setts to be firmly tamped.
- > Select the top side of the sett for surface uniformity and tap into the mix to the pre-compaction position.
- > Compact with a hand ram or mechanical compactor.
- > Water spray the surface and allow the bedding to harden.
- > Grout joints.

1.4.8.3 Adhesive bedding

Adhesive bedding: Fix pavers dry.

Bedding: Use bedding methods and materials which are appropriate to the paver, the substrate, the conditions of service, and which leave the paver firmly and solidly bedded in the bedding material and adhered to the substrate. Form falls integral with the substrate.

Thick adhesive beds: Provide on substrates with deviations up to 6mm when tested with a 2m straight edge, and with pavers having deep keys or frogs with depressions greater than 10mm.

Nominal thickness: 6mm.

Adhesive bedding application: Apply adhesive by notched trowel to substrates and direct to pavers if required, to provide evenly distributed coverage of more than 90% after laying.

Pattern of distribution of adhesive: Conform to AS 3958.1. Verify by examining one paver in ten as work proceeds.

Grouting: Allow the adhesive to cure for the period recommended by the manufacturer before grouting.

1.4.9 Movement joints

1.4.9.1 General

General: Provide control joints as follows:

Location:

- > Over structural control joints.
- > At internal corners.
- > Close to external corners in large paved areas.
- > Around the perimeter at abutments.
- > At junctions between different substrates.
- > To divide large paved areas into bays, maximum 5m wide, maximum area 16m².
- > At abutments with the building structural frame and over supporting walls or beams where flexing of the substrate is anticipated.

Requirement: To *MITS 06 Concrete kerbs, footpaths and minor works* unless specified otherwise.

Joint: 10mm thick filled with jointex or equivalent. The jointing material shall be of a width equal to the paving units against which it is to be laid.

Method: Apply jointing material firmly against the clean face of the adjoining restraint and push paving units firmly against the jointing to prevent intrusion of stones or other contaminants.

1.4.10 Grouted joints

1.4.10.1 Grouted joints

General: Commence grouting as soon as practicable after bedding has set and hardened sufficiently. Clean out joints as necessary before grouting.

Face grouting: Fill the joints solid and tool flush. Clean off surplus grout and wash down as the grouting proceeds.

1.4.11 Tolerances

1.4.11.1 Tolerances

General: Conform to the following:

- > Absolute level tolerance: +10mm.
- > Relative level tolerance: ±4mm.

Lippage:

- > Unpolished pavers: < 2mm.
- > Polished pavers 300 x 300mm or less: 1mm, with < 5% exceeding 1.5mm.
- > Polished pavers over 300 x 300mm: 1.5mm, with < 5% exceeding 2mm.

Changes of grade: Subject to easing constraints, the surface shall not deviate more than 5mm from a 3m straight edge.

1.5 Completion

1.5.1.1 Protection of the work

Restrictions: Do not allow traffic to use the pavement until compaction and joint filling operations have been completed or until the mortar or adhesive bedding has set and attained its working strength.

Foot or barrow traffic: Provide boards overlaying paving to prevent disturbance of pavers before all compaction and joint filling is completed and all edge restraints are in place.

Construction traffic: Do not allow construction traffic on the pavement before all compaction and joint filling is completed and all edge restraints are in place. Construction traffic may be encouraged to use the pavement after joint filling, do not allow traffic within 1m of the working face or other unrestrained edge.

Cleaning: Keep the work clean as it proceeds and protect finished work from damage.

1.5.1.2 Submissions

Work as Executed Records: To *MIT'S OOB Quality Requirements*.

1.5.1.3 Opening to traffic

Excess sand: Remove excess joint filling sand before opening to traffic.

Cleaning: Removing mortar stains and leave pavements clean on completion.

1.5.1.4 Inspection

Joint filling: Inspect the pavement at regular intervals during the Defects Liability Period to make sure that all joints remain completely filled.

Inspection type: **WITNESS POINT**.

1.5.1.5 Final inspection

General: Before the date for practical completion carry out the following inspections:

- > Subsidence: Offset less than 1.5m length of the design profile, not more than 5mm.
- > Stepping: Between adjacent elements within the pavement area, not more than 5mm.
- > Chipping and spalling to pavement units: Maximum 10 per 100 units with chipped or spalled arrises.
- > Ponding: Maximum 10mm deep 15 minutes after rain ceases.
- > Paving joints: Refill joints as required.

2 MEASUREMENT AND PAYMENT

2.1 Measurement

2.1.1.1 General

Payments made to the Bill of Quantities: To *MITS 00 Preliminaries*, this Specification, the drawings and the **Pay items table**.

2.1.1.2 Methodology

The following methodology will be applied for measurement and payment:

- > Allow for all work, materials, testing and quality assurance requirements in each Pay Item.
- > Excavation and preparation of subgrade *MITS 02 Earthworks*.
- > Subbase and Base: *MITS 04 Flexible pavement construction* or *MITS 06 Concrete kerbs, footpaths and minor works* as appropriate.
- > Kerb and gutter: *To MITS 06 Concrete kerbs, footpaths and minor works*.
- > Edge strips: In conformance with this Specification and not *MITS 06 Concrete kerbs, footpaths and minor works*.
- > *Miscellaneous minor concrete work* not included in **Pay items**: *To MITS 06 Concrete kerbs, footpaths and minor works*.

2.2 Pay items

Table 7-8 Pay items table

Item No	Pay items	Unit of measurement	Schedule of rates scope
07.1	Segmental Paving	m ² of gross paving area including manholes, pit covers and tree pits.	<p>This pay item shall include all setting out, excavation, backfilling, preparation, supply of bedding mortar or sand, jointing sand and sealant, laying, cutting pavers at interfaces with different pavement types, structures, posts etc., vibration and compaction as required.</p> <p>A separate pay item shall be included in the Contract for each pavement design. For example;</p> <ul style="list-style-type: none"> 07.1.1 Segmental Paving – Road Pavements (Pattern and Thickness) 07.1.2 Segmental Paving – Other Than Road Pavements (Pattern and Thickness) 07.1.3 Tactile Pavers (Directional) 07.1.4 Tactile Pavers (Warning)



Transport Canberra and
City Services

July 2019