

Engineering Construction Specification C12 Segmental Paving

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1 General

1.1 Responsibilities

1.1.1 General

Requirement: Provide segmental paving, as documented.

1.2 Cross references

1.2.1 General

Requirement: This worksection is not a self-contained specification. In addition to the requirements of this worksection, conform to the following:

- *C01 General requirements (Construction)*
- *C02 Quality management (Construction)*
- *C03 Control of traffic*
- *C04 Control of erosion and sedimentation (Construction)*
- *C06 Earthworks (Road reserve)*
- *C07 Stabilisation*
- *C08 Flexible pavement base and subbase*
- *C11 Kerbs and channels (gutters)*
- *C14 Subsurface drainage*

1.3 Standards

1.3.1 General

Standards: To AS 3727.1.

1.4 Interpretation

1.4.1 Abbreviations

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

- CBR: California bearing ratio.
- CMAA: Concrete Masonry Association of Australia.
- MDD: Maximum dry density.
- PICP: Permeable interlocking concrete pavement.

1.4.2 Definitions

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

- Absolute level tolerance: Maximum deviation from design levels.
- Base: One or more layers of material, forming the uppermost structural element of a pavement and on which the surfacing may be placed.
- Clay segmental 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 m² 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.
- Lippage: Height deviation between adjacent units.
- Permeable pavers: Segmental paving units designed and manufactured for PICP, to permit rapid infiltration of rainfall.
- Relative level tolerance: Maximum deviation from a 3 m straightedge laid on the surface.

1.5 Tolerances

1.5.1 Base course

Absolute: +10 mm, -0 mm.

Relative: 10 mm.

1.5.2 Finished surface after compaction of pavers

Absolute:

- Class 4 clay segmental pavers: ±6 mm.
- 80 mm thick concrete segmental pavers: ±6 mm.
- All other segmental pavers: ±8 mm.

Relative: 6 mm, except at grade changes.

Lippage: 2 mm or less.

1.5.3 Drainage inlets

Pavers level: + 5 mm to + 10 mm above adjacent inlets.

1.6 Submissions

1.6.1 Products and materials

Segmental paving materials: Submit details of proposed materials, including bedding, joint filling materials and interlocking type.

Proprietary products: Submit the manufacturer's technical data.

1.6.2 Samples

Requirement: Submit labelled samples of pavers, illustrating the range of variation in colour and finish.

1.6.3 Subcontractors

Requirement: Submit names and contact details of proposed installers of all paving materials.

1.6.4 Suppliers

Requirement: Submit names and contact details of proposed suppliers of all paving materials.

1.6.5 Tests

Results: Submit results of testing to **ANNEXURE – MAXIMUM LOT SIZE AND MINIMUM TEST FREQUENCIES**.

Other tests: Submit results, as follows:

- Slip resistance site test of completed paving.

1.6.6 Variations

Requirement: Submit any proposed changes to approved drawings, materials or execution, 5 days before the related construction activity.

1.6.7 Warranties

Requirement: Submit the manufacturer's warranty.

1.7 Inspections

1.7.1 Notice

General: Give notice so that inspection may be made of the following:

- Subgrade preparation: Completed subgrade.
- Subbase preparation: Completed subbase.
- Base preparation: Completed base.
- Compaction of bedding course: Moisture content of trial section after screeding sand bedding course.
- Commencement: Confirm pattern, starting point and edging.

2 Materials

2.1 Marking

2.1.1 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. Submit technical data sheets if not shown on labels.
- Handling and installation instructions.
- Safety data sheets.

2.2 Concrete and clay segmental pavers

2.2.1 General

Standard: To AS/NZS 4455.2.

Permeable interlocking concrete pavers: To the recommendations of CMAA PE01 Section 7.

Slip resistance classification: To AS 4586.

Proprietary product: Conform to the **ANNEXURE– PAVER SCHEDULE**.

2.3 Sand

2.3.1 General

Description: Well-graded, clean, hard sand, with uncoated grains of uniform quality and free of soluble salts or other contaminants which may cause efflorescence.

Storage: Protect from rain.

Cement: Do not use cement bound material.

2.3.2 Bedding sand

Grading: Obtain material from a single source or blend.

Fines: Do not use single-sized, gap-graded or excessive fine material.

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

2.3.3 Bedding sand grading table

AS sieve to AS C13	% passing
9.52 mm	100
4.75 mm	95–100
2.36 mm	80–100
1.18 mm	50–85
600 µm	25–60
300 µm	10–30
150 µm	5–15
75 µm	0–10

2.3.4 Joint filling sand

Moisture content: Dry when spread.

2.3.5 Joint filling sand grading table

AS sieve to AS C13	% passing
2.36 mm	100
1.18 mm	90–100
600 µm	60–90
300 µm	30–60
150 µm	15–30
75 µm	5–10

2.4 Granular material

2.4.1 Permeable pavement

Description: Well-graded, clean aggregate of uniform quality.

Grading: Bedding and jointing material to the recommendations of CMAA PE01 Table 2.

Bedding and jointing course material: 2 to 5 mm uniform size of aggregate.

2.4.2 Joint filling material grading table

AS sieve to AS C13	% passing
9.5 mm	100
4.75 mm	85–100
2.36 mm	10–40
1.18 mm	0–10
0.3 mm	0–5

2.5 Geotextile and liner

2.5.1 Geotextile standards

Marking and labelling: To AS 3705.

Test methods: To AS 3706.1.

Properties and application: To Austroads AGPT04G.

2.5.2 Permeable pavement

Requirement: To the recommendations of CMAA PE01 Section 9.5.

2.5.3 Storage and handling

Requirement: Store under protective cover or wrapped with a waterproof, opaque UV protected sheeting, off the ground and unaffected by heat, dirt or damage and as recommended by the manufacturer.

2.5.4 Properties

Geotextile description: Non-woven needle punched continuous filament polyester or polypropylene geotextile. Free of flaws, stabilised against UV radiation, rot proof and chemically stable with low water absorbency. Filaments resistant to delamination and dimensionally stable.

Geotextile filtration: Conform to the following:

- Mass: Minimum 140 gsm.
- Wide strip tensile strength: Minimum 9.5 kN.
- Pore size: Maximum 110 µm.
- Flow rate: Minimum 200 L/m²/s.

Impermeable liner protection: Conform to the following:

- Mass: Minimum 280 gsm.
- Wide strip tensile strength: Minimum 21 kN.
- CBR: Minimum 3600 N.

2.6 Concrete for edge restraints

2.6.1 Properties

General: To AS 1379 clause 1.5.3.

Concrete strength: Unless documented otherwise, conform to the following minimum characteristic compressive strength at 28 days:

- For pavers on road pavements: 32 MPa.
- For pavers on medians, traffic islands and driveways: 32 MPa.

Slump: 60 mm.

2.7 Testing

2.7.1 Quality

Requirement: Test for all characteristics in conformance with **ANNEXURE - MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES**.

Quality verification: If material/product quality verification can be obtained from the supplier, documented tests need not be repeated.

3 Execution

3.1 Subgrade

3.1.1 Subgrade preparation

Requirement: Form subgrade to the required depth below the finished surface level as documented and to the *C06 Earthworks (Road reserve)* worksection.

3.1.2 Permeable pavements

Requirement: To the recommendations of CMAA PE01 clause 7.1.2 and the following:

- Compaction: 92 to 96% standard MDD for trafficable areas.
- Cohesive subgrades: Install filter fabric under base course as documented.
- Contaminated, saline or expansive subgrade: Install an impermeable membrane and run up the sides of the pavement, as documented.

Subsurface drainage: If required, to *C14 Subsurface drainage (Construction)* as documented.

3.2 Subbase

3.2.1 Subbase preparation

Requirement: If required, construct a subbase or working platform, to the documented thickness, compaction and depth below the surface level and to the design grade and crossfalls of the finished surface.

Rigid pavements: To the *RMS Supplement to Austroads Guide to Pavement Technology Part 2 Pavement Structural Design*.

Flexible pavements: To the following worksections as appropriate:

- *C07 Stabilisation*.
- *C08 Flexible pavement base and subbase*.

3.2.2 Permeable pavement

Construction: To the recommendations of CMAA PE01 clause 7.1.2 and the following:

- Unbound subbase: Compact to 95% modified MDD for trafficable areas.

3.3 Base

3.3.1 Dimensions and specification

Construction For Paver Surfaced Road Pavements: To the specified thickness and depth below finished surface level, and to the design grade and crossfalls of the finished surface, as shown on the drawings or as directed by the Superintendent in conformance with RMS Supplement to Austroads Guide to Pavement Technology Part 2 Pavement Structural Design. Extend the base course in width to at least the rear face of all new edge restraints.

Construction For Paver Surfaced Footpaths: Depth below finished surface level shall be the sum of the specified paver thickness and the compacted bedding layer thickness. Concrete base for footpaths shall generally conform to the specified thickness, reinforcement details and concrete strength details in Council's Standard Drawings or as directed by the Superintendent. Extend the base course in width to at least the rear face of all new edge restraints.

3.3.2 Base preparation

Requirement: Construct base to the documented depth below the finished surface level.

Width: Extend the base course to at least the rear face of all new edge restraints.

Rigid pavement: To *RMS Supplement to Austroads Guide to Pavement Technology Part 2 Pavement Structural Design*.

Remedial work: Do not use sand bedding material as a levelling material to compensate for base finishing outside the documented tolerances.

Finished surface of base: Drain free from ponding.

3.3.3 Permeable pavement

Construction: To the recommendations of CMAA PE01 clause 7.1.2 and the following for trafficable areas:

- Unbound base: Compact to 98% modified MDD.
- Cement-stabilised materials: Compact to 96% modified MDD.
- Construction vehicles trafficking mud onto the base course for permeable paving: If unavoidable, increase documented base thickness by 50 mm, scalp off and immediately discard before installing the bedding course.

3.4 Edge restraints

3.4.1 General

Requirement: Construct edge restraints along the perimeter of all segmental paving as documented, with the vertical face of edge restraints abutting the pavers.

Edge restraint support: On compacted base and/or subbase to AS 3727.1 Appendix D.

3.4.2 Joints

Contraction joints: 20 mm deep at 3 m maximum spacing.

3.4.3 Kerbs and/or gutters, and edge strips

Requirement: To AS 2876 and Council's standard drawings.

Construction: To the *C11 Kerbs and channels (gutters)* worksection.

3.4.4 Backfilling

Timing: Backfill at least 3 days after placing concrete.

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

3.5 Bedding course

3.5.1 Geotextile

Position: Place fabric over prepared base course before laying the bedding course.

Requirement: Cover within 48 hours of being placed, rectify any punctures or tears prior to covering. Overlap 500 mm where deformations are expected.

3.5.2 Screeding

General: Spread the bedding course in a single uniform layer and screed in a loose condition to the nominated design profile and levels.

Sand bedding course thickness: 20 mm to 30 mm following final compaction of the paving.

Progressive screeding: Do not screed more than 2 m 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 exceeding 5 mm.

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

3.5.3 Permeable pavement

Granular bedding course thickness: 20 to 40 mm, following final compaction of the paving or as documented.

Sand: Do not use.

3.5.4 Drainage

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

3.5.5 Compaction of bedding course

Moisture content of sand bedding course: Prepare a trial section to establish the moisture content limits which will allow paver system compaction to be achieved.

Incorporation: Incorporate the trial section in the completed works.

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

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

3.6 Laying pavers

3.6.1 Placing and jointing

Placement: Uniformly place pavers on the screeded bedding to the documented laying pattern. Lay the pattern at either 90° or 45° to the line of edge restraints.

Joint width: Lay pavers with a joint range after bedding compaction and joint filling operations as follows:

- Pavers generally: 2 to 5 mm.
- Permeable type A pavers: 2 to 5 mm.
- Permeable type B pavers: 2 to 5 mm or less than 13 mm.
- Permeable type C pavers: Less than 13 mm.

Colour variation: Mix the pavers between pallets to evenly distribute colour variation over the whole paved area.

Sequence: Lay first row next to edge restraint or an established straight line.

Odd shapes: In each row, lay the full units first followed by cut closer units. Do not use cut pieces smaller than one quarter the size of a full block.

Cutting edge or closer units: Cut neatly using a paver scour or mechanical/hydraulic guillotine.

3.6.2 Laying around obstacles and edging

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

- Minimum thickness between the utility pit and adjacent pavers: 100 mm.
- Strength grade: N32.
- Plan shape: Square or rectangular.

Pit covers: Adjust the levels of the pit covers before paving around them. Make sure the water drains away from closed pits.

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

Patterns around obstacles: Continue to lay pavers along both sides of the obstacle, from the main or original laying face.

3.6.3 Control joints

Pavers over joints in underlying concrete base: If pavers are placed over an isolation, contraction or expansion joint, provide a control joint in the segmental paving.

Joint: 10 mm thick preformed bituminous fibreboard jointing material.

3.6.4 Protection

Foot or barrow traffic: Provide boards overlaying paving to prevent disturbance of pavers before compaction.

Other construction traffic: Do not allow on the pavement before compaction and joint filling.

3.7 Bedding compaction

3.7.1 Method

Requirement: Compact the bedding after laying the pavers with not less than two passes of a high frequency low amplitude plate compactor which covers at least 12 units.

Pavers damaged during compaction: Replace and re-compact the pavement for at least 1 m 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 1 m of laying face except where next to edge restraint.

3.8 Filling joints

3.8.1 Timing

Joint filling: After bedding compaction and before the end of each day.

3.8.2 Method

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

Permeable pavement: Fill the joints completely with granular jointing material. Sweep off excess aggregate.

Compaction: After filling joints, make one or more passes of a plate compactor and refill the joints. Repeat the process until the joints and drainage voids are completely filled.

3.9 Completion

3.9.1 Protection

Traffic generally: Do not allow traffic to use the pavement until compaction and joint filling operations have been completed.

Exceptions: Foot and barrow traffic, wheeled trolleys, forklifts and cluster-clamp vehicles.

3.9.2 Opening to traffic

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

Construction traffic: Allow on pavement after completion of compaction and joint filling. Encourage traffic over the greatest possible area of pavement to assist in the development of lock-up.

3.9.3 Inspection

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

3.10 Testing

3.10.1 Quality

Requirement: Test for all characteristics in conformance with **ANNEXURE - MAXIMUM LOT SIZES AND MINIMUM TEST FREQUENCIES**.

3.10.2 Site tests

Slip resistance site test of completed paving: To AS 4663.

4 Annexure

4.1 Summary of hold and witness points

Reference No:	Clause and description	Type*	Submission/Inspection details	Submission/Notice times	Process held
C12-HP01	SUBMISSIONS, Products and materials Segmental paving materials	H	Details of proposed materials, including bedding and joint filling materials	2 weeks before commencement	Ordering material
C12-HP02	INSPECTIONS, Notice Subgrade preparation	H	Completed subgrade	1 day before proceeding	Subbase preparation, For inspections book through "MyInspect"
C12-WP03	INSPECTIONS, Notice Subsurface drainage	W	Installed system	1 day before proceeding	-
C12-WP04	INSPECTIONS, Notice Subbase preparation	W	Completed subbase	1 day before proceeding	-
C12-HP05	INSPECTIONS, Notice Base preparation	H	Completed base	2 days before proceeding	Edge restraint construction or bedding placement, For development inspections book through "MyInspect".
C12-HP06	INSPECTIONS, Notice Compaction of bedding course	H	Moisture content of trial section of paving after screeding sand bedding course	1 day before laying pavers	Laying pavers, For development inspections book through "MyInspect".
**H = Hold Point, W = Witness Point					

4.2 Annexure - Maximum lot sizes and minimum test frequencies

Activity	Key quality verification requirements	Maximum lot size	Minimum test frequency	Test method
Material supply	Suppliers documentary evidence and certification of:			
	Concrete/clay segmental paving units:			
	• Characteristic breaking load and flexural strength	1 contract	1 per contract	AS/NZS 4456.5
	• Dimensional deviations	1 contract	1 per contract	AS/NZS 4456.3
	• Abrasion resistance	1 contract	1 per contract	AS/NZS 4456.9
	• Salt attack resistance grade	1 contract	1 per contract	AS/NZS 4456.10
	• Slip resistance	1 contract	1 per contract	AS 4586
	Geotextile	1 contract	1 per contract or change in material	AS 3706
	Bedding:			
	• Sand grading	1 contract	1 per contract or change in material	AS C08.11.1
	• Granular grading	1 contract	1 per contract or change in material	AS C08.11.2
	Joint filling:			
	• Sand grading	1 contract	1 per contract or change in material	AS C08.11.1
	• Granular grading	1 contract	1 per contract or change in material	AS C08.11.2
Base	Geometry	1 layer 5000 m ² or max 1 day's placement	1 cross section per 25 m	Survey
	Surface quality	1 layer 5000 m ² or max 1 day's placement	10 per 200 m ² or lot	3 m straightedge
Subgrade, subbase & base	Trafficked permeable pavement: Compaction/moisture content/dry density testing	1 layer 5000 m ² or max 1 day's placement	10 per 5000 m ² layer or 3 per lot, whichever is greater	AS 1289.5.4.2
Edge restraints	Ready mixed	1 day's placement	1 per production	AS 1379

Activity	Key quality verification requirements	Maximum lot size	Minimum test frequency	Test method
	concrete material and supply		batch	
Laying paver units	Joint width	1 day's placement	All joints	Measure
	Geometry	1 day's placement	1 cross section per 15 m	Survey

4.3 Annexure - Referenced documents

The following documents are incorporated into this worksection by reference:

AS C08		Methods for sampling and testing aggregates
AS C08.11.1	2009	Particle size distribution - Sieving method
AS C08.11.2	2008	Particle size distribution for vision sizing systems
AS 1289		Methods of testing soils for engineering purposes
AS 1289.5.4.2	2007	Soil compaction and density tests - Compaction control test - Assignment of maximum dry density and optimum moisture content values
AS 1379	2007	Specification and supply of concrete
AS 2876	2000	Concrete kerbs and channels (gutters) - Manually or machine placed
AS 3705	2012	Geotextiles - Identification, marking, and general data
AS 3706		Geotextiles - Methods of test
AS 3706.1	2012	General requirements, sampling, conditioning, basic physical properties and statistical analysis
AS 3727	2016	Pavements
AS 3727.1	2016	Residential
AS/NZS 4455		Masonry units, pavers, flags and segmental retaining wall units
AS/NZS 4455.2	2010	Pavers and flags
AS/NZS 4456		Masonry units and segmental pavers and flags - Methods of test
AS/NZS 4456.3	2003	Determining dimensions
AS/NZS 4456.5	2003	Determining the breaking load of segmental pavers and flags
AS/NZS 4456.9	2003	Determining abrasion resistance
AS/NZS 4456.10	2003	Determining resistance to salt attack
AS 4586	2013	Slip resistance classification of new pedestrian surface materials
AS 4663	2013	Slip resistance measurement of existing pedestrian surfaces
Austrroads AGPT		Guide to pavement technology
Austrroads AGPT04G	2009	Geotextiles and geogrids
CMAA PE01	2010	Permeable interlocking concrete pavements - Design and construction guide
Council's Standard Drawings		
Bowral CBD Footpaving Details		