CMAA

CONCRETE MASONRY
ASSOCIATION OF AUSTRALIA

PA01

Concrete Segmental Pavements - Detailing Guide

The Standards referenced in this manual were current at the time of publication.

Cover: The Sydney Olympic Park was a major development that used over 7 million paving units across 17 different product lines. This was all laid by hand, in preparation for the 2000 Sydney Olympics. The design by Hassell Architects includes Olympic Boulevard and Plazas and Olympic Park Railway Station. Paving Contractors by Shannon Tower Pty and Sam the Paving Man.

Pavers: Adbri Masonry Honed Trihex®

Photography: Art One Advertising & Design – Alvaro Zaralli

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Introduction

A key factor which separates concrete segmental paving from other pavement types is that it combines both serviceability and a surface which provides a range of appearances in terms of colour, pattern and texture. These are provided by the segmental paving units.

For Municipal and other related applications in housing and civic developments, the detailing of the surface layer can be integrated with the selection of colour, unit shape and laying pattern. Detailing affects both the appearance and serviceability of the pavement surface. Accordingly, co-ordination of architectural and engineering requirements will enhance the successful completion of a project.

Information on the selection of pavers for pedestrian and vehicular traffic can be found in *Concrete Segmental Pavements – Guide to Specifying* (T44) and *Concrete Segmental Pavements – Design Guide for Residential Accessways and Roads* (T45).

After the selection of paver shape and laying pattern for pedestrian and/or vehicular traffic, consideration should be given to surface detailing including: edge restraint and edge detailing, organising the worksite, commencement and development of the surfacing pattern, variable-width pavements and junctions between pavements, draining the surfacing, and treatments at features such as public utility pits and planter boxes.

After many years of development and experience in Australia and overseas, a series of guidelines for the detailing of concrete segmental pavements is provided in this Guide. The guidelines address a typical range of planning, design and construction issues related to surface detailing. Not every possible contingency is included. However, by utilising the principles outlined in this Guide, designers and constructors will be able to provide attractive and serviceable solutions to most issues affecting surface detailing.

Many CMAA member companies have introduced products which provide specific solutions for detailing requirements. These include precast kerb units to be used as edge restraints and special segmental paver sets for manhole surrounds. These products are available in the same colour and texture as the main pavers.

As with all other aspects of segmental paving, designers and builders are encouraged to consult local CMAA member companies on detailing solutions, and the availability of products to assist their detailing requirements based on local or regional experience.

The Guide is presented in the form of a series of data sheets, viz:

1 **Concrete Paver Selection**
2 **Laying Pattern**
3 **Edge Restraints**
4 **Edge Detailing**
5 **Jobsite Arrangements**
6 **Establishing the Laying Pattern**
7 **Developing the Laying Face**
8 **Paving Variable-Width Footways or at Variable-Width Shopfronts**
9 **Junctions Between Segmental Paved and Other Streets**
10 **Bedding Course Drainage**
11 **Public Utility Pits and Penetrations**
12 **Paving Around Planter Boxes and Surface Penetrations**

Industry Support *Most of the manufacturers of quality concrete segmental pavers in Australia are members of the Concrete Masonry Association of Australia (CMAA). It is recommended that advice be obtained from local CMAA members to adapt or supplement information contained in this Guide.*

Remember, when working with cement and concrete/mortar or manufactured or prefabricated concrete products, ALWAYS follow the manufacturer's instructions and seek advice about working

Concrete Paver Selection

Selection Criteria

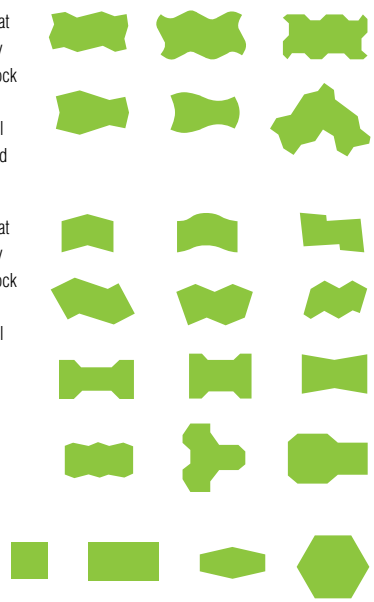
The performance of the pavement in terms of appearance and serviceability under pedestrian or vehicular traffic is enhanced by the selection of a suitable segmental paver shape, strength, thickness and colour.

Concrete segmental paving units manufactured as outlined in *Concrete Segmental Pavements – Guide to Specifying* (T44) are classified into three shape types, viz A, B and C. Examples of these are shown in Figure 1.1. The member companies of CMAA can advise on the shape classification of specific products. The minimum recommended thickness for trafficked pavements is either 60 mm or 80 mm, depending on the type and amount of traffic expected to use the pavement. For practical purposes in designing road, residential street and pedestrian pavements, shape Types B and C are considered equal in performance.

Recommended combinations of paving units and laying patterns for various traffic loads are set out in Table 1.1. It can be seen that a wide range of surfacing designs are suitable for lightly trafficked pavements.

Detailing Notes

For parking areas designated principally for passenger cars and light utility or delivery vans weighing less than 3 t gross and for pedestrian areas likely to be subject to occasional light service-vehicle use, the paving unit recommendations for estimated traffic loads up to 10 000 commercial vehicles over the life of the pavement may be used.



Type A Dentated units that key into each other and, by their plan geometry, interlock and resist the relative movement of joints parallel to both the longitudinal and transverse axes of the unit

Type B Dentated units that key into each other and, by their plan geometry, interlock and resist the relative movement of joints parallel to one axis

Type C Units that do not interlock

Figure 1.1

In many contemporary low- and medium-density housing developments and in some pedestrian areas, the progressive action of vehicular traffic (even light and low-speed traffic) can lead to a disturbance of the laying bond and loss of pavement serviceability if an inappropriate laying bond is used. This can occur in parking areas, areas outside and adjacent to garages, cul-de-sac turning heads and similar situations. The use of a paver which can be laid in a herringbone laying bond is recommended in these situations.

Concrete segmental pavers will not be softened or broken down by oil-based materials. However, on areas outside food shops or where other spillages may occur over a period, the surface of the pavers may become stained or darkened. In addition to cleaning from time to time, the selection of a darker coloured paver in such areas can be useful to mask the presence of spillages.

Experience has shown that pavements subject to constant use by high-heeled shoes can be subjected to abrasive forces from the small heel imprint area. The advice of CMAA members in the selection of pavers for these areas should be sought.

Table 1.1 Paving-unit shape, thickness and laying pattern

Estimated traffic† (commercial vehicles exceeding 3 t gross)	Recommended surface layer		
	Shape type	Thickness (mm)	Laying pattern*
Up to 10^3	A,B or C	60	H,B or S
10^3 to 10^4	A	60	H only
	A, B or C	80	H,B or S
Over 10^4	A only	80	H only

†Including building construction traffic
*H = Herringbone, B = Basketweave, S = Stretcher

Notes

1 If 80-mm shape Type A paving units, laid in herringbone bond only, are selected for a pavement subject to traffic loads up to 10^4 commercial vehicles, basecourse thickness may be reduced by 20 mm.
2 For parking areas catering for family cars and station wagons only, the recommendations for traffic below 10^4 commercial vehicles are suitable. For access driveways or loading docks incorporated in a parking area and which may be regularly used by commercial vehicles exceeding 3t gross, the surfacing should be appropriate for the estimated traffic load.
3 For pedestrian-mall pavements likely to be subject to occasional heavy construction service-vehicle usage, the recommendations for traffic loads up to 10^4 commercial vehicles should be used.

■

Laying Pattern

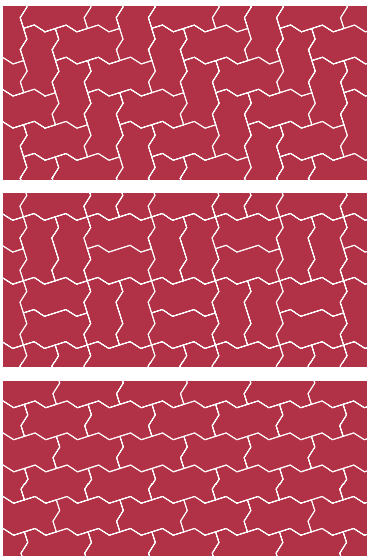
Selection Criteria

One function of the laying pattern, other than appearance, is to resist the effects of vehicular traffic in particular, whether travelling in a straight line or turning, from moving or disturbing the laid pavers thereby leading to loss of serviceability.

Detailing Notes

Recommended laying patterns for various traffic loads are set out in Figure 2.1. For pedestrian-only areas, the laying pattern is not as important to serviceability as it is for vehicular traffic. The most effective laying pattern is herringbone bond. In relation to the main direction or alignment of the pavement, pavers laid in herringbone bond will be placed either along and at right-angles to this direction, or at about 45° to this direction. The orientation of herringbone bond in relation to the direction of vehicular traffic does not effect the performance of the pavement. Other laying patterns, in descending order of effectiveness for vehicular trafficked pavements, are basket-weave and stretcher bond.

The selection of a paver which can be laid in herringbone bond is a key recommendation for any area subject to regular straight-line or turning vehicular traffic. Whilst not always obvious in the early life of a concrete segmental pavement, both accelerated trafficking of test pavements and experience have shown that after a few months, (or even a couple of years, depending on traffic volume), laying patterns other than herringbone bond can be disturbed by the traffic. Irregular gaps can open between rows of pavers, leading to a loss of jointing material and spalling of contact points between pavers. This disturbance to the laying bond can then lead to some permanent surface deformation or rutting. Herringbone bond has been shown by experience to be the most effective laying bond in avoiding these problems.

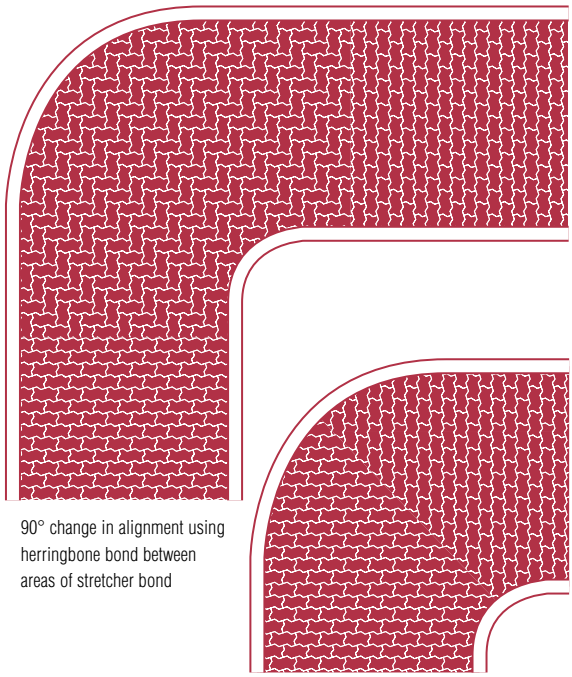


Herringbone bond
(Most effective, traffic direction not critical)

Basket-weave bond
(Less effective)

Stretcher bond
(Least effective)

Figure 2.1



90° change in alignment using herringbone bond between areas of stretcher bond

90° change in alignment using stretcher bond throughout

Figure 2.2

One of the benefits of the herringbone laying pattern is that it can be paved around bends and corners without the laying pattern being interrupted Figure 2.2. Other laying patterns do not have this advantage.

On steep gradients, and for both trafficked and pedestrian areas, the laying pattern can be arranged to minimise potential for sub-layer scouring during heavy rainfall. Under these conditions, it is preferable to use a herringbone laying pattern with the rows of pavers oriented at 45° to the direction down the gradient. In this way, as many irregularly oriented paver edges as possible are presented to the flowing runoff from the rain. This will assist in breaking up the pattern and speed of flow of water, thereby minimising the potential for scouring.

Where, for appearance purposes in a trafficked pavement, it is decided to break up the scale of large areas of paving by introducing bands of two or three rows of contrasting colours, careful planning of the construction can allow them to be incorporated into the laying pattern. It is not necessary to provide gaps in the surfacing or to introduce concrete strips or other similar features to allow for expansion movements in a concrete segmental pavement.

Where it is decided to introduce bands of alternate materials in a pedestrian concrete segmental pavement for appearance purposes, then the edge detailing discussed elsewhere in this Guide can be used to ensure a neat and effective junction between the main paving and such bands.

■

Edge Restraints

Selection Criteria

Concrete segmental pavements derive much of their strength from horizontal forces developed between the pavers. These forces, which are generated by the wedging action of the filler material between pavers, must be resisted by installing edge restraints at the pavement perimeter. In addition to purpose-made/formed units, commonly used profiles for kerbs, gutters and edge strips suited to particular traffic situations are also suitable edge restraints for segmental paving. Special proprietary units are also provided by some manufacturers.

Detailing Notes

Some of the important detailing requirements for edge restraints are shown in Figure 3.1. These include:

- The top of pavers should be slightly above the front edge of the edge restraint to which they are draining so that water will not pond on the pavement.
- The edge restraint should have a vertical or near-vertical side on the face which abuts the segmental pavers so that edge pavers can fit in.
- The basecourse should extend below the edge restraint for its full width (to minimise the likelihood of the edge restraint itself being disturbed) except at situations such as walls or pits.
- Where the edge restraint is in the form of a standard road-authority kerb, gutter/channel or dish drain, the requirements of that authority in relation to concrete quality should be followed. Elsewhere the use of a Grade N32 concrete is recommended.
- For very lightly trafficked pavements, a concealed edge restraint can be used to allow grass or other ground covers to abut the pavers to provide a particularly pleasing edge.

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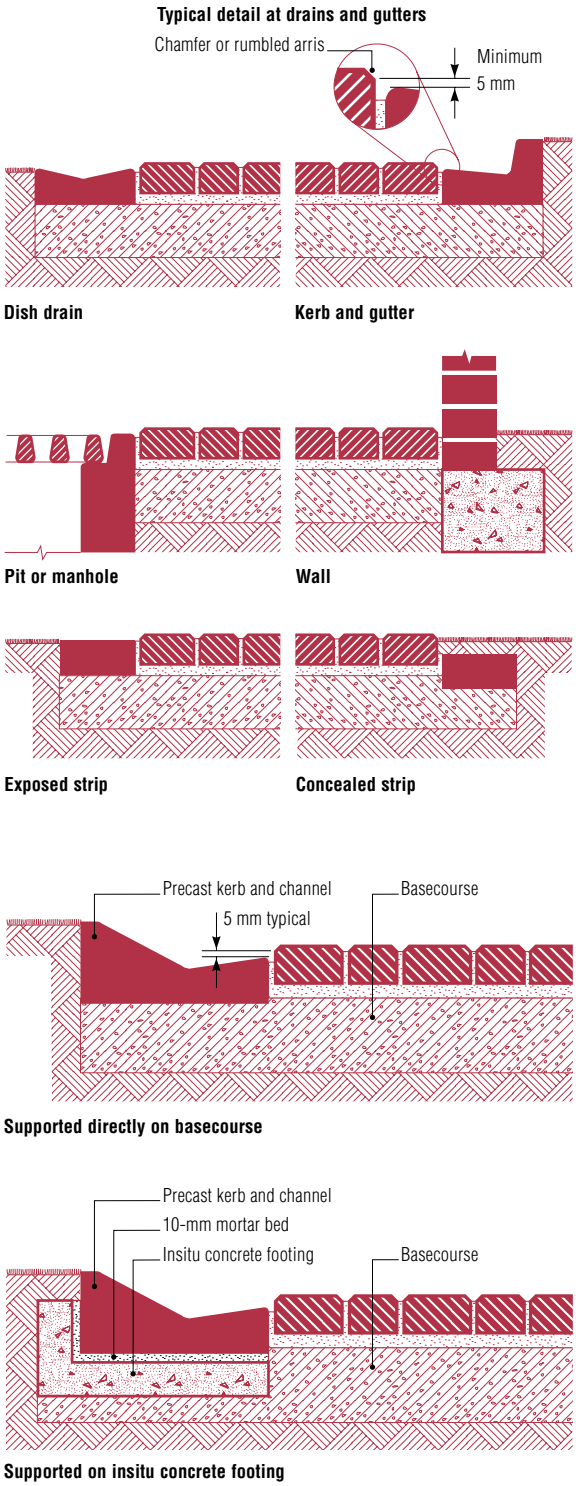

Figure 3.1

Edge Detailing

Selection Criteria

The detailing of pavers adjacent to the edge restraints should be considered together with the detailing of the edge restraint to provide a functional and attractive pavement.

The general use of a soldier course adjacent to edge restraints is recommended. It includes a whole or trimmed rectangular paver at the pavement edge as shown in Figure 4.1. Pavers which need to be adjusted are cut to size against the soldier course.

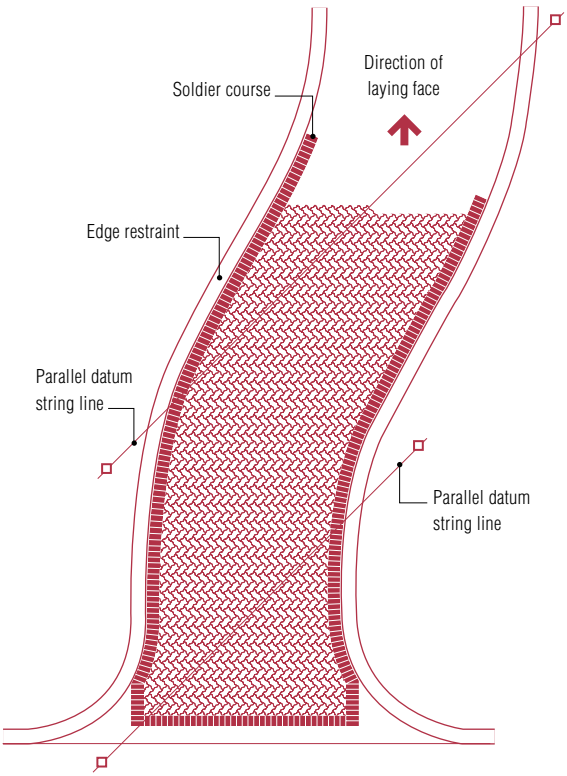

Figure 4.1

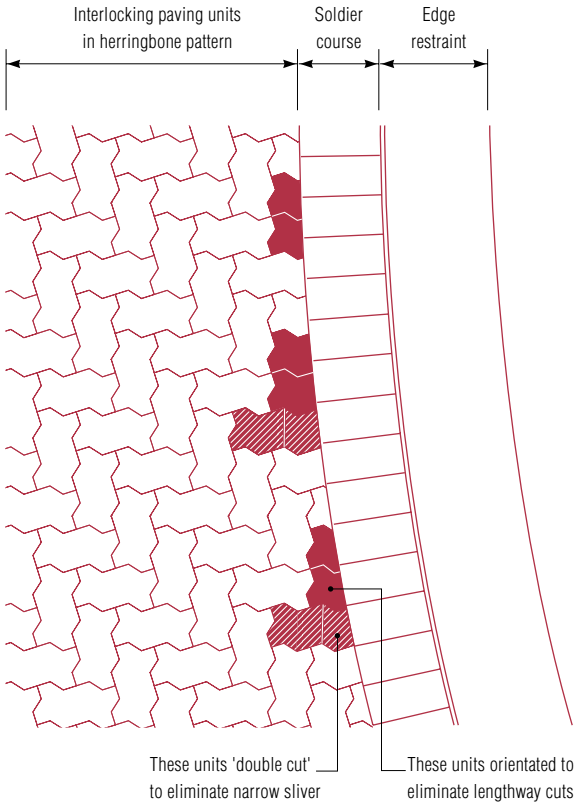

Figure 4.2

Detailing Notes

Some of the key detailing requirements are:

- The use of rectangular pavers as a stack-bonded soldier course.
- Making localised adjustments to the main laying pattern to orient any cut pavers to eliminate the likelihood of having slender (cut) infill pieces which may be prone to breaking.
- Using the 'double-cut' method as shown in Figure 4.2 to meet the above requirement.

When convenient, the use of a herringbone bond with rows of pavers aligned both along and at right angles to the main direction of the pavement can minimise if not eliminate cutting pavers at the soldier course.

Where, for appearance purposes, contrasting bands of alternate paving materials are incorporated into the pavement, the use of a soldier course at these bands can assist in making a neat connection between the different materials.

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Jobsite Arrangements

Selection Criteria

A significant part of the cost of construction of segmental paving is the on-site handling of materials and co-ordination of materials handling. Careful planning of the jobsite before the job starts can greatly enhance the efficiency and quality of the completed pavement.

Detailing Notes

The general sequence of paving after completion of the basecourse is shown in Figure 5.1. Each of the operations shown in Figure 5.1 should proceed in a timely and co-ordinated sequence. Each successive operation should commence as soon as practicable after the preceding one. Experience over many years has confirmed that the employment of an experienced site supervisor to control and co-ordinate these operations will produce a good result at less cost than that of remedial work and without disruption to pavement use.

Key factors in successful detailing of the jobsite include:

- Ensuring that edge restraints are located to minimise cutting of pavers.
- Carefully locating start lines and subsequent development of the laying face to ensure that the paving face continues in one general direction. Starting from both ends and meeting in the middle will produce an unsightly join.
- Positioning of bedding and jointing materials to minimise double handling.
- The use of screed rails for the control of bedding material and mechanical placement and screeding of the bedding course where possible.
- The use of suitable trolleys or buggies to ease transport of pavers to the laying face.
- Location and co-ordination of laying and bedding compaction teams to facilitate orderly progress of the work.
- Anticipating and planning ahead for working around obstructions and penetrations into the pavement.
- Employment of an experienced supervisor not directly involved in the laying of pavers to control and co-ordinate site activities.

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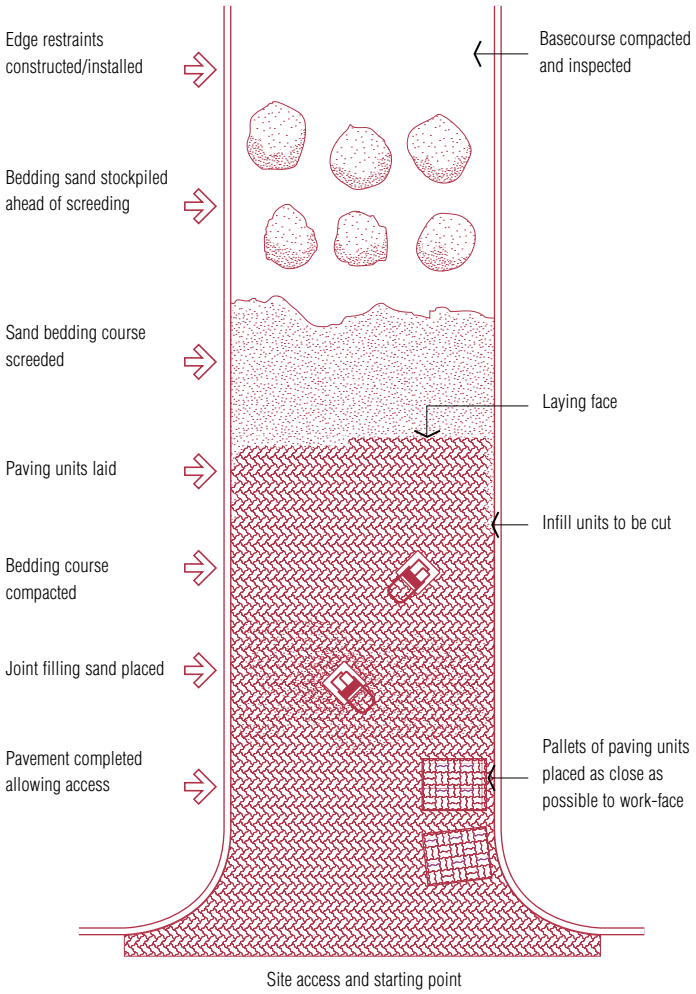


Figure 5.1

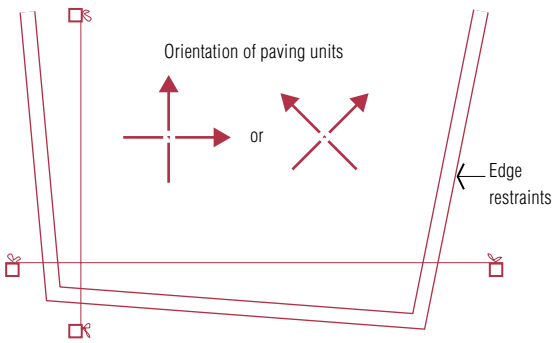
Establishing the Laying Pattern

Selection Criteria

It is important to locate the starting line and to establish the laying face at the commencement of paving to achieve the required orientation and rows of pavers in the completed pavement.

- The laying pattern and orientation of the rows of pavers should be selected well before paving commences.
- Wherever possible, paving should commence at or near an edge restraint. The location of the start line should take this into account.
- The alignment of the edge restraint in relation to the preferred arrangement of pavers in the completed pavement should be considered.
- It is desirable to work away from materials-delivery points to facilitate orderly paving.
- Pave uphill wherever possible to avoid downhill creep and the loss of a uniform laying pattern.

To avoid an unsightly join where the two laying faces meet, paving should not commence from opposite ends or adjacent sides.

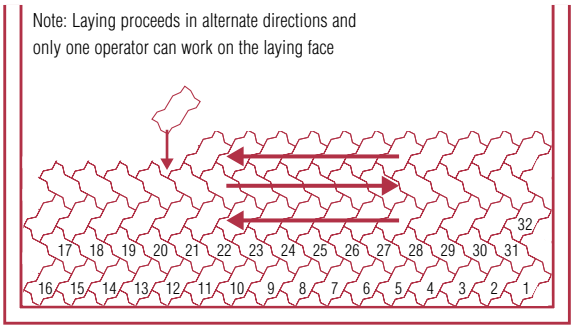


Stringlines used to set out pavement starting point when edge restraints do not suit required orientation of paving units

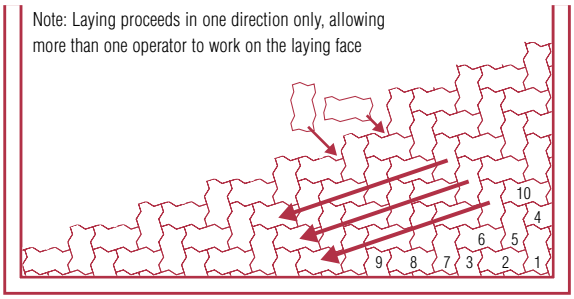
Figure 6.1

Detailing Notes

- Positioning the first few rows requires care and should proceed slowly. Time spent at this stage will improve the speed of paving as paving proceeds.
- Pavers need to be placed at the correct angle to the start line to achieve the final orientation of pavers. A stringline should be established a few rows away from curved or unfavourably oriented edge restraints to position the first row. Some later cutting and infilling will be unavoidable. The stringline should be located to maximise the use of whole or near-whole pavers in any such infilling.



Axis of units not parallel to edge restraints



Axis of units parallel to edge restraints

Figure 6.2

- The first few square metres should be carefully placed to ensure that large gaps between pavers do not occur. Close checking at this stage is important.
- A laying pattern which requires a paver to be placed or forced between two others should not be used.
- In establishing the laying pattern, use only whole pavers to start with. Any cutting or filling at edges can be done later.

Important Note: In starting the laying and developing the laying face, a small uniform gap – typically 2–5 mm – is required between pavers. This gap or 'joint' will be progressively filled with a suitable jointing material as the paving proceeds. All paver shape types should be laid with this gap. Tight laying in pavements subject to vehicular traffic, whether travelling in a straight line or turning, and/or on sloping sites, will lead to edge or corner contact. This will in turn lead to corner or edge spalling and, in some situations, the paver may crack into two pieces.

Most shape Type A and B pavers are actually manufactured to be self-locating to allow this gap. If these pavers are laid too tightly then some wandering of the orientation of rows of pavers will become evident even after a few metres of paving. Square, rectangular and other pavers which are not self-locating require particular care when placing to ensure the small gap is obtained.

■

Developing the Laying Face

Selection Criteria

After establishing the laying face, the development and maintenance of control over the alignment of the pavers will avoid wandering or meandering of the laying pattern and will assist in paving around landscaping or public-utility features.

Detailing Notes

Due to their shape characteristics, shape Type A and B pavers tend to be self locating when used in the recommended laying patterns with a properly managed laying face.

In manual laying, there will be some slight variations in gap widths resulting from the differences in the way individuals place the pavers. Although rarely a problem, this effect can be minimised by regularly rotating personnel at the laying face. Pavers are normally dimensioned to achieve small uniform gaps between them. Tightly butted units will probably spall due to corner contact and may fracture under traffic. Nominal widths of 2–5 mm, which is a suitable gap, will be obtained using the normal practice of holding a paver lightly against the previous one and allowing it to slide down into position.

Maintenance of control over alignment of laying pattern and uniformity of gap width can be assisted by the use of stringlines at about 5-m intervals. Alternatively, lines can be made in the bedding by stretching and flicking a chalked stringline. For narrow pedestrian paths, a straightedge can be used.

Normal practice for all concrete segmental paving applications is to progressively compact the paving as laying proceeds. This is done by using a suitable plate compactor over the placed pavers as the laying face is developed. This should be done as frequently as practicable and should not be left until the end of the day, or even half way through a day.

As soon as this is completed, the gaps between pavers should be filled with a suitable jointing material. This will greatly reduce any tendency for corner or edge contact even when the specified gaps were made during placing the pavers.

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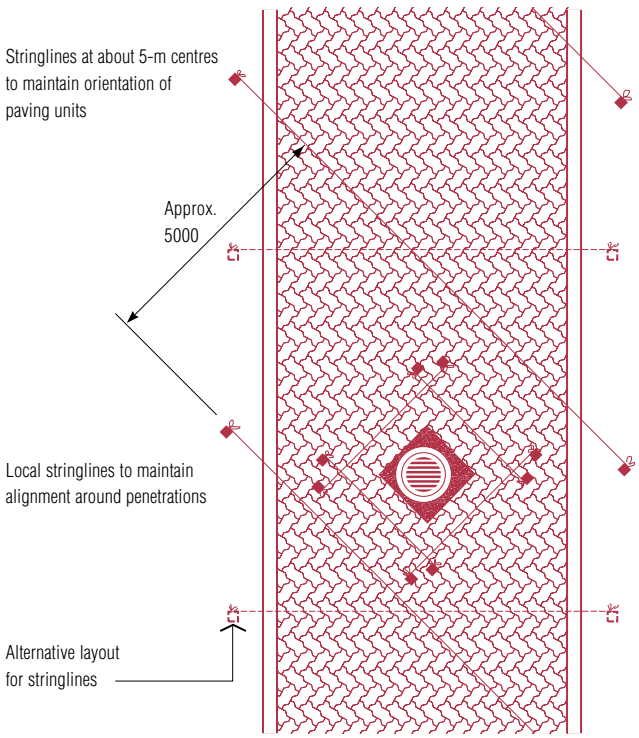

Figure 7.1

Paving Variable-Width Footpaths or at Variable-Width Shopfronts

Selection Criteria

Most kerbs and shopfronts are not perfectly straight nor do footpaths have regular, constant widths. The recommended detailing is to produce a uniform width in the segmental paving by concrete infill at kerbs or shopfronts rather than trying to fit small, irregular shaped pavers which can be unsightly.

Detailing Notes

- Instead of cutting and infilling small or irregular-shaped pavers, first place narrow concrete strips adjacent to the shopfronts in particular. Plain grey Grade N32 concrete is suitable. Joints should be placed in the concrete strips to match kerb joints. The course next to the concrete infill will normally be a soldier course
- Detail the concrete infill such that the final width of segmental paving maximises the use of whole or half pavers.
- The concrete strips can be used as control lines for the segmental pavers.
- On completion, the main visual line will be the outer soldier course.
- The use of a herringbone bond with rows of pavers aligned along and across the main direction of the pavement will assist neat edge detailing in this type of situation.

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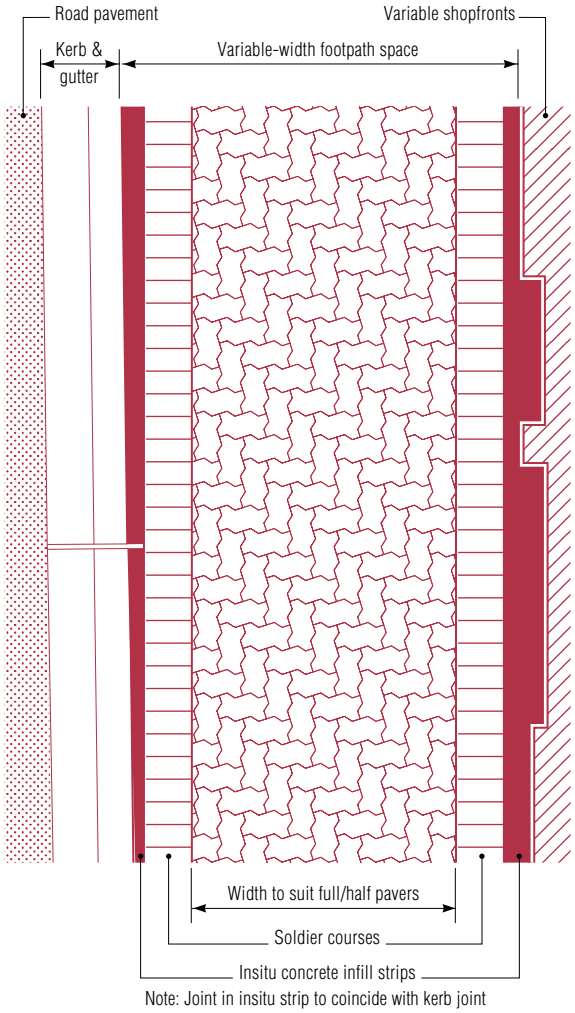

Figure 8.1

Junctions Between Segmental Paved and Other Streets

Selection Criteria

The aim is to provide a structurally sound transition between a segmental pavement and an asphalt pavement and to minimise the number of irregular cut pavers. Successful detailing will also include consideration of the appearance of the junction, particularly in situations such as entry statements in housing estates.

Detailing Notes

- Construct the concrete edge restraint first. The dimensions of the edge restraint can be adjusted to take into account the street geometry and to maximise the inclusion of a whole-paver, stack-bonded soldier course.
- The right-angled corner avoids a triangular taper to connect to the kerb and difficult cutting of pavers in the acute angle which would otherwise be formed.
- Note the orientation of the main segmental paving to suit the connection.

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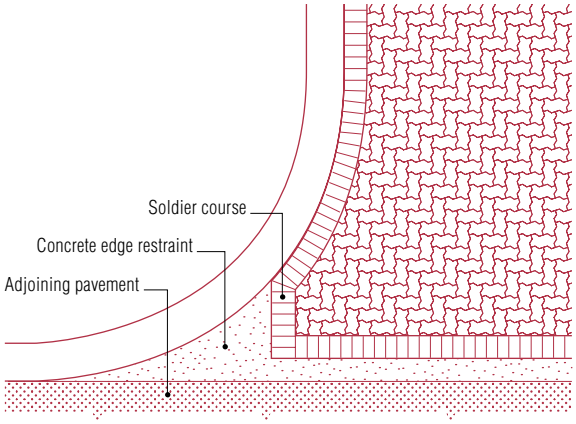
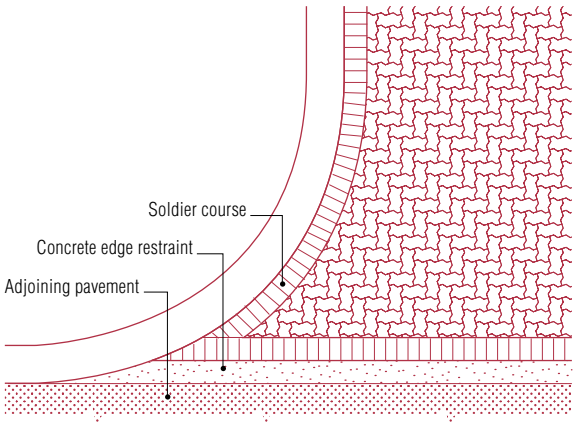


Preferred detail



Non-preferred detail

Figure 9.1

Bedding Course Drainage

Selection Criteria

On wide pavements and after extended rainfall, water may penetrate the jointing and bedding courses, particularly when the pavement is new. This water can be trapped against the face of the edge restraint leading to unsightly if only temporary ponding. The bedding course can be drained either into a nearby pit or directly into subsoil drainage where provided.

Detailing Notes

The key detailing requirements are shown in Figure 10.1.

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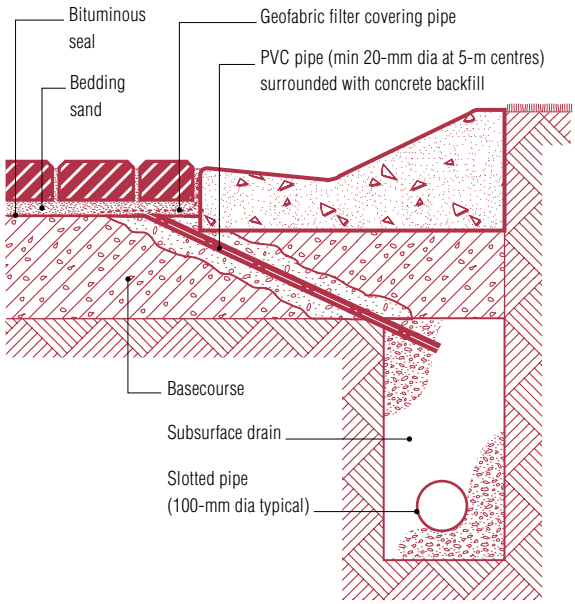
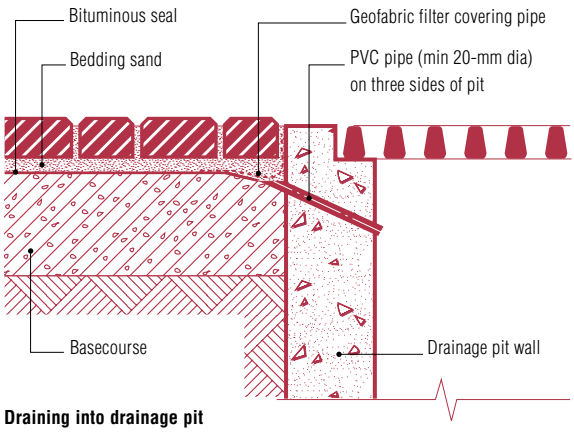
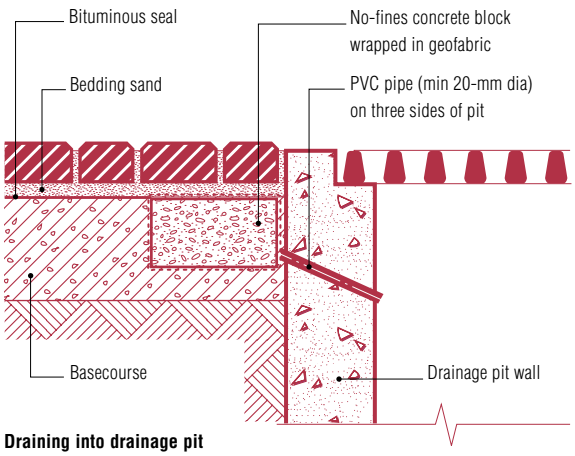


Draining directly into subsurface drain



Draining into drainage pit
Alternative 1



Draining into drainage pit
Alternative 2

Figure 10.1

Public Utility Pits and Penetrations

Selection Criteria

Most penetrations in pavements do not match the shape or 'squareness' of the laying pattern. From both serviceability and appearance considerations, the space can benefit from being infilled with another material such as concrete or pavers of another type.

Detailing Notes

Key detailing requirements are:

- The levels of the pit covers should be adjusted before paving around them. It is important that water drains away from pits with lids and into surface inlet drainage structures.
- Where a small concrete surround is to be placed around the pit, it is not necessary for the pit to be located exactly in the centre of the surround. The orientation of the pit within the surround is not visually important. It is more important that the outside dimensions of the surround are square or rectangular and make a smooth connection with the laying pattern of the pavers.
- The surround should preferably be concrete. The recommended minimum thickness of any concrete surround between a utility pit and nearby pavers is 100 mm. A conventional grey (Grade N32) concrete is preferable to an unsuccessful attempt to match the colour of the pavers. Asphalt is not recommended as it tends to soften in hot weather.
- Some manufacturers make precast manhole-surround paversets to suit specific dimensions of authority manholes. They require only two paver shapes and are made with the same colour and texture as the main pavers.

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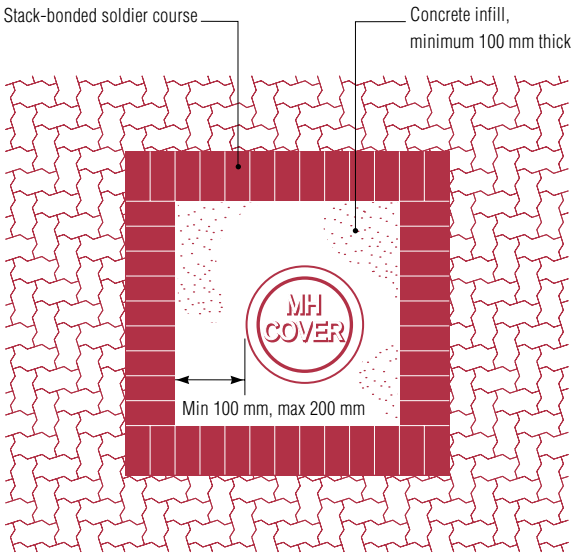
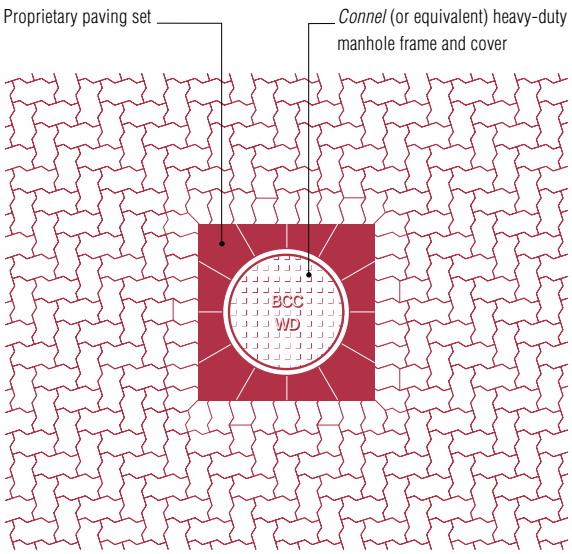


Pavement penetration detailing



Manhole paving set

Figure 11.1

Paving Around Planter Boxes and Surface Penetrations

Selection Criteria

It is important to pave around planter boxes and other surface penetrations in such a way that the laying pattern is maintained around and past them.

Detailing Notes

- In the confined areas around these features and also kerb gullies, good compaction of the basecourse right up to the edge of the intrusion is vital. Otherwise, localised depressions in the areas adjacent to the feature are likely to develop in service.
- As shown in Figure 12.1, the preferred laying procedure is to lay up both sides of the feature from the main or original laying face. The alignment of pavers should be continually monitored using stringlines or other suitable controls until the two paving edges rejoin on the far side of the feature. Any localised adjustments can be made with long-handled screwdrivers or similar devices before compacting the bedding course.
- As also shown in Figure 12.1, laying along one side of the feature and then returning the paving to the main laying face by going 'around' the feature will usually result in a poor match which is difficult and time-consuming to correct.

■

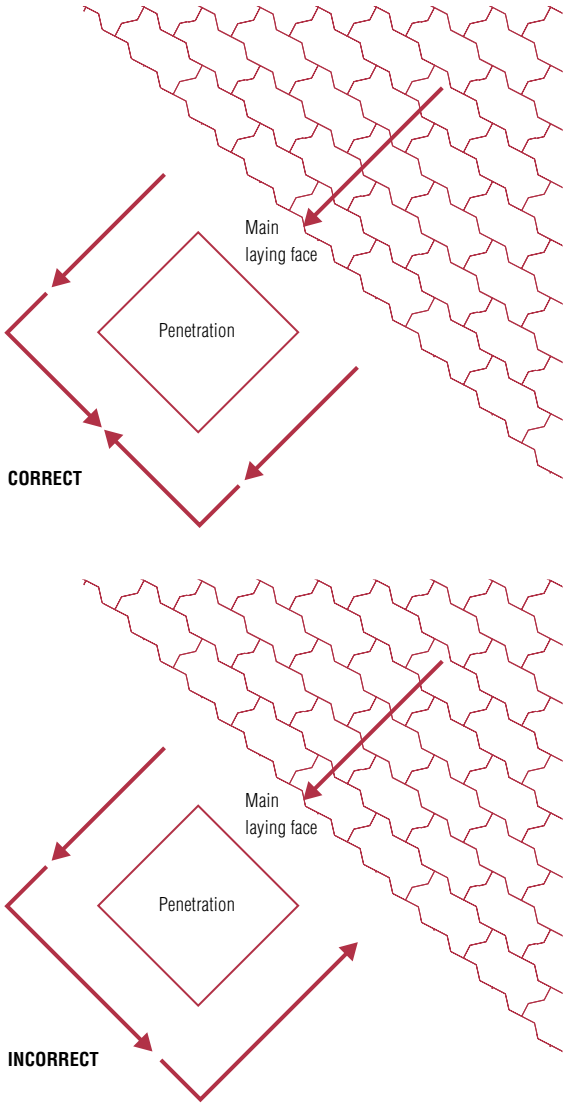


Figure 12.1

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