BS 7533-9:2010

BSI Standards Publication

Pavements constructed with clay, natural stone or concrete pavers –

Part 9: Code of practice for the construction of rigid pavements of clay pavers

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Contents

Summary of pages
This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 12, an inside back cover and a back cover.

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Foreword

Publishing information

This part of BS 7533 is published by BSI and came into effect on 30 April 2010. It was prepared by Technical Committee B/507, *Paving units, kerbs, screeds and in-situ floorings*. A list of organizations represented on this committee can be obtained on request to its secretary.

Relationship with other publications

BS 7533 consists of the following parts:

- *Part 1: Guide for the structural design of heavy duty pavements constructed of clay pavers or precast concrete paving blocks;*
- *Part 2: Guide for the structural design of lightly trafficked pavements constructed of clay pavers or precast concrete paving blocks;*
- *Part 3: Code of practice for laying precast concrete paving blocks and clay pavers for flexible pavements;*
- *Part 4: Code of practice for the construction of pavements of precast concrete flags or natural stone slabs;*
- *Part 6: Code of practice for laying natural stone, precast concrete and clay kerb units;*
- *Part 7: Code of practice for the construction of pavements of natural stone paving units and cobbles, and rigid construction with concrete block paving;*
- *Part 8: Guide for the structural design of lightly trafficked pavements of precast concrete flags and natural stone flags;*
- *Part 9: Code of practice for the construction of rigid pavements of clay pavers;*
- *Part 10: Guide for the structural design of trafficked pavements constructed of natural stone setts and bound construction with concrete paving blocks;*
- *Part 11: Code of practice for the opening, maintenance and reinstatement of pavements of concrete, clay and natural stone;*
- *Part 12: Guide to the structural design of trafficked pavements constructed on a bound base using concrete paving flags and natural stone slabs;*
- *Part 13: Guide for the design of permeable pavements constructed with concrete paving blocks and flags, natural stone slabs and setts and clay pavers.*

Use of this document

As a code of practice, this part of BS 7533 takes the form of guidance and recommendations. It should not be quoted as if it were a specification and particular care should be taken to ensure that claims of compliance are not misleading.

Any user claiming compliance with this part of BS 7533 is expected to be able to justify any course of action that deviates from its recommendations.

It has been assumed in the preparation of this British Standard that the execution of its provisions will be entrusted to appropriately qualified and experienced people, for whose use it has been produced.

Presentational conventions

The word "should" is used to express recommendations of this standard. The word "may" is used in the text to express permissibility, e.g. as an alternative to the primary recommendation of the clause. The word "can" is used to express possibility, e.g. a consequence of an action or an event.

Notes and commentaries are provided throughout the text of this standard. Notes give references and additional information that are important but do not form part of the recommendations. Commentaries give background information.

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

1 Scope

This part of BS 7533 gives recommendations for the rigid laying of clay pavers conforming to BS EN 1344 intended for pavements and other paved surfaces subjected to all categories of static and vehicular loading, and pedestrian traffic.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS 5212-1, *Cold applied joint sealant systems for concrete pavements – Part 1: Specification for joint sealants*

BS 7533-11, *Pavements constructed with clay, natural stone or concrete pavers – Part 11: Code of practice for the opening, maintenance and reinstatement of pavements of concrete, clay and natural stone*

BS EN 998-2, *Specification for mortar for masonry – Part 2: Masonry mortar*

BS EN 1344, *Clay pavers – Requirements and test methods*

[1] HIGHWAYS AGENCY. Manual of Contract Documents for Highway Works, Volume 1: Specification for Highway Works, London: The Stationery Office.

3 Terms and definitions

For the purposes of this part of BS 7533, the terms and definitions given in BS EN 1344 and the following apply.

NOTE A typical cross-section of a pavement is shown in Figure 1.

3.1 bedding mortar
blend of sand and cement or cement and lime on which paving units are bedded and jointed

3.2 damp proof membrane (DPM)
layer of material applied over the structural base to prevent free lime from the structural base staining the paving surface

NOTE A DPM might be needed if the structural base is suspended, to prevent ingress of water to the underlying structure.

3.3 edge restraint
feature to define edge of paved area which sometimes incorporates a movement joint to absorb movement at the edge of the paved area

3.4 joint finish
final profile of the mortar joint

NOTE Joint finishes are usually formed by special profiled tools.

3.5 joint width
size of the filled space between adjacent paving units or between paving units and edge restraint

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3.6 laying face
working edge of the surface course at which paving units are laid

3.7 laying pattern
arrangement of paving units to form specific patterns either for structural reasons or visual effect

3.8 paver
paving unit with square edges to all arrises, having work dimensions of between 200 mm and 215 mm in length, between 65 mm and 215 mm in width and between 30 mm and 65 mm in thickness

3.9 structural base
layer, upon which paving units are bedded, which carries all loads imposed on the pavement to the sub-base, or in the case of suspended slabs, back to the structure

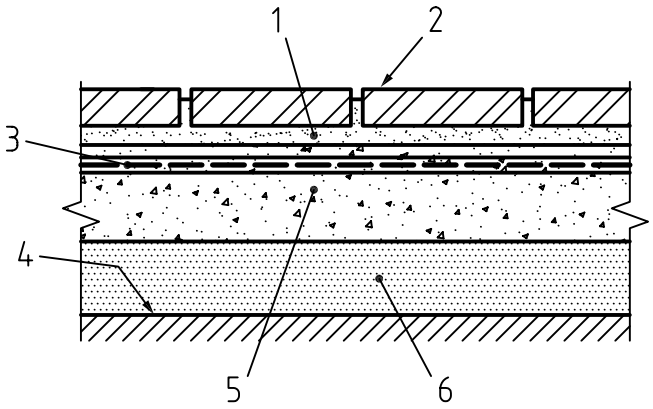
NOTE The structural base normally consists of reinforced or unreinforced concrete or asphalt.

3.10 sub-base
one or more layers of material placed immediately above the subgrade and which provides a firm foundation for the rigid pavement

3.11 subgrade
upper part of the soil, natural or constructed, that supports the loads transmitted by the overlying pavement

3.12 surface course
layer of paving units which acts as the wearing surface of the pavement

Figure 1 **Typical cross-section of a pavement**



Key
1 Bedding mortar
2 Clay paver
3 DPM (if necessary)
4 Subgrade
5 Structural base
6 Prepared sub-base

*NOTE The structural base is laid to falls (see **4.1** and **6.5**).*

4 Construction of base and restraints

4.1 Subgrade and sub-base

Construction of the subgrade and sub-base should be in accordance with current practice as described in the *Specification for Highway Works [1]*.

The subgrade and sub-base, if present, should be prepared so that:

a) surface levels are within ±15 mm;

b) longitudinal falls and crossfalls of the completed pavement allow water to drain, avoiding ponding (see Table 1);

c) the extent of the site preparation includes provision for adequate foundations and backing for any edge restraint in accordance with the *Specification for Highway Works [1].*

NOTE For detailed information on construction of adequate kerb foundations and backing see BS 7533-6.

Table 1 **Minimum longitudinal falls and crossfall to avoid ponding**

Carriageways using pavers as a channel		**Non-trafficked area**		**Carriageways using proprietary drainage systems**	
Min. longitudinal fall	Min. crossfall	Min. longitudinal fall	Min. crossfall	Min. longitudinal fall	Min. crossfall
1.25%	2.5%	1%	1.25%	Check with supplier	2.5%

4.2 Structural base

The structural base should be capable of safely transmitting all loads imposed on the paving either back to other structural elements or to the sub-base. The layer should be durable, have its top surface free from dust, detritus and other loose material and, where possible, should be tamped to provide texture to aid adhesion of bedding mortar.

4.3 Edge restraints

Edge restraints should be sufficiently robust to withstand override by the anticipated pedestrian or vehicular traffic.

5 Laying bedding mortar

5.1 Mortar

Mortar for bedding and jointing pavers should be strength class M12 to BS EN 998-2.

5.2 Modified cement mortar

To modify or improve the adhesion of the mortar to the pavers and/or change the strength characteristics of the mortar, mortar should contain admixtures, such as styrene butadiene rubber (SBR).

NOTE It is advisable to agree the appearance of natural and coloured mortar jointing incorporating SBR admixtures before paving construction starts.

5.3 Preparation of bedding mortar

The bedding mortar should be uniform in thickness and should not be used to overcome variations in levels of underlying construction or to achieve falls.

Only sufficient bedding mortar should be prepared and laid to enable the laying operation to be completed within reasonable time, this being determined by the mortar which should not be used when more than 2 hours old.

5.4 Stiff plastic mortar bed

Bedding material usually comprises a layer of M12 mortar which should be of a stiff plastic consistency, with the joints pointed or formed to a desired profile as work proceeds. The mortar layer should be a minimum of 20 mm thick after compaction.

NOTE Reference is sometimes made to a grouting or tiling method of laying, whereby joints are filled using a cement-rich grout or a strong pointing mix [1:3 cement-sand (proportions by volume)] as a separate operation some 12 hours or more after bedding. Experience has shown, however, that unless the contractor is very experienced in the technique, an unsatisfactory messy or stained finish might result, particularly with rougher-textured pavers.

6 Installation of paver surfaces

6.1 General

Due to the variety of clay pavers available and their ranging physical characteristics, reference should be made either to previous applications or to the manufacturer before a paver is chosen for a particular application (see Annex A).

Details of the laying pattern should be specified before laying begins.

A reference panel with a minimum size of 1 m^2, should be used for establishing the visual acceptability of materials and workmanship maintained during paving construction work.

6.2 Bonding and laying patterns

6.2.1 Pavers should be laid on their bed face (i.e. the largest face) or on their edge (i.e. the second largest face). The consequence of laying standard format pavers on the bed face is that the normal length to width ratio is 2:1, whereas when laid on edge the length to width proportion is 3:1; these proportions should be borne in mind when specifying a bond pattern.

NOTE Pavers of less than 65 mm thickness, when laid on edge, are not intended to bond with their length, but they may be used on edge for the margins of paved areas. Pavers of any thickness can be laid in stretcher/running bond and stack bond patterns.

6.2.2 For economy, pavers should be laid on their bed faces because each square metre of paved surface requires 40 standard format pavers, but 60 pavers if they are laid on their edge faces; more mortar is also required to fill the additional number and depth of the joints.

NOTE Pavers on their edge might have different slip or skid resistance values to those on their bed face.

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6.2.3 Paver size suitability should be selected in accordance with Table A.1.

NOTE There are four basic bond patterns shown in Figure A.1. Variation and mixture of these patterns gives a great variety of choice, and the inclusion of borders and panels separating courses can lead to further enrichment of the surface. Not all paver shapes are suitable for all the patterns illustrated.

6.2.4 Normally, patterns are based on whole pavers, with cut pavers only being used to fit into edges and the non-regular abutments of paving to walls, etc., therefore sections smaller than half unit pavers should be avoided. Cuts should be made using a diamond-tipped water cooled saw to ensure sharp square arrises on pavers.

NOTE The use of half pavers allows many additional attractive bond patterns to be created in rigid laid pavers.

6.2.5 Within the same area, pavers should be laid either on edge or on bed face throughout. Pavers laid in a trafficked area should be laid in a herringbone pattern [see Figure A.1a)] to aid interlock.

NOTE For edging, pavers may be laid on their edge, or on end (on their smallest face). This allows for a more substantial concrete haunching to be placed to restrain the edge of the paved area, unless an edge restraint is provided by some vertical element, for example walling.

6.3 Specific types of laying pattern

6.3.1 Stretcher/running bond

The directional nature of a pattern should be related to the overall design concept.

NOTE Stretcher/running bond has a strong linear quality. Curves in the line of the paving can be accommodated without difficulty.

Both curved and straight lines should be carefully set out and maintained using lines and squares, as appropriate, to achieve consistency, as haphazard deviation will mar the appearance of the paving.

Quarter-, half- and third-overlapping bonds may be adopted to accentuate the linear character of the pattern; however, with quarter-overlapping bonds, care should be taken if curves are part of the design as the bond is easily lost when easing the pavers around the curve.

6.3.2 Stack bond

Stack bond has a strong linear character, in this case in two directions, and care should be taken in maintaining consistent straight lines.

NOTE 1 The pattern of this bond cannot follow a curve.

The pattern also demands greater dimensional consistency than is provided by some clay pavers and, if a precise effect is required, some sorting of the pavers should be made.

NOTE 2 Clay pavers of quite rustic character in such a pattern can look well laid.

Rustic pavers have by their nature, a wider variation in their plan size and designers should allow for a more varied joint width when such pavers are installed.

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6.3.3 Herringbone

NOTE 1 Herringbone is a good general purpose paving pattern without strong directional emphasis. However, brick-on-edge versions have slightly more directional quality than when pavers are laid on their bed face. Many consider that herringbone bond tends to make the paved area appear larger. The interrupted straight lines generated by the long edges of the pavers can easily become misaligned.

The pattern should be set out at 45° to the principal direction of viewing in order to minimize the chances of misalignment becoming noticeable.

NOTE 2 The disadvantage in adopting this laying pattern is that additional cuts are needed for the inevitable triangular edge infill pieces. Although the pattern cannot accommodate curves within it, it does relate well to curved or free form areas.

Not all paver shapes work well with rigid laid herringbone bond so a trial area should be laid out before a final choice of bond is made.

6.3.4 Basket weave

NOTE Although straight lines are present in basket weave, they do have a very static character, and this tends make the size of the paved area appear smaller.

As with the stack bonding, there should be some sorting of the pavers when laying pavers of less consistent shape and size.

6.4 Curved and circular patterns

NOTE 1 Success in laying rectangular pavers to curved patterns depends on the tolerances of the mortar joint to ease the units around the radii. By using cut pavers, more joints are introduced and, therefore, more adjustment is possible. By splaying the cut units, tighter radii can be built.

When setting out curved and circular patterns skill and care should be employed.

NOTE 2 Suitable curved units are available as well as circular patterns and feature work details from some manufacturers.

6.5 Drainage

Drainage should be provided for all rigid laid paving (see **4.1**).

6.6 Laying pavers

If a DPM is required, it should be a liquid and applied by a brush or spray. The DPM should be applied to the structural base prior to the pavers being laid. It should be applied to a clean, dust free surface in accordance with the manufacturer's instructions. If the top surface of the structural base is not tamped when laid, some coarse sand particles sprinkled over the wet membrane should be used to help adhesion between the membrane and bedding mortar. Any loose sand should be brushed from the surface before the bedding mortar is laid.

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6.7 Preparation

Only sufficient bedding mortar should be prepared and laid to enable laying to be completed within a reasonable time (see **5.3**).

NOTE In dry warm weather it might be necessary to wet the surface of pavers to reduce suction but without over-wetting.

Low water absorption units should not be wetted as they can slide on the mortar.

6.8 Cutting and trimming

The modular nature of pavers means that some cutting to complete a pattern or to meet a fixed dimension is inevitable, and acceptable, but this should be minimized by efficient design prior to construction.

Edge cutting becomes relatively less necessary as the area of paving increases and as the shape of the area approaches a square; the implications of designing a pattern involving abnormally great amounts of cutting should be determined.

NOTE Cutting delays the work and involves wastage and extra cost.

Cutting should be carried out as recommended in **6.2.4**.

7 Joints

7.1 Simultaneous bedding and jointing

The most satisfactory method of laying involves simultaneous bedding and jointing; each paver should be mortared on the vertical face and pushed into the mortar bed. Additional mortar should be carefully placed in the joints as necessary using a trowel, ensuring that the vertical joints are fully filled to avoid impact damage and frost damage to the joint. The surplus mortar should be quickly removed and a tooled joint profile formed using an appropriate tool. The surface of the paver should be wiped clean, with care being taken not to allow excess mortar or slurry to stain by entering the surface texture.

NOTE Other laying methods, e.g. the semi-dry method, the grouting method and jointing the pavers as a separate operation, have been used but are not recommended.

7.2 Joint finishing

The joint should be well compacted, using an ironing tool to create a bucket handle profile, to give a dense top surface. The profile should be formed level with the top surface of pavers to provide support to arrises of paver units.

NOTE If the joint profile is recessed below the top surface of pavers, chipping of the arrises of pavers can occur.

Flushed, open texture mortar joints should not be used for paver surfaces as they are liable to be damaged by traffic, frost action and encourage moss and algae growth on joints.

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7.3 Movement joints

Perimeter joints should be provided if the paved area exceeds 6 m in any one dimension. Intermediate joints should be installed in the paving if any run exceeds 6 m. In some situations, such as on suspended floors or in areas where temperature or moisture fluctuations are more severe, the joint spacing should be reduced to 4.5 m.

NOTE 1 Manufacturers might be able to offer advice on movement joint spacing in relation to their own products.

Movement joints should be provided around fixed points of restraint, such as manholes, columns and upstands. Where there is a movement joint in the concrete base, it should be carried through to the surface.

NOTE 2 On suspended constructions, the provision of movement joints in the paving over supports might also have to be considered.

NOTE 3 The movement joint itself is normally 10 mm in width and comprises the following materials:

a) a compressible joint filler (backup material);

b) a barrier (joint breaker); and

c) an extensible tackfree sealant.

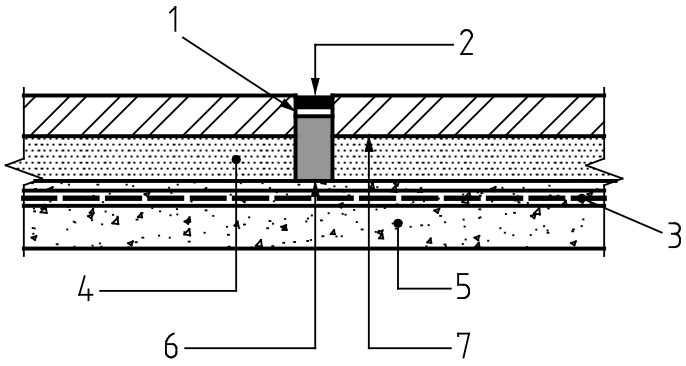
Various materials can be employed as compressible joint fillers although, normally, cellular polymers (e.g. polyethylene and polyurethane foam materials) should be used as these materials can be compressed to at least 50% of their original thickness.

The purpose of the barrier is to prevent the sealant sticking to the joint filler, as this can adversely affect the extensibility of the sealant; polyethylene film or masking tape should be used as such a barrier.

The joint sealant should comply with BS 5212-1, Type N. The advice of the manufacturer of the joint filler or sealant should be followed.

NOTE 4 A typical example of the construction of a movement joint is given in Figure 2.

Figure 2 **Typical example of movement joints**



Key

1 Joint breaker
2 Tack-free flexible sealant
3 DPM (if necessary)
4 Bedding mortar
5 Concrete base
6 Compressible joint filler
7 Paver

Proprietary jointing products containing compressible materials within plastic, stainless steel, or brass edging are available and should be laid in accordance with the manufacturer's instructions.

NOTE 5 Clay pavers exhibit irreversible moisture expansion in addition to cyclic thermal movement.

8 Step detailing

NOTE 1 Step and associated landings can be formed in wet laid clay pavers. Most manufacturers produce special units for such work as standard units are not faced on their sides and therefore give unsatisfactory appearance on the front and side of the step.

The step should be formed with a suitable concrete base in the profile of the step (see Figure 3). If this is cast in-situ, the top surface of the wet concrete should be tamped to aid adhesion of the mortar.

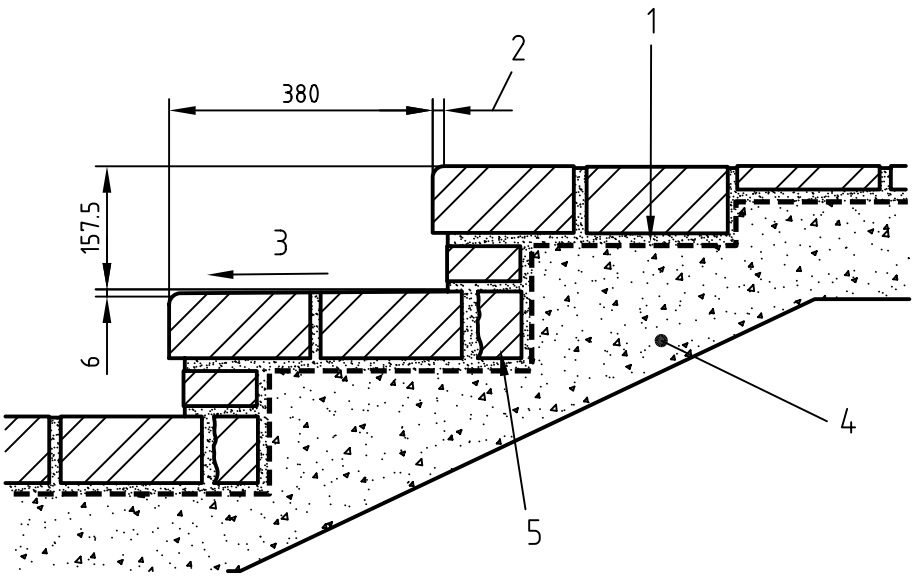
When the concrete has cured or is otherwise ready for the clay units, it should be brushed or sprayed with a DPM (see **6.6**).

NOTE 2 If a membrane is not included there is a risk of lime staining appearing on the face of the clay paving.

The paver and any special step units should be laid as recommended in **6.6**. Construction should start at the base of the steps, ensuring that the work is carried out from the sides of the steps, or that each level is sufficiently protected or cured before it is walked on to prevent any movement in the freshly laid units.

Movement joints should be incorporated in accordance with **7.3**.

Figure 3 **Profile of a typical step**



Key

1 Brushed bitumen DPM dressed with sharp sand to provide key for bedding
2 20 mm overhang
3 Fall
4 Concrete
5 Rough cutting

NOTE Various tread depth dimensions can be constructed as rough cutting can be masked by the riser unit.

9 Care after laying

9.1 Protection and curing

In winter and adverse weather conditions, the finished paving should be covered by polyethylene sheeting for at least 24 h after completion to allow adequate curing.

NOTE In winter months additional precautions such as frost mats might be required to avoid frost damage to immature joints.

In summer, joints should be protected against rapid drying out by covering the finished area with polyethylene sheeting or hessian sheeting.

9.2 Early trafficking

NOTE The rate at which strength develops within the bedding and jointing material depends upon prevailing weather conditions and the adequacy of the protective measures adopted. Correctly protected areas will develop sufficient performance for pedestrian only applications, after seven days and in vehicular trafficked areas after 14 days. The full design strength of the recommended bedding and jointing material develops after 28 days.

Where early trafficking is required, the use of a proprietary mortar with high early strength can be used; the manufacturer's recommendations should be followed.

9.3 Cleaning and maintenance

Cleaning and maintenance of laid paving should be carried out in accordance with BS 7533-11.

9.4 Reinstatement

The reinstatement of paving surfaces following maintenance or other such works should be carried out in accordance with BS 7533-11.

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Annex A (informative) Laying patterns

Laying patterns are shown in Figure A.1, and their suitability relating to paver size is given in Table A.1.

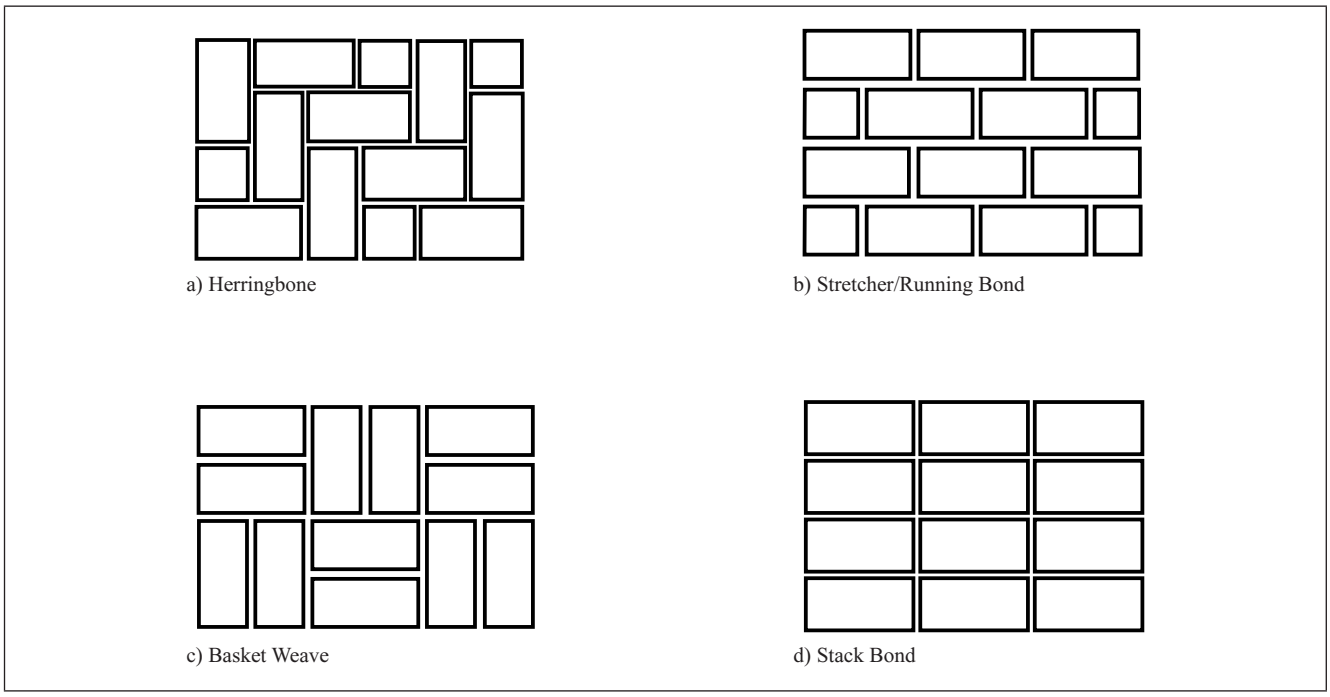
Table A.1 **Paver size suitability for different laying patterns**

Paver size [A] (mm)	Laying pattern			
	Stretcher/running bond	**Stack bond**	**Herringbone**	**Basket weave**
210 × 110	Yes	Yes	Yes [B]	No
225 × 112.5	Yes	Yes	Yes	Yes
230 × 115	Yes	Yes	Yes	Yes

[A] Each length includes the 10 mm joint.

[B] Appearance should be checked using the reference panel.

Figure A.1 **Laying patterns**



Bibliography

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Standards publications

BS 7533-6, *Pavements constructed with clay, natural stone or concrete pavers – Part 6: Code of practice for laying natural stone, precast concrete and clay kerb units*

Further reading

BS 7533-7, *Pavements constructed with clay, natural stone or concrete pavers – Part 7: Code of practice for the construction of pavements of natural stone setts and cobbles*

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