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Foreword

Rwanda Standards are prepared by Technical Committees and approved by Rwanda Standards Board (RSB) Board of Directors in accordance with the procedures of RSB, in compliance with Annex 3 of the WTO/TBT agreement on the preparation, adoption and application of standards.

The main task of technical committees is to prepare national standards. Final Draft Rwanda Standards adopted by Technical committees are ratified by members of RSB Board of Directors for publication and gazettment as Rwanda Standards.

DRS 630:2025 was prepared by Technical Committee RSB/TC 9, *Civil engineering and building materials*.

In the preparation of this standard, reference was made to the following standard (s):

1) BS 7533-7:2010, Pavements constructed with clay, natural stone or concrete pavers – Part 7: Code of practice for the construction of pavements of natural stone paving units and cobbles, and rigid construction with concrete block paving

The assistance derived from the above source is hereby acknowledged with thanks.

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Introduction

The Code of Practice for the Construction of Pavements Constructed with Clay, Natural Stone or Concrete Pavers is a technical document developed within the framework of standardization to ensure quality, consistency, and durability in pavement construction. It serves as a practical guide for professionals involved in the design, specification, and execution of pavements using modular paving units made from clay, natural stone, or concrete.

This standard forms part of the broader infrastructure and construction standardization efforts aimed at harmonizing practices, promoting safety, and supporting sustainability. It reflects industry best practices, advances in materials science, and engineering principles while incorporating lessons learned from field performance.

Pavements of natural stone paving units and cobbles, and rigid construction with concrete block paving — Part 7: Code of practice for construction

1 Scope

This Daft Rwanda Standard provides recommendations for the laying of natural stone paving units and cobbles, and rigid construction with concrete block paving intended for pavements, roads, industrial areas 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.

ASTM C936/C936M-24, *Standard Specification for Solid Concrete Interlocking Paving Units*

RS ISO 1920-2, *Testing of concrete — Part 2: Properties of fresh concrete*

ISO 14824-3, *Grout for prestressing tendons — Part 3: Test methods*

RS 96-5, *Aggregates — Determination of particle shape — Part 5: Flakiness index of course aggregates*

RS 211-5, *Methods of test for mortar for masonry — Part 5: Determination of flexural and compressive strength of hardened mortar*

RS 211-6, *Methods of test for mortar for masonry — Part 6: Determination of adhesive Strength of hardened rendering and plastering mortars on substrates*

RS 373, *Aggregates for concrete — Specification*

RS 521, *Sets of natural stone for external paving — Requirements and test methods*

3 Terms and definitions

For the purposes of this standard, the following terms and definitions apply.

3.1

bedding mortar

Blend of fine aggregate and cementitious binder

3.2

cobble

natural stone element rounded by erosion

3.3

complementary fitting

paving unit used at the end of alternative rows of paving units or cobbles to break bond to avoid the need to cut paving units

3.4

concrete block paving

precast concrete unit used as a surfacing material that satisfies the following conditions:

— at a distance of 50 mm from any edge, any cross-section does not show a horizontal dimension less than 50 mm;

— its overall length divided by its thickness is less than or equal to four.

Note 1 to entry: These two conditions are not applicable to complementary fittings.

3.5

creep

horizontal movement of paving units resulting from the action of deceleration, cornering forces or gravity

Note 1 to entry: The principal cause of creep is vehicular traffic.

3.6

edge restraint

device that prevents lateral movement of paving units and prevents loss of material from the laying course, road base, or sub-base where applicable

3.7

inboard cutting

cutting the paving unit to break the bond to allow the cut at the edge to be greater than one third of a paving unit

3.8

interlock

effect of frictional forces between paving units that prevents them moving in relation to each other

3.9

intermediate restraint

device used to restrain paving units at intervals within a paved surface

3.10

joint width

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

3.11

jointing material

material used to fill in the joints between paving units

3.12

laying course

layer of material on which paving units are bedded

Note 1 to entry: See Figure 1.

3.13

laying course material

fine aggregate or fine concrete into which paving units are bedded

3.14

laying face

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

3.15

laying pattern

arrangement of paving units to form specific patterns either for structural requirements or visual effect

3.16

paving unit

natural stone or concrete block paving

3.17

regulating layer

layer of compacted material upon which the laying course is laid, which ensures the laying course thickness is in tolerance

3.18

road base

one or more layers of material placed above the sub-base that constitute the main structural elements of a non-rigid or composite pavement upon which the laying course is laid

Note 1 to entry: The road base can be a bituminous material and/or cement bound material.

Note 2 to entry: See Figure 1.

3.19

Sett

small natural stone paving block with work dimensions between 50 mm and 300 mm and no plan dimension generally exceeding twice the thickness

3.20

sub-base

one or more layers of material placed immediately above the subgrade

Note 1 to entry: See Figure 1.

3.21

Subgrade

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

Note 1 to entry: See Figure 1.

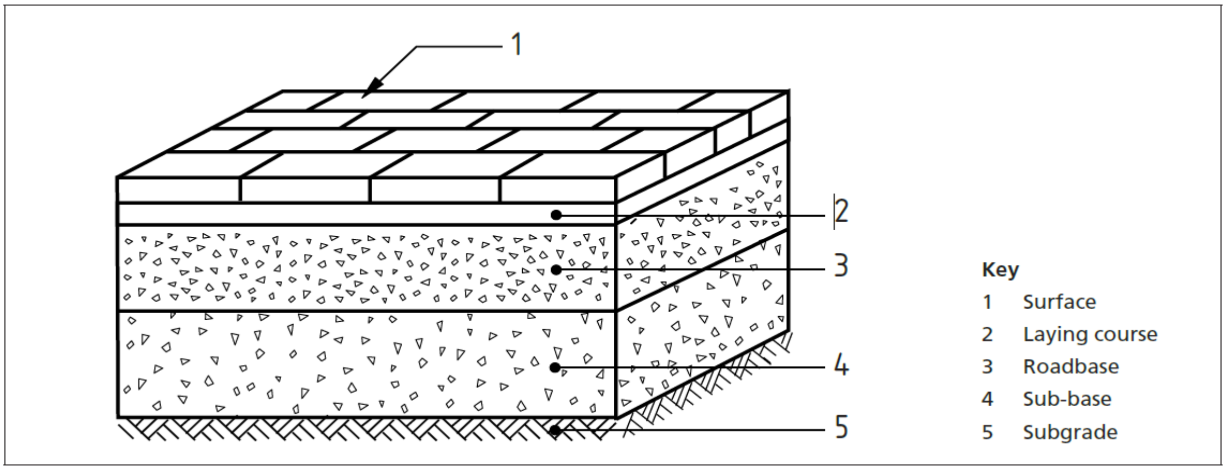
3.22

surface course

layer of paving unit that acts as the wearing surface of the pavement

Note 1 to entry: See Figure 1.

Figure 1 Typical cross-section of a pavement



4 Construction of subgrade, sub-base and road base

4.1 The overall thickness of the construction of subgrade, sub-base or road base should be determined in accordance with relevant applicable Standard to give adequate frost protection to the subgrade.

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

a) they provide a construction platform;

b) surface levels are within the tolerances given in Annex A;

c) longitudinal falls and crossfalls of the completed pavement allow water to drain avoiding ponding, as detailed in Annex B;

d) the road base, regulating layer and/or sub-base is compacted to achieve density in accordance with the relevant approved standards for roads construction;

e) provision is made to prevent the sand laying course material migrating into the drainage systems;

f) the extent of the site preparation includes provision for adequate foundations and backing for any edge restraint in accordance with the relevant approved standards for roads construction;

g) any trenches across the works are permanently reinstated to prevent local settlement.

4.2 Work should not take place when the subgrade is waterlogged or frozen.

4.3 Where an existing road or footway surface is to be overlaid, it should be checked for structural adequacy in accordance with relevant applicable Standard. It should be milled to tolerance in accordance with Annex A or additional bituminous material added to regulate the surface to tolerance prior to spreading the laying course.

5 Materials

5.1 Laying course material

5.1.1 Non-rigid construction

5.1.1.1 Fine aggregate for use with sawn side paving units (e.g. sandstone)

Naturally occurring sand, either from the Quaternary geological series or sea dredged, should be selected and graded according to use, as recommended in Annex C (C.1.1). The laying course should contain no cementitious material, as this might detract from the non-rigid nature of the pavement.

5.1.1.2 Fine aggregate for use with cropped side paving units (e.g. granite)

Crushed igneous rock should be selected as recommended in C.1.5.

5.1.2 Rigid construction

5.1.2.1 General

The compressive strength of the material should be measured by producing samples made in a 100 mm cube mould from actual mixes being used on site. These should be stored under wet hessian in the open, close to the site. The cubes should be tested to determine the strength of the in-situ material at appropriate age, depending on when the area is opened for use. The minimum strength should satisfy design requirements and achieve the desired strength before being opened to vehicles.

5.1.2.2 Fine concrete – Type A mortar

5.1.2.2.1 Moist mix

A mixture of crushed rock as recommended in C.2.1, 5 mm all-in aggregate, and Portland/PFA cement or Portland blast furnace cement should be used. When compacted into a cube mould the mixture should satisfy the requirements given in C.2.1. The compaction of the sample for testing should be achieved using a mechanical hammer.

5.1.2.2.2 Plastic mix

A mixture of crushed rock as recommended in C.2.1, with Portland/PFA cement or Portland blast furnace cement should be used. When compacted, using hand-tamping techniques, into a cube mould the mixture should satisfy the requirements given in C.2.1.

5.1.2.2.3 Modified fine concrete – Type B mortar

Where the mixes described in **5.1.2.2.1** and **5.1.2.2.2** require enhanced properties, e.g. better adhesion or elasticity, chemicals should be added.

5.2 Joint filling material

5.2.1 Non-rigid construction

5.2.1.1 Sawn side paving units (e.g. sandstone)

The aggregate should be in accordance with the grading of Table C.1.

5.2.1.2 Cropped/cleft paving units (e.g. granite)

To seal the joint, a filling material that conforms to **C.1.5** should be used. The joint topping material should be selected to match the joint filling material.

NOTE Jointing material is the same material as the laying course material described in **5.1**.

5.2.2 Rigid construction – Jointing mortar

The fine concrete grout used for jointing should be a slurry designed to satisfy the recommendations of Table C.5. It should have a compressive strength depending on its application as recommended in relevant applicable Standard. The maximum aggregate particle size should be 3 mm.

Dry fine aggregate and cement mixtures should not be used as they have poor adhesion properties and are not frost resistant. Where strength greater than 40 N/mm^2 is required then a proprietary/designed system should be used as recommended in 5.1.2.2.3.

5.3 Paving units

When sawn sided paving units are used, the maximum plan dimension should have a ±3 mm tolerance with the diagonal difference not more than 3 mm.

When cropped sided paving units are used then the tolerances should be as specified in RS 521.

NOTE 1 Paving units might have slight variations in colour and surface texture even when from the same source; this is a natural feature of the product and not a defect. Where variation occurs, materials can be mixed to randomize the effect.

When reclaimed paving units are used, they should be cleaned thoroughly of all loose material and checked for dimensional tolerance before use.

NOTE 2 It might be necessary to stack reclaimed paving units by depth to ensure that the depth of the laying course remains constant and within the permitted tolerance.

5.4 Concrete paving blocks

Concrete paving blocks should conform to the relevant applicable Standard.

6 Moisture content of laying course material

6.1 Fine aggregate laying course

The moisture content of the laying course for non-rigid construction should be maintained within a range that ensures consistent compaction of the laying course to the tolerances in this standard. The materials should be moist without being saturated; therefore, if the prepared laying course is saturated prior to laying of paving units, it should be removed or allowed to dry to an acceptable moisture content.

Stockpile moisture content should be controlled through covering with a waterproof material, e.g. a tarpaulin or polyethylene sheet.

6.2 Fine concrete

6.2.1 General

The moisture content for the laying course for rigid systems should be either a moist mix or a plastic mix.

6.2.2 Moist mix

There should be enough water in a moist mix to hydrate the cement but not so much as to prevent the paving units being hammered in by hand; this is assessed by squeezing the mix in the hand. When the pressure is released, the mix should show no water on the surface and should remain bound together.

6.2.3 Plastic mix

The mortar should have a slump of 150 mm in accordance with RS ISO 1920.

NOTE The material can be purchased premixed, or mixed on site.

The components should be accurately measured by volume using suitable equipment, e.g. clean gauge boxes or buckets. The materials should be mixed in a mixer until free from lumps and of a consistency suitable for the work, i.e. so that they will support the paving unit.

Admixtures can be added to retard set, reduce shrinkage and/or entrain air and should be used in accordance with the manufacturer's instructions.

7 Edge restraints

7.1 General

Edge restraints should be sufficiently robust to withstand override by the anticipated amount of pedestrian and vehicular traffic, creep and construction activity, and to prevent loss of the laying course material from beneath the surface course.

The edge restraint should present a vertical face at least up to the bottom of the laying course.In non-rigid construction, where the laid paving units are to be vibrated, the edge restraint and concrete haunching should gain sufficient strength before vibration takes place. It is essential that any temporary edge restraints are secured so that they do not move under load. At different material intersections, e.g. paving unit and bitumen bound material, an edge restraint should be used.

NOTE 1 It is necessary to include a substantial edge restraint within the construction of the pavement as it is crucial to the pavement's performance. Edge restraints give a guide to levels and falls. Typical examples of edge restraints are kerbs, channels, established structures, and rigid abutments such as securely fixed paving units as shown in Annex D.

NOTE 2 An example of an edge restraint is given in Figure D.2.

Where there is a likelihood of water needing to escape the laying course, edge restraints should contain weep holes or gaps to ensure water entering the laying course can escape.

NOTE 3 The use of a geotextile to prevent migration of laying course might be required.

7.2 Intermediate restraints

Where required, the restraints should be a maximum of 15 m apart, although the specific distance between them is dependent upon the loading, traffic, etc.

NOTE In certain applications, e.g. steep slopes or large paved areas, intermediate restraints might be required.

7.3 Temporary restraints

Temporary restraints should be used to stop paving units from moving during construction and are particularly important if a partially completed pavement is to be trafficked or it is necessary to preserve the integrity of the laying face at the end of the working period.

8 Laying paving units

8.1 Preparation of laying course

The sub-base, regulating layer or road base, if present, should be profiled to the profile intended, to the tolerances recommended in Table A.1. The laying course material should be as uniform in thickness as possible and should not be used as a regulating course or to achieve falls.

If any disturbance of the laying course material by pedestrian or wheeled traffic occurs prior to placing paving units, re-screeding or re-compacting areas of laying course material, it is essential to achieve uniformity of compaction after laying.

8.2 Installation of paving units

The method of installation of the paving units and the laying course material is dependent upon the use of the surface by traffic; the recommendations of relevant applicable Standard when selecting the appropriate method.

Laying patterns should be specified before laying starts, and take into account the size of the product.

Sawn sided paving units should be stored and handled with care to prevent damage to corners and edges. Paving units should be laid onto the prepared laying course. Any minor adjustments necessary to maintain the laying pattern should be made. A laying order, which maintains an open laying face, should be followed. The alignment and level of paving units should be checked periodically, e.g. by using string lines, and adjustments made where necessary.

Where it is necessary to achieve a regular laying pattern, the paving units should be graded into appropriate sizes.

NOTE 1 In the case of sawn sided paving units, where paving units of different width and random length are supplied, the materials might need to be sorted.

8.3 Laying pattern

Where straight line bond patterns have been requested, e.g. stretcher bond, running bond or herringbone, the joint should display a straight line along its centre rather than trying to achieve a line along the edge of the paving unit.

When arc (bogen) patterns have been requested, suitably sized paving units should be selected to ensure that the desired pattern is achieved.

NOTE 1 Annex D shows examples of laying pattern for both rigid and non-rigid construction.

NOTE 2 In non-rigid constructions, laying patterns are crucial to the ability of the surface to achieve interlock and resist lateral forces.

8.4 Non-rigid laying

8.4.1 Sawn sided paving units

When laying on a sub-base or on a roadbase, the target laying course thickness after paving unit compaction should be 40 mm.

The laying course should be prepared by spreading the loose material in a uniform layer, and screeding it to the thickness required, including the surcharge, to give the 40 mm thickness after the paving units have been laid and vibrated into place.

Where previous experience of a particular material is lacking, a small trial area should be used to determine the surcharge.

Following careful removal of the screeding rails, the disturbed area should be filled and re-screeded with laying course material.

The area of laying course prepared should be such that at the end of a working day, its boundary is not less than 1 m ahead of the laying face.

All areas of prepared laying course material should be protected by e.g. a tarpaulin or polyethylene sheet, and not left exposed overnight.

The paving units should be laid with a joint width of between 2 mm and 4 mm.

NOTE 1 The paving unit shape and the laying pattern both influence the joint width.

NOTE 2 The width of the joint does not include the chamfer dimension (if any).

The paving units should be laid onto the laying course by each paving unit being tapped to line and level. Before final compaction, joint filling material should be brushed into the joint and then a plate vibrator used as described in Clause 11 to compact until refusal. The joints should be totally filled with jointing material.

8.4.2 Cropped/cleft or textured side paving units (e.g. granite)

The laying course material should be spread loosely and adjusted for each paving unit individually to ensure that after the hammering into position of each paving unit, the correct line and level including surcharge is achieved.

When laying the laying course material, the layer should try to achieve uniform density as far as possible.

The paving units should be laid with a nominal joint width of 10 mm, with a maximum joint width of 15 mm. After the paving units have been tapped into position, the laying course material should rise up the joint to ensure the paving units are held in place.

NOTE 1 For small paving units, having relatively narrow joints, and for large paving units intended to withstand heavy vehicular trafficking, a joint filling aggregate as described in C.1.3 is used to fill the upper regions of the joint void.

NOTE 2 For lightly trafficked pavements where joint widths are not less than 10 mm, it is normal practice to fill the joints using the same aggregate as for the laying course.

The joint filling material should be swept into the joints filling them completely and the paving units compacted to refusal using a plate vibrator as recommended in Clause 11. The fine topping aggregate, described in C.1.4, should be spread over the surface to a thickness of between 5 mm and 10 mm and, to ensure the joints are completely filled, the surface should be sprayed with a fine water spray to wash the material into the joints.

Dry sand and cement mixtures should not be brushed into the joint as such materials are not durable and have poor adhesion quality.

8.4.3 Additional work after early trafficking on non-rigid construction

The surface course should be inspected soon after completion and at regular intervals thereafter. Additional material should be brushed into the joints where necessary.

Joints gradually become semi-impervious due to the sealing effect of accumulated dust, etc.; until this has occurred, i.e. a crust of dust is evident upon the surface of the joint, the paving should only be brushed by hand. Mechanical sweepers and in particular sweepers with high suction forces should only be used with care, as any resultant loss of jointing sand from between the paving units can affect the performance of the construction.

NOTE When the joints need to be stabilized early in the life of the pavement, for example to stop water going into the joint, joint stabilizer material can be applied in strict accordance with the manufacturer's instructions. This treatment helps to prevent the unwanted removal of jointing material by suction cleaners and at the same time helps to prevent the ingress of water through joints. This treatment might affect the colour of the surface of the paving unit and, at least initially, its slip and skid resistance.

8.5 Rigid laying

8.5.1 General

The laying course thickness after compaction should be 40 mm for moist bedding and 30 mm for plastic bedding using mortar specifications in accordance with applicable standards.

NOTE The use of dry or semi-dry fine concrete for bedding and jointing is not recommended. It leads to inadequate support, poorly filled joints and uncertain performance in-service.

Surplus material should be quickly removed. The surface of the paving unit should be wiped clean, with care being taken not to allow excess material to stain by entering the surface texture. Care should be taken to ensure the slurry does not choke or pollute drainage systems, e.g. excess material should be washed away after laying.

Spot bedding should not be used.

8.5.2 Moist mix laying with vibratory compaction

The moist laying course should be spread out, including surcharge, and paving units rammed into place to partially compact the laying course. The laying course material should rise up in the joint to approximately 50% of the depth of the paving unit.

Additional laying course material should be spread over the surface and brushed to completely fill the joint and final compaction completed by vibratory compaction as recommended in Clause 11. The area should then be soaked. The joint should finish at least 30 mm below the top surface before re-grouting is carried out to fill the joint completely.

NOTE The joints can be left open overnight before final grouting takes place.

8.5.3 Moist bed with full depth slurry joint

This method should only be carried out by an experienced installer. The moist laying course should be spread out, including surcharge, and paving units rammed into place to partially compact the laying course to a consistent degree. The laying course material should rise up in the joint to no more than 20 mm. The bed should be allowed to cure to reach initial set, which should take approximately one day, before the filling of the joint is attempted.

The fine concrete jointing material in a pourable self-compacting grout should be applied to fill the joint in one operation; this can be achieved by pouring the grout over the area, using a squeegee, by using a can with a fine nozzle, or by injecting the joint with a handgun. Surplus grout on the surface should be kept moist until the grout has set sufficiently to permit the surface of the paving units to be gently rinsed clean, and the area should not be opened to traffic until the jointing material has achieved sufficient strength to withstand the traffic over-riding the pavement without causing failure.

NOTE 2 Where coloured grout is used, particular care is required to prevent staining of the stone.

8.5.4 Plastic mix laying

The bedding layer should be spread out with the surcharge, the paving units placed on the bed and tapped to final level. The bed should be allowed to cure to reach initial set, which should take approximately one day. The area should be flooded with the grout, ensuring the joint is fully filled. The surplus grout should be removed from the surface.

The area should not be open to traffic until the bedding and jointing materials have achieved sufficient strength.

8.6 Proprietary systems

All proprietary systems should be load bearing.

NOTE Some systems are only deemed suitable for pedestrian use.

The instructions of the manufacturer should be followed.

8.7 Joint details

The finish level of the joints should not be greater than 3 mm below the surface of the pavement.

NOTE To ensure joints are fully filled, cores can be taken.

9 Laying cobbles

9.1 Cobbles should generally be laid on fine moist concrete laying course mixture, ratio 1:3 cement-sharp sand proportions by volume, on a suitable base.

9.2 The laying course material should be laid between edge restraints to a depth depending on the size of cobble used.

NOTE 1 The edge restraint provides a guide to levels and falls as well as containing the laying course material.

9.3 The cobbles should be soaked in water for 3 min to 10 min, and then placed in position one-by-one and lightly tapped into place. After a suitable area has been laid, e.g. 1 m × 1 m, a strong flat board should be placed over the area and beaten down to compact the area. Sufficient time should be allowed for the fine concrete to harden; approximately one day.

6.4 After hardening, the area should be wetted and a slurry of 1:3:1 cement-building sand-concrete sand (proportions by volume) poured over the surface. The slurry should be worked into the gaps between the cobbles with a brush to ensure no air or water is trapped and that at least 60% of the cobble is embedded.

9.5 To remove excess mortar and wipe clean the surface of the cobbles, a sponge or brush should be used. This process should be continued until all the mortar is removed from the exposed cobbles.

NOTE 2 The mortar between the cobbles can be trowelled to achieve a smooth finish if desired.

9.6 After the mortar has hardened, the area should be cleaned with either a pressure water jet washer or by scrubbing with a thin layer of kiln dry sand and a stiff brush.

10 Cutting and trimming of paving units and the use of complementary fittings

10.1 Cropped paving units can be cut, using e.g. a splitter, a chisel or a bolster chisel; sawn sided paving units should be sawn by disc cutter or masonry saw.

10.2 The paved area should be covered as far as possible with full sized paving units. Where paving units need to be trimmed, sizes smaller than a third of the original plan size of the large paving unit should be avoided. No plan dimension should be less than 50 mm. When using small paving units (40 mm to 60 mm) cutting should be avoided if possible.

10.3 Whole large paving units should be laid first, followed by paving units cut around obstructions and adjacent to edge restraints; this can be achieved by inboard cutting where necessary or by using complementary fittings. Cutting and laying cut paving units should be completed as soon as is practical, preferably in the same working day and before any fine concrete laying course has set.

10.4 The joint between the cut paving units and the full paving units or the edge restraint, should be the same as those of full-size paving units laid within the body of the pavement.

NOTE 1 These are dependent upon the system of bedding used.

10.5 Cut paving units or complementary fittings should be incorporated into the curved lengths of running bond patterns to prevent cross-joints coinciding and to re-establish the correct pattern.

10.6 For trimming and laying around ironwork, units should either be trimmed to fit after laying full units around any obstruction with joint widths not exceeding 5 mm between ironwork and paving unit, or alternatively, a smaller sized paving units in either the same material or in a different material may be used.

NOTE 2 The paving units might require regulation of the sub-structure with fine concrete to maintain finish levels.

10.7 Where this is not possible, the obstruction should be surrounded in advance of laying the paving units with C35 air entrained concrete or equivalent (maximum aggregate size of 10 mm) to form a more regular shape of sufficient dimension. The thickness should either be at least the total depth of the paving unit and laying course, or at least the depth of the ironwork, whichever is the greater. To provide structural integrity, the width should be not less than 100 mm. Wherever possible, when new ironwork is being used in conjunction with paving units, the shape and size of the ironwork should be taken into account when choosing it so as to ensure minimum cutting.

10.8 Raw materials should be selected for matching colour. Proper curing of the concrete is essential; bitumen sprays, curing agents, wet material or plastic sheeting held in place are effective. Care should be taken to avoid staining the finished face of the paving units with cementitious material.

Concrete should be mixed and laid, as dry as possible to obtain the surface finish. Compaction in place should be carried out to remove air bubbles and voids.

NOTE 3 Rapid setting cementitious mortar can be used, in accordance with manufacturers' instructions.

11 Vibratory compaction

11.1 Non-rigid laying and rigid laying (moist bed with topping joint)

11.1.1 Compaction should be carried out as soon as possible after laying but not within 1 m of any laying face. Apart from this edge strip, areas of paving should be left compacted at the completion of the day's work.

NOTE 1 See Annex E for recommendations on the types of plate vibrators to be used for compacting the laying course and paving units.

NOTE 2 To minimize damage to the surface of the paving units, some manufacturers recommend the use of a compactor with a neoprene sole plate.

11.1.2 The finished surface levels should be within the tolerances given in Annex A.

11.2 Rigid laying

For rigid laying the paving units should be bedded directly into the mortar, by hand, before the initial setting of the cement begins.

The finished surface levels should be within the tolerances given in Annex A.

12 Construction in inclement weather and reinstatement

12.1 In adverse weather conditions, paving should not be laid or jointed if the temperature is below 3 °C on a falling temperature or below 1 °C on a rising thermometer. The surface should not be frozen.

12.2 The paving should be adequately protected from moisture, or in the case of cement bound material frost damage, until adequate strength has been achieved for damage not to occur in such conditions.

12.3 If weather conditions are such that the performances of the pavement might be jeopardized, all operations should be discontinued. Care should be taken to maintain the laying course material at a consistent moisture content.

12.4 Reinstatement should be carried out in accordance with relevant applicable standard(s).

Annex A
(normative)

Maximum permissible deviation from design level

The tolerance of each layer from the required finish datum, when measured over a 3 m grid, should be as recommended in Table A.1. The thickness of the laying course should be the target thickness ±1 mm.

NOTE 1 Therefore, the full range of tolerances for surface levels might not be available.

Table A.1 — Tolerances on surface levels title

Layer of pavement	Non-rigid construction mm	Rigid construction mm
Sub-base	+20 -15	± 15
Rad base	±5	±5
Surface course	±5	±5
To ensure positive drainage, the finish level of the paving to the top surface of drainage inlets and channel should be a minimum of 5 mm. NOTE 2 This is important to avoid ponding around drainage inlets or channels.		

Annex B
(informative)

Surface drainage

The falls for surface drainage given in Table B.1 can be used to ensure that surface water is removed efficiently from the surface and that ponding is avoided.

Table B.1 — Falls for surface drainage

Type of drainage	Recommended	Extreme limits
Crossfalls: rough paving units smooth paving units	 3.0 % 2.5 %	 1.5% to 7 %
Longitudinal: rough paving units smooth paving units	 min. 2.5 % min. 1.25 %	 max. 8 % max. 8 %
NOTE 1 Some materials can be laid on slopes steeper than these gradients, but as most paved areas are shared with pedestrians they would be considered to be unwalkable. 8% is considered to be a comfortable maximum. NOTE 2 In large paving areas, it is important to consider the resultant fall from the combination of crossfalls and longitudinal fall. NOTE 3 Large areas can be divided into panels which can be drained, particularly where levels are constrained by edges of buildings, etc.		

Surface regularity of the surface course is described in Table B.2.

Table B.2 — Surface regularity of the surface course

Measurement of surface regularity	Tolerances
Flatness of pavements when laid Differences in levels at the join of adjacent paving units	3 mm under 3 m straight edge 2 mm
NOTE 1 When laying riven face units the tolerances do not apply. NOTE 2 Tolerances only apply for units which are sawn and then textured.	

Annex C
(normative)

Recommendations for laying course material and jointing material grading

C.1 Non-rigid laying of paving units

C.1.1 Sawn paving units

Naturally occurring and sea-dredged sands to the grading given in Table C.1 and Table C.2 should be used.

C.1.2 Grading

The grading of laying course should conform to a RS 373 coarse aggregate, as shown in Table C.1.

Table C.1 — Grading of laying course for non-rigid laying of sawn paving units

Sieve size mm	Percentage by mass passing %
10 6.3 2 1 0.063 (fines content)	100 80 – 99 0 – 20 0 – 5 0 - 2

C.1.3 Jointing material

Jointing material should be dried free-flowing silica aggregate, the grading of which should conform to a RS 373 fine aggregate, as shown in Table C.2.

Table C.2 — Jointing material

Sieve size mm	Percentage by mass passing %
2 1 0.5 0.63 (fines content)	100 85 – 99 55 – 100 fines category

C.1.4 Cropped/cleft paving units

The laying course should be crushed igneous rock with:
a) a flakiness index of less than FI_{35} when measured in accordance with RS 96-5; and
b) which conforms to a RS 373, fine aggregate, as shown in Table C.3.

Table C.3 — Grading of laying course for non-rigid laying of cropped paving units

Sieve size mm	**Percentage by mass passing** %
8	100
6.3	85 – 99
4	55 – 100
0.5	5 - 45
0.063 (fines content)	fines category

C.1.5 Joint filling material

Crushed igneous rock, specified as 3 mm to dust with equiaxial particle shape, should be used. The grading should be determined using formulae C.1 and C.2 as appropriate for each laying course material.

$$\frac{\text{D passing at 15\%}}{\text{d passing at 85\%}} < 4 \qquad \text{(C.1)}$$

and

$$\frac{\text{D passing at 50\%}}{\text{d passing at 50\%}} < 10 \qquad \text{(C.2)}$$

where

D = sieve size of laying course material;

d = sieve size of joint topping material.

C.1.6 C.1.6 Fine topping material

Crushed igneous rock or carboniferous limestone, specified as 1 mm to dust, with not less than 50 % passing the 0.09 mm sieve, should be used.

C.2 Rigid construction of paving units and concrete paving blocks

C.2.1 Fine bedding concrete

The laying course should be aggregate, which contains at least 70 % crushed igneous rock with a flakiness index of less than FI35 when measured in accordance with RS 96-5, and which conforms to a RS 373 fine aggregate.

The laying course should conform to the characteristics specified in Table C.4

Table C.4 — Laying course characteristics

Type A mortar	
Minimum compressive strength	25 N/mm^2
Flexural strength	3.5 N/mm^2
Minimum adhesive strength when measured in accordance with RS 211-6	0.5 N/mm^2
Modulus of elasticity when measured in accordance with applicable standard	(15 000 ± 3 500) N/mm^2
Maximum shrinkage when measured in accordance with ISO 14824-3	not greater than 0.10 %
Type B mortar	
Minimum compressive strength	35 N/mm^2
Flexural strength	4.5 N/mm^2
Minimum adhesive strength when measured in accordance with RS 211-6	0.2 N/mm^2
Modulus of elasticity when measured in accordance with applicable standards	(18 000 ± 3 500) N/mm2
Maximum shrinkage when measured in accordance with ISO 14824-3	not greater than 0.10 %
A) Includes the use of primer mortar.	
The laying course should be frost resistant and allow the passage of water through it after it has cured. NOTE 1 This might take between 7 and 28 days. NOTE 2 In all situations, Type A mortar may be substituted with Type B mortar. NOTE 3 Brittleness is an important factor in the performance of laying course material. Experience has shown that a value of 3.0 Joules and above has proved satisfactory.	

C.2.2 Jointing mortar

Jointing mortar should be in accordance with the recommendations given in Table C.5.

Table C.5 — Jointing mortar characteristics

Requirement	Mortar strength designation	
Min. compressive strength A)	25 N/mm^2	40 N/mm^2
Min. flexural strength	3.5 N/mm^2	6 N/mm^2
Min. adhesive strength	1.0 N/mm^2	1.5 N/mm^2
Modulus of elasticity	(18 000 ±4 000) N/mm^2	(20 000 ±4 000) N/mm^2
Min. density	2 000 kg/m^3	2 000 kg/m^3
Max. shrinkage	not greater than 0.10 %	not greater than 0.10 %

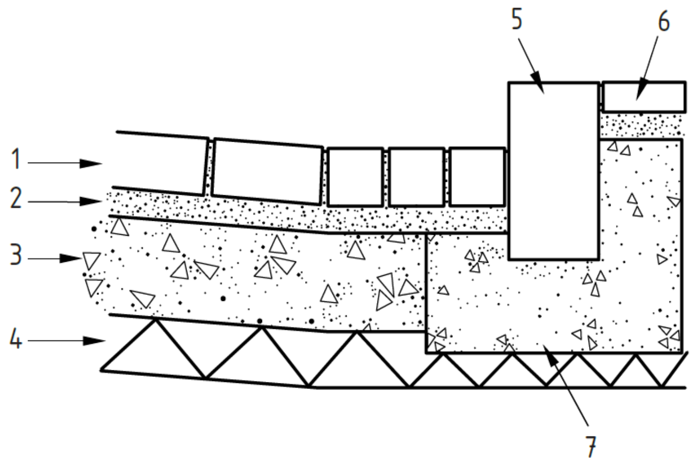
Jointing mortar should be frost resistant and resistant to de-icing salts.

Annex D
(informative)

Restraints and laying patterns

D.1 Examples of restraints for non-rigid construction

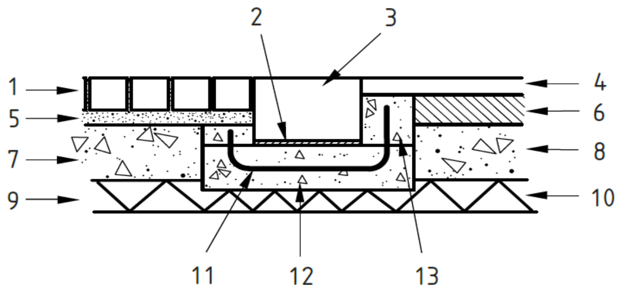
Figure D.1, Figure D.2 and Figure D.3 provide examples of restraints for non-rigid construction.



Key

1 Paving unit
2 Laying course
3 Water permeable base
4 Sub-base
5 Kerb
6 Footway
7 Concrete foundation and haunch

Figure D.1 — Example of kerb edge details for non-rigid construction

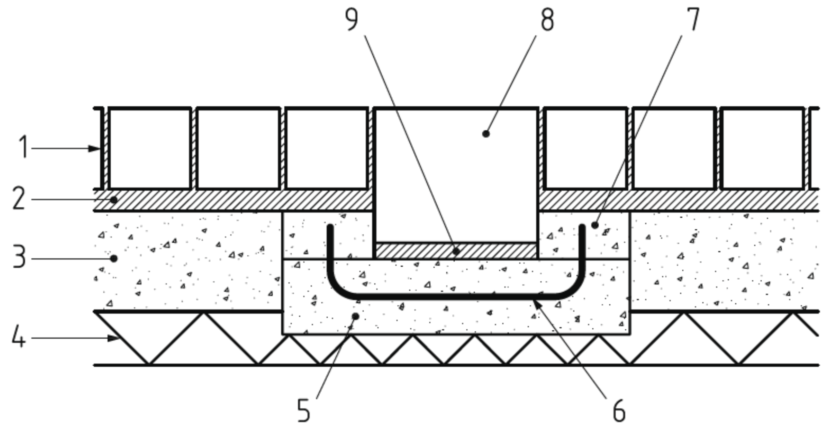


Key

1 Paving unit
2 Bedding
3 Channel kerb
4 Carriageway surface course
5 Laying course
6 Carriageway roadbase
7 Water permeable base
8 Carriageway sub-base
9 and 10 Sub-base
11 Steel reinforcement
12 Concrete
13 Concrete haunch

NOTE The length of reinforced concrete base is at least 1 m.

Figure D.2 — Example of edge restraint between non-rigid construction and different construction (transverse joint)



Key

1 Paving elements
2 Laying course
3 Water permeable base
4 Sub-base
5 Concrete
6 Steel reinforcement
7 Concrete haunch
8 Channel kerb
9 Bedding

NOTE The length of reinforced concrete base is at least 1 m.

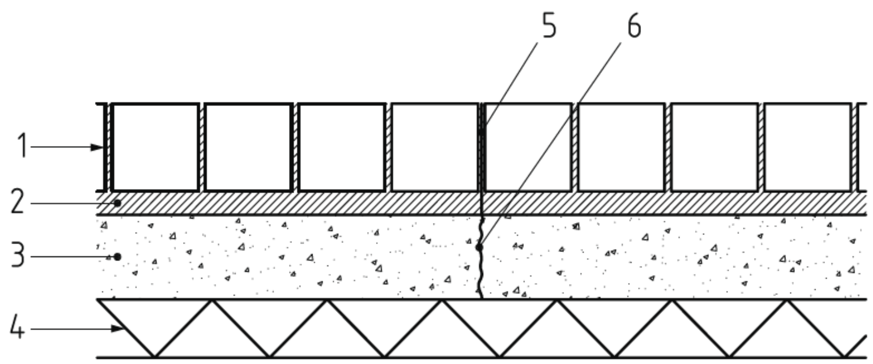
Figure D.3 — Example of intermediate edge restraint between areas of non-rigid construction (transverse joint)

D.2 Examples of restraints for rigid construction

Figures D.4 to Figure D.10 provide examples of restraints for rigid construction.

Where an asphalt road base is employed beneath rigid construction, the last 1 m is detailed as a reinforced concrete slab.

Where an unreinforced concrete road base is employed beneath rigid construction, reinforcement to be included for a minimum length of 1 m.

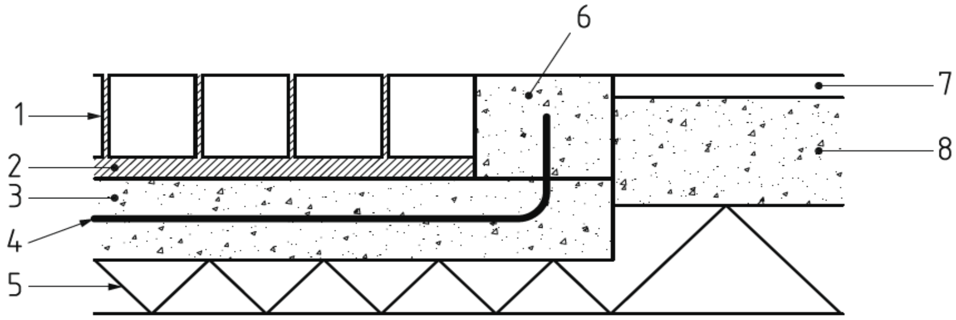


Key

1 Paving elements
2 Laying course
3 Concrete base
4 Sub-base
5 Thin paper break formed with jointing and bedding mortars
6 Induced break formed in concrete base

NOTE The length of reinforced concrete base is at least 1 m.

Figure D.4 — Example of induced break detail in rigid construction (transverse joint)



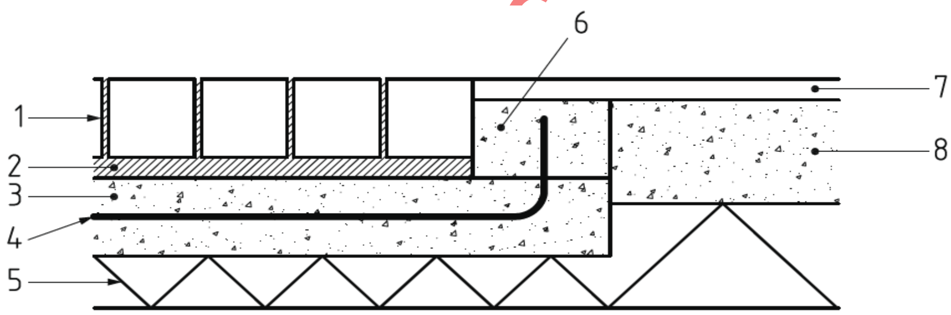
Key

1	Paving elements	5	Sub-base
2	Laying course	6	Visible concrete haunch
3	Concrete base	7	Carriageway surface course
4	Steel reinforcement	8	Carriageway roadbase

NOTE 1 The length of reinforced concrete base is at least 1 m.

NOTE 2 The reinforcement is at least steel mesh.

Figure D.5 — Example of visible concrete transition restraint between rigid construction and different construction (transverse joint)



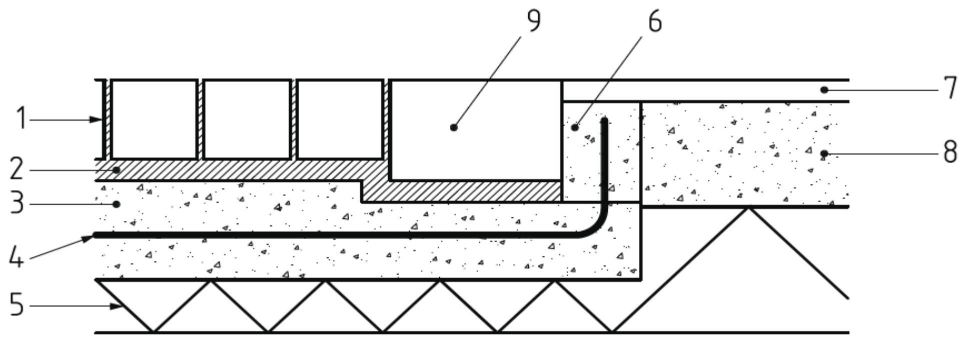
Key

1	Paving elements	5	Sub-base
2	Laying course	6	Concrete haunch
3	Concrete base	7	Carriageway surface course
4	Steel reinforcement	8	Carriageway roadbase

NOTE 1 The length of reinforced concrete base is at least 1 m.

NOTE 2 The reinforcement is at least steel mesh.

Figure D.6 — Example of hidden concrete transition restraint between rigid construction and different construction (transverse joint)



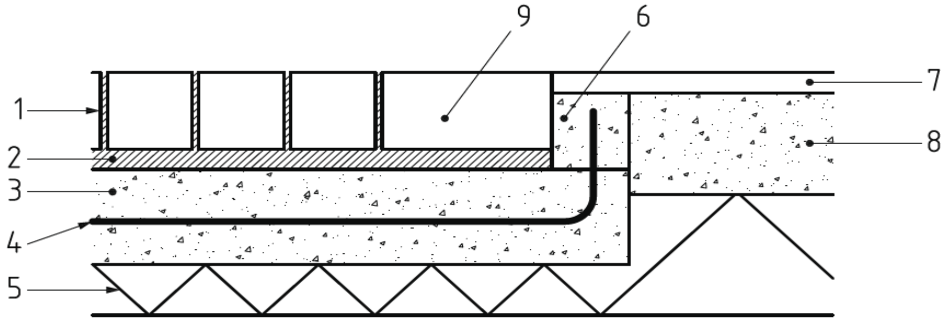
Key

1 Paving elements
2 Laying course
3 Concrete base
4 Steel reinforcement
5 Sub-base
6 Concrete haunch
7 Carriageway surface course
8 Carriageway roadbase
9 Channel kerb

NOTE 1 The length of reinforced concrete base is at least 1 m.

NOTE 2 The reinforcement is at least steel mesh.

Figure D.7 — Example of deep channel kerb transition restraint between rigid construction and different construction (transverse joint)



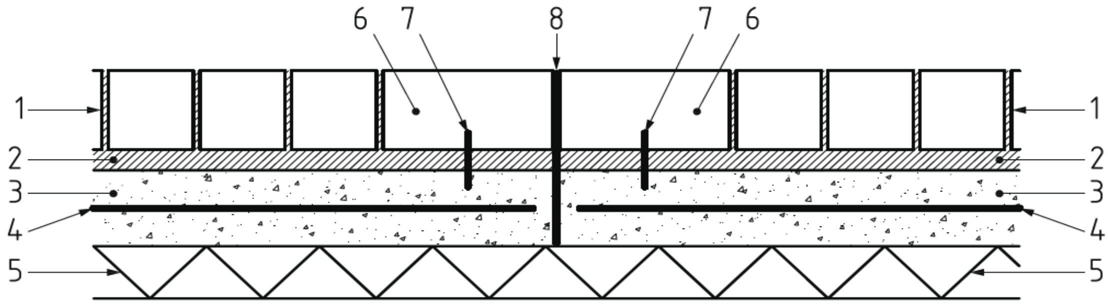
Key

1 Paving elements
2 Laying course
3 Concrete base
4 Steel reinforcement
5 Sub-base
6 Concrete haunch
7 Carriageway surface course
8 Carriageway roadbase
9 Channel kerb

NOTE 1 The length of reinforced concrete base is at least 1 m.

NOTE 2 The reinforcement is at least steel mesh.

Figure D.8 — Example of shallow channel kerb transition restraint between rigid construction and different construction



Key

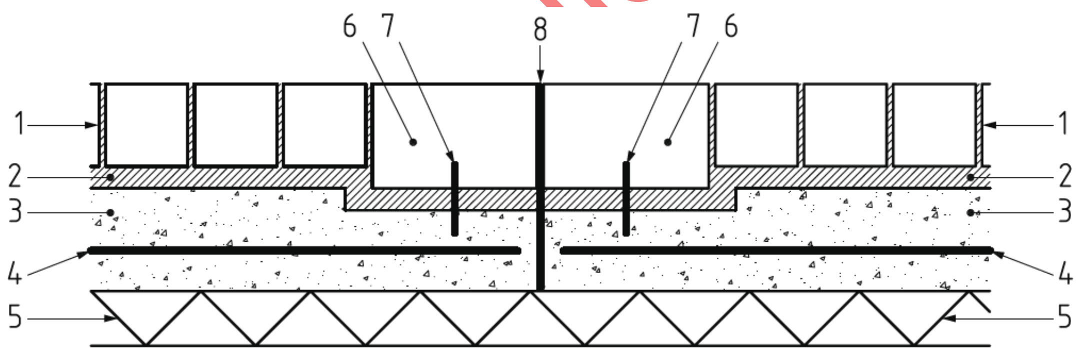
1	Paving elements	5	Sub-base
2	Laying course	6	Channel kerb
3	Concrete base	7	Steel dowel pin fixed into kerb using proprietary resin system
4	Steel reinforcement	8	Movement joint sealed with proprietary low modulus sealant

NOTE 1 The length of reinforced concrete base is at least 1 m.

NOTE 2 The reinforcement is at least steel mesh

NOTE 3 The dowel bar is mild steel bar 20 mm diameter

Figure D.9 — Example of low modulus movement joint using shallow channel kerbs (transverse joint)



Key

1	Paving elements	5	Sub-base
2	Laying course	6	Channel kerb
3	Concrete base	7	Steel dowel pin fixed into kerb using proprietary resin system
4	Steel reinforcement	8	Movement joint sealed with proprietary low modulus sealant

NOTE 1 The reinforcement is at least steel mesh

NOTE 2 The dowel bar is mild steel bar 20 mm diameter

Figure D.10 — Example of low modulus movement joint using deep channel kerbs

D.3 Examples of laying patterns

Figure D.11, Figure D.12, Figure D.13 and Figure D.14 give examples of laying patterns.

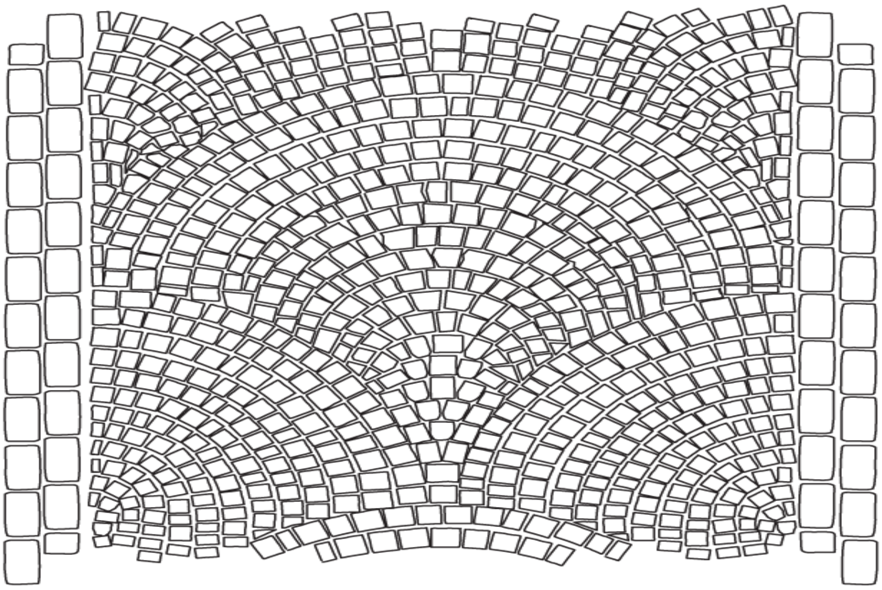


Figure D.11 — Example of florentina pattern – Cube setts

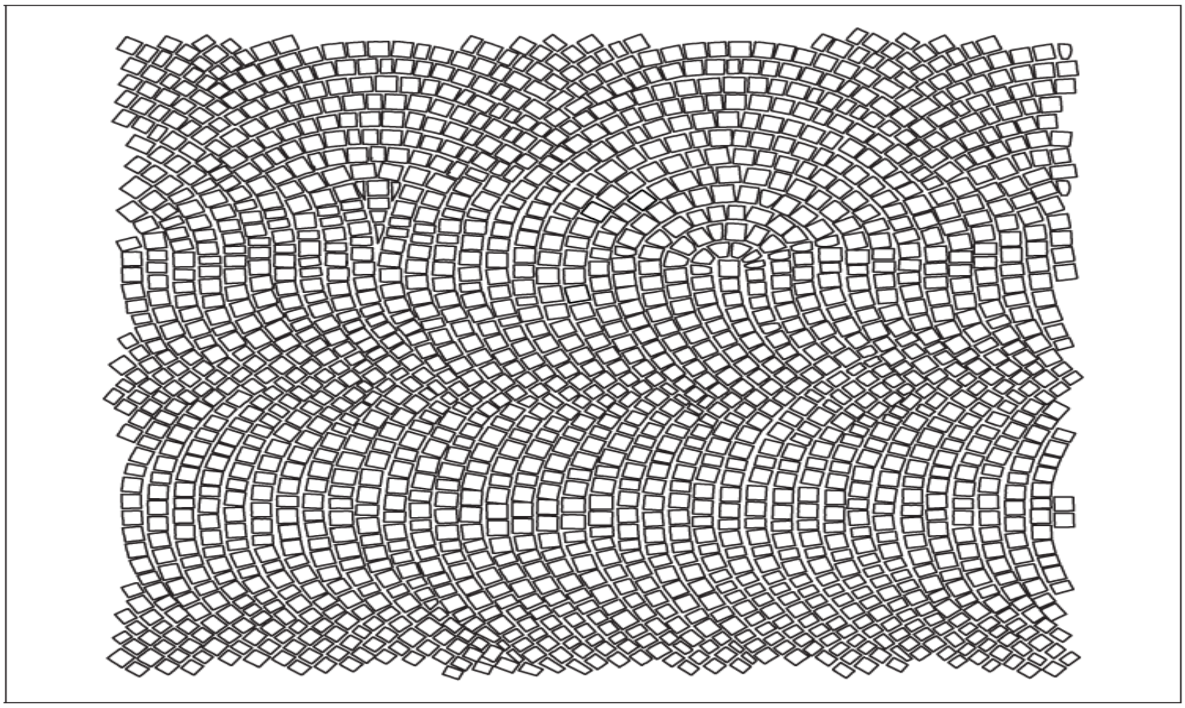


Figure D.12 — Example of segmental arch pattern 90° direction change – Cube setts

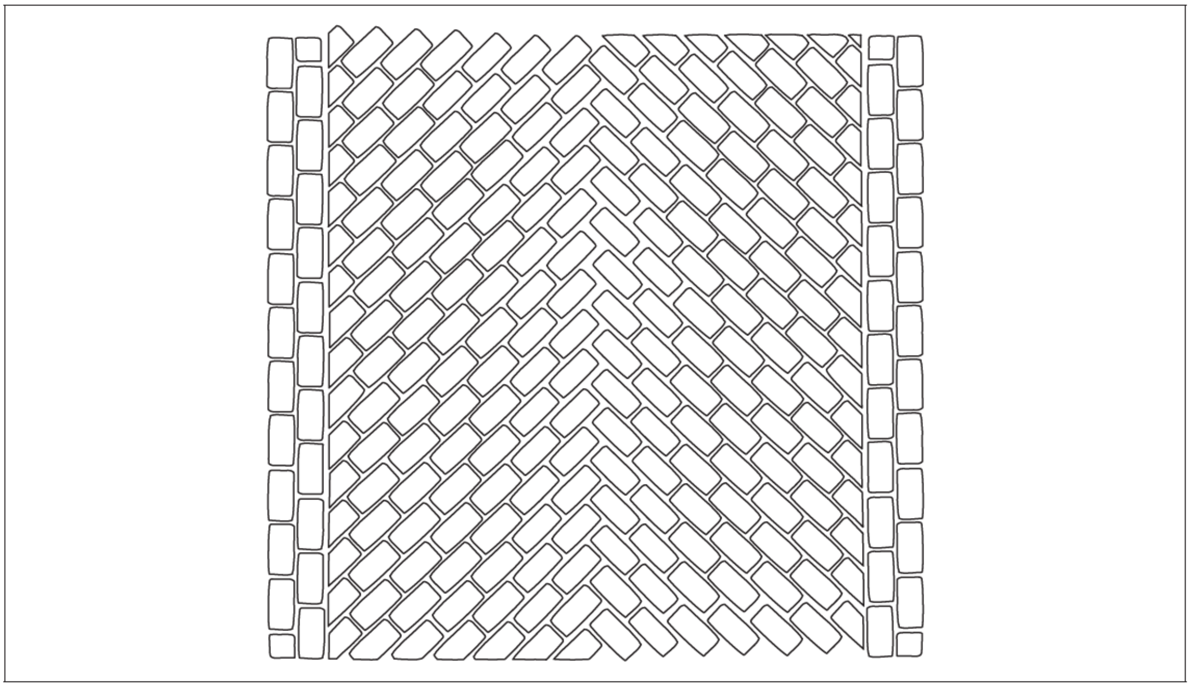


Figure D.13 — Example of chevron pattern – Setts

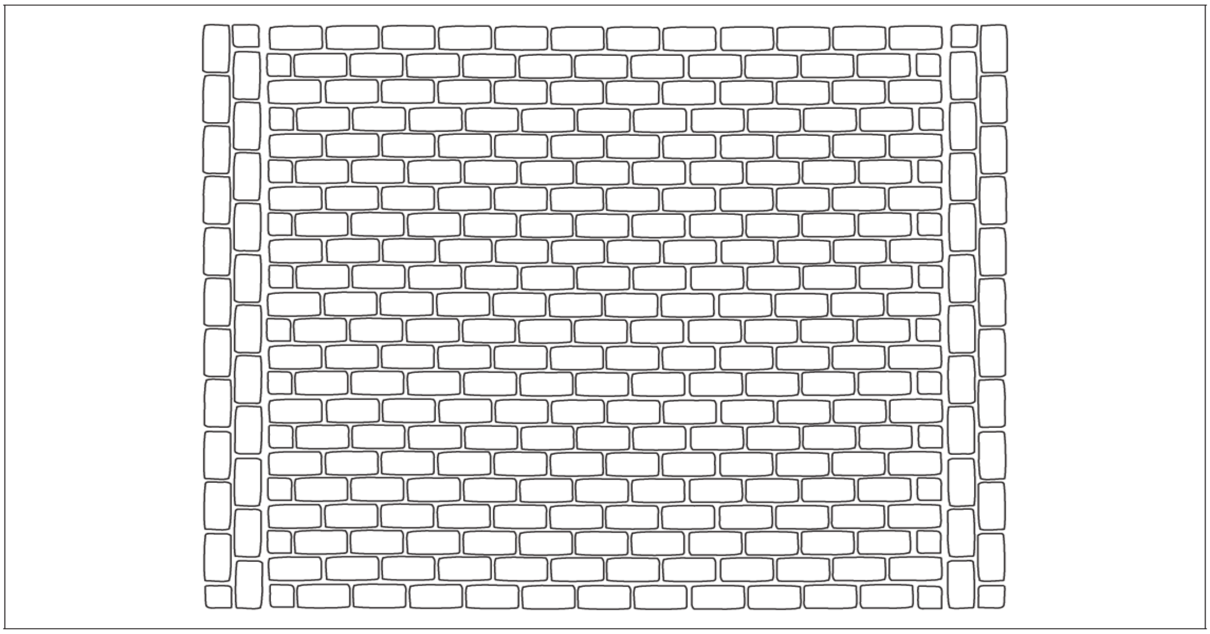


Figure D.14 — Example of stretcher bone pattern – Setts

Annex E
(informative)

Plate vibrator details for non-rigid laying

For non-rigid laying plate vibrators as detailed in Table E.1 can be used.

Table E.1 — Plate vibrator details for non-rigid laying

Min. plate area m^2	Min. effective force per area of plate kN/m^2	Frequency Hz	Min. mass kg
0.25	75.00	65–100	200.00
0.2	60.00	75–100	80.00

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