



BSI Standards Publication

Pavements constructed with clay, natural stone or concrete pavers

Part 13: Guide for the design of permeable pavements constructed with concrete paving blocks and flags, natural stone slabs and setts and clay pavers

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This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 26, an inside back cover and a back cover.

Foreword

Publishing information

This part of BS 7533 is published by BSI and came into effect on 31 March 2009. 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 5: Guide for the design of pavements (other than structural aspects);*
- *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 setts and cobbles;*
- *Part 8: Guide for the structural design of lightly trafficked pavements of precast concrete flags and natural stone slabs;*
- *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;*
- *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 guide, 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.

Presentational conventions

The provisions in this standard are presented in roman (i.e. upright) type. Its recommendations are expressed in sentences in which the principal auxiliary verb is “should”.

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

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 guidance on the design of permeable pavements surfaced with:

- concrete paving blocks manufactured in accordance with BS EN 1338;
- concrete paving flags manufactured in accordance with BS EN 1339;
- natural stone slabs manufactured in accordance with BS EN 1341;
- natural stone setts manufactured in accordance with BS EN 1342; and
- clay pavers manufactured in accordance with BS EN 1344.

and laid in accordance with BS 7533-3.

It applies to all pavements subjected to the usual road spectrum of axle loads up to 8 000 kg, including both highway pavements and light industrial pavements where the traffic is similar in character to highway vehicles.

It specifically excludes heavy duty pavements with traffic and other applications such as aircraft pavements and those in ports and specialized industrial areas.

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 1377-4:1990+A2:2002, *Methods of test for soils for civil engineering purposes – Part 4: Compaction-related tests*

BS 1377-9, *Methods for test for soils for civil engineering purposes – Part 9: In-situ tests*

BS 6100-3, *Building and civil engineering – Vocabulary – Part 3: Civil engineering – General*

BS 7533-1:2001, *Pavements constructed with clay, natural stone or concrete pavers – Part 1: Guide for the structural design of heavy duty pavements constructed of clay pavers or precast concrete paving blocks*

BS 7533-3, *Pavements constructed with clay, natural stone or concrete pavers – Part 3: Code of practice for laying precast concrete paving blocks and clay pavers for flexible pavements*

BS EN 752, *Drain and sewer systems outside buildings*

BS EN 993-1, *Methods of test for dense shaped refractory products – Part 1: Determination of bulk density, apparent porosity and true porosity*

BS EN 1097-6:2000+A1:2005, *Tests for mechanical and physical properties of aggregates – Part 6: Determination of particle density and water absorption*

BS EN 1338, *Concrete paving blocks – Requirements and test methods*

BS EN 1339, *Concrete paving flags – Requirements and test methods*

BS EN 1341, *Slabs of natural stone for external paving – Requirements and test methods*

BS EN 1342, *Setts of natural stone for external paving – Requirements and test methods*

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

BS EN 12457-3, *Characterisation of waste – Leaching – Compliance test for leaching of granular waste materials and sludges – Part 3: Two stage batch test at a liquid to solid ratio of 2 l/kg and 8 l/kg for materials with a high solid content and with a particle size below 4 mm (without or with size reduction)*

BS EN 12620, *Aggregates for concrete*

BS EN 13242:2002+A1:2007, *Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction*

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 1339, BS 6100-3 and the following apply.

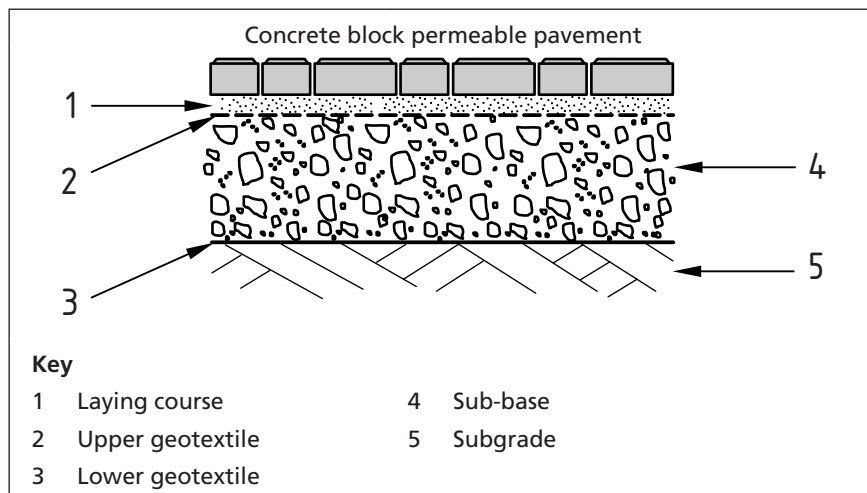
- 3.1 paving unit**
either a concrete paving block or flag, natural stone slab or sett or clay paver designed to allow water ingress into the pavement sub-layers
 - 3.2 laying course**
layer of material on which paving units are bedded
 - 3.3 subgrade**
upper part of the soil, natural or constructed, that supports the loads transmitted by the overlying pavement
 - 3.4 sub-base**
one or more layers of open graded material placed immediately above the subgrade
 - 3.5 standard axle**
axle carrying a load of 8 200 kg
 - 3.6 permeable pavement**
pavement consisting of a surface course of paving units laid with wide joints, voids or openings that allows water to pass through the pavement construction into an open graded sub-base that is designed for storage or attenuation of storm water
 - 3.7 geo-cellular box system**
storm water storage system comprising a series of modular plastic boxes clipped together to form a void either for the storage or attenuation of storm water
 - 3.8 jointing material**
material applied to fill the joints between paving units
- NOTE See Annex B for gradings for jointing material.*

3.9 geotextile

permeable textile, mesh, net or grid that allows water to flow through and prevents migration of particulates between construction layers

NOTE Can be used in the upper layer or lower layer position of the construction (see Figure 1).

Figure 1 Typical location of geotextile

**3.10 coarse graded aggregate**

main structural and hydraulic functional layer with particle within the range 20 mm to 4 mm

3.11 hydraulically bound coarse graded aggregate

layer to strengthen and stiffen the pavement

3.12 capping layer

subgrade improvement layer

layer of granular or treated material at the top of the subgrade to improve foundation for the pavement

3.13 impermeable membrane

membrane which contains all the water entering the pavement and being detained within the structure

4 General design criteria

4.1 Basis of design

A permeable pavement is an effective means of providing a structural pavement suitable for pedestrians and vehicular traffic whilst allowing water to pass straight through the surface into the pavement construction for temporary storage, storm attenuation and dispersal to the ground or collection.

A permeable pavement needs to be able to capture the specified amount of water to be retained and then discharge it in a controlled manner through the subgrade or drainage system. At the same time, the pavement has to be able to withstand the loadings imposed by vehicles. The design of the pavement is approached by considering the sub-base thickness required to meet both the hydraulic factors and the loading factors. The greater sub-base thickness identified for either of these factors is adopted.

4.2 Design considerations

4.2.1 General

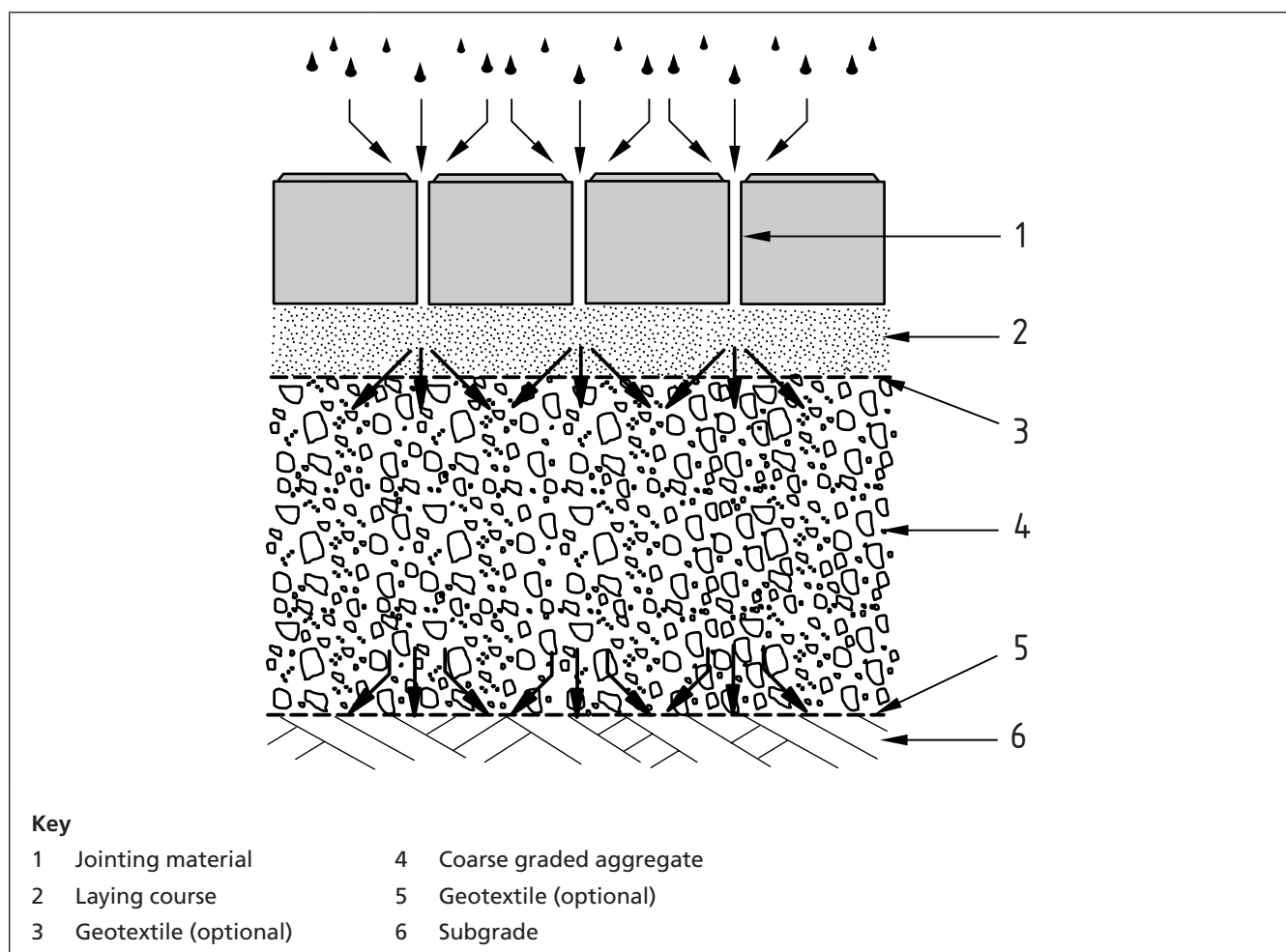
Design for pavements is in two parts, support the traffic load and manage the surface water effectively, which are considered separately.

There are three types of permeable pavement systems as given in 4.2.2, 4.2.3 and 4.2.4.

4.2.2 System A – total infiltration

System A (see Figure 2) allows all water falling onto the pavement to infiltrate down through the joints or voids between the paving units passing through the constructed layers below and eventually into the subgrade. Some retention of the water will occur temporarily in the sub-base layer allowing for initial storage before it eventually passes through. System A offers a solution with zero discharge, i.e. no additional water is discharged eliminating the need for associated traditional drainage systems such as gulleys and associated pipe work. In some situations, overflows might be needed to provide support drainage in storm conditions.

Figure 2 Typical section of total infiltration construction (System A)

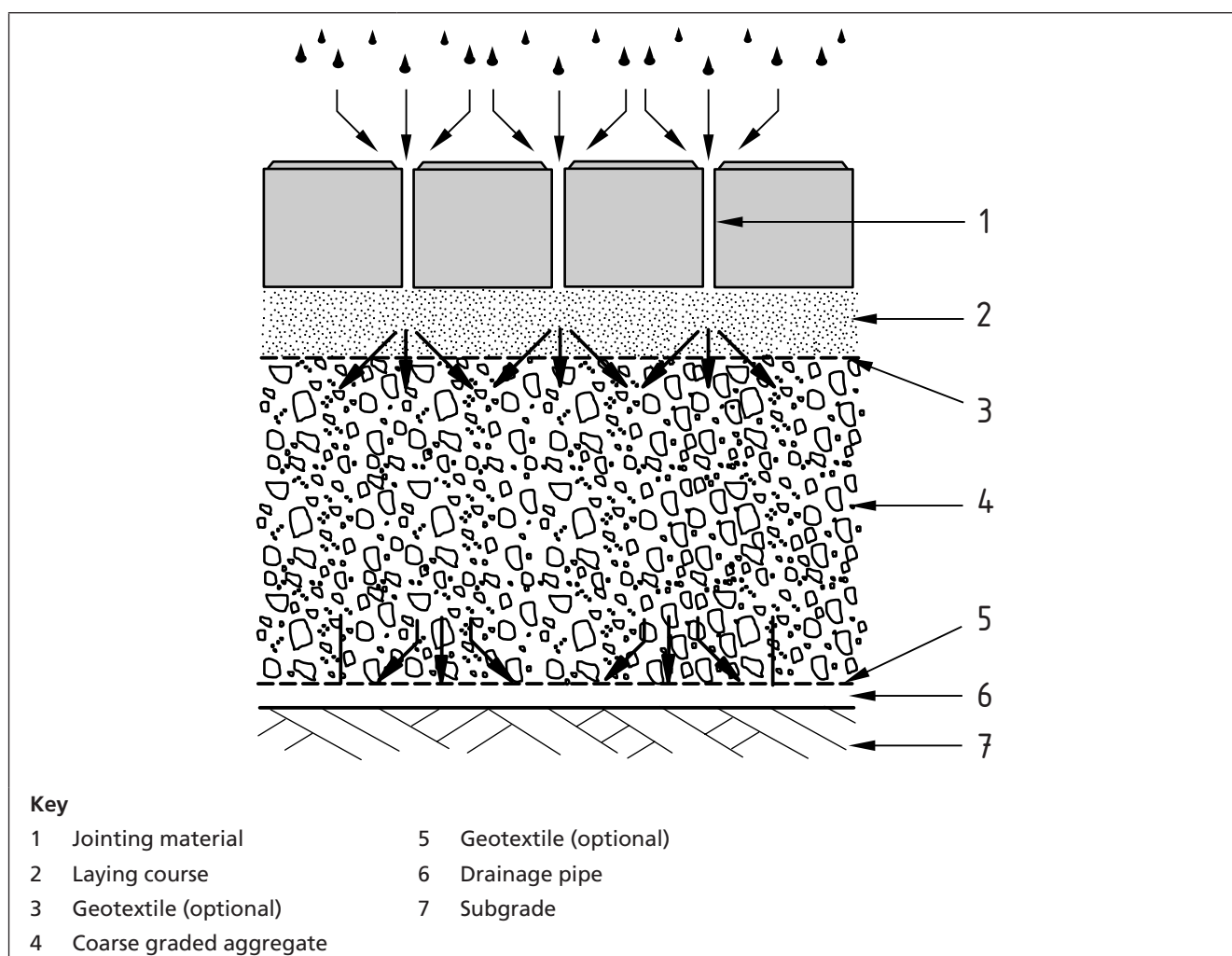


4.2.3 System B – partial infiltration

System B (see Figure 3) allows all water falling onto the pavement to infiltrate down through the joints or voids between units passing through into the sub-base. A series of perforated pipes or fin-drains are normally laid at or near the top of subgrade to collect and to allow excess water to be drained to suitable sustainable drainage systems, e.g. sewers, swales or watercourses or a drainage system if permitted.

NOTE System B can be used in situations where the existing subgrade might not be capable of absorbing all the water. This system can, therefore, prevent the existing soil from losing its stability.

Figure 3 Typical section of partial infiltration (System B)



4.2.4 System C – no infiltration

System C (see Figure 4) allows for the complete capture of the water using an impermeable, flexible membrane placed on top of the formation level and to the sides of the sub-base to effectively form a storage tank. A series of perforated pipes or fin-drains are placed on top of the impermeable membrane to transmit the water to sewers, watercourses or treatment systems.

NOTE 1 System C is used in situations where the existing subgrade has a low permeability or low strength and would therefore be damaged by the introduction of additional water. It can also be used for water-harvesting or to protect sensitive existing conditions such as water extraction zones.