



BSI Standards Publication

Pavements constructed with clay, concrete or natural stone paving units

Part 101: Code of practice for the structural design of
pavements using modular paving units

Publishing and copyright information

The BSI copyright notice displayed in this document indicates when the document was last issued.

© The British Standards Institution 2021

Published by BSI Standards Limited 2021

ISBN 978 0 59 12738 6

ICS 1.10.30

The following BSI references relate to the work on this document:

Committee reference B/507

Draft for comment 21/30410785 DC

Amendments/corrigenda issued since publication

Date	Text affected
------	---------------

Contents

	Page
Foreword	v
1 Scope	1
2 Normative references	1
3 Terms, definitions and abbreviated terms	3
<i>Figure 1 — Pavement layers</i>	8
<i>Figure 2 — Pavement layers over a structural slab</i>	8
4 General design criteria	9
4.1 Design options	9
4.2 Evaluation of traffic	9
<i>Table 1 — Standard axles per commercial vehicle</i>	10
<i>Table 2a — Traffic categories for unbound construction</i>	10
<i>Table 2b — Traffic categories for bound construction</i>	11
<i>Table 3 — Recommended maximum traffic categories for paving unit types</i>	12
4.3 Slip/skid resistance for concrete, clay and stone paving units	12
<i>Table 4 — Recommended USRV and PPV/PSRV for concrete, clay and stone paving units</i>	13
5 Materials	13
5.1 Foundation materials	13
5.2 Base materials	13
5.3 Laying course materials for unbound surface construction	14
<i>Table 5 — Grading of laying course for unbound laying material in all traffic categories</i>	14
<i>Table 6 — Fines content of unbound laying course material</i>	14
<i>Table 7 — Grading for unbound laying course material for natural stone slabs in all traffic categories and cropped natural stone setts in traffic categories 1 to 4</i>	15
<i>Table 8 — Grading for unbound laying course material for cropped natural stone setts in traffic categories 5 to 9</i>	15
5.4 Laying course materials for bound surface construction	15
<i>Table 9 — Bedding mortar characteristics</i>	16
<i>Table 10 — Recommended aggregate properties for site-batched non-proprietary bedding mortar</i>	17
5.5 Jointing materials for unbound surface construction	17
<i>Table 11 — Grading for jointing material for concrete, clay and sawn sided stone paving units</i>	17
5.6 Jointing materials for bound surface construction	18
<i>Table 12 — Jointing mortar characteristics</i>	18
5.7 Paving units	18
<i>Table 13 — Maximum recommended abrasion resistance ^{A)}</i>	21
<i>Table 14 — Maximum recommended water absorption ^{A)}</i>	22
5.8 Kerbs	22
6 Design	23
6.1 Subgrade assessment	23
<i>Table 15 — Estimated CBR values based on equilibrium suction-index</i>	23
6.2 Foundation design	25
<i>Table 16 — Foundation design thickness – sub-base only design</i>	25
<i>Table 17 — Foundation design thickness – Sub-base on capping design</i>	26
6.3 Frost susceptibility	27
6.4 Types of construction	27
6.5 Concrete blocks, clay pavers and unbound sawn-sided stone setts	28
<i>Table 18 — Concrete block, clay paver and unbound sawn-sided sandstone sett design thicknesses</i>	29
<i>Table 19 — Recommended maximum traffic categories for typical laying patterns</i>	30
6.6 Concrete flags and stone slabs	30

	<i>Table 20 — Minimum flag thickness for Bound B installation only</i>	31
	<i>Table 21 — Maximum recommended traffic categories for standard concrete flag designations</i>	31
	<i>Table 22 — Stone slab and concrete flag design load</i>	32
	<i>Table 23 — Surface construction factor for stone slab and non-standard concrete flag design</i>	32
	<i>Table 24 — Base design thickness for flags and slabs</i>	32
6.7	Natural stone setts	33
	<i>Table 25 — Minimum sett width</i>	34
	<i>Table 26 — Pattern factor for laying patterns using natural stone setts</i>	34
	<i>Table 27 — Unfactored module thickness (T)</i>	35
	<i>Table 28 — Base design thickness for natural stone setts laid unbound and bound</i>	35
	<i>Table 29 — Joint widths for cropped setts laid unbound</i>	36
	<i>Table 30 — Minimum joint widths for setts laid bound</i>	36
6.8	Kerbing and linear drainage	36
	<i>Table 31 — Concrete for kerb bases</i>	37
	<i>Table 32 — Kerb bedding mortar</i>	37
6.9	Construction over a structural deck	38
6.10	Management of moisture in the pavement structure	38
7	Pavement overlay design	38
7.1	Evaluation of existing pavement	38
7.2	Determination of overlay feasibility	39
	<i>Table 33 — Material conversion factors (MCF) for evaluating highway pavement materials</i>	40
	<i>Table 34 — Condition factor CF1</i>	40
	<i>Table 35 — Condition factor CF2</i>	40
8	Construction details	40
8.1	Restraint	40
8.2	Surface falls and drainage	41
	<i>Table 36 — Recommended surface gradients</i>	41
8.3	Detailing around curves and corners	41
8.4	Vehicular crossings	41
8.5	Detailing around features	41
8.6	Steps using modular paving units	42
8.7	Movement joints	43
Annex A	(normative) Conditions to be applied to the test procedure specified in BS EN 1097-1:2011 for determination of the resistance to wear (modified micro-Deval) of laying concrete material for unbound construction	46
Annex B	(normative) Simple permeameter test	47
Annex C	(informative) Factory production control test for proprietary bedding mortar	48
Annex D	(informative) Commentary on natural stone properties	49
Annex E	(informative) Examples of laying patterns	52
	<i>Figure E.1 — Concrete block, clay paver and sett laying patterns</i>	52
	<i>Figure E.2 — Typical concrete block, clay paver and sawn sett edge details</i>	53
	<i>Figure E.3 — Examples of laying patterns that incorporate complimentary fittings</i>	53
	<i>Figure E.4 — Inboard cuts and half cuts adjacent to a single stretcher course</i>	54
	<i>Figure E.5 — Examples of laying patterns for natural stone setts</i>	55
	<i>Figure E.6 — Concrete flag and stone sett laying patterns for bound and unbound construction</i>	56
Annex F	(informative) Examples of the minimum thickness of natural stone slabs laid bound or unbound in all appropriate traffic categories	56
	<i>Table F.1 — Stone slabs ≤600 mm (unbound) with flexural strength 8.0 MPa</i>	56

	<i>Table F.2 — Stone slabs ≤600 mm (unbound) with flexural strength 12.0 MPa</i>	57
	<i>Table F.3 — Stone slabs ≤600 mm (unbound) with flexural strength 15.0 MPa</i>	57
	<i>Table F.4 — Stone slabs ≤600 mm (unbound) with flexural strength 25.0 MPa</i>	57
	<i>Table F.5 — Stone slabs >600 mm (unbound) with flexural strength 8.0 MPa</i>	57
	<i>Table F.6 — Stone slabs >600 mm (unbound) with flexural strength 12.0 MPa</i>	57
	<i>Table F.7 — Stone slabs >600 mm (unbound) with flexural strength 15.0 MPa</i>	58
	<i>Table F.8 — Stone slabs >600 mm (unbound) with flexural strength 25.0 MPa</i>	58
	<i>Table F.9 — Stone slabs ≤600 mm (Bound system A) with flexural strength 8.0 MPa</i>	58
	<i>Table F.10 — Stone slabs ≤600 mm (Bound system A) with flexural strength 12.0 MPa</i>	58
	<i>Table F.11 — Stone slabs ≤600 mm (Bound system A) with flexural strength 15.0 MPa</i>	59
	<i>Table F.12 — Stone slabs ≤600 mm (Bound system A) with flexural strength 25.0 MPa</i>	59
	<i>Table F.13 — Stone slabs >600 mm (Bound system A) with flexural strength 8.0 MPa</i>	59
	<i>Table F.14 — Stone slabs >600 mm (Bound system A) with flexural strength 12.0 MPa</i>	59
	<i>Table F.15 — Stone slabs >600 mm (Bound system A) with flexural strength 15.0 MPa</i>	59
	<i>Table F.16 — Stone slabs >600 mm (Bound system A) with flexural strength 25.0 MPa</i>	59
	<i>Table F.17 — Stone slabs (Bound system B) with flexural strength 8.0 MPa</i>	60
	<i>Table F.18 — Stone slabs (Bound system B) with flexural strength 12.0 MPa</i>	60
	<i>Table F.19 — Stone slabs (Bound system B) with flexural strength 15.0 MPa</i>	60
	<i>Table F.20 — Stone slabs (Bound system B) with flexural strength 25.0 MPa</i>	60
Annex G	(informative) Typical sett thickness for various traffic categories	61
	<i>Table G.1 — Minimum design thickness for unbound surface construction using cropped setts</i>	62
	<i>Table G.2 — Minimum design thickness for bound surface construction system A using natural stone setts</i>	63
	<i>Table G.3 — Minimum design thickness for bound surface construction system B using natural stone setts</i>	64
Annex H	(informative) Procedure for determining the design depth of setts with length greater than twice the width	65
Annex I	(informative) Typical edge restraint and linear drainage details	66
	<i>Figure I.1 — Example of intermediate restraint between areas of construction (light traffic)</i>	66
	<i>Figure I.2 — Example of intermediate restraint between areas of construction (light traffic)</i>	66
	<i>Figure I.3 — Example of transition restraint between modular construction and different construction</i>	67
	<i>Figure I.4 — Example of visible concrete transition restraint between modular construction and different construction</i>	67
	<i>Figure I.5 — Example of a hidden concrete transition between modular construction and different construction</i>	68
	<i>Figure I.6 — Example of a deep channel transition restraint between modular construction and different construction</i>	68
	<i>Figure I.7 — Example of a shallow channel transition restraint between modular construction and different construction</i>	69
	<i>Figure I.8 — Example of a linear drainage channel interface with an unbound modular pavement</i>	69
	<i>Figure I.9 — Typical details around types of drainage channels in unbound modular paving</i>	70
	<i>Figure I.10 — Example of a linear drainage channel in bound construction modular paving, employing low modulus movement joints to protect drainage channel from thermal movement in adjacent paving (transverse joint)</i>	71
Annex J	(informative) Pavement overlay worked examples	71
	<i>Table J.1 — Overlay example existing pavement layers</i>	71
	<i>Table J.2 — Overlay example determination of existing equivalent asphalt thickness</i>	72

	<i>Table J.3 — Overlay example determination of required equivalent asphalt thickness</i>	72
	<i>Table J.4 — Inlay example existing pavement layers</i>	72
	<i>Table J.5 — Inlay example determination of existing equivalent asphalt thickness</i>	73
	<i>Table J.6 — Inlay example determination of required equivalent asphalt thickness</i>	73
Annex K	(informative) Typical construction details	74
	<i>Figure K.1 — Trimming around obstructions – detail at ironwork</i>	74
	<i>Figure K.2 — Example of a ramped crossing</i>	75
	<i>Figure K.3 — Example of a dropped crossing</i>	76
	<i>Figure K.4 — Example of a run-out corner</i>	77
	<i>Figure K.5 — Example of a new town corner</i>	77
	<i>Figure K.6 — Example of a bonded corner</i>	77
	<i>Figure K.7 — Example of a splayed corner</i>	78
	<i>Figure K.8 — Example of a profile of a step constructed using small paving units</i>	78
	<i>Figure K.9 — Example of a monolithic step laid onto a profiled concrete foundation (step on step)</i>	79
	<i>Figure K.10 — Example of a monolithic step laid onto a profiled concrete foundation (step behind step)</i>	79
	<i>Figure K.11 — Example of a flag/slab tread and riser laid onto a profiled concrete foundation</i>	80
Annex L	(informative) Typical movement joint details	80
	<i>Figure L.1 — Example of an induced contraction joint in bound surface construction</i>	80
	<i>Figure L.2 — Example of a pavement expansion joint using shallow channels</i>	81
	<i>Figure L.3 — Example of a pavement expansion joint using deep channels</i>	81
	Bibliography	82

Summary of pages

This document comprises a front cover, an inside front cover, pages I to VI, pages 1 to 82, an inside back cover and a back cover.

Foreword

Publishing information

This part of BS 7533 is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on 31 August 2021. 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 committee manager.

Supersession

This part of BS 7533 supersedes [BS 7533-1:2001](#), [BS 7533-2:2001](#), [BS 7533-8:2003](#), [BS 7533-10:2010](#) and [BS 7533-12:2006](#), which are withdrawn. This part of BS 7533 also partially supersedes [BS 7533-6:1999](#) and [BS 7533-7:2010](#).

Relationship with other publications

BS 7533 is published in the following parts:

- Part 101: *Code of practice for the structural design of pavements using modular paving units*;
- Part 102: *Code of practice for the construction and maintenance of pavements using modular paving units¹⁾*; and
- Part 13: *Guide for the design of permeable pavements constructed with concrete paving blocks and flags, natural stone slabs and setts and clay pavers*.

Information about this document

This is a full revision of the BS 7533 series, in which the principal change is to reduce 12 parts of the series to 3 parts. The following principal changes have been made:

- the combination of information on the structural design of rigid and flexible pavements (now retitled “bound and unbound pavements”), using concrete, clay and stone paving units, from the following parts of the withdrawn series:
 - 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 8: *Guide for the structural design of lightly trafficked pavements of precast concrete flags and natural stone slabs*;
 - Part 10: *Guide for the structural design of trafficked pavements constructed of natural stone setts and bound construction with concrete paving blocks*;
 - Part 12: *Guide to the structural design of trafficked pavements constructed on a bound base using concrete paving flags and natural stone slabs*;
- the removal of repetition between the parts of BS 7533 listed above;
- updating of references and test methods; and,
- clarification and removal of ambiguity and anomalies.

¹⁾ In preparation

This publication can be withdrawn, revised, partially superseded or superseded. Information regarding the status of this publication can be found in the Standards Catalogue on the BSI website at bsigroup.com/standards, or by contacting the Customer Services team.

Where websites and webpages have been cited, they are provided for ease of reference and are correct at the time of publication. The location of a webpage or website, or its contents, cannot be guaranteed.

Use of this document

As a code of practice, this British Standard takes the form of recommendations and guidance. It is not to be quoted as if it were a specification. Users are expected to ensure that claims of compliance are not misleading.

Users may substitute any of the recommendations in this British Standard with practices of equivalent or better outcome. Any user claiming compliance with this British Standard is expected to be able to justify any course of action that deviates from its recommendations.

Presentational conventions

The provisions of 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.

Where words have alternative spellings, the preferred spelling of the Shorter Oxford English Dictionary is used (e.g. “organization” rather than “organisation”).

Contractual and legal considerations

This publication has been prepared in good faith, however no representation, warranty, assurance or undertaking (express or implied) is or will be made, and no responsibility or liability is or will be accepted by BSI in relation to the adequacy, accuracy, completeness or reasonableness of this publication. All and any such responsibility and liability is expressly disclaimed to the full extent permitted by the law.

This publication is provided as is, and is to be used at the recipient’s own risk.

The recipient is advised to consider seeking professional guidance with respect to its use of this publication.

This publication is not intended to constitute a contract. Users are responsible for its correct application.

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

1 Scope

This British Standard provides recommendations and guidance on the design of pavements surfaced with:

- a) concrete paving blocks produced in accordance with BS EN 1338;
- b) concrete paving flags produced in accordance with BS EN 1339;
- c) natural stone slabs produced in accordance with BS EN 1341;
- d) natural stone setts produced in accordance with BS EN 1342;
- e) clay pavers produced in accordance with BS EN 1344;

constructed in accordance with [BS 7533-3](#), [BS 7533-4](#), [BS 7533-7](#), [BS 7533-9](#)²⁾.

It also provides guidance on the use of:

- 1) concrete kerbs produced in accordance with BS EN 1340; and
- 2) natural stone kerbs produced in accordance with BS EN 1343;

constructed in accordance with [BS 7533-6](#)²⁾.

It applies to areas subject to pedestrian and vehicular loading permissible under The Road Vehicles (Construction and Use) Regulations 1986 [1] with axle loads up to 11 000 kg and a cumulative design traffic of up to 30 million standard axles (msa).

It specifically excludes design traffic above the specified maximum, and areas of higher vehicle loading such as aircraft pavements and those in ports and specialized industrial areas.

NOTE 1 Specialist engineering guidance is advised when considering the use of modular paving in applications not covered by this standard.

NOTE 2 Due to historic precedent, it might be preferred to use paving units which are outside the dimensions of the EN standards.

NOTE 3 This standard does not address the specific requirements for applications of tactile paving or other assistance devices. Pedestrian access paving needs to be designed to include appropriate tactile indicators as required by current standards and legislation.

The design of permeable pavements which collect, attenuate and provide a drainage feature are not within the scope of this standard. Refer to [BS 7533-13](#).

Reused materials may be used provided they meet the recommendations of the appropriate clause(s).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes provisions 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.

Standards publications

[BS 1377-4](#), *Methods of test for soils for civil engineering purposes – Part 4: Compaction-related tests*

[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*

²⁾ These parts of BS 7533 are expected to be merged into the new BS 7533-102, which is currently in preparation.