

BS 5534:2014+A1:2015



BSI Standards Publication

Slating and tiling for pitched roofs and vertical cladding – Code of practice

bsi.

...making excellence a habit.™

Publishing and copyright information

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

© The British Standards Institution 2015

Published by BSI Standards Limited 2015

ISBN 978 0 580 90491 2

ICS 91.060.20

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

Committee reference B/542/1

Draft for comment 13/30271503 DC, 15/30325014 DC

Publication history

First published as CP 142, September 1942

Second edition, January 1958

Third edition, April 1968

Fourth edition, October 1971

Fifth edition as BS 5534-1, April 1978

Sixth edition as BS 5534-1, September 1997

Seventh edition as BS 5534, June 2003

Eighth (present) edition, August 2014

Amendments issued since publication

Date	Text affected
September 2015	A1. See Foreword.

Contents

Foreword v

1	Scope	1
2	Normative references	1
3	Terms, definitions and symbols	4
4	Materials, fittings and accessories	11
4.1	Clay tiles and fittings (single-lap and double-lap)	11
4.2	Concrete tiles and fittings (single-lap and double-lap)	11
4.3	Fibre-cement slates and fittings	11
4.4	Natural slates and fittings	11
4.5	Bitumen shingles	12
4.6	Proprietary products	12
4.7	Wooden shingles and shakes	12
4.8	Metal tiles	12
4.9	Roofing underlay	12
4.10	Board and sheet sarking	14
4.11	Timber battens and counterbattens	16
4.12	Mechanical fixings	18
4.13	Flashings and junctions	22
4.14	Mortar	22
4.15	Other fittings and accessories	24
5	Design criteria	27
5.1	General	27
5.2	Structural stability	28
5.3	Resistance to wind uplift	30
5.4	Rain and snow resistance	34
5.5	Minimum pitch, head-laps and side-laps for roofs	44
5.6	Minimum head-laps, side-laps and overlaps for walls (75° pitch and above)	50
5.7	Aesthetics	50
5.8	Durability	51
5.9	Hygrothermal factors	54
5.10	Fire	56
5.11	Sound	57
5.12	Sustainability	57
6	Application and installation details	57
6.1	General	57
6.2	Underlays	58
6.3	Battens, counterbattens and sarking boards	60
6.4	Double-lap clay and concrete plain tiles	62
6.5	Single-lap clay and concrete interlocking tiles	66
6.6	Fibre-cement slates	70
6.7	Natural slates	74
6.8	Bitumen shingles	79
6.9	Metal tiles	80
6.10	Wooden shingles and shakes	81
6.11	Other tiles and artificial slates (non-traditional)	81
6.12	Vertical (75° or steeper) slating, tiling and shingling	82
6.13	Roof drainage, flashings and weatherings	83
6.14	Workmanship, repairs and maintenance	86

Annexes

- Annex A (normative) Method of test and classification of roof underlays for wind uplift resistance 87
- Annex B (normative) Design and installation of pitched roof systems where insulation is placed at rafter level 94
- Annex C (normative) Reinforced bitumen underlays 100
- Annex D (normative) Permissible characteristics and defects for grading timber battens *Text deleted* 102
- Annex E (normative) Preservative treatment for timber battens 105
- Annex F (normative) Determination of batten sizes by calculation 106
- Annex G (informative) Examples of structural design calculations for tiling battens 107
- Annex H (normative) Formulae and the calculation of wind loads on the underlay, sarking boards, slates, tiles, ridges, hips and valleys 112
- Annex I (normative) Method of test and calculation for wind uplift resistance of mechanical fasteners for single-lap tiles 127
- Annex J (normative) Method of test and calculation for wind uplift resistance of nail hook fixings for double-lap slates 136
- Annex K (informative) Worked examples of wind uplift and fixing calculations 141
- Annex L (normative) Method of test for air permeability of unsealed small element roofing assemblies 154
- Bibliography 159

List of figures

- Figure 1 – Drive slate hook dimensions 21
- Figure 2 – UK map of categories of exposure to driving rain 36
- Figure 3 – Laps for centre-nailed, head-fixed and shoulder-fixed double-lap slates 38
- Figure 4 – Lap and pitch of slates in double-lap slating 39
- Figure 5 – Lap and pitch of tiles in double-lap plain tiles 40
- Figure 6 – Lap and pitch of tiles in single-lap tiles 41
- Figure 7 – Valley gutter with unbedded and bedded tiles or slates 84
- Figure A.1 – Layout of test assembly 88
- Figure A.2 – Cross-section of test assembly (shown with uplift pressure applied) 89
- Figure A.3 – Locations of nails for nailing overlap to rafter 90
- Figure A.4 – Design wind pressures for geographical wind zones in the UK for underlays used for specific applications conforming to conditions in A.7 92
- Figure A.5 – Illustration of a zonal-classification label for an underlay 93
- Figure B.1 – Force diagram of vectored load down a roof slope 96
- Figure B.2 – Bending stress in a fixing through rigid insulation 97
- Figure B.3 – Bending moment diagram of a fixing through rigid insulation 98
- Figure B.4 – Deflection diagram of a fixing through rigid insulation 98
- Figure D.1 – Examples of knot configurations 102
- Figure D.2 – Permissible wane 103
- Figure D.3 – Permissible depth of fissures 103
- Figure D.4 – Permissible slope of grain 103
- Figure D.5 – Permissible rate of growth 104
- Figure D.6 – Measurement of distortion 105
- Figure G.1 – Loads and bending moments on roof battens 108
- Figure H.1 – Key for $c_{p,net}$ data for duopitch and hipped roofs 114
- Figure H.2 – Key for $c_{p,net}$ data for monopitch roofs 115
- Figure H.3 – Wind uplift loading on single-lap tiles, including where the eaves overhang exceeds 60 mm 117
- Figure H.4 – Wind uplift loading on double-lap slates or tiles, including where the eaves overhang exceeds 60 mm 118
- Figure H.5 – Wind uplift loading on single-lap tiles where the verge overhang exceeds 60 mm 119

Figure H.6 – Distances around obstructions	120
Figure H.7 – Wind uplift loading on ridges and hips	122
Figure I.1 – Example of an arrangement of the test apparatus for determination of clip strength for single-lap tiles	128
Figure I.2 – Example of a hinged batten for supporting a clipped test tile	129
Figure I.3 – Tiles laid in straight bond	130
Figure I.4 – Tiles laid in broken (half) bond	131
Figure I.5 – System of forces in an array of clipped tiles under uplift load	135
Figure J.1 – Example of an arrangement of the test apparatus for determination of nail hook fixing strength for double-lap slates	137
Figure K.1 – Dimensions and forces acting on a single-lap tile	142
Figure K.2 – Dimensions and forces acting on a plain tile	145
Figure K.3 – Dimensions and forces on centre-nailed double-lap slating with an example of slate hook arrangement	151
Figure L.1 – Arrangement of apparatus	155
Figure L.2 – Plenum chamber arrangement for air permeability test	156

List of tables

Table 1 – Material specifications for board and sheet sarking	15
Table 2 – Material specifications for insulated board sarking	15
Table 3 – Minimum timber batten sizes (roofing and vertical work)	17
Table 4 – Dimensions of drive slate hooks	20
Table 5 – Materials for flashings and junctions	22
Table 6 – Recommended standard mortar mixes for slating and tiling (all proportions by volume)	23
Table 7 – Minimum spacing of nails and screws	34
Table 8 – Values of c for head-lap calculations for double-lap fibre-cement and natural slates, nail-fixed or hook-fixed	46
Table 9 – Minimum head-laps and E_1 factors for double-lap fibre-cement and natural slates, pegged, nailed or hook-fixed ^(A), B), C), D), E)	47
Table 10 – Head-laps for underlay	58
Table 11 – Minimum widths of valley gutter for different roof pitches and plan areas	84
Table 12 – Minimum width of lead to line valley gutters for different roof pitches and plan areas	85
Table C.1 – Recommendations for mass per unit area of constituent materials	101
Table F.1 – GS grade bending stresses and moduli for batten timber species	107
Table H.1 – Net uplift coefficient, $c_{p,net}$ for single-lap tiles and double-lap slates	113
Table H.2 – Net uplift coefficient, $c_{p,net}$ for plain tiles	113
Table H.3 – Summarized values of external pressure coefficient, c_{pe}	114
Table H.4 – Values of roof substrate shielding factor, S	116
Table H.5 – Design ultimate withdrawal resistance against wind loading for nails	125
Table H.6 – Design ultimate withdrawal resistance against wind loading for screws	125
Table H.7 – Values of K_n for tiles	126
Table H.8 – Wind uplift resistance of twice nailed plain tiles	127
Table I.1 – Values of k_n for single-lap tile fasteners	133
Table J.1 – Values of k_n for slate hooks	139
Table K.1 – Wind uplift resistance of twice nailed plain tiles fixed in various patterns assuming aluminium nails meeting the recommendations of Table H.8	146

Table K.2 – Wind uplift resistance of twice nailed plain tiles fixed in various patterns assuming stainless steel nails meeting the recommendations of Table H.8 148

Table L.1 – Arrangement of unsealed elements 155

Summary of pages

This document comprises a front cover, an inside front cover, pages i to vi, pages 1 to 164, an inside back cover and a back cover.

Foreword

Publishing information

This British Standard is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on 31 August 2014. It was prepared by Subcommittee B/542/1, *Slating and tiling*, under the authority of Technical Committee B/542, *Roofing and cladding products for discontinuous laying*. A list of organizations represented on this committee can be obtained on request to its secretary.

Supersession

BS 5534:2014+A1:2015 supersedes BS 5534:2014, which is withdrawn.

Relationship with other publications

This British Standard is intended to be read in conjunction with BS 5250, BS 9250 and BS 8000-6.

Information about this document

Text introduced or altered by Amendment No. 1 is indicated in the text by tags **A1** and **A1**. Minor editorial changes are not tagged.

This British Standard was first published as BS 5534-1 in April 1978 and was updated in 1990, 1997 and 2003. BS 5534-2 was first published in November 1986 and was withdrawn on publication of BS 5534-1:1997, by which it was superseded.

This is a full revision of the standard, and includes a complete re-structuring intended to make the standard more usable in addition to introducing the following principal changes.

- a) Subclause 5.2 and Annex H, which deal with structural stability, have been revised to reflect new knowledge and experience on wind loads and uplift resistances of the roof covering and underlay, expressed in terms of the relevant Eurocodes for basis of structural design, enhanced safety factors, loads and resistances.
- b) The worked examples of wind uplift and fixing calculations given in Annex K have been updated.
- c) Wind uplift resistance of self-supporting underlays has been included. A pressure test (Annex A) has been introduced to determine the wind uplift resistance of underlays in order to determine their scope of application and classification.
- d) Clause 6, which deals with application and design details has been revised, including references to workmanship, which are now covered in the 2013 revision of BS 8000-6.
- e) Reliance on the tensile strength of mortar bedding to resist wind uplift has been withdrawn.

Updated information relating to the preservative treatment of timber battens has been contributed by the Wood Protection Association (www.wood-protection.org) ¹⁾.

Product certification. Designers and specifiers are advised to consider the desirability of using roofing products, fittings and accessories that are supported by recognized UKAS-accredited third-party assessment.

¹⁾ Last accessed 26 August 2014.

Use of this document

As a code of practice, this British Standard 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 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").

In the case of "sulfur" (and its derivatives), the International Union of Pure and Applied Chemistry (IUPAC) spelling is used.

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.

Particular attention is drawn to the Control of Substances Hazardous to Health Regulations 2002 [1].

1 Scope

This British Standard gives recommendations for the design, performance and installation of pitched roofs and vertical cladding using slates, tiles, shingles and shakes and their associated components. It does not cover the structural design of the roof.

NOTE Recommendations for workmanship, repair and maintenance are given in BS 8000-6.

This British Standard does not give detailed recommendations for special roof types such as curved or random slating, but it does give recommendations for determining minimum roof pitches and calculating the minimum head-laps and side-laps that can be used for such types of slating.

This British Standard is intended for use by designers, manufacturers and installers of roofing products.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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 416-1, *Discharge and ventilating pipes and fittings, sand-cast or spun in cast iron – Part 1: Specification for spigot and socket systems*

BS 1202-2, *Specification for nails – Part 2: Copper nails*

BS 1202-3, *Specification for nails – Part 3: Aluminium nails*

BS 2000-49 (BS EN 1426), *Bitumen and bituminous binders – Part 49: Determination of needle penetration*

BS 2000-58 (BS EN 1427), *Bitumen and bituminous binders – Part 58: Determination of the softening point – Ring and ball method*

BS 4841-5, *Rigid polyisocyanurate (PIR) and polyurethane (PUR) products for building end-use applications – Part 5: Specification for laminated boards (roofboards) with auto-adhesively or separately bonded facings for use as thermal insulation boards for pitched roofs*

BS 5250, *Code of practice for control of condensation in buildings*²⁾

BS 6100-6, *Building and civil engineering – Vocabulary – Part 6: Construction parts*

BS 8000-6, *Workmanship on building sites – Code of practice for slating and tiling of roofs and claddings*³⁾

BS 8417, *Preservation of wood – Code of practice*

BS 9250, *Code of practice for design of the airtightness of ceilings in pitched roofs*

BS EN 197-1:2011, *Cement – Part 1: Composition, specifications and conformity criteria for common cements*

BS EN 300:2006, *Oriented strand boards (OSB) – Definitions, classification and specifications*

²⁾ This standard also gives informative references to BS 5250:2011.

³⁾ This standard also gives an informative reference to BS 8000-6:2013.