

Wall and floor tiling —

Part 1: Code of practice for the design and installation of internal ceramic and natural stone wall tiling and mosaics in normal conditions

ICS 91.060.10; 91.060.30

Committees responsible for this British Standard

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- Association of Building Engineers
- British Adhesives and Sealants Association
- British Ceramic Research Ltd.
- British Ceramic Tile Council
- Building Employers' Confederation
- Chartered Institute of Building
- Concrete Society
- Contract Flooring Association
- Department of the Environment (Building Research Establishment)
- Federation of Master Builders
- Federation of Resin Formulators and Applicators
- Institute of Clerks of Works of Great Britain
- Local Authorities Association
- Mortar Producers' Association
- National Federation of Clay Industries
- National Federation of Terrazzo, Marble and Mosaic Specialists
- National Master Tile Fixers' Association
- National Tile, Faience and Mosaic Fixers' Society
- Natural Slate Quarries Association
- Royal Institute of British Architects
- Stone Federation

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Foreword

This part of BS 5385 has been prepared by Technical Committee B/539. This edition introduces technical changes but it does not reflect a full review or revision of the 1990 edition, which will be undertaken in due course.

Technical changes include the addition of recommendations on using natural stone tiles. Guidance is now given on means to avoid staining of permeable tiles by other materials such as adhesives and grouts.

For the purposes of this code “normal conditions” means normal environmental temperature and humidity. However, it is not to be inferred from this that all recommendations made in this code are unsuitable for more extreme conditions.

Throughout this code, references to tiles and tiling are intended to apply equally to mosaics and mosaic work except where the recommendations for mosaics are different, as in Section 5.

This part of BS 5385 is one of a series dealing with the installation of floor and wall tiling, the other parts being:

- *Part 2: Code of practice for external ceramic wall tiling and mosaics;*
- *Part 3: Code of practice for the design and installation of ceramic floor tiles and mosaics;*
- *Part 4: Code of practice for ceramic tiling and mosaics in specific conditions;*
- *Part 5: Code of practice for the design and installation of terrazzo tile and slab, natural stone and composition block floorings.*

Assessed capability. Users of the British Standard are advised to consider the desirability of assessment and registration of a supplier’s quality systems against the appropriate part of BS EN ISO 9000 by a third party certification body.

Enquiries as to the availability of third party certification schemes are forwarded by BSI to the Association of British Certification Bodies. If a third party certification scheme does not already exist, users should consider approaching an appropriate body from the list of Association members.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This standard comprises a front cover, an inside front cover, pages i to iv, pages 1 to 41 and a back cover.

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Sidelining in this document indicates the most recent changes by amendment.

Section 1. General

1.1 Scope

This part of BS 5385 gives recommendations for the design and installation of internal ceramic and natural stone wall tiling and mosaics in normal conditions. It deals with classes and types of background and their suitability to receive tiling using the following fixing methods, which are described in the relevant sections:

- a) bedding in cement-based adhesives on an intermediate substrate or as a direct bedding method;
- b) bedding in organic-based adhesives on an intermediate substrate or as a direct bedding method;
- c) bedding in cement: sand mortar on rendering or as a direct bedding method.

Ceramic tile fittings for use at corners and edges are shown in Annex A.

Where the tiling installation needs to meet specific functional or environmental requirements, or to assist in counteracting potentially detrimental effects on the installation and/or the structure, reference should be made to BS 5385-4. The specific conditions dealt with in BS 5385-4, for example, swimming pools, shower areas, etc. are listed in Annex B.

Composite stone tiles are not included within the scope of this standard. Dimensionally similar to natural stone tiles, they possess different physical and chemical characteristics as a result of the various natural stone, mineral and binder constituents from which they are manufactured. The recommendations of the manufacturer or supplier for design and installation should be followed.

1.2 References

1.2.1 Normative references

This part of BS 5385 incorporates, by dated or undated reference, provisions from other publications. These normative references are made at the appropriate places in the text and the cited publications are listed on the page 40. For dated references, only the edition cited applies; any subsequent amendments to or revisions of the cited publication apply to this part of BS 5385 only when incorporated in the reference by amendment or revision. For undated references, the latest edition of the cited publication applies, together with any amendments.

1.2.2 Informative references

This part of BS 5385 refers to other publications that provide information or guidance. Editions of these publications current at the time of issue of this standard are listed on the page 41, but reference should be made to the latest editions.

1.3 Definitions

For the purposes of this Part of BS 5385 the definitions given in BS 6100-1 and BS 6431-1 apply together with the following.

1.3.1

natural stone tiles

tiles made from rock which has been sorted, dressed or machined to finish

1.3.2

composite stone tiles

natural stone and/or mineral fragments set in a binder subsequently cut to form tiles with a surface that is ground and polished to finish

1.4 Exchange of information and time schedules

NOTE This subclause deals with the exchange of information for the whole wall, including tiles, tile bed, background and intermediate substrate (if any).

1.4.1 Exchange of information

Working drawings and specifications should be prepared in sufficient detail to afford proper guidance in the design and execution of the work. At the tendering stage the following information should be provided.

- a) *Site*. Location and means of access.
- b) *Building*. Nature of building and particulars of corrosive or other potentially damaging conditions to which the installation may be subjected in service (e.g. mechanical cleaning).

- c) *Walls*. Type and age of construction, location within the building, type and accuracy of background and need for intermediate substrate.
- d) *Associated work*. Services embedded in or passing through the wall, skirtings and abutments, junctions with other adjacent finishes.
- e) *Finishes*. Type(s) of tiles and/or mosaics, bedding and jointing requirements and required surface plane.
- f) *Contract*. Particulars if the work is to be completed in any specific order or in sections.
- g) *Health and safety*. Information on articles and substances for use during the work that are liable to be a health risk.
- h) *Time schedule*. A time schedule for the progress of the work. (See 1.4.3).
- i) *Testing*. Details of any conformity testing required.

1.4.2 Provision of utilities, facilities and materials

1.4.2.1 General

To prevent misunderstanding, particularly at the tendering stage, and to avoid possible situations detrimental to installation, it should be made clear whether or not the following will be provided and by whom:

- a) adequate, clean, dry, lockable storage space protected from frost if necessary;
- b) clean water supply adjacent to working area;
- c) adequate artificial lighting, if required (see 1.4.2.2);
- d) safe means of access and places of work, to include where required, suitable scaffolding and staging which should conform to BS 5973; attention is drawn to the requirements of the Construction (Working Places) Regulations 1966 [1] made under the Factories Act 1961 [2];
- e) unloading and hoisting facilities;
- f) electric power supply adjacent to working areas;
- g) protection of work during and after fixing;
- h) supplies of cement and sand in accordance with 2.4 and 2.5.

1.4.2.2 Lighting on site

Lighting on site should be of the same type, direction and intensity as envisaged for the completed installation. If this condition is not met then the appearance of the finished wall may be significantly different from that originally intended. This is a matter which should be appreciated by the specifier at the design stage.

1.4.3 Time schedules

The time schedule for the whole building work should be planned in the initial stages before operations are begun and, where possible, in consultation with those who will become responsible for carrying out the work of each of the trades concerned.

Before tiling commences at least 6 weeks should be allowed for a new concrete or masonry wall to dry out. If rendering is subsequently to be applied, it should be left for at least a further 2 weeks. New gypsum plasterwork should be left for at least 4 weeks. These times may require extension depending on the conditions on site and the mass of the structure.

The schedule should allow time for all cutting of holes and chases in the walls to be tiled and in adjacent walls before any intermediate substrate is applied.

Provision should also be made for the completion of all subsidiary work necessary before the application of tiles or mosaic systems begins. The schedule should include times for commencement and completion of tiling or mosaic work in the different parts of the building, allowing sufficient time intervals between the bedding, grouting and final cleaning down.

Tiling can be adversely affected by frost during installation and provision should be made in the time schedule to allow for suspension of operations during freezing conditions.

Section 2. Materials

2.1 Transport and storage

The delivery of materials should be so arranged as to minimize handling. Adequate precautions should be taken to guard against the possibility of damage.

Products should be stored in clean, dry, frost free (if necessary) lockable storage to avoid excessive handling, theft and damage.

2.2 Tiles

2.2.1 Ceramic tiles

Ceramic tiles are classified in BS 6431-1 and fall into two main classes according to their method of manufacture.

- a) *Extruded tiles (shaping A)*, whose body is shaped in the plastic state in an extruder and the resulting column cut into tiles of predetermined lengths.
- b) *Dust-pressed tiles (shaping B)*, which are formed of powder or small grains, shaped in moulds under high pressure before firing. These tiles generally are made to finer dimensional tolerances than extruded tiles.

Tiles are further sub-divided according to their water absorption: low (group I), medium (groups IIa and IIb) and high (group III); see Table 1.

Tiles may be unglazed, engobed, partly glazed or glazed. The range of sizes, thicknesses and accessories varies with individual manufacturers. The range is predominantly of square or oblong shapes but other geometrical and decorative shapes are also made. The fittings for use at corners and edges are shown in Annex A.

Properties and characteristics to which products should conform are laid down in the standards for individual products, BS 6431-2 to BS 6431-9, and the relevant standard(s) should be quoted in the specification.

2.2.2 Natural stone tiles

Natural stone tiles should not exceed 20 mm in thickness. They are frequently prepared and polished by wet processes and consequently they should be allowed to dry in natural ventilation before use.

2.3 Mosaics

Mosaics are available in a variety of shapes and sizes, in glazed and unglazed ceramic, glass and marble. To facilitate ease of handling, mosaics are assembled as sheets, the individual tessera being glued either face side down to paper (paper-faced mosaics), or bed side down to synthetic mesh, or to small tabs.

Paper-faced mosaics allow full contact to be achieved with the bed, i.e. mortar or adhesive. When sheets are assembled by means of a backing material it should be made of synthetic fabric, not of cotton or paper.

For a mosaic which has been assembled with backing fabric or tabs it is essential that:

- a) the fabric or tabs and their adhesive should not occupy more than 25 % of the area of each tessera. The critical factor is the contact of the adhesive over the backs of the tesserae;
- b) the fabric or tabs and their adhesive should not deteriorate in service and that they should be compatible with the mortar or adhesive bed.

The physical and chemical properties of ceramic tesserae should be in accordance with the relevant part of BS 6431.

Before selecting a particular system the advice of the mosaics suppliers or mosaics fixing specialists should be obtained as to the suitability of a particular type of mosaic for a particular environment. Mosaics should not be used in corrosive situations.

2.4 Cement

Cement should conform to BS 12, BS 4027 or BS 5224.

Portland cements and sulfate resisting cements having a number of strength classes are now available. Specifiers should select the class appropriate to the intended use.

Cement should be stored under dry conditions and used in order of delivery. Cement which contains air set lumps should not be used.

2.5 Sand

2.5.1 General

All stocks of sand should be protected from rain, frost and any form of contamination.

2.5.2 Sand for cement: sand rendering and mortar beds

Sand should conform to the grading limits of type A of Table 1 of BS 1199:1976.

2.5.3 Sand for grouting

For joints of normal widths, 6 mm and above, sand for grouting should conform to the grading limits of type B of Table 1 of BS 1199:1976.

For joints less than 6 mm wide, sands for grouts should conform to the grading limits given in Table 2. Sands conforming to type G of Table 1 of BS 1200:1976 may be suitable, provided the fraction greater than 2.36 mm is screened off.

Table 1 — Classification of ceramic tiles

	Group I	Group IIa	Group IIb	Group III
Water absorption (<i>E</i>)	$E \leq 3 \%$	$3 \% < E \leq 6 \%$	$6 \% < E \leq 10 \%$	$E > 10 \%$
Tile shaping				
A Extruded	AI	AIa	AIb	AIII
B Dust-pressed	BI	BIIa	BIIb	BIII

Table 2 — Sand for grouts for joints less than 6 mm wide

BS 410 sieve mesh size	Percentage by mass passing BS sieves % (<i>m/m</i>)
2.36 mm	100
1.18 mm	95 to 100
600 µm	80 to 100
300 µm	30 to 100
150 µm	0 to 60
75 µm	not greater than 7

2.6 Plaster

Plaster backgrounds to receive tiles are usually based on gypsum building plasters and should be provided in accordance with BS 5492.

Gypsum plasters should conform to BS 1191-1 or BS 1191-2.

Proprietary materials should be used strictly in accordance with the manufacturer's instructions.

2.7 Water

Water should be fresh and clean. Sea water is not suitable. All containers used for storing or carrying water or for soaking tiles should be clean.

2.8 Adhesives

2.8.1 Cement-based adhesives (hydraulically-hardening mortars)

These should conform to type 1 in BS 5980:1980.

2.8.2 Organic-based adhesives

These should conform to the following types given in BS 5980:1980.

- Type 2. Dispersion adhesive;
- Type 3. Dispersion/cement adhesive;
- Type 4. Dissolved resin adhesive;
- Type 5. Reaction resin adhesive.

2.8.3 Admixtures for adhesives

A polymer additive or some other liquid or powdered product may be incorporated in adhesives to obtain greater adhesion, improved resilience or some degree of water repellence.

Admixtures should be used strictly in accordance with the manufacturer's instructions and they should not be added to an adhesive unless approved by the manufacturer of the adhesive.

2.9 Bonding agents

Bonding agents may be used to improve the adhesion of rendering and/or tile beds to backgrounds. Manufacturers recommend particular grades and methods of application depending on the materials involved and service conditions: their instructions should be followed.

2.10 Sealants and back-up materials for movement joints

2.10.1 Sealants

Guidance on the selection and application of joint sealants is given in BS 6213.

Materials for movement joints should be composed of non-rigid materials applied either in the form of a compound or a pre-formed strip; they should combine the properties of resilience and/or plasticity within the maximum temperature ranges likely to be encountered. Table 3 provides a guide to most of the sealants in general use and a summary of their properties.

There should be no evidence of mould growth when sealants are tested by the method described in Appendix B of BS 5980:1980.

Acetoxy silicone sealants should not be used with natural stone tiles.

Some sealants, e.g. low modulus silicone sealants, can cause staining of stone and reference should be made to the sealant manufacturer to confirm their suitability and fitness for purpose.

2.10.2 Back-up materials

Back-up materials should be compressible materials that will not force out the sealant when the joint closes. Suitable materials include cellular rubber and plastics such as cellular polyethylene, some fibre building boards, cork boards and caulking cotton. These materials are available in strip form.

Table 3 — Flexible sealants: summary of properties

Type	Movement accommodation factor (see note 2) %	Service temperature limits °C	Hardness (see note 3) IRHD	Cure time before serviceable e.g. washing down (see note 4) Days	Comments
Epoxide polysulfide and flexibilized epoxide (two part)	5 to 10	– 20 to + 80	70 to 95	1 to 7	Chemically cure. Rate of cure depends on temperature
Acrylic (emulsion type)	15	– 20 to + 70	10 to 50	1 to 14	Should not be exposed to water until an adequate skin has formed
Acrylic (solution type)	20	– 35 to + 90	25 to 30	3 to 14	Sets by solvent loss
Polysulfide (one part)	25	– 20 to + 80	15 to 40	7 to 21	Moisture cure. Rate of cure depends on temperature and relative humidity
Polysulfide (two part)				1 to 7	Chemically cure. Rate of cure depends mainly on temperature
High modulus	20	– 20 to + 80	40 to 60		
Low modulus	35	– 20 to + 80	15 to 20		
Polyurethane (one part)	25 to 35	– 40 to + 70	15 to 40	3 to 14	Moisture cure. Rate of cure depends mainly on temperature
Silicone				1 to 14	Moisture cure. Rate of cure depends on temperature and relative humidity
High modulus	25	– 60 to + 180	20 to 30		
Low modulus	50 to 100	– 50 to + 120	10 to 20		

NOTE 1 Under favourable conditions the expected service life of the sealants listed is approximately 15 years for the acrylic types and not less than 20 years for the others.

NOTE 2 The values quoted are average values varying within wider or narrower limits according to manufacture. Where the movement accommodation factor is below 15 % the sealant should not be used over structural movement joints.

NOTE 3 The figures quoted are as measured on an IRHD meter (see BS 903-A26). Low figures indicate that the sealant is soft, high figures that the sealant is hard, e.g. tyre tread would have a hardness of 60° to 70° on this scale. Ranges are shown for each sealant in the table, reflecting variations encountered in practice according to the manufacturer of the product. Hardness measured in Shore A units is similar in value to that measured in IRHD units.

NOTE 4 Cure times vary according to environmental conditions, but the ranges shown in the table also reflect variations between different manufacturer's products.

2.11 Grouts

2.11.1 General

Grouts should have good working characteristics, low shrinkage and good adhesion to the sides of the joints. When selecting a grout the specifier should establish that it is suitable for the conditions it has to meet, for example, imperviousness; resistance to water, heat, cleaning agents and chemical attack; resistance to mould growth and bacteria; resilience and compressibility.

2.11.2 Types of grout

2.11.2.1 *Proprietary grouts*

Proprietary grouts are generally one of the following types:

- a) mixes based on cement, modified by the inclusion of various additives, that require only the addition of clean water to obtain the desired consistency;
- b) ready-mixed, organic polymer-based compositions;
- c) mixes based on epoxide resin; these are supplied as two or three separate components, in pre-gauged proportions, which have to be mixed together immediately before use.

Materials of type a) are used in most normal tiling situations. Those of types b) and c) find application where special service requirements apply, e.g. hardness, imperviousness, resistance to cleaning agents, etc.

NOTE Epoxide resin mixes are more expensive than those based on cement. The treatment of joints using these compositions is slower.

Proprietary grouts should be stored and used in accordance with the particular manufacturer's instructions but in general, they do not require prior wetting of the tile joints before use.

2.11.2.2 *Cement: sand mortar grouts*

These grouts are sometimes used for joints over 3 mm wide (see 4.3.3). Mixes of this kind need dampness in the joint cavities to promote good adhesion and are best suited for use with cement: sand mortar bedding systems where, if necessary, the joints can be re-wetted without affecting the bed.

NOTE The physical properties of a cement: sand mortar grout are likely to be inferior to those of proprietary grouts, which offer the advantages of controlled formulations and consistency.

A grout composition consisting of ordinary cement and whiting should not be used.

Neat cement mixed with water is not a satisfactory grout except for mosaics.

2.11.3 Coloured grouts

Many proprietary grouts are available in various colours as well as white. Coloured joints can also be achieved by adding pigments to proprietary materials and cement: sand compositions providing they are used in accordance with the manufacturer's instructions.

Pigments should be inorganic and compatible with the grout. When used in cement: sand compositions or cement-based proprietary materials they should also be alkali resistant. Some organic pigments may be suitable for incorporating in epoxide resin-based grouts.

As many stone tiles are absorptive, the grout colour should be similar to the stone colour.

2.11.4 *Admixtures to cement: sand mortar grout materials (other than colouring pigments)*

A polymer additive or some other liquid or powdered product may be incorporated in the grout mix to obtain greater adhesion, improved resilience or some degree of water repellence.

In all such cases admixtures should be used strictly in accordance with the manufacturer's instructions. They should not be added to a proprietary grouting product unless approved by the manufacturer of that product.

2.11.5 *Resistance to moulds and bacteria*

For normal internal installations, cement-based mixtures are generally used and offer good resistance to the growth of moulds and bacteria. Where an exceptionally high standard of hygiene is essential, e.g. food preparation areas, operating theatres, pathology laboratories, etc., epoxide resin-based materials are superior to cement-based mixtures by virtue of their imperviousness and ease of cleaning and decontamination.

When tested as described in Appendix B of BS 5980:1980, grouts should not show any evidence of mould growth.

2.12 Mechanical support for cement: sand rendering

2.12.1 General

Metal used to reinforce rendering should be galvanized steel or stainless steel and metal fixings should be compatible. (See clauses 14 and 15 of BS 5262:1991).

2.12.2 Expanded metal lathing

This material should conform to BS 1369-1.

2.12.3 Ribbed lathing

This material should conform to BS 1369-1. Ribs are formed integrally with expanded metal, thus providing rigidity.

2.12.4 Welded wire mesh

Plain welded wire mesh should either be galvanized after manufacture in accordance with BS 729 or be of stainless steel. It should be of 25 mm to 50 mm mesh and have wires not less than 1.02 mm diameter. One proprietary type, which is self-firring, is manufactured from wires galvanized in accordance with BS 443 and includes additional stainless steel wires and an interwoven layer of absorptive paper. A water-resistant breather paper is fixed to the back. It has a mesh aperture of 38 mm × 50 mm. This type is designed to be fixed principally with stainless steel fixings.

2.12.5 Galvanized wire netting

Netting should be of 20 mm to 38 mm mesh and conform to BS 1485.

2.12.6 Corner and stop beads

Beads should conform to BS 6452-1.

2.12.7 Plastics coated glass fibre mesh sheets and plastics netting

These proprietary products should be used strictly in accordance with the manufacturer's instructions.

Section 3. Design

3.1 Backgrounds

3.1.1 General

3.1.1.1 *General*

The nature of the background is a prime consideration in deciding the choice of any intermediate substrate or other preparatory treatment necessary before tiling. Properties of the background that may influence the choice are indicated in 3.1.1.2, 3.1.1.3, 3.1.1.4, 3.1.1.5, 3.1.1.6, 3.1.1.7 and 3.1.1.8 and are also summarized in Table 4.

3.1.1.2 *Porosity and suction*

Porosity and suction affect the key and adhesion of cement: sand rendering. The amount of wetting required to reduce suction and to ensure uniformity of suction will depend upon the nature of the background, the type of mix being used, the method of application and the ambient conditions.

Porosity and suction affect both the adhesion and the cohesion of plaster and therefore influence the selection of the type of tile bed to be used.

3.1.1.3 *Mechanical key*

Mechanical key is afforded by the nature of the background or is artificially provided.

3.1.1.4 *Trueness of construction*

Trueness is important because it affects the thickness and number of coats of cement: sand mortar rendering or plaster (if any), the choice of fixing method and the final appearance of the tiling.

3.1.1.5 *Moisture movement and thermal movement*

These movements produce differential contraction or expansion between the background and tiling system and are potential causes of defects.

3.1.1.6 *Chemical action*

Soluble salts, particularly sulfates, sometimes occur in backgrounds and may have harmful effects on the adhesion of any applied treatment and finish. The risk of defects arising from this cause is much greater if backgrounds are persistently damp or if excessive water is used, or is permitted to enter the background, during construction.

3.1.1.7 *Contamination*

Backgrounds subjected to industrial processes and atmospheres may be contaminated by oil, grease, soot and dirt, organic growths, etc., and this may lead to loss of adhesion of the intermediate substrate or tiling or both. Backgrounds previously treated with decorative coating, e.g. lime wash or paints, may also cause failure.

3.1.1.8 *Physical deterioration*

Backgrounds that have deteriorated by physical damage or other agencies may have an adverse effect on the adhesion of the intermediate substrate or tiling or both.

3.1.1.9 *Staining*

Moisture can permeate some tiles so backgrounds should be checked and, if necessary, sealed to ensure that stains cannot be drawn from them.

3.1.2 Classes and types of background

3.1.2.1 *General*

Backgrounds may be conveniently placed into one of the classes listed in 3.1.2.2, 3.1.2.3, 3.1.2.4, 3.1.2.5, 3.1.2.6, 3.1.2.7, 3.1.2.8, 3.1.2.9 and 3.1.2.10 (see also Table 4).