

BS 5385-1:2009

Incorporating Corrigendum No. 1



BSI Standards Publication

**Wall and floor tiling –
Part 1: Design and installation of
ceramic, natural stone and mosaic
wall tiling in normal internal
conditions – Code of practice**

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Contents

Foreword *ii*

1	Scope	1
2	Normative references	1
3	Terms and definitions	3
4	Exchange of information and time schedule	4
5	Materials	6
6	Design	13
7	Application of tiles: methods and materials	36
8	Application of mosaics: methods and materials	48
9	Protection and cleaning	51

Annexes

Annex A (informative) Ceramic tiles, mosaics and natural stone	53
Annex B (informative) The special conditions included in BS 5385-4	54

Bibliography **55**

List of tables

Table 1 – Classification of ceramic tiles with respect to water absorption (E) and shaping, from BS EN 14411:2006	6
Table 2 – Sand for grouts for joints less than 6 mm wide	8
Table 3 – Backgrounds: summary of data and suitable tile beds	18

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 56, an inside back cover and a back cover.

Foreword

Publishing information

This part of BS 5385 was published by BSI and came into effect on 31 July 2009. It was prepared by Technical Committee B/539, *Ceramic tiles and other rigid tiling*. A list of organizations represented on this committee can be obtained on request to its secretary.

Supersession

This part of BS 5385 supersedes BS 5385-1:1995, which is withdrawn.

Relationship with other publications

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: Design and installation of external ceramic and mosaic wall tiling in normal conditions – Code of practice;*
- *Part 3: Design and installation of internal and external ceramic and mosaic floor tiling in normal conditions – Code of practice;*
- *Part 4: Design and installation of ceramic and mosaic tiling in special conditions – Code of practice;*
- *Part 5: Design and installation of terrazzo, natural stone, agglomerated stone tile and slab flooring – Code of practice.*

Information about this document

The start and finish of text introduced or altered by Corrigendum No. 1 is indicated in the text by tags C1 C1.

This is a full revision of this British Standard, and introduces the following principal changes.

- References have been updated to reflect changes in standards documents and in legislation.
- Consideration has been given to recent trends in backgrounds for tiling, and to the increasing variety of tiles in terms of tile type, and of size and thickness.
- Ceramic tile fittings for corners and edges etc., are less readily available than hitherto and are now excluded from the scope of BS EN 14411; details are therefore not included in this British Standard. Individual manufacturers can give advice about the range of types and sizes of fittings they produce, and their availability.

Throughout this British Standard, references to tiles and tiling are intended to apply equally to mosaics and mosaic work, except where the recommendations for mosaics are different.

Additional information regarding the workmanship element of ceramic tiling is contained in BS 8000-11.1 *Workmanship on building sites – Part 11: Code of practice for wall and floor tiling – Section 11.1: Ceramic tiles, terrazzo tiles and mosaics*; and for natural stone tiling and BS 8000-11.2 *Workmanship on building sites – Part 11: Code of practice for wall and floor tiling – Section 11.2: Natural stone tiles*.

Use of this document

As a code of practice, this part of BS 5385 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 5385 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.

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.

Attention is drawn to the following.

- The Construction (Health, Safety and Welfare) Regulations [1];
- The Lifting Operations and Lifting Equipment Regulations [2];
- The Manual Handling Operations Regulations [3].

1 Scope

This part of BS 5385 gives recommendations for the design and installation of ceramic, natural stone and mosaic wall tiling in normal internal conditions; a description of tile types can be found in Annex A. It deals with classes and types of background and their suitability to receive tiling using the following fixing methods.

- a) Bedding in cementitious adhesives on an intermediate substrate or as a direct bedding method.
- b) Bedding in organic-based adhesive (dispersion or reaction resin) on an intermediate substrate or as a direct bedding method.
- c) Bedding in cement:sand mortar on rendering or as a direct bedding method.

Natural stone modular tiles as defined in BS EN 12057 are included within the scope of this British Standard, but natural stone slabs (i.e. units with nominal thickness greater than 12 mm thick) are excluded.

Ceramic tile fittings for corners and edges etc., are less readily available than hitherto, and are now excluded from this British Standard. Specially moulded features, for example trims, are also excluded.

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

Agglomerated stone tiles and slabs are not included within the scope of this British 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.

NOTE 1 Agglomerated stone tiles and slabs are natural stone and/or mineral fragments set in a binder subsequently cut to form tiles with a surface that is normally ground and polished to finish.

Metal, plastic, resin or mirror tiles and glass tiles of similar construction are not included within the scope of this British Standard, as these require different techniques, adhesives etc., to traditional tiles.

NOTE 2 Mirror tiles are tiles manufactured from float or plate glass with an applied backing.

For the purposes of this British Standard "normal conditions" means normal environmental temperatures and humidity. However, it is not to be inferred from this that all recommendations made in this British Standard are unsuitable for more extreme conditions. Manufacturers' instructions contain limitations of their products.

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 410-1, *Test sieves – Technical requirements and testing – Part 1: Test sieves of metal wire cloth*

BS 4027, *Specification for sulfate-resisting Portland cement*

BS 4551, *Mortar – Methods of test for mortar – Chemical analysis and physical testing*

BS 5385-2, *Wall and floor tiling – Part 2: Design and installation of external ceramic and mosaic wall tiling in normal conditions – Code of practice*

BS 5385-4, *Design and installation of ceramic and mosaic tiling in special conditions – Part 4: Code of practice*

BS 5974, *Code of practice for temporarily installed suspended scaffolds and access equipment*

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

BS 6150, *Painting of buildings – Code of practice*

BS 6213, *Selection of constructional sealants – Guide*

BS 8000-3:2001, *Workmanship on building sites – Part 3: Code of practice for masonry*

BS 8000-11.1, *Workmanship on building sites – Code of practice for wall and floor tiling – Ceramic tiles, terrazzo tiles and mosaics*

BS 8000-11.2, *Workmanship on building sites – Code of practice for wall and floor tiling – natural stone tiles*

BS 8212, *Code of practice for dry lining and partitioning using gypsum plasterboard*

BS 8481:2006, *Design, preparation and application of internal gypsum, cement, cement and lime plastering systems – Specification*

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

BS EN 520, *Gypsum plasterboards – Definitions, requirements and test methods*

BS EN 1008, *Mixing water for concrete – Specification for sampling, testing and assessing the suitability of water, including water recovered from processes in the concrete industry, as mixing water for concrete*

BS EN 12002:2002, *Adhesives for tiles – Determination of transverse deformation for cementitious adhesives and grouts*

BS EN 12004:2007, *Adhesives for tiles – Requirements, evaluation of conformity, classification and designation*

BS EN 12811-1 *Temporary works equipment – Part 1: Scaffolds – Performance requirements and general design*

BS EN 13139:2002, *Aggregates for mortar*

BS EN 13279-1, *Gypsum binders and gypsum plasters – Part 1: Definitions and requirements*

BS EN 13888:2002, *Grouts for tiles – Definitions and specifications*

BS EN 13914-2:2005+A1:2006, *Design, preparation and application of external rendering and internal plastering – Part 2: Design considerations and essential principles for internal plastering*

BS EN 14411, *Ceramic tiles – Definitions, classification, characteristics and marking*

BS EN 14647, *Calcium aluminate cement – Composition, specifications and conformity criteria*

3 Terms and definitions

For the purposes of this part of BS 5385, the terms and definitions given in BS 6100-6 and BS EN 14411 and the following apply.

3.1 bond breaker tape

self-adhesive tape, usually polyethylene or polytetrafluoroethylene (PTFE) used to prevent sealant sticking to a substrate

3.2 natural stone tiles

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

3.3 open time

period of time during which tiles can be adequately bedded after spreading the adhesive

3.4 large tile

tile that has an edge that exceeds 60 cm combined with a surface area of greater than 1 800 cm²

3.5 tile backer board

dimensionally stable and moisture-resistant fibre-reinforced cement-based boards, specifically designed to be used in place of wood-based boards, especially in areas exposed to moisture

NOTE Typically of thickness 12.5 mm.

3.6 lightweight tile backer board

rigid, extruded inert polystyrene foam board with glass fibre reinforced polymer modified cement coating

NOTE Typically available in thicknesses ranging from 5 mm to 80 mm.

4 Exchange of information and time schedule

COMMENTARY ON CLAUSE 4

Clause 4 deals with the exchange of information for the whole wall, including tiles, tile bed, background and intermediate substrate (if any).

4.1 Exchange of information

The 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 sought and documented.

- 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 might be subjected in service (e.g. mechanical cleaning).
- c) *Wall(s)*. Type and age of construction, location within the building, type and accuracy of background and need for intermediate substrate.
- d) *Associated work*. Elements embedded in or passing through the wall, skirtings and abutments, junctions with other adjacent finishes. Consideration should also be given to protection work to tiled/mosaic finishes in location with high impact risks, wall bumpers, corner protectors and so on.
- e) *Finishes*. Type(s) of tiles and/or mosaics, bedding and jointing requirements and required surface plane.
- f) *Contract*. Details, 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 4.3).
- i) *Testing*. Details of any compliance testing required.

4.2 Provision of utilities, facilities and materials

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 are to be provided and by whom.

- a) Provision of adequate, clean, dry, lockable storage space protected from frost (if necessary) (see 5.1).
- b) Provision of clean water supply adjacent to working area (see 5.6).
- c) Provision of adequate artificial lighting, if required (see 4.2.2).

- d) Provision of safe means of access and places of work, to include where required, suitable scaffolding and staging, which should conform to either BS EN 12811-1 or BS 5974.

NOTE 1 Attention is drawn to the requirements of the Construction (Health, Safety and Welfare) Regulations [1].

- e) Provision of unloading and hoisting facilities.

NOTE 2 Attention is drawn to the requirements of the Lifting Operations and Lifting Equipment Regulations [2] and Manual Handling Operations Regulations [3].

- f) Provision of electric power supply adjacent to working areas.
- g) Protection of work during and after fixing (see 9.1).
- h) Provision of supplies of cement and sand in accordance with 5.3 and 5.4.
- i) Provision of tiles, adhesives, grouts, primers and sealants.
- j) Provision of waste disposal.
- k) Control of site temperature.

Parties should also agree who will ensure that all the materials required for the installation are available.

4.2.2 Lighting on site

Lighting on site should be of similar type, direction and intensity as envisaged for the completed installation. If this condition is not met, then the appearance of the finished wall might be different from that originally intended; it should be appreciated that serious consequences might then result, including the necessity for complete retiling.

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 responsible for carrying out the work of each of the trades concerned.

In preparing the time schedule, each operation should be considered in relation to others. Due consideration should be given to the most economical use of general plant and scaffolding by all trades, also to ensure that the various trades do not interfere unduly with each other's work.

Before tiling commences, at least six weeks should be allowed under good drying conditions for a new concrete or masonry wall to dry out. Whenever rendering is applied onto old or new concrete, it should be left for at least a further two weeks. New gypsum plasterwork should be left for at least four weeks. These drying times require extension under slow drying conditions and depending on the conditions on site (e.g. low temperatures, high humidity) and the mass of the structure; in conditions of impaired drying, the moisture content of the backing should be checked to determine suitability prior to application.

The schedule should allow time for all cutting of holes and chases and/or other work involving the use of percussion tools in or on the

walls to be tiled and in or on adjacent walls before any intermediate substrate is applied.

The schedule should provide for the completion of all necessary subsidiary work before the fixing of tiles or mosaic 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.

Provision should be made for adjustment to the time schedule to allow for suspension of operations due to unfavourable conditions that jeopardize the success of the installation.

5 Materials

5.1 Transport and storage

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

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

5.2 Tiles

5.2.1 General

All tiles should be clean and dry before use, except when bedding in cement:sand mortar (see 7.2.3.3).

5.2.2 Ceramic tiles

NOTE 1 Informative Annex A contains information about ceramic tiles.

NOTE 2 Table 1 provides classification of ceramic tiles with respect to water absorption (E) and shaping.

Large format tiles (3.4) and tiles with length to width ratio exceeding 2:1 might require special bedding procedures in accordance with tile or adhesive manufacturers' recommendations (see also 5.11); before selecting a particular type of tile, advice about its suitability should be obtained from the manufacturer via the supplier.

Table 1 Classification of ceramic tiles with respect to water absorption (E) and shaping, from BS EN 14411:2006

	Group Ia	Group Ib	Group IIa	Group IIb	Group III
Water absorption (E)	$E \leq 0.5\%$	$0.5\% < E \leq 3\%$	$3\% < E \leq 6\%$	$6\% < E \leq 10\%$	$E > 10\%$
A Extruded	A Ia	A Ib	A IIa	A IIb	A III
B Dust-pressed	B Ia	B Ib	B IIa	B IIb	B III

5.2.3 Natural stone tiles

NOTE Annex A contains information about natural stone.

The thickness of natural stone tiles should not exceed the weight restriction requirements of the different background types (see 6.2.4.3 and 6.4.1). The density of natural stone tiles can vary quite considerably and this should be established at the design stage; they are usually prepared and polished by wet processes and consequently they should be allowed to dry in natural ventilation and be clean before use.

Before selecting a particular type of tile, advice about its suitability should be obtained from the supplier.

5.2.4 Mosaics

NOTE 1 Informative Annex A contains information about mosaics.

For a mosaic that has been assembled with a backing material, it is essential that the following are checked.

- a) The backing material and its adhesive do not occupy more than 25% of the area of each tessera; the critical factor is the spread of the adhesive over the backs of the tesserae.
- b) The backing material and its adhesive do not deteriorate in service and that they are compatible with the mortar or adhesive bed in accordance with mosaic suppliers' recommendations.

For wet areas, readers should refer to BS 5385-4, for external areas, see BS 5385-2.

NOTE 2 Annex B describes the contents of BS 5385-4.

Ceramic tesserae should conform to the relevant physical properties given in BS EN 14411:2006, Table 1.

Before selecting a particular type of mosaic, advice about its suitability should be obtained from the supplier.

5.3 Cement

The cement for cement:sand mortar beds to be used for bedding mosaics should be one of:

- a) Portland cement (CEM I) conforming to BS EN 197-1;
- b) sulfate-resisting cement conforming to BS 4027; or
- c) calcium aluminate cement (high alumina cement) conforming to BS EN 14647.

Cement of all types should be used with care, because of the possible risk of adverse skin effects. Suppliers' material safety data sheets obtained at the exchange of information stage described in 4.1 should be used as a basis for assessing and managing the risk associated with its use in a particular application.

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

5.4 Sand

5.4.1 General

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

5.4.2 Sand for cement:sand rendering and mortar beds

Sand conforming to BS EN 13139:2002 recommended European designation 0/2 (CP or MP), category 2 fines, should be used for cement:sand rendering and mortar beds for mosaics.

NOTE For guidance, see the first entry under "Plastering or rendering" in PD 6682-3:2003, Table A.1.

5.4.3 Sand for grouting

5.4.3.1 For joints of nominal widths 6 mm and above

Sand conforming to the grading limits of BS EN 13139:2002, European designation 0/2 (FP or MP), category 2 fines, should be used for grouting joints 6 mm or more in width.

NOTE For guidance, see the second entry under "Plastering or rendering" in PD 6682-3:2003, Table A1.

5.4.3.2 For joints of nominal widths of less than 6 mm wide

Sands for grouts should conform to the grading limits given in Table 2.

Sands conforming to BS EN 13139:2002 recommended European designation 0/2 (FP or MP), category 3 fines might be suitable, but the fraction greater than 2.36 mm should be screened off.

NOTE For guidance see the second entry under "Masonry" in PD 6682-3:2003, Table A1.

For narrow joints below 3 mm, finer grading should be used.

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

BS 410-1 sieve mesh size	Percentage by mass passing BS 410-1 sieves
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

5.5 Plaster

Plaster backgrounds to receive tiles are usually based on gypsum building plasters and should be in accordance with BS 8481. Gypsum plasters should conform to BS EN 13279-1.

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

5.6 Water

Water should be fresh and clean and free of materials deleterious to mortar beds in their fresh and hardened states (see BS EN 1008).

NOTE Drinking water is suitable; seawater is not suitable.

All containers used for storing or carrying water or for soaking tiles for cement:sand bedding as in 7.2.3.3 should be clean.

5.7 Adhesives

5.7.1 General

Cementitious adhesives (C), dispersion adhesives (D) and reaction resin adhesives (R) should all conform to BS EN 12004:2007.

NOTE For each type it is possible to have different classes, related to the different characteristics. These classes are designated with the following abbreviations.

1: Normal adhesive.

2: Improved adhesive (meets the requirements for additional characteristic).

F: Fast setting adhesive.

T: Adhesive with reduced slip.

E: Adhesive with extended open time.

The designation of the adhesive comprises the symbol of the type (C, D or R), followed by the abbreviation of the class or classes it belongs to.

5.7.2 Admixtures to adhesives

A polymer additive, or other liquid or powdered product, can be incorporated in to cementitious adhesives to obtain greater adhesion, improved resilience or some degree of water resistance; such admixtures should be used only with adhesives approved by the manufacturer (alternatively, the use of admixtures can be eliminated by use of adhesives with additional characteristics such as those given in BS EN 12004:2007 under Type C Class 2 and Type R Class 2).

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.

Cementitious adhesives can be further characterized as either S1 or S2 depending upon the values achieved in the transverse deformation test BS EN 12002:2002; the following should be considered.

- a) S1 and S2 categories are normally achieved by polymer modification of the adhesive. Transverse deformation indicates the extent to which the polymer content of the adhesive has modified the inherent brittle character of the cement, allowing it to deform further before cracking. This is often taken as an indication that the adhesive will prevent localized stresses in the installation by absorbing any stresses that occur between the adhesive and the background.

- b) Adhesives in the S1 and S2 category are sometimes described as flexible or resilient. The term “flexible” is not correct since flexibility implies deformation under a relatively low load, and what is being measured here is the deformation at which failure occurs, not the deformation at a particular load; nor is the term “resilient” correct, since resilience refers to elastic deformation (i.e. it will reverse itself if the load is released) whereas the transverse deformation measured by BS EN 12002:2002 could well be plastic (i.e. permanent). It is probably better to think of such materials as less brittle.

EXAMPLE

It is possible that an S2 adhesive could require a much higher load to achieve a given degree of deformation than an S1 adhesive, in which case this particular S2 adhesive can be thought of as being less flexible, since it requires a higher load to deform it.

NOTE This classification is not available for non-cementitious adhesives, even though they might still be equally (or more) deformable.

- c) Regardless of whether transverse deformation measures flexibility, even when highly flexible fixing materials are used, unstable backgrounds might still cause the installations to fail, the mode of failure then probably being via broken tiles rather than adhesion failure or breakdown of the adhesive layer. Furthermore, an adhesive which accommodates more movement in the background will also accommodate more flexing movement in the tile above it under load or impact, reducing the resistance of the installation to impact damage and cracking under load, since the flexing of the poorly-supported tile could cause stresses which exceed its breaking strength.

It should therefore always be ensured that backgrounds are sufficiently rigid and stable, so that the tiling does not become subjected to excessive stresses leading to failure.

5.8 Bonding agents

NOTE 1 Bonding agents are available to improve the adhesion of renderings and/or tile beds to backgrounds, the most commonly used type being a water-based dispersion of styrene butadiene copolymer (SBR).

Bonding agents are usually mixed with cement and sand, or more commonly with neat cement, and should be applied as a wet slurry or stipple immediately prior to the application of the mortar.

NOTE 2 For optimum results the bonding agent could also be used as an admixture in the mortar if recommended by the manufacturer. This gives improved compressive and tensile strength, allowing mortars to be applied in thinner sections, thus reducing the weight of the construction.

The manufacturer’s recommendations for the particular type of bonding agent to be used and its method of application should always be strictly followed.

5.9 Sealants and back-up materials for movement joints

5.9.1 General

Materials for movement joints should be non-rigid. They should combine the properties of resilience and/or plasticity within the maximum temperature ranges likely to be encountered and should be resistant to mould growth.

5.9.2 Sealants

Joint sealants should be selected and applied in accordance with the guidance given in BS 6213.

Sealant manufacturers' advice should be taken into account as the properties of individual sealants can vary. A sealant should be capable of accommodating the anticipated amount of movement without loss of adhesion to the sides of the joints and be able to withstand the normal service conditions affecting the installation, e.g. resistant to water, ultraviolet light etc.

Where movement joints are intended to cover structural joints, and frequent movement is possible, class 25 sealants should be used. For joints undergoing smaller and less frequent movement, classes 20 or 12.5 should be considered.

NOTE 1 A given extent of movement can be accommodated either by a wider joint or by the use of a more flexible sealant, or a combination of the two; however, where the class number is less than 20, the sealant might not be suitable over structural movement joints. For a given extent of movement the narrower the joint, the higher the sealant class needed to accommodate the movement.

NOTE 2 Information on sealant installation is given in 6.5.4.

5.9.3 Back-up materials

The compressible back-up material should be a material to which the sealant can not adhere, or one which can be covered with a bond breaker tape to prevent adhesion.

The back-up material in the lower part of the joint should be compatible with the sealant used, should recover after compression and should support the sealant. It should not exude bituminous or oily products and should not absorb excessive amounts of moisture. In particular, its compressibility should be such that when the joint closes, the sealant is not forced out. Typical materials that should be used include closed cell cellular rubber and plastics, such as cellular polyethylene, some fibre building boards, cork boards and mineral or synthetic ceramic cords or blankets

NOTE 1 Back-up materials are available in sheet, strip and cord form in a range of sizes.

NOTE 2 For further information on installing back-up materials see 6.5.3.

5.10 Grouts

5.10.1 General

Grouts should have good working characteristics (e.g. ease of cleaning off the face of the tiles) as well as low shrinkage characteristics and good adhesion to the sides of the tiles. The class stated for a grout should not be taken as any indication of deformability; BS EN 12002 describes test methods for determining the deformability of adhesives and grouts and so on.

5.10.2 Types of grout

5.10.2.1 Proprietary grouts

Proprietary grouts should conform to BS EN 13888:2002, type CG or RG and should be one of the following types.

- a) Mixes based on cement and mineral fillers but modified by the inclusion of various additives, including pigments and organic additives, that only require to be mixed with clean water to the recommended consistency (CG).
- b) Mixes based on cement and mineral fillers and additives to be mixed with aqueous synthetic polymer dispersions to the recommended consistency (CG).
- c) Mixes based on epoxide resin consisting of separate pre-gauged components to be mixed together immediately before use (RG).

Manufacturers' instructions for safe handling and use should be strictly adhered to.

NOTE Epoxide resin grouts are more expensive and some might take longer to apply and clean off than cement based grouts. Ready-mix dispersion grouts are not covered by BS EN 13888:2002.

5.10.2.2 Cement:sand mortar grouts

Mortar grouts are sometimes used for grouting joints that are over 3 mm in width; in order to promote good adhesion and strength development, there should be dampness in the joint cavities.

Mixes of this type should be used for mosaics in cement:sand mortar beds that are thick enough to retain sufficient dampness when re-wetted.

NOTE The physical properties of cement:sand mortar grouts are generally inferior to those of proprietary grouts, which provide performance and properties that are more consistent.

Neat cement mixed with water should not be used as a grout for tiling except for pre-grouting paper-faced mosaics with narrow joints (see 8.5.1).

5.10.3 Admixtures to grouts

COMMENTARY ON 5.10.3

Admixtures, normally in the form of aqueous dispersions, can be incorporated in grout mortars based on cement and sand to enhance adhesion in the tile joints, whilst improving the resilience and reducing the water permeability of the hardened grout mortar. Proprietary aqueous admixtures are available for incorporation in proprietary grouts to provide improved characteristics.

Admixtures should be used strictly in accordance with the manufacturer's instructions and they should not be added to a proprietary grout unless approved by the grout manufacturer.

5.11 Mechanical fixing

Where large format ceramic tiles are required to be fixed above first floor height, especially above pedestrian walkways, they should be secured by mechanical means. In other circumstances where the background is not sufficiently robust to support the load of the tile installation, it might be considered necessary to provide mechanical reinforcement. For such cases, which are much more common for external fixing, reference should be made to BS 5385-2, which gives details regarding appropriate materials and procedures.

6 Design

6.1 Backgrounds

6.1.1 General

The nature of the background should be established before choosing any intermediate substrate or other preparatory treatment necessary before tiling.

NOTE 1 Table 3 contains methods of preparation and choice of materials for the various backgrounds covered in 6.1.

NOTE 2 Some backgrounds might limit the choice of tile.

6.1.1.1 Porosity and suction

COMMENTARY ON 6.1.1.1

Porosity and suction affect the adhesion of cement:sand rendering; the amount of wetting required to reduce suction and to ensure uniformity of suction depends upon the nature of the background, the type of mix, the method of application and the ambient conditions.

Wetting should be carefully controlled and only the necessary amount of water applied.

6.1.1.2 Mechanical key

If a mechanical key is necessary but not afforded by the nature of the background, it should be artificially provided.

6.1.1.3 Trueness of construction*COMMENTARY ON 6.1.1.3*

The trueness of the background construction also affects the final appearance of the tiling particularly where the tiles are fixed directly to the background because the tile fixing methods are not designed to correct background irregularities. Excessively thick applications of cement:sand render and/or gypsum plaster can lead to prolonged shrinkage and extended drying times.

The trueness of the background construction should be controlled because of the limitations in the thickness and the number of coats of any in situ applied intermediate substrate (see 6.3.3 and 6.4.3).

6.1.1.4 Moisture movement and thermal movement

NOTE Stresses might develop between the background and the tiling system from differential expansion and contraction movements and are potential causes of failure.

Where it is suspected that moisture movement or thermal movement of the background and/or tiling threatens the stability of the installation, special precautions or provisions of additional movement joints should be considered. Adhesives conforming to the requirements of BS EN 12004 should be used and the choice of adhesive discussed with the manufacturer.

6.1.1.5 Soluble salts in backgrounds**6.1.1.5.1 Chemical action**

NOTE Soluble sulfates are present in some backgrounds such as brickwork; if these backgrounds become wet, soluble sulfates can migrate into cement-based mortars in sufficient quantities to cause damage from sulfate attack. This type of damage is likely to affect the adhesion of cement:sand renders/beds and cement-based adhesives.

Gypsum plaster (calcium sulfate) based materials should not be used as backings for ceramic tiling in wet or damp conditions.

6.1.1.5.2 Staining

Moisture migrating from bedding mortar or adhesive and from temporarily wetted backgrounds can carry soluble materials to the surface of some natural stone tiles and this can result in staining; a trial fixing should be carried out to see if the tiles are affected by moisture from the bedding mortar or adhesive. Where staining is likely, the backgrounds should be dry and effectively sealed before natural stone tiles are fixed.

6.1.1.6 Contamination

Any laitance on the surface, contamination by oil, grease or any other substances that inhibit adhesion of the intermediate substrate or tiling or both should be cleaned or removed.

Backgrounds previously treated with decorative coating, e.g. lime wash or paints, could also cause failure and should be cleaned off. Any loose material on the surface should be brushed off.

6.1.1.7 Physical deterioration

Backgrounds that have deteriorated by physical damage, inappropriate preparation (see 6.2) or other agencies might have an adverse effect on the adhesion of the intermediate substrate or tiling or both: it is essential that such backgrounds be brought to a condition suitable for tiling.

6.1.2 Classes and types of background

6.1.2.1 General

Backgrounds are classed according to 6.1.2.2 to 6.1.2.10 (see also Table 3); all backgrounds should be fully dry before the application of intermediate substrate or direct fixing. Moderately weak backgrounds and wood-based sheets and board should not be used to support heavy tiles or for internal walls greater than one storey.

6.1.2.2 Dense, strong and smooth materials

These factors should be given due consideration when choosing the bedding system to use for such backgrounds (which include high density clay bricks or blocks, dense concrete either pre-cast or in situ, some natural stones, glazed bricks and glazed tiles).

- Low porosity.
- Little suction.
- Smooth surfaces that offer no mechanical key.
- Drying shrinkage of dense clay bricks or blocks is negligible; in dense concrete, it might vary from low to high according to mix, quality, etc., but is usually no more than moderate, though drying out can be slow.

6.1.2.3 Moderately strong and porous materials

Most bricks and blocks, other than the very dense types described in 6.1.2.2 or lightweight products described in 6.1.2.4, fall into this class, together with some medium strength natural aggregate concretes and structural lightweight concrete; these materials should be used where relatively high suction and a generally good mechanical key and good adhesion for an intermediate substrate is required. Drying shrinkage of concrete is variable and should be taken into consideration.

6.1.2.4 Moderately weak and porous materials

Blocks containing lightweight aggregate, autoclaved aerated concrete and some bricks of relatively low strength need more care in the selection of an intermediate substrate than backgrounds considered in 6.1.2.3; it is particularly important that the in situ applied intermediate substrate should not be stronger than the background since shrinkage of the latter is liable to result in delamination within the surface of the background.

NOTE Lightweight concrete blockwork might have a large drying shrinkage movement depending on composition and/or moisture content.

Where the surface strength of the background is weak, it should be supplemented using either a mesh-reinforced render adequately secured to the blockwork (see 6.1.2.9), or mechanically fix a suitable pre-formed/proprietary substrate, e.g. paper-faced plasterboard, appropriate for the service conditions to the background. This should always be adopted for walls constructed of lightweight concrete blockwork with a density less than 625 kg/m³, taking into account the advice of the blockwork manufacturer.

6.1.2.5 No-fines concrete

NOTE No-fines concrete has many relatively large voids and provides an effective mechanical key for an intermediate substrate. Drying shrinkage and suction vary from low to moderate according to the aggregate used.

Cement:sand render should be used as an intermediate substrate for adhesive fixing of tiles to this background.

6.1.2.6 Sheets and boards

The use of sheets or boards that are subject to movement from changes in moisture content should be avoided if at all possible. If such boards (plywood board, chipboard, some fibre building boards) have to be used, they should be restricted to small areas and installed in such a way that they provide a dimensionally stable and rigid background. The backs and edges of such boards should be treated against the ingress of atmospheric moisture that would result in movement and warping. Tiles should not bridge joints between boards.

NOTE 1 Sheets and boards include plasterboard, glass fibre reinforced cement boards (e.g. tile backer board, 3.5), fibre building boards, plywood, chipboard and other composite boards (e.g. lightweight tile backer board, 3.6).

All sheets and boards should be dry before tiling is commenced; they are mainly used with framed or battened constructions which should be designed to provide a rigid surface. Tile backer boards and lightweight tile backer boards can be laid over existing substrates, the minimum thickness should be 5 mm on walls; these products can be screw fixed or adhesive bonded. Sheets and boards to receive natural stone tiles should always be positively fixed, using stainless steel screws to avoid surface staining. Natural stone tiles should not be fixed to fibre building boards or chipboards.

If sheets and boards are not dimensionally stable with changing humidity, they should not be used in wet or damp conditions (see BS 5385-4).

Any wood-based sheets or boards should be conditioned to the moisture content appropriate for the humidity and temperature that prevails once the room is in normal use.

NOTE 2 Achieving this recommendation can prove difficult in new constructions or premises that are subsequently heated, but the use of wood-based sheets or boards dried to the required moisture content can help reduce the risk.

NOTE 3 Further information is given in the document Tiling to timber sheets and boards, timber substrates and alternative products [4] prepared by The Tile Association.

6.1.2.7 Cement:sand rendering

Subclause 6.3 should be consulted for further information.

NOTE Cement:sand rendering is the preferred background for internal ceramic tiling.

6.1.2.8 Gypsum plaster

Subclause 6.4 should be consulted further information.

NOTE Gypsum plaster is suitable for most internal wall tiling applications, except wet areas or where the tiles to be fixed are heavier than 20 kg/m².

6.1.2.9 Metal lathing

Ribbed lathing or welded wire mesh is mainly used with framed construction to provide rigid support to cement:sand rendering over backgrounds unsuitable to support a bonded rendering, and should be used to support directly-applied ceramic tiling where the background surface is too weak.

6.1.2.10 Other backgrounds

There are a variety of materials and surfaces, particularly in old buildings, that might require tiling to change their appearance and performance: sometimes they might be too weak in themselves or be too weakly-adhering to the background to support tiling; in such cases, expert advice should be sought.

Owing to the differences in thermal expansion, tiles should only be fixed to metals using special adhesives designed for the purpose.

For proprietary surfaces, the manufacturer's recommendations should be followed.

Table 3 Backgrounds: summary of data and suitable tile beds

a) Dense, strong and smooth background				Material for fixing tiles				
Background	Drying shrinkage movement	Surface characteristic	Preparation of backgrounds		Cement-based adhesives	Organic-based adhesives	Cement-sand mortar	
			For direct bedding (see 6.2.4)	For rendering or cement: sand mortar bed				Additional comments
High density clay brickwork and clay blockwork (see 6.1.2.2)	Negligible	Low suction	Direct fixing with an adhesive can be adopted provided the surface is suitable (see 6.2.4.1)	Poor key; might need more than raking back of joints, e.g. scabbling, spatterdash, bonding agent, lathing or netting; keyed bricks need no raking back (see 6.2.2.2.1)	Where adhesive is used, drying out can be delayed and grouting should be deferred for at least three days or as long as practicable	S	S	S
Dense concrete, either precast or in situ (see 6.1.2.2)	Can vary from low to high ^{A)}	Low suction		Poor key; remove any ridges and fins from in situ concrete before cleaning down. Remove grease and mould oil. Might need scabbling, spatterdash, bonding agent, lathing or netting (see 6.2.2.2)	New concrete should be left for at least six weeks before rendering or direct fixing is commenced; cement:sand mortar rendering should be left for two weeks before tiling is applied	S	S	S
Hard natural stone (see 6.1.2.2)	Negligible	Low suction		Poor key; might need more than raking back of joints, e.g. scabbling, spatterdash, bonding agent, lathing or netting (see 6.2.2.2.3)		S	S	S
Glazed brickwork and tiling (see 6.1.2.2)	Negligible	Very low suction	Clean down existing surface to remove grease, grime, condensation, etc., (see 6.2.4.5)	Unsuitable	Old tiles/bricks should be checked as being firmly bedded, remedy isolated loose areas; drying time of adhesive might be extended; delay grouting as long as practicable	U	S	U

Key

S Suitable, but all adhesives within a particular group might not be suitable.
U Unsuitable.
C Confirmation of suitability should be sought from the manufacturer.

NOTE *Properties of backgrounds indicate only relative characteristics of the materials.*

^{A)} The amount of movement to be expected can vary according to the particular grade and/or free water:cement ratio.

Table 3 Backgrounds: summary of data and suitable tile beds (continued)

b) Moderately strong and porous backgrounds				Material for fixing tiles			
Background	Drying shrinkage movement	Surface characteristic	Preparation of backgrounds		Cement-based adhesives	Organic-based adhesives	Cement-sand mortar
			For direct bedding (see 6.2.4)	For rendering or cement: sand mortar bed			
Clay brickwork and blockwork (see 6.1.2.3)	Negligible	Moderate or high suction	Direct fixing with an adhesive can be adopted provided the background is suitable (see 6.2.4.1)	Rake back joints (see 6.2.2.3.1)	S	S	S
Concrete (natural aggregate) (see 6.1.2.3)	Low to high ^{A)}	Moderate suction	Poor to fair key; remove any ridges and fins from in situ concrete before cleaning down; remove grease and mould oil; might need scabbling, spatterdash, bonding agent, lathing or netting (see 6.2.2.3.2)		S	S	S
Concrete brickwork and blockwork (natural aggregate)	Low to high ^{A)}	Moderate suction	Rake back joints to form key; with some types of extremely smooth and dense bricks, scabbling, spatterdash, bonding agent, lathing or netting can be used to obtain a good key (see 6.2.2.3.3)		S	S	U
Calcium silicate brickwork (hard)	Low to high ^{A)}	Moderate suction			S	S	U

Key

S Suitable, but all adhesives within a particular group might not be suitable.

U Unsuitable.

C Confirmation of suitability should be sought from the manufacturer.

NOTE Properties of backgrounds indicate only relative characteristics of the materials.^{A)} The amount of movement to be expected can vary according to the particular grade and/or free water:cement ratio.

Table 3 Backgrounds: summary of data and suitable tile beds (continued)

c) Moderately weak and porous backgrounds

Background	Drying shrinkage movement	Surface characteristic	Preparation of backgrounds		Additional comments	Material for fixing tiles		
			For direct bedding (see 6.2.4)	For rendering or cement:sand mortar bed		Cement-based adhesives	Organic-based adhesives	Cement:sand mortar
Autoclaved blockwork and lightweight aggregate concrete with open surfaces ^{B)} (see 6.1.2.4)	Moderate to high ^{A)}	Moderate to high suction	Direct fixing with an adhesive can be adopted provided the background is suitable (see 6.2.4.1)	Good key; spatterdash, bonding agent, lathing or netting might be needed (see 6.2.2.4.1 and 6.2.2.4.2)	Walls should be kept dry and should be at least six weeks old before any rendering is applied and left a further two weeks before fixing is commenced; the rendering should not exceed 13 mm in thickness	S	S	U
Autoclaved blockwork and lightweight concrete with closed surfaces ^{B)} (see 6.1.2.4)	Moderate to high ^{A)}	Moderate suction		Poor key; sight need spatterdash, bonding agent, lathing or netting (see 6.2.2.4.1 and 6.2.2.4.2)		S	S	U
Autoclaved aerated concrete. In situ and panels (see 6.1.2.4)	Moderate to high ^{A)}	Moderate suction		Poor to fair key; spatterdash, bonding agent, lathing or netting might be needed (see 6.2.2.4.2)		S	S	U
Soft natural stone (see 6.1.2.4)	Negligible	Moderate or high suction		Might need scabbling, spatterdash, bonding agent, lathing or netting (see 6.2.2.4.3)		S	S	S
Calcium silicate brickwork (soft)	Low to high ^{A)}	Moderate suction		Rake back joints; with some types of extremely smooth bricks, spatterdash, bonding agent, lathing or netting might be used to obtain a good key (see 6.2.2.3.3)		S	S	U

Key

S Suitable, but all adhesives within a particular group might not be suitable.

U Unsuitable.

C Confirmation of suitability should be sought from the manufacturer.

NOTE Properties of backgrounds indicate only relative characteristics of the materials.

^{A)} The amount of movement to be expected can vary according to the particular grade and/or free water:cement ratio.^{B)} Confirm with the concrete block manufacturer that the treatment described is appropriate to the product.

Table 3 Backgrounds: summary of data and suitable tile beds (continued)

d) Other backgrounds		Preparation of backgrounds		Material for fixing tiles				
Background	Drying shrinkage movement	Surface characteristic	For direct bedding (see 3.2.4)	For rendering or cement:sand mortar bed	Additional comments	Cement-based adhesives	Organic-based adhesives	Cement-sand mortar
No-fines concrete (see 6.1.2.5)	Low to moderate according to aggregate used ^{A)}	Low to moderate suction	Unsuitable	Open textured surface should not require further keying (see 6.1.2.5.1)	New concrete should be left for at least six weeks before rendering. cement:sand rendering should be left for two weeks before tiling is applied	S	S	S
Plasterboard (see 6.1.2.6)	Negligible	True and smooth	(See 6.2.4.3)	Unsuitable	All boards should be rigidly fixed; plasterboard is generally unsuitable for frequently wetted areas; see BS 5385-4 for further guidance for wet conditions	C	S	U
Fibre cement board. Wood based panel products (see 6.1.2.6)	Moderate to high	True and smooth	Seal exposed edges and back, but not the face, against water absorption; priming might be necessary; refer to adhesive manufacturer (see 6.2.4.2)	Unsuitable	All boards should be rigidly braced; sheets and boards should not be used in wet or damp areas unless they are dimensionally stable	C	S	U

Key

S Suitable, but all adhesives within a particular group might not be suitable.

U Unsuitable.

C Confirmation of suitability should be sought from the manufacturer.

NOTE Properties of backgrounds indicate only relative characteristics of the materials.^{A)} The amount of movement to be expected can vary according to the particular grade and/or free water:cement ratio.

Table 3 Backgrounds: summary of data and suitable tile beds (continued)

d) Other backgrounds (continued)				Material for fixing tiles			
Background	Drying shrinkage movement	Surface characteristic	Preparation of backgrounds		Cement-based adhesives	Organic-based adhesives	Cement-sand mortar
			For direct bedding (see 3.2.4)	For rendering or cement-sand mortar bed			
Gypsum plaster (see 6.2.3 and 6.4)	Negligible	Depends upon age and conditions but usually smooth with high suction	Clean or strip if painted, distempered or otherwise decorated; apply binding coat of suitable primer prior to tiling (see 6.2.4.1)	Unsuitable	C	S	U
Paintwork (see 6.2.4.4)	According to back-ground	Low suction. (Depends upon age and condition)	(see 6.2.4.4)	If paint is flaking it should be stripped off mechanically; emulsion paint, limewash, distemper and similar finishes are best removed since they can possess poor adhesion to backing; solvent-based adhesives should not be used	U	S	U
Metal surfaces (e.g. iron/steel) (see 6.2.4.6)	Nil	Low suction and poor key	Clean to remove rust, grease, etc., (see 6.2.4.6)	For metals other than iron/steel or when abnormal conditions apply, advice should be sought from the adhesive manufacturer	U	S	U

Key

S Suitable, but all adhesives within a particular group might not be suitable.

U Unsuitable.

C Confirmation of suitability should be sought from the manufacturer.

NOTE Properties of backgrounds indicate only relative characteristics of the materials.

6.2 Preparation of backgrounds

6.2.1 General

COMMENTARY ON 6.2.1

The suitability of a background to receive tiling depends on the quality of its surface relative to the various methods and materials that can be used to fix the tiles. It might be necessary to introduce some intermediate treatment of which the following are examples.

a) Mechanical keying of the surface (see 6.2.2.1).

b) Application of a preparatory treatment to the substrate to control its surface suction if high or variable or to enhance the adhesion of surfaces with low suction.

c) Application of an intermediate substrate to provide the necessary measure of accuracy; this intermediate substrate might also require application to a keyed surface or one treated with a bonding agent in order to improve its adhesion to the background.

d) Taking down backgrounds of sheets or boards if they are not sufficiently rigid or accurate, then re-installing or replacing them.

All backgrounds should be inspected for contamination and any potentially deleterious material should be removed.

Backgrounds not built accurately to a specified plane, or having surfaces that are uneven, might have deviations too great to be capable of accommodation within the recommended thickness of a tile bed; if such backgrounds are of bricks, blocks, stone or concrete, an intermediate substrate should be applied to provide a true surface to receive the tiling.

Where backgrounds are sheets and boards, painted surfaces, tiles or glazed bricks, the tiling is usually applied directly to the background by means of a suitable adhesive; backgrounds having irregularities exceeding the limit defined in 6.2.4.1 should be corrected by reinstatement in the case of sheets and boards or by the application of an intermediate substrate if the background is capable of supporting such a substrate.

Tile beds of thicknesses greater than those recommended in Clause 7 should not be used to accommodate inaccuracies in a background surface, especially if the bed thickness is not consistent throughout the installation: this can give rise to variable stresses and possible loss of adhesion, or cracking.

Apart from correcting major irregularities in backgrounds, an intermediate substrate can be used to provide an accurate surface for adhesives, which should be spread to a recommended consistent thickness.

Cement:sand rendering provides a much stronger background for tiling than plaster and, wherever possible, it should be used; however, tiles can be fixed satisfactorily to sound plaster surfaces providing the recommendations in this British Standard are observed.

Clause 7 and Table 3 demonstrate that preference is given to the use of adhesives for the application of tiles to most surfaces, but there might be combinations of tile and background for which certain

classes of adhesive are unsuitable; in such circumstances, the advice of the adhesive manufacturer should be sought regarding bed thicknesses, or consideration might be given to the use of cement:sand mortar bedding; these systems are not compatible with tiling to gypsum plaster or most sheet and board backgrounds.

NOTE Reaction resin adhesives (classified R in BS EN 12004:2007) are mainly used where substrates, which are difficult to adhere to, are encountered or where high levels of chemical resistance are needed (see BS 5385-4).

6.2.2 Treatment of backgrounds to receive cement:sand rendering

6.2.2.1 General

Before applying cement:sand rendering, the substrate should be checked to ensure that the substrate has dried out, especially where it consists of materials such as lightweight concrete blocks, calcium silicate bricks, concrete bricks and concrete blocks, which can have an appreciable drying shrinkage related to their composition and degree of saturation (see also Table 3).

The background should dry out for at least six weeks before any rendering is applied; longer times are required under adverse drying conditions (see BS 5385-4).

Any laitance on the surface and contamination by oil, grease, release agents or any other substances that inhibit adhesion of the rendering should be cleaned or removed. All loose material on the surface should be brushed off.

It is essential that the surface to be rendered should provide a good key; a good bond being dependent upon a mechanical key and adequate suction and/or the use of a suitable bonding agent. Mechanical keys should be achieved by one of the following.

- a) *Mechanical preparation.* The surface is removed to a depth of about 3 mm by means of a hand scabbler, by bush-hammering, shot-blasting or water scabbling as appropriate.
- b) *Indented keys.* These are formed in concrete by rubber or composition formers fixed to the shuttering. Clay bricks are available with indented keys.
- c) *Spatterdash.* A mix of cement and sand, or a proprietary composition, is applied over the surface in the form of closely spaced globules.
- d) *Retarders.* These are painted on shuttering to enable a good key to be formed on the surface of concrete; after removal of the shuttering, considerable care is required to ensure that all traces of retarder, unset cement and loose particles are removed and that the aggregate is exposed uniformly; this can be done by wire brushing and thorough washing using clean water with a suitable detergent, followed by a final washing down with clean water. Retarders and detergents containing coloured dyes are recommended so that their removal can be seen to be complete when no traces of the dyes remain.

- e) *Metal lathing and reinforcement.* Suitable gauges of metal lathing and wire mesh should be used and fixings spaced at intervals so that the applied rendering is rigid. Ensure that stainless steel fixings are used with stainless steel mesh. Galvanized wire netting can be used to inhibit cracking in the rendering at the junctions between different background materials not separated by a structural movement joint.
- Lathing and netting made of other materials, such as plastics or coated glass fibre, should be able to provide adequate support for the subsequently applied rendering and tile bedding.
- f) *Bonding agents.* Several different chemical types of bonding agents are available; before deciding on a proprietary bonding treatment the advice of the manufacturer of the bonding agent should be obtained as to its suitability, the method of application and the physical and mechanical properties necessary in the surface to receive it. Backgrounds on which bonding agents can be used are included in Table 3. The bonding agent should be one that does not re-emulsify after application. Bonding agents can be applied by one of the following methods.
- 1) As a coating without additives before rendering.
 - 2) As a slurry formed by mixing with cement, applied before rendering.
 - 3) As an admixture to the rendering mix, partially or completely replacing the gauging water.
 - 4) By combining 1) or 2) with 3) in one rendering operation.

Surfaces to be rendered should have a uniform and adequate suction, otherwise a preparatory treatment should be specified. Such treatments are provided by a spatterdash [see 6.2.2.1c)] or bonding agents [see 6.2.2.1f)].

6.2.2.2 Dense, strong and smooth materials

6.2.2.2.1 High density clay brickwork and clay blocks

Some brickwork might have been raked back during construction (walls constructed of keyed bricks need no raking back); where this has not been done and needs to be, brickwork should be raked back to a depth of 13 mm if the joints are soft enough. If the mortar is too hard for raking back or if the bricks or blocks are very hard and smooth, other methods of forming a key should be used (see 6.2.2.1).

6.2.2.2.2 Dense concrete (precast or in situ)

Ridges and fins left on concrete by shuttering imperfections should be removed before cleaning down; methods of providing a good key are given in 6.2.2.1. Joints in new and old concrete block walling should be treated as described for brickwork (see 6.2.2.2.1).

6.2.2.2.3 Hard natural stone

Dense or smooth stone should be checked before rendering, as it might need to be treated to form a key using the methods described in 6.2.2.1.

6.2.2.3 Moderately strong and porous materials

6.2.2.3.1 Clay bricks and blocks

Treatment for clay bricks and blocks should be as described in 6.2.2.2.1.

6.2.2.3.2 Medium strength natural aggregate concrete

Treatment for medium strength natural aggregate concrete should be as described in 6.2.2.1 and 6.2.2.2.2.

6.2.2.3.3 Calcium silicate bricks and concrete bricks and blocks

Joints in calcium silicate bricks and concrete bricks and blocks should be raked back using the methods described in 6.2.2.2.1; with some types of extremely smooth calcium silicate bricks, spatterdash coat, lathing or netting might be needed (see 6.2.2.1).

6.2.2.4 Moderately weak and porous materials

6.2.2.4.1 Autoclaved aerated concrete blocks and concrete blocks containing lightweight aggregate

Apart from general cleaning (see 6.2.2.1) special treatment is seldom necessary for autoclaved aerated concrete blocks and concrete blocks containing lightweight aggregate, as they usually have moderate suction and a good key, although some dampening might be required to control suction; the minimum amount of water should be used to achieve this objective.

Smooth blocks should be treated as described for brickwork (see 6.2.2.2.1).

If these blocks have a high or variable suction, preparatory treatments should be used (see 6.2.2.1).

6.2.2.4.2 Autoclaved aerated concrete panels and in situ concrete and panels containing lightweight aggregate

Special treatment is generally necessary with autoclaved aerated concrete panels, in situ concrete and panels containing lightweight aggregate and should be undertaken as described in 6.2.2.1.

6.2.2.4.3 Soft natural stone

Where necessary, soft natural stone should be treated to form a good key in accordance with 6.2.2.1; lathing or netting might be most appropriate.

6.2.2.5 Other backgrounds

6.2.2.5.1 No-fines concrete

No-fines concrete usually requires no preparation other than cleaning; cleaning should be carried out in accordance with 6.2.2.1.

6.2.2.5.2 Other substrates

Other substrates should be inspected and a decision taken as to whether or not cement:sand rendering is compatible with them, and whether or not they have sufficient integral strength to support both rendering and subsequently-applied tiled finish.

6.2.3 Treatment of backgrounds to receive a gypsum plaster finish

Preparatory treatment prior to the application of plastering systems to the backgrounds classified in 6.1.2 should be carried out in the same way as described in 6.2.2 for the application of cement:sand rendering (see also BS 8481:2006, Clause 5, and BS EN 13914-2+A1, 4.1.3 and 4.1.5).

6.2.4 Treatment of backgrounds to receive tiles by direct bedding

6.2.4.1 General

NOTE Tiles can be bedded directly to a background using an appropriate adhesive or cement:sand mortar as the bed. Methods of application and suitability of backgrounds to accept these methods are described in Clause 7 and Table 3.

The trueness of the background surface for adhesive beds should be such that, when checked with a 2 m straight edge, any gap behind the straight edge between points of contact does not exceed 3 mm. Where the gap exceeds 3 mm, correction over small localized areas of the background, by dubbing out up to 6 mm, can sometimes be done as a separate operation using the adhesive subsequently to be used for the tiling: the adhesive manufacturer's advice should be sought before undertaking such a technique.

Where a cement:sand mortar tile bed is to be applied directly to a background, the surface should be treated as described for cement:sand rendering in 6.2.2.

6.2.4.2 Sheets and boards

Sheets and boards include the materials listed in 6.1.2.6, except plasterboards; sheets or boards should be adequately braced to provide a rigid surface, be free from any springiness and surface undulations and undergo no subsequent distortion during and after completion of the tiling. Wherever possible, the boards should be screwed, not nailed, to the supporting framework.

In general, where the sheet or board has a smooth and a rough side, the latter should be used for tiling. The surface to receive the tiles should be clean and free from dust and other forms of contamination.

The use of sheets and boards that are subject to movement from changes in moisture content, e.g. wood-based materials such as plywood, chipboard, wood particle boards, etc., should be avoided if at all possible. If such boards have to be used, they should be restricted to small areas and tiles should not bridge joints between

boards. All exposed edges and the backs, but not the faces, of such boards should be sealed with a suitable sealer to prevent distortion by atmospheric humidity changes. Care should be taken to ensure such boards are not installed in a condition where their moisture content is higher than the ambient equilibrium moisture content once the tiled installation is in use; failure to observe this can lead to subsequent warping and distortion of the boards with consequent cracking and delamination of the tiling.

6.2.4.3 Plasterboards

Gypsum plasterboard is generally suitable as a background for tiling, but as considerable differences occur in usage between housing and public buildings, consideration should be given to the plasterboard specification and the fixing system.

Plasterboard should conform to BS EN 520. Plasterboard is generally unsuitable for frequently wetted areas, see BS 5385-4 for further guidance for wet conditions; where there is exposure to moisture, e.g. splash backs, the plasterboard should either be type H or pre-primed and the perimeter sealed.

The following precautions should be observed.

- a) When fixing to timber framing or battening, 12.5 mm board should be used as a minimum thickness, with stiffening noggings where necessary.
- b) Boards should be positively fixed by either nailing or screwing over the complete area.
- c) Where boards are not fixed to timber backgrounds, reference should be made to BS 8212 or the recommendations for the proprietary system by the manufacturer.
- d) The weight of tiling should not exceed 32 kg/m², generally equivalent to tiles with a thickness of 12.5 mm or natural stone tiles with a thickness of 10 mm.
- e) Boards should not become damp either during storage or after installation.
- f) Plasterboard wall linings not fixed by nails or screws should be allowed to stand for ten days before tiling commences.
- g) Where tiling heights exceed 2 400 mm, reference should be made to the recommendations of the plasterboard manufacturer.
- h) The tiles should be fixed directly on the paper facing of the plasterboards in accordance with the adhesive manufacturer's instructions.
- i) In areas where the plasterboard has to be smoothed with gypsum plaster to receive other finishes, the plaster finish coat should be applied in accordance with the plasterboard manufacturer's recommendations (see 6.4).
- j) Dry lining angle beads and the like should not be used if the boards are to be tiled using adhesives.

6.2.4.4 Painted surfaces

Painted surfaces are generally unsuitable for natural stone tiles; for ceramic tiles and mosaics, a detailed examination of the painted surface should be made to decide whether it is suitable: the permanent success of the installation is dependent upon good adhesion between the paint and the surface to which it has been applied and between any substrate and the basic structure.

When the adhesion of the coating is in doubt, it should be stripped: for information on stripping paint and distemper, see BS 6150.

NOTE Backgrounds decorated with hard gloss paint, e.g. fair-faced brickwork and plasterwork, are often sufficiently plumb and smooth for tiles to be fixed directly to them using a suitable adhesive; where the paintwork is sound and shows no sign of flaking, and provided that the surface is sufficiently flat and true to permit thin-bed fixing, the only preparation required is a thorough cleaning down to remove any surface grease, grime, condensation and so on.

When it is necessary and appropriate to render decorated backgrounds, e.g. painted brickwork or concrete, the paint should be removed and an adequate key provided or the rendering should be supported on reinforcement mechanically fixed to the background: the general principles described in 6.4 apply to plaster used as a base for decoration and subsequent tiling.

6.2.4.5 Existing glazed tile and glazed brick surfaces

Existing ceramic wall tiling (and glazed brick) usually provides a sufficiently flat surface to enable new tiles fixed with an appropriate adhesive; the existing ceramic wall tiling should be sound and well adhered to the backing, which should be sufficiently strong to support the added weight of the new tiling, see 6.4.1. Check that the old tiles are still firmly adhered; all loose or hollow sounding tiles should be removed. If only isolated areas of tiling are loose, the face of the original cement sand or adhesive bed, if sound, should be dressed back to sufficient depth to allow the old tiles to be re-fixed flush with the surrounding tiles using a suitable adhesive. When only a few isolated tiles are loose, they should be removed and the spaces left can then be filled in flush with the surrounding tile surface using suitable mortar or adhesive, which should be allowed to dry out thoroughly before the new tiles are applied.

Before fixing the new tiles, the existing glazed surface should be thoroughly cleaned down to ensure the removal of grease, grime, condensation and so on. In most cases, the use of a strong detergent, combined with an abrasive technique, should be used to ensure removal of any grime and other residues adhered to the tiled surface. The cleaned surface should be rinsed down with clean water to leave a clean, uncontaminated tiled surface. The new tiles should be fixed as recommended by the adhesive manufacturer, either directly on the dry prepared tiled surface, or after the application of a suitable primer.

When most or all of the tiles are loose or hollow-sounding, they should all be removed and the new tiling should be applied directly to the original cement:sand or adhesive bed, when it is sound; the original bed might need dressing back or levelling to conform to the

trueness of the background required by the bedding method for the new tiles, see **6.2.4.1**.

If the existing cement:sand or adhesive bed is not firmly bonded to its backing, or if the backing is not sound and sufficiently strong, all unsound layers should be removed to expose a sufficiently strong and sound surface and a suitable intermediate substrate installed (see Table 3).

6.2.4.6 Other backgrounds

By using a suitable adhesive, tiles can be fixed to most surfaces (those most likely to occur in practice are discussed in **6.1**, **6.2**, **6.3** and **6.4**); occasionally, other backgrounds are encountered (e.g. metals) that pose special problems; in such cases, advice should be sought from adhesive manufacturers to whom full information should be given of the application and service conditions.

6.3 Cement: sand rendering

6.3.1 General

It is essential that the rendering be confirmed as compatible with the background to which it is applied; recommendations for achieving the best relationship between the component materials in respect of their strength and shrinkage movement factors are included in Table 3.

The rendering should be true (see **6.3.3**), firmly bonded to the background and, as far as practicable, free from hollow-sounding areas. It should be protected, if necessary, to prevent rapid drying-out for at least the first three days after application and should be completed at least two weeks (depending on weather, humidity and site conditions) before tile fixing begins.

NOTE Complete bonding might not be achieved with reinforced renderings.

Care is necessary to ensure that surfaces wetted to control suction do not dry before the rendering is applied: the rendering should keep pace with the wetting or the surfaces should be re-wetted as necessary.

6.3.2 Mix for rendering to various backgrounds

6.3.2.1 General

The relationship between the background, rendering, adhesive or mortar bed and the tiles is very important in respect of two properties of the components; their strength and their drying shrinkage movements; attention should be paid to **6.1.2** regarding the variation in strength and drying shrinkage movement of the common backgrounds.

Masonry cement and sand mixes can be used; these mixes, providing equivalent strength to the cement:sand mixes described in **6.3.2.2** to **6.3.2.5**, should be in accordance with the instructions of the manufacturers of any proprietary materials employed.

Weight batching should be adopted whenever practicable as this helps to ensure uniformity of mix proportions and thus the uniformity of the quality of the material; for further details of batching and mixing, see 7.2.3.4.

6.3.2.2 Dense, strong and smooth or moderately strong and porous backgrounds

On backgrounds such as high density clay bricks or blocks, dense concrete (either precast or in situ) and stone, the rendering should consist of 1 part of cement to between 3 and 4 parts of sand by volume (1:3.5 to 1:4.5 by mass) when based on dry sand. Sand is usually delivered and used in the damp state and if no allowance is made for this, the mix (particularly if volume batched) might be richer than is desirable; therefore, based on damp sand with the maximum effect of bulking, the mix should consist of 1 part of cement to 4 to 5 parts of sand by volume (1:3.5 to 1:5 by mass): if a mix is too strong, the drying shrinkage is increased and if a mix is too lean, it might be too weak to support the tile bed mortar.

6.3.2.3 Moderately weak and porous backgrounds

For backgrounds such as certain types of lightweight aggregate concrete, autoclaved aerated concrete, and bricks of relatively low strength, the rendering mix should be 1 part cement to 4 parts sand by volume (1:4.5 by mass) and applied to a total thickness not greater than 13 mm.

6.3.2.4 Mixed backgrounds

Where tiling is continuous across backgrounds of varying types, their differential movements could induce cracking; this risk should be avoided by incorporating a movement joint in such positions (see 6.5).

6.3.2.5 Backgrounds subject to dampness

NOTE Where backgrounds can become damp, e.g. by absorption of water through an external wall surface, any soluble salts in them dissolve. If the resultant solution is able to evaporate via the tiled face, the dissolved salts can be deposited at an interface such as that between background and rendering and could give rise to a stress great enough to cause adhesion failure.

Where soluble salts in the background are sulfates, there is the additional possibility that these might react with the cement of any cement:sand rendering to form the mineral ettringite. The formation of this mineral is accompanied by expansion, and this again can lead to stresses great enough to cause adhesion failure. Sulfate-resisting cements resist this particular form of chemical attack but have no greater resistance than any other cement to the physical action of deposited salts referred to above.

Water should be permanently excluded from the background, this practice being more effective than the use of sulfate-resisting cements, since it minimizes the possibility not only of sulfate attack, but also of salt deposition.

6.3.3 Thickness and trueness of rendering

The trueness required of a rendered finish depends upon the method of tile fixing used (i.e. into a mortar or adhesive bed); for bedding in adhesive, a greater accuracy is needed and in these circumstances the trueness of the surface of the rendering should be such that it does not deviate by more than 3 mm in any 2 m. For bedding in cement:sand mortar, the trueness of the surface should not deviate more than 6 mm (see 7.2.3.2).

The thickness and number of render coats needed is governed by the trueness necessary in the rendered finish and also by the trueness of the background being rendered; rendering should not have a total thickness in excess of 20 mm, as any application thicker than 20 mm results in unduly high shrinkage stresses.

NOTE 1 Backgrounds which are built to the accuracies recommended in Tables 2 and 3 of BS 8000-3:2001 might not be able to be rendered plumb or to line unless sufficient thickness of render is used.

NOTE 2 No tolerance can be imposed for rendering less than 12 mm thick because the rendering closely follows the contour of the background.

Nominal 12 mm thick render can only overcome minor irregularities or small deviations from line of the background; provided the background is constructed to within the tolerance required in the final render surface, and that permanent grounds and linings are fixed to a true line, then the final render surface should not deviate by more than 3 mm in any consecutive 2 m when a straightedge is placed against it (note that the final surface might not be plumb).

Render up to 20 mm thick can overcome backgrounds which are constructed to larger tolerances, but still within the limits permitted by Tables 2 and 3 of BS 8000-3:2001; such render surfaces should not deviate by more than 3 mm in any 2 m.

Where suspended ceiling systems (non-plastered type) are installed, permanent timber grounds should be fixed above the finished level of the suspended ceiling to ensure that the interface of the ceiling and tiled wall presents a reasonable line.

Ideally, render coats should be approximately 12 mm thick, but they might vary slightly in thickness in order to accommodate slight variations in the trueness of the background. Render coats should not be less than 8 mm nor more than 12 mm thick, except in localized areas where the maximum can be 16 mm.

If two coats of render are needed, the first coat should be combed before it hardens to provide a key for the following coat. The first coat should be allowed to harden and dry out to permit shrinkage to take place before the second coat is applied. The second coat should not be richer than the first and should be less thick. If the tile bed is cement:sand mortar, the final coat should be lightly combed but if an adhesive is to be used the surface should have a wood float finish.

NOTE 3 The comb used for this purpose usually consists of a wooden handle with metal teeth approximately 20 mm apart and is used to create wavy horizontal furrows approximately 5 mm deep.

6.4 Plastering

6.4.1 General

Plasterwork should be carried out in accordance with the recommendations given in BS EN 13914-2:2005+A1.

The plasterwork should be firmly bonded to its background and be sufficiently strong to support the specified tiling. The maximum weight of tiling which should be supported by a dry, firmly adhered plaster background is 20 kg/m², generally equivalent to ceramic tiles with a thickness of 8 mm or natural stone tiles with a thickness of 7 mm.

Before tiling work begins, the plasterwork should be checked for evidence of complete adhesion to its background. The surface should be examined for potential weakness, especially decaying and loose areas behind the surface of old plaster. Defective areas should be cut out and made good and sufficient time allowed for any new plaster involved in the remedial work to dry out thoroughly before tiling is applied. It is essential that there is a good bond between the plaster backing coat and the plaster finish coat. Tiles should be fixed only to the finish coat and should not be fixed directly to the backing coat. New plasterwork should have been completed at least four weeks previously and should be dry throughout before tiling commences.

Excessive trowelling of the plaster should be discouraged, since this practice can result in a dusty surface that is unsatisfactory for tiling and it could also create a denser finish than normal, thus reducing suction. Before commencing tiling, the dry plaster surface should always be brushed down with a stiff brush; the use of a fine wire brush is recommended on a water flashed surface, so that any weakly adhered residues are effectively removed.

NOTE Plaster is not a satisfactory background for tiling in continuously damp areas, e.g. shower compartments.

6.4.2 Plastering systems for various backgrounds

The plastering systems that should be used for various backgrounds are given in BS 8481, in which the characteristics of and mixes for plaster final coats and undercoats are detailed.

6.4.3 Thickness and trueness of the plaster surface

Since an adhesive bed not greater than 3 mm should always be used for fixing tiles to plaster, the trueness of the surface should be such that, when checked with a 2 m straightedge, any gap under the straightedge between points of contact does not exceed 3 mm. Where the gap exceeds 3 mm, local correction of the background should be made; this also applies to backgrounds not built accurately to a specified plane, e.g. not upright.

NOTE The thickness and number of coats of plaster necessary to enable a flat, true and uniform surface to be obtained depends on the evenness in level and the suction of the background. Guidance on the plaster thickness required for backgrounds of different flatness tolerance and the trueness that can be expected of the plaster surface is given in 6.3.3.

6.5 Movement joints

6.5.1 General

Consideration should be given at the design stage to the provision of movement joints; the type and location of movement joints involve considerations of construction materials, bedding systems, anticipated temperature and humidity conditions, areas concerned and the setting out of the tiling.

NOTE Stresses occur in the tiled installation as a result of background movement due to such factors as drying shrinkage and moisture and thermal changes. These stresses can sometimes cause loss of adhesion, bulging or cracking of the tiling, but can be localized by incorporating movement joints.

Where the background is mature and stable, e.g. existing rendering or plaster, the movement joints in the tiling, which are not to be confused with structural movement joints, might need to extend only through the tiling and its bed, and should be a minimum of 6 mm wide.

Materials for movement joints should conform to 5.9.

6.5.2 Location

Movement joints should be located in the tiled installation to coincide and be continuous with all existing structural movement joints, although they are actually formed as separate joints isolated by suitable thicknesses of back-up material.

The movement joints should be able to accommodate expected movement and when detailing the location of movement joints in tiling, the designer normally specifies that they are positioned in the following locations.

- a) Over existing and/or structural movement joints.
- b) Where tiling abuts other materials;
- c) Where tiling is continuous across junctions of different background materials.
- d) In large tiled areas, at internal vertical corners and at 3 m to 4.5 m centres horizontally and vertically.
- e) Where stresses are likely to be concentrated, for example at changes of alignment.

Where large degrees of thermal movement or vibration are expected, the frequency of movement joints should be increased to accommodate the movement.

Movement joints in the tiling should be of a suitable width to permit the sealant to accommodate the expected structural movement.

Conversely, in small tiled areas in normal conditions, intermediate joints should not be necessary on walls up to 6 m long provided the background is strong and dimensionally stable, there is adequate compressible joint width around each tile and movement joints are included at internal angles.

6.5.3 Back-up materials

From both functional and economic standpoints, the joint should be partially filled the joint with a compressible back-up material before topping up the joint to the final level with sealant.

NOTE 1 Sealants perform best when they are bonded only to the opposing faces of the joint, allowing the sealant to stretch or compress freely when subjected to movement. If the sealant is bonded to a third surface at the back of the joint, this inhibits movement accommodation and increase the stress on the joint and the likelihood of sealant failure.

The compressible back-up material should be a material to which the sealant can not adhere, or one which might be covered with a bondbreaker tape to prevent adhesion; where there is insufficient depth in the joint to accommodate a compressible back-up material, a bondbreaker tape at the bottom of the joint improves performance.

The back-up material in the lower part of the joint should be compatible with the sealant used, should recover after compression and should support the sealant. It should not exude bituminous or oily products and should not absorb excessive amounts of moisture. In particular, its compressibility should be such that when the joint closes the sealant is not forced out.

NOTE 2 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.

The back-up material should be placed so that it allows the application of an adequate depth of sealant into the joint to perform satisfactorily; the minimum depth should be 6 mm.

6.5.4 Sealant installation

The sealant manufacturers' advice should be taken into account as the properties of individual sealants vary. Generally, a sealant should be capable of accommodating the anticipated amount of movement without loss of adhesion to the sides of the joints and be able to withstand the normal service conditions affecting the installation, e.g. resistant to water, damage from cleaning processes.

NOTE Where movement is large and frequent, elastomeric sealants such as silicones and polyurethanes are most suitable; however, where movement is large but infrequent, polysulfide sealants can give better results.

In most cases, the sealant should not be applied until the joint spaces are thoroughly clean and dry, but special sealants are available which can be applied under wet conditions. Preferably, joints awaiting sealing should be protected from the ingress of foreign matter by being covered, e.g. by an adhesive tape or batten, but when moisture or solvents are present in the bed or the background, the joints should be left exposed until all moisture has dried out and any solvents have evaporated. Joint spaces left open and uncovered might collect deleterious matter and should be thoroughly cleaned before sealing.

If the sealing of the joints is carried out by a specialist, tiling contractors should be made aware of any requirements in the instructions for applying the sealant that affect their operations: particular care is necessary to avoid contamination of the joint.

6.6 Coloured grouts

When deciding whether or not to apply coloured grouts to tiles which are liable to retain particles of coloured material, the potential risk of staining should be checked, at the design stage, by applying the grout to a few tiles; in any doubtful case, this would enable an alternative grouting procedure to be adopted, or, alternatively, the use of a proprietary tile sealer could be considered.

Proprietary tile sealers should be used strictly in accordance with the manufacturer's instructions and should be applied before grouting is carried out to provide a protective coating that can readily be removed after completion of grouting.

Tile sealers developed for ceramic tiles might not be suitable for all applications and the manufacturer's advice should always be sought.

7 Application of tiles: methods and materials

7.1 General

7.1.1 Bedding materials

Bedding materials that should be used are:

- a) cementitious adhesives, classified C as in BS EN 12004:2007 (see 7.2.1);
- b) dispersion adhesives, classified D as in BS EN 12004:2007 (see 7.2.2);
- c) reaction resin adhesives, classified R as in BS EN 12004:2007 (see 7.2.2); or
- d) cement: sand mortar (see 7.2.3).

The backgrounds to which each system is suited are listed in 7.1.1 to 7.1.5 and summarized in Table 3.

For fixing tiles with smooth or shallow keyed (or ribbed) backs, materials a), b) and c) should be used. For fixing tiles with deep keys, adhesives which can be used at bed thicknesses up to 6 mm and more or a cement:sand mortar should be used, provided they are compatible with the background.

7.1.2 Workmanship

The application of wall tiling demands efficient supervision and the employment of skilled operatives working safely using protective clothing and equipment where appropriate; workmanship should comply with BS 8000-11.1 for ceramic tiles and mosaics and BS 8000-11.2 for natural stone tiles.

7.1.3 Compatibility of backgrounds and tile beds

NOTE 1 In Clause 7, the term “backgrounds” is used to mean the surfaces intended to receive the bed directly. These could be the surfaces of structural walls or the surfaces of applied materials such as rendering, plastering, sheets, boards and existing tiles.

Clause 6 should be consulted for the treatment of base surfaces to produce backgrounds conditioned to receive tiling.

NOTE 2 In 7.2.1.2, 7.2.2.2 and 7.2.3.2, additional information is given that could be specific to a bedding method; in particular the acceptable maximum surface unevenness in the background is stated for each bedding method.

When specifying the treatment of base surfaces in accordance with Clause 6, it should be stated down that these maxima are not exceeded.

Preparatory work in the formation of backgrounds that fails to meet the recommendations of this British Standard should be corrected before tiling is commenced. Sufficient additional time should be allowed for curing, commensurate with the extent of making good, before using the chosen bedding system.

Gypsum plaster surfaces which are dusty, should be primed. The primer should be compatible with the adhesive and should be applied in accordance with the manufacturer’s instructions.

7.1.4 Setting out

It is important for the appearance of the finished wall tiling that unsightly cut tiles are avoided and that joints are of a uniform width, true to line, continuous and without steps: allowance should be made for an adequate width of joint (see **7.2.1.6**). Cut courses, both vertical and horizontal, should be:

- a) kept to a minimum;
- b) determined in advance;
- c) as large as possible; and
- d) arranged in the least prominent of alternative locations.

NOTE The ideal is to establish a vertical centre line in each wall area on which either a joint or a tile centre resides, the centre line being struck between assessed finished surfaces.

Where wall surfaces are interrupted by features, e.g. windows, access panels or sanitary fittings, the tile fixer should seek guidance from the designer as to the setting out to be adopted; similar guidance might be required in the positioning of movement joints, since they are predominant and could determine the setting out pattern.

Horizontal joints and cut courses should be positioned depending on several factors, of which the following are examples.

- 1) Tiled areas that adjoin or are adjacent should be set out so that horizontal joints are aligned.
- 2) The upper and/or lower extremities of a wall might not be level, requiring a course or courses to be cut with a raking edge. Wherever possible the horizontal joints should be positioned so that the whole of the rake can be taken up within the height of the tile in the cut course.

- 3) If it is thought desirable to align a joint with a feature, this becomes the setting out point and might initiate the need for, and frequently dictate the location of, cut courses elsewhere.
- 4) To ensure that rows of tiles are truly horizontal, a level line should be established to position the starting course. This level line should be continuous across all tiles surfaces.

7.1.5 Movement joints

Provision should be made to incorporate movement joints in appropriate positions when setting out the tiling (see 6.5).

All joints should be rectangular in section, with firm, straight, smooth edges free from cavities and irregularities. The width:depth ratios and dimensions of the sealant profile in a joint should accord with the recommendations of the sealant manufacturer.

When forming the joints, it is useful to insert a temporary filler strip that can be removed when the tiling is sufficiently firm; the filler strip can be wrapped in polyethylene film to ensure smooth, clean joint faces and to assist in its removal: care should be taken to avoid grout and other materials becoming trapped in the joint cavity that prevent proper application of the back-up and sealant and might prevent movement of the joint, resulting in damage or displacement.

7.1.6 Preparation of the tiles

Although tiles should be dry for bedding methods, occasionally, ceramic tiles are fixed in cement:sand mortar and might need to be soaked prior to fixing. The need for soaking should be checked, as neglect of this is almost certain to lead to adhesion failures (see 7.2.3.3).

7.1.7 Inspection

Before fixing commences, any significant shade or colour variations between tiles, particularly if not intended, should be confirmed as acceptable to the designer. Variegated tiles should be thoroughly mixed by selecting from a number of boxes as fixing proceeds.

7.1.8 Mixing of the tile bed materials

When a proprietary adhesive is used as the tile bed, strict attention should be paid to the manufacturer's instructions. Tiles should be dry; general guidance is given in 7.2.

NOTE It is not practicable to give similarly precise instructions concerning cement:sand mortar beds. The properties of sand depend upon its source and influence in particular, the quantity of water to be added to the mortar batch in order to give it a desired consistency. Thus, the sand has to be selected with care to obtain optimum performance from the cement:sand mortar. Correct water content is vital in minimizing the drying shrinkage of the mortar and thus any tendency towards adhesion failures.

7.1.9 Tolerances

7.1.9.1 Finished tile surfaces

The surface should be true such that, when checked with a 2 m straightedge with 3 mm thick feet at each end, the straightedge should not be obstructed by the tiles and no gap should be greater than 6 mm.

There are permissible manufacturing tolerances for ceramic tiles defined in BS EN 14411; certain types of tiles, e.g. extruded or large format, might have permissible surface flatness irregularities that cannot satisfactorily be accommodated within the surface flatness tolerance permitted to the tile installer; this should be taken into account when evaluating the achievable flatness of a wall floor tiling installation.

NOTE Where adhesives are used, this degree of accuracy can be achieved only when the background surface is equally true.

7.1.9.2 Across joints

There should be no appreciable difference in level across joints (commonly called "lippings") and the maximum deviation between tile surfaces either side of a joint, including movement joints, should be as follows.

- a) Joints less than 6 mm wide, 1 mm.
- b) Joints 6 mm or more wide, 2 mm.

7.1.10 Lighting

The type, direction and intensity of lighting at the time of tile fixing should not be appreciably different from the ultimate permanent lighting.

NOTE Within the tolerance determined for the overall plane, there could be minute differences of plane between adjacent tiles that can be rendered visually insignificant in the ambient lighting by adjustments of the tiles during fixing. If the finished tiling is subsequently exposed to lighting from a different source, its appearance might be affected and no adjustments can then be made to the tiles to meet the changed circumstances.

7.2 Bedding methods

7.2.1 Bedding in cement-based adhesives (Type C)

7.2.1.1 General

The method to be adopted for fixing tiles varies according to the type of background, the nature of the adhesive and the anticipated conditions to which the installation is subjected in service; the methods should be selected as described in 7.2.1.3 to 7.2.1.7, which are those usually adopted with this group of adhesives, but there are many products available and some variations in fixing procedures exist. Therefore, the precise recommendations of the adhesive

manufacturers should be followed concerning, for example, the type of trowel, the mixing procedure, the working time after spreading and the suitability of the background.

Cement-based adhesives should be chosen to avoid staining appearing on natural stone tiles. A polymer additive might be necessary in the adhesive for tiles of low water absorption.

7.2.1.2 Backgrounds

Cement-based adhesives are suitable for use on mature rendered surfaces, concrete and brickwork, but should not be used directly onto surfaces such as plaster, wood, metal and glazed surfaces such as existing tiling, unless their adhesive properties have been altered/improved by the inclusion of polymer additives; a summary of backgrounds and their treatment is given in Table 3.

The background should be dry and the surface should not be dampened before applying the adhesive.

The trueness of the background surface needed for adhesive beds should be in accordance with 7.1.9.1. Where the gap exceeds 3 mm, local correction of the background by dubbing out up to 6 mm thick can sometimes be conducted using the same adhesive, but advice on this should be sought from the manufacturer of the adhesive.

The preparation of various backgrounds to receive cement-based adhesives and the precautions that should be adopted in each instance are described in Clause 6 (see also 7.1.3).

NOTE Some cement-based adhesives have been specially formulated for use on suitably primed gypsum plaster. As with all plaster backgrounds, success is very dependent on the plaster being sufficiently strong and dry throughout.

7.2.1.3 Preparation of tiles

Tiles should be fixed dry, they should not be soaked.

7.2.1.4 Mixing of the adhesives

Cement-based adhesives should be mixed with clean water as recommended by the manufacturer to obtain the desired consistency.

The open time of the mix and the working time is defined by the manufacturer and these time limits should be strictly observed.

7.2.1.5 Application of adhesive and tiles

7.2.1.5.1 Notched trowelling method

Adhesives should be applied to the background with a trowel as a floated coat, the adhesive should be pressed into the surface, and combed through with a suitably designed notched trowel of the type recommended by the adhesive manufacturer: this gives a series of ribs into which the dry tiles should be pressed with a twisting or sliding action; this operation has to be carried out correctly to ensure that the adhesive wets the back of the tile and achieves an area of contact of at least 50%, spread evenly over the back of the tile.

☐ Whatever type of trowel is used, it should apply the adhesive in a manner such that the finished bed thickness is no greater than that recommended by the manufacturer and that maximum practical contact between tile and adhesive is achieved.

The period of time during which tiles can be adequately bedded after spreading the adhesive is approximately 20 min but this varies according to the prevailing atmospheric conditions. It is important that more adhesive should not be spread on the wall than can be covered with tiles within the open time. ☐

NOTE 1 The amount of adhesive used and the height of the ribs obtained are governed by the angle at which the trowel is held against the surface. The amount of contact is also dependent on the twisting or sliding of the tiles as they are pressed onto the ribs of adhesive.

NOTE 2 It is good practice to remove a tile occasionally as fixing proceeds to check that adequate contact and wetting is being maintained with the adhesive.

7.2.1.5.2 Buttering method

The buttering method can be used for occasional awkward tiling positions, e.g. around openings and restricted areas where a notched trowel cannot be used; where this technique has to be adopted, the adhesive should be spread evenly over the whole of the back of each dry tile with a trowel. The bed thickness should be slightly greater than the final thickness required so that when each tile is pressed or tapped firmly into position the correct thickness is achieved. The thickness should not be greater than the maximum recommended by the manufacturer of the adhesive. Care should be taken to ensure that as far as possible no voids are left behind the tiles.

7.2.1.5.3 Notched trowelling and buttering method

The notched trowelling and buttering method combines 7.2.1.5.1 and 7.2.1.5.2 and should be used for fixing large tiles (3.4) and tiles with ribbed, deep keyed or heavy buttoned back profiles. A thin coating of adhesive buttered over the backs should fill the deep keys before placing the tiles in position on the combed adhesive bed. There should be no significant increase in the bed thickness.

NOTE This bedding method aims to achieve a solid bed but, in practice, a number of small voids are inevitable.

7.2.1.6 Tile joints

Tiles should never be fixed with butt-joints, as an adequate width of joint is necessary for the relief of any local stress. Joints of approximately 1 mm to 2 mm should be left around every tile by inserting spacing pegs of suitable thickness between the tiles as fixing proceeds. If for design reasons wider joints are required, the same technique should be adopted.

Joint widths should be consistent throughout the installation unless specified otherwise (see also 7.1.4).

Any surplus bedding material remaining on the surface of the tiles or in the joint spaces should be removed before it hardens, in readiness for grouting (see 7.3).

7.2.2 Bedding in organic-based adhesives (Type D or R)

7.2.2.1 General

Bedding methods are similar to those given for cement-based adhesives but there are some variations in fixing procedures; the precise recommendations of the adhesive manufacturers should be followed concerning, for example, the type of trowel, the mixing procedure, the working time after spreading and the suitability of the background.

7.2.2.2 Backgrounds

COMMENTARY ON 7.2.2.2

Organic-based adhesives are available for use on mature cement-rendered surfaces, concrete, brickwork, plaster surfaces, various sheets and boards, metal surfaces, painted surfaces, and existing tile and glazed brick surfaces; a summary of backgrounds and their treatment and suitability for organic-based adhesives is given in Table 3.

The background should be dry and the surface should not be dampened before applying the adhesive.

Subclause 6.2.4.1 should be consulted for the trueness required of the background surface and any necessary treatment.

The preparation of various backgrounds to receive organic-based adhesives and the precautions that should be adopted in each instance are described in Clause 6 (see also 7.1.3).

7.2.2.3 Preparation of tiles

Tiles should be fixed dry; they should not be soaked.

7.2.2.4 Preparation of the adhesive

Most organic-based adhesives are supplied ready for use; some require prior mixture of powder and liquid components and the manufacturer's instructions should be followed in every case.

7.2.2.5 Application of adhesive and tiles

Application of organic-based adhesives should be by similar methods to those described for cement-based adhesives, as described in 7.2.1.5.1, 7.2.1.5.2 and 7.2.1.5.3.

7.2.2.6 Tile joints

Subclause 7.2.1.7 should be consulted for recommendations on tile joints.

7.2.3 Bedding in cement: sand mortar

7.2.3.1 General

This method of fixing should only be used for extruded tiles which still have very coarse manufacturing ribs, as the bond strength of this mortar is generally less than that of adhesives; advice on the selection and storage of suitable cement and sand is given in Clause 5, mixing and application are dealt with in 7.2.3.4 and 7.2.3.5.

7.2.3.2 Backgrounds

Backgrounds suitable to receive tiling fixed by cement: sand mortar over a rendered or non-rendered surface should be rigid, provide an adequate key as well as suitable suction and whose movements, subsequent to tiling, is sufficiently low as not to affect the applied finish.

Cement-rendered surfaces should have been applied at least 3 weeks before tiling is commenced (see 6.3.1).

Dry background surfaces should be wetted just sufficiently to prevent excessive absorption of water from the mortar bed.

The trueness of the background should be such that, when checked with a 2 m straightedge, any gap under the straightedge does not exceed 6 mm.

The preparation of various backgrounds to receive a cement: sand mortar bed and the precautions that should be adopted in each instance are described in Clause 6 (see also 7.1.3); a summary of backgrounds and their treatment is given in Table 3.

7.2.3.3 Preparation of porous tiles

To prevent rapid suction and subsequent failure to bond with the mortar bed, porous tiles should be soaked before fixing. Tiles should be removed from their cartons and completely immersed in clean water for at least 30 min. After soaking, they should be stacked tightly together, with the end tiles face outwards, on a clean surface and allowed to drain. Tiles classified in BS EN 14411:2006 in groups IIb and III require this saturation treatment; soaking of tiles of groups Ia, Ib and IIa is unnecessary (see Table 1).

7.2.3.4 Mix: materials, proportions and method

Cement: sand mortars should be adequately cohesive and water retentive but should be neither richer than 1:3 nor leaner than 1:4 cement:sand by volume (1:3.4 to 1:4.5 by mass). Within these limits, the choice of the precise proportions should be governed by the need to produce a mortar of the required properties with the minimum water content (see 7.2.1.4). If the sand is damp, due allowance should be made.

Care should be taken that the use of admixtures such as plasticizers, waterproofers, fungicides, etc., does not adversely influence the adhesion strength, contraction or expansion of the mortar.

Once the proportions are established, every attempt should be made to minimize random variations. Materials should be weight batched wherever possible and water addition controlled.

Where weight batching is impracticable, mortar batches should be based on multiples of a whole bag of cement (50 kg, approximating to 0.035 m³ or 35 L). In such cases, the sand and water should be measured by volume using correctly-made gauge boxes or other suitable containers of fixed, measurable volume; this method allows water addition to be checked and thus permits appropriate mix proportions to be established and maintained.

Batching by the shovelful should never be allowed as it eliminates any possibility of establishing and controlling mix proportions.

Wherever it is practicable, mixing of mortars should be by machine and preferably of the forced action type. Subjective estimations of consistency should preferably be supplemented with quantitative measurements (as described in BS 4551) when establishing or controlling mix proportions; it is recognized, however, that it is not always be practicable to adopt these recommendations, particularly in the cases of small tiling operations and work in restricted surroundings.

NOTE BS 4551 warns that, where samples of the cement and aggregate used are not available, the analysis of the mortar might lead to inaccurate assessment of the mix proportions and that the use of assumed data can give results which could be at variance with the true mix proportions.

When mixing by machine is not possible, mortars can be mixed on a clean non-absorbent surface using clean hand tools; whatever method of mixing is used, the materials should be thoroughly blended in the dry state before water is added. Mixing should be continued until the batch has a uniform consistency.

No water should be added once mixing is complete. Any mortar unused within 2 h of adding the mixing water should be discarded.

7.2.3.5 Application of cement: sand mortar and tiles

7.2.3.5.1 Floating and back filling method

The mix as described in 7.2.3.4 should be floated on to the background by trowelling to a thickness not exceeding 10 mm and finished with a wooden float. The bed should be allowed to stiffen slightly before any tiles are applied to assist it in supporting the added weight.

A mix of one part cement and one part fine sand by volume, the sand conforming to the grading limits given in Table 2, should be prepared including sufficient water to produce a mortar capable of being trowelled thinly (1 mm to 2 mm) as a bonding coat. This should be trowelled over the backs of the tiles before they are placed in position on the floated bed and tapped back firmly. Care should be taken to ensure that tiles having deep keys, ribs or heavy buttoned

back profiles are filled with the 1:1 cement:sand mortar before they are placed in position on the floated wall.

NOTE All cement:sand bedding systems aim to achieve a solid bed, but in practice, a number of small voids are inevitable.

7.2.3.5.2 Buttering method

The buttering method should only be used for small areas of tiling or in situations where it would be impracticable to “float” the walls.

Tiles should be evenly buttered with the cement:sand mix and tapped back firmly into position in order to ensure that as far as possible the bedding is solid over the whole of the backs of the tiles, including the corners; it is not sufficient just to place the tiles on the wall. Deep keys or frogs in the backs of tiles should be filled with the bed mix when buttering. The resultant thickness of the bed behind the tiles should generally be 6 mm and in no circumstances should it be more than 12 mm; the depth of mortar in keys or frogs are additional to these thicknesses.

The method should not be used to fix thin tiles (less than 5.5 mm thick) due to the risk of cracking.

7.2.3.5.3 Finish

A straightedge should be used to ensure that the surface of the tiling is flat and true as stated in 7.1.9. Any adjustment of tiles should be made within 10 min of fixing.

The tiling should be cleaned down using a damp cloth before any mortar begins to harden on the surface or in the joint spaces, care being taken to avoid disturbance of the tiles during the setting of the bedding.

7.2.3.6 Tile joints

Subclause 7.2.1.7 should be consulted for recommendations on tile joints.

7.3 Tile joint treatment

7.3.1 General

NOTE The selection of tile joint treatment depends upon the joint widths and the functional requirements of the installation. A wide range of grouts is available (see 5.10) for filling the joints between tiles. The methods for using these products to fill the joint spaces between tiles, other than movement joint spaces (which require different and special treatment), are described in 7.3.2, 7.3.3 and 7.3.4.

When using proprietary grouts, the joint cavities should not usually be wetted, particularly where fixing is being carried out with adhesives, due to the possible adverse effect of water on the bed whilst this is setting behind the tiles. When grouting with cement:sand mortar, however, there should be dampness in the joint cavities and if, in the interval between the completion of tile fixing and the start of grouting, the cavities have dried out, they should be re-wetted.

Care should be taken when grouting glazed tiling to avoid damage to the surface. In the case of tiles faced with soft glazes, trims or appliances which might easily be scratched, the glaze or surface adjacent to the joints should be protected with masking tape; hard plastic scrapers used as grouting tools are a frequent cause of glaze scratching.

NOTE Further advice is also given in Technical Advice Note 3 Grouting high gloss glazed wall tiles [5] on this subject.

7.3.2 Grouting procedure for joints up to 3 mm wide

Grouting of the joints can be carried out at any time to suit the convenience of the work, although it is essential to allow sufficient time to elapse to ensure adequate setting of the bed to avoid disturbance of the finish during the grouting operation. However, grouting should not be delayed unduly, as the open joints might collect general building dust and deleterious material.

Proprietary grouts should be mixed and applied strictly in accordance with the manufacturer's instructions.

The usual procedure is to apply the grout to as large an area as can be worked before hardening commences (this being dependent on climatic conditions); the grout should be applied with a rubber squeegee or grouting trowel, working back and forth over the area until the joints are completely filled. Surplus grout should be removed from the tiles with the aid of a rubber squeegee or grouting trowel and a damp, not wet, cloth. The joints should then be tooled (if appropriate) with a piece of wood or other material of suitable size and shape. After the grout has dried, the tile surface should be given a final polish using a clean, dry cloth.

7.3.3 Wide joint filling

Proprietary jointing mortars are recommended for wide joint filling and should be prepared and applied strictly in accordance with the manufacturer's instructions.

Where mortar is used for wide joint filling it should be a stiff, slump free mix consisting of one part cement and three parts sand mixed with the minimum of water necessary to achieve workability.

Admixtures can also be incorporated (see 5.10.3).

The consistency of the jointing mortar should be such that no slumping of the mortar occurs during setting. The wider the joints the greater should be the stiffness of the mix.

Joints should be well filled and their surface should be even.

Using a rubber float or similar tool, the mortar should be applied over the surface of the finished work to as large an area as can be worked before hardening commences.

Surplus mortar should be cleaned off the face of the work with a rubber squeegee, which also helps to ensure that all joints are filled. The joints should then be tooled with a piece of wood or other material of suitable size and shape, after which the work should be carefully washed down and, when dry, polished with a clean, dry cloth.

7.3.4 Application of coloured grout

Where coloured grouts are required, it is advisable to check the potential risk of staining by applying the grout to a few tiles in a small trial area; in any doubtful case, this should enable an alternative grouting procedure to be adopted, or, alternatively, the use of a proprietary tile sealer might be considered; note, however, tile sealers developed for ceramic tiles might not be suitable for natural stone tiles. Proprietary tile sealers should be used strictly in accordance with the manufacturer's instructions and should be applied before grouting is carried out to provide a protective coating that can readily be removed after completion of grouting. Care should be taken to avoid excess sealer entering the tile joints and affecting grout adhesion.

For colouring cement:sand grout, the pigment should be thoroughly mixed with the dry cement before this is added to the mix in order to obtain the best staining power and homogeneity; alternatively, coloured cement can be used as supplied by the manufacturer. In the case of proprietary grout, pigments can be incorporated at source by the grout manufacturer, or subsequently by the user on site, in which case the instructions of the pigment manufacturer should be followed.

NOTE Mineral or organic pigments can be incorporated in cement-based or epoxide resin-based proprietary grout compositions, usually in amounts of up to 5% by mass, depending on the shade required. With most tiles, no problems arise, provided surplus coloured grout is cleaned off promptly in accordance with the manufacturer's instructions. However, coloured grouts might prove more difficult to remove from matt glazed tiles, tiles with textured surfaces and some unglazed tiles and, in general, grouts containing finer-grained pigments are likely to prove more troublesome in this respect than those containing coarser-grained pigments.

Many natural stone walling products can have a high water absorption at the surface; a grout with a similar colour to the natural stone being grouted should be used. Any excess grout should be cleaned off quickly and effectively as work proceeds.

The use of ordinary Portland cement in grouts should be avoided where possible with white or light coloured natural stone materials. In such instances, a white cement should be used instead.

The use of impregnators prior to grouting can reduce the likelihood of picture frame staining; with more absorbent natural stones, it might be necessary to flood grout the entire surface to ensure an even finish, however this should only be carried out in accordance with the manufacturers/suppliers recommendation.

Epoxide resin grouting products should never be used with natural stone materials as such grouts tend to be too rigid and unable to withstand with any differential movement in the surface finish.

Before selecting a particular grout for a natural stone, advice about its suitability should be obtained from the supplier/manufacturer.

8 Application of mosaics: methods and materials

8.1 General

8.1.1 Modifications

NOTE The description of mosaics is given in 5.2.4.

The recommendations for the application of tiles, including suitable backgrounds and movement joints, given in Clause 7 are of equal importance to the success of mosaic installations, but some modification is necessary concerning the setting out, preparation, placing in position and grouting of mosaics; it is recommended that if (in the absence of experience) there is doubt as to the suitability of a bedding method for a particular kind of mosaic, advice should be sought from the adhesive manufacturer, or fixing specialist.

8.1.2 Workmanship

The application of mosaics requires efficient supervision and the employment of skilled operatives working safely, using protective clothing and equipment where appropriate: in the finished work, the outline of the sheets of mosaic should not be apparent; the joints between them being the same as those between the tesserae (joints within the mosaic sheets are determined in manufacture and are usually less than 3 mm wide).

8.1.3 Tolerance for finished mosaic surfaces

Unless an uneven surface is specified or the tesserae are made with irregular or distorted faces, there should be no significant visible change of plane between adjacent tesserae. Surface tolerances should conform to 7.1.9.1.

8.1.4 Mosaic beds

The beds that should be used for mosaics are:

- a) cement-based adhesive: thin-bed (see 7.2.1);
- b) organic-based adhesives: thin-bed (see 7.2.2); and
- c) cement:sand mortar (see 7.2.3).

NOTE If the background surface to receive the bed and mosaic is not flat and true, the use of adhesive fixing methods can be precluded.

Cement:sand mortar beds should only be used with paper-faced mosaics as these beds require the mosaics to be pre-grouted (see 8.5.1); the pre-grouting of mesh-backed mosaics is not recommended as it is not practical, because the mesh might distort or disintegrate.

8.2 Setting out

Drawings provided for designs and murals should be checked before any fixing commences.

The setting out of the finished work should be controlled from a given datum. To ensure the rows of tesserae are truly horizontal, a level line should be established to position the starting row of sheets.

A gauge rod should be made indicating the overall measurement of a given number of sheets of mosaic with the specified joint widths. Using this rod, the best arrangement of sheets should be determined so that, as far as possible, uncut tesserae occur at external corners and prominent features, and cut tesserae are located at internal corners where they are less noticeable.

The work should be planned to start fixing at the top of the area to be covered (see 8.5.2).

NOTE Any attempt to minimize cutting of the tesserae by adjusting joint widths where the bedding has partly set could break the bond between the tesserae and the bedding. This condition could arise if a long interval has elapsed between the fixing and the removal of any paper facing.

8.3 Preparation of mosaics

All mosaics should be inspected and damaged tesserae removed and replaced. Designs and murals should be laid out prior to fixing.

The paper of paper-faced mosaics should be clear of the edges to assist with joint alignment while the sheets are being fixed.

8.4 Bedding methods for mosaics

8.4.1 Bedding in adhesives: thin-bed

Both cement-based and organic-based adhesives are suitable and the information given in 7.2.1 and 7.2.2 is relevant; the precise recommendations of the adhesive manufacturer should be followed concerning the suitability of the background, the mixing procedure, the method of use, the thickness of adhesive and the open time after spreading.

8.4.2 Bedding in cement:sand mortar

The mortar mix should be as given in 7.2.3.4 and applied using the technique described in 7.2.3.5.1 onto the prepared background and finished with a wood float. The bed should be allowed to stiffen slightly before any mosaic is applied but should not be left more than 2 h before fixing commences.

8.5 Application of mosaics

8.5.1 Pre-grouting

Ideally, paper-faced mosaics should be pre-grouted. It is not always practical to pre-grout mosaics bedded in adhesives, but paper-faced mosaics bedded in cement:sand mortar should always be pre-grouted with a neat cement grout.

Where the joints are wider than 2 mm, or the mosaic thickness is greater than 4 mm, fine sand should be mixed with the cement to

avoid cracking as the grout dries out; a suitable mix is 1:1 cement: sand by volume.

8.5.2 Sequence and method of fixing

Sheets of mosaic should be fixed in horizontal lines starting at the top. Each sheet should be hung in position as accurately as possible and tapped with a laying-on trowel, or wooden beater, so that full contact with the bedding is achieved.

Horizontal and vertical alignment should be checked as the work proceeds.

The joint width between the tesserae established when the mosaics were assembled should be maintained between the sheets, otherwise the overall appearance of the mosaic is marred by the outline of the sheets.

Sheets of mosaic that have been pre-grouted should have the joints between them filled with grout as the work proceeds.

A straightedge should be used to ensure that the surface of the mosaic is true, as stated in **8.1.3**.

After the sheets have been firmly tapped in place, any facing papers should be removed by soaking and sponging. Any necessary adjustment of tesserae or joints should then be carried out before the bedding sets.

Any surplus cement or adhesive remaining on the face of the mosaic should be removed before it sets.

8.5.3 Grouting of mosaics

NOTE The general information given in **7.3** for the treatment of tile joints is relevant.

With paper-faced mosaics, it is usual for the grouting to be of similar material in type and colour to that used for any pre-grouting; the grout should be rubbed over the surface to fill the joints either as the work proceeds, or when it is sufficiently firm, and then the surface should be given a preliminary cleaning.

After the grout has hardened sufficiently, the surface of the work should be washed over with water and left clean.

When a proprietary grouting material is used, the manufacturer's instructions for cleaning off should be followed.

8.6 Glass mosaics

The preferred method of fixing glass mosaics is on a thin-bed of adhesive and the recommendations of the adhesive manufacturer should be sought before fixing commences.

NOTE The colour of grouting and bedding material, when seen through translucent tesserae, affects the shade of the finished work.

Glass mosaics, if paper-faced, might need to be pre-grouted; suppliers' recommendations should be consulted.

If a cement:sand mortar is used, a bonding agent should be added to the pre-grouting mortar to ensure good adhesion of the glass tesserae.

9 Protection and cleaning

9.1 Protection

Wall tiling should be scheduled as late as is practically possible in the building programme in order to reduce the danger of damage and soiling by following trades, particularly in locations with high impact risks.

While tiles are being fixed and grouted, consideration should be given to the protection of work already completed by other tilers.

9.2 Cleaning

9.2.1 General

Adequate instructions from the specifier should be requested and provided to ensure that the use of incorrect cleaning materials is avoided. Advice about cleaning tiles and suitable cleaning materials should be available from the appropriate manufacturers. Personnel responsible for cleaning should be given full information concerning any particular risks or misuse likely to occur.

NOTE Further information is given in the document The cleaning of ceramic tiles [6] prepared by The Tile Association.

9.2.2 Glazed ceramic tiles

The routine cleaning of glazed ceramic wall tiles and mosaics should be carried out with warm water or a weak solution of soapless detergent followed by a final rinsing with clean water. Clean water and utensils should be used and are essential to avoid any dust or dirt (which might be on the face of the tiles) being deposited in the joints, with resulting discoloration of the grouting.

9.2.3 Unglazed ceramic tiles

Unglazed ceramic tiles might retain a cement film (which is insoluble in water) at the completion of the tiling work; this should be removed with suitable proprietary acidic cleaners developed for this purpose, used strictly in accordance with the manufacturer's instructions and then rinsed with clean water. Great care should be taken to avoid damage to adjacent walls, fittings and paintwork when using such cleaners.

Routine cleaning should be as for glazed tiles (see 9.2.2).

NOTE As a new installation dries out, unglazed ceramic tiles might also develop efflorescence which appears as a white bloom on the surface of the tiles. This diminishes and eventually disappears with repeated washing.

9.2.4 Natural stone tiles

Effective cleaning of natural stone tiles can usually be achieved by normal washing or scrubbing with warm water and a neutral sulfate-free detergent or a proprietary stone cleaner followed by a final rinsing with clean water; the use of harsh cleaning chemicals should be avoided where possible as these can harm the surface of the natural stone tile. With natural stone products containing carbonate minerals, e.g. marbles, travertines and limestones, acid based cleaners should be avoided as they can damage the surface. The use of commercial cleaning agents containing bleach should not be used to clean natural stone products either, as such alkaline products might discolour the surface of the stone.

Natural stone products might well require surface treatment to maintain the appearance in service and to resist staining from household commodities; the treatment used should be compatible with the natural stone product and the suitability confirmed by the supplier.

Annex A (informative) Ceramic tiles, mosaics and natural stone

Ceramic tiles are classified in BS EN 14411 and fall into two main categories according to their method of manufacture.

- *Extruded tiles (shaping A)*, whose body is shaped in the plastic state in an extruder and the resulting column cut into tiles of predetermined thicknesses.
- *Dry-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.

Ceramic tiles are further sub-divided according to their water absorption (see BS EN 14411); porcelain tiles are a form of ceramic that fall into the Bla category.

Ceramic tiles can be glazed, partly glazed, unglazed, polished, textured or profiled.

The range of sizes, thicknesses and accessories varies with individual manufacturers. The range is predominantly of square or rectangular shapes but other geometrical and decorative shapes are available.

Various tile edge shaping and finishes of tiles are manufactured as standard, e.g. square, rounded, cushioned and bevelled.

Some unglazed class Bla, Blb and Ala and Alb tiles are suitable for special edge profiling such as full round, half round or other decorative shaping, utilizing similar machinery and grinding equipment that is normally used for shaping natural stone tiles and slabs.

Mosaics can be glazed and unglazed ceramic, glass and natural stones. They are available in a variety of shapes and sizes. BS EN 14411 gives physical dimensions.

To facilitate handling, some mosaics are assembled as sheets, the individual tessera being adhered either face side down to paper (paper-faced mosaics) or bed side down to synthetic strips, dots or mesh.

Paper-faced or dot-mounted mosaics allow maximum contact with the bed, i.e., mortar or adhesive. When sheets are assembled using backing material, synthetic fabric is preferred, not natural fabric such as cotton or paper, as this becomes embedded in the mortar or adhesive.

Requirements for natural stone tiles are given in BS EN 12057; common stone types that are used for wall tiling fall into the following categories: granite, sandstone, quartzite, slate, limestone, marble, travertine.

Annex B (informative) **The special conditions included in BS 5385-4**

BS 5385-4 gives recommendations for the following for both wall and floor tiling:

Anti-static conditions.

Chemical attack.

Movement:

- drying shrinkage movement;
- moisture movement (wetting and drying);
- moisture movement (long-term expansion);
- thermal movement;
- vibration;
- movement joints.

Radioactivity.

Sound and thermal insulation.

Sterile conditions.

Thermal effects (climatic and environmental).

Traffic and load conditions:

- dynamic and static loading;
- impact;
- abrasion.

Wet and damp conditions:

- not immersed but subject to frequent contact;
- not immersed but subject to occasional wetting;
- high humidity areas.

Wet conditions (continuous immersion):

- internal swimming pools of concrete construction (excluding salt water pools);
- external swimming pools of concrete construction (excluding salt water pools);
- salt water pools, tanks and reservoirs of concrete construction;
- pools, tanks, and reservoirs of metal construction;
- tanks for aggressive liquids;
- tanks for liquids at elevated temperatures.

Cleaning and slip resistance.

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For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS 5385-3, *Wall and floor tiling – Part 3: Design and installation of internal and external ceramic and mosaic floor tiling in normal conditions – Code of practice*

BS 5385-5, *Code of practice for the design and installation of terrazzo tile and slab, natural stone, and composition block floorings.*

BS EN 12057, *Natural Stone Products – Modular Tiles – Requirements*

Other publications

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- [4] THE TILE ASSOCIATION. Tiling to timber sheets and boards, timber substrates and alternative products. Beckenham, The Tile Association.¹⁾
- [5] THE TILE ASSOCIATION. Technical Advice Note 3 Grouting high gloss glazed wall tiles. Beckenham, The Tile Association.¹⁾
- [6] THE TILE ASSOCIATION. The cleaning of ceramic tiles. Beckenham, The Tile Association.¹⁾

¹⁾ Obtainable from The Tile Association, Forum Court, 83 Copers Cope Road, Beckenham, Kent, BR3 1NR.

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