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Wall and floor tiling —

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

ICS 91.060.10; 91.060.30

Committees responsible for this British Standard

The preparation of this British Standard was entrusted to Technical Committee B/539, Ceramic tiles and other rigid tiling, upon which the following bodies were represented:

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

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Contents

Foreword

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

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

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

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

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

— *Part 2: Code of practice for external ceramic wall tiling and mosaics;*

— *Part 3: Code of practice for the design and installation of ceramic floor tiles and mosaics;*

— *Part 4: Code of practice for ceramic tiling and mosaics in specific conditions;*

— *Part 5: Code of practice for the design and installation of terrazzo tile and slab, natural stone and composition block floorings.*

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Summary of pages

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

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Section 1. General

1.1 Scope

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

a) bedding in cement-based adhesives on an intermediate substrate or as a direct bedding method;

b) bedding in organic-based adhesives on an intermediate substrate or as a direct bedding method;

c) bedding in cement: sand mortar on rendering or as a direct bedding method.

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

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

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

1.2 References

1.2.1 Normative references

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

1.2.2 Informative references

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

1.3 Definitions

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

1.3.1
natural stone tiles
tiles made from rock which has been sorted, dressed or machined to finish

1.3.2
composite stone tiles
natural stone and/or mineral fragments set in a binder subsequently cut to form tiles with a surface that is ground and polished to finish

1.4 Exchange of information and time schedules

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

1.4.1 Exchange of information

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

a) *Site*. Location and means of access.

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

c) *Walls*. Type and age of construction, location within the building, type and accuracy of background and need for intermediate substrate.

d) *Associated work*. Services embedded in or passing through the wall, skirtings and abutments, junctions with other adjacent finishes.

e) *Finishes*. Type(s) of tiles and/or mosaics, bedding and jointing requirements and required surface plane.

f) *Contract*. Particulars if the work is to be completed in any specific order or in sections.

g) *Health and safety*. Information on articles and substances for use during the work that are liable to be a health risk.

h) *Time schedule*. A time schedule for the progress of the work. (See **1.4.3**).

i) *Testing*. Details of any conformity testing required.

1.4.2 Provision of utilities, facilities and materials

1.4.2.1 *General*

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

a) adequate, clean, dry, lockable storage space protected from frost if necessary;

b) clean water supply adjacent to working area;

c) adequate artificial lighting, if required (see **1.4.2.2**);

d) safe means of access and places of work, to include where required, suitable scaffolding and staging which should conform to BS 5973; attention is drawn to the requirements of the Construction (Working Places) Regulations 1966 [1] made under the Factories Act 1961 [2];

e) unloading and hoisting facilities;

f) electric power supply adjacent to working areas;

g) protection of work during and after fixing;

h) supplies of cement and sand in accordance with **2.4** and **2.5**.

1.4.2.2 *Lighting on site*

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

1.4.3 Time schedules

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

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

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

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

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

Section 2. Materials

2.1 Transport and storage

The delivery of materials should be so arranged as to minimize handling. Adequate precautions should be taken to guard against the possibility of damage.
Products should be stored in clean, dry, frost free (if necessary) lockable storage to avoid excessive handling, theft and damage.

2.2 Tiles

2.2.1 Ceramic tiles

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

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

b) *Dust-pressed tiles (shaping B)*, which are formed of powder or small grains, shaped in moulds under high pressure before firing. These tiles generally are made to finer dimensional tolerances than extruded tiles.

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

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

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

2.2.2 Natural stone tiles

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

2.3 Mosaics

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

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

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

a) the fabric or tabs and their adhesive should not occupy more than 25 % of the area of each tessera. The critical factor is the contact of the adhesive over the backs of the tesserae;

b) the fabric or tabs and their adhesive should not deteriorate in service and that they should be compatible with the mortar or adhesive bed.

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

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

2.4 Cement

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

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

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

2.5 Sand

2.5.1 General

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

2.5.2 Sand for cement: sand rendering and mortar beds

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

2.5.3 Sand for grouting

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

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

Table 1 — Classification of ceramic tiles

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

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

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

2.6 Plaster

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

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

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

2.7 Water

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

2.8 Adhesives

2.8.1 Cement-based adhesives (hydraulically-hardening mortars)

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

2.8.2 Organic-based adhesives

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

Type 2. Dispersion adhesive;

Type 3. Dispersion/cement adhesive;

Type 4. Dissolved resin adhesive;

Type 5. Reaction resin adhesive.

2.8.3 Admixtures for adhesives

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

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

2.9 Bonding agents

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

2.10 Sealants and back-up materials for movement joints

2.10.1 Sealants

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

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

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

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

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

2.10.2 Back-up materials

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

Table 3 — Flexible sealants: summary of properties

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

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

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

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

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

2.11 Grouts

2.11.1 General

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

2.11.2 Types of grout

2.11.2.1 *Proprietary grouts*

Proprietary grouts are generally one of the following types:

a) mixes based on cement, modified by the inclusion of various additives, that require only the addition of clean water to obtain the desired consistency;

b) ready-mixed, organic polymer-based compositions;

c) mixes based on epoxide resin; these are supplied as two or three separate components, in pre-gauged proportions, which have to be mixed together immediately before use.

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

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

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

2.11.2.2 *Cement: sand mortar grouts*

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

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

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

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

2.11.3 Coloured grouts

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

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

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

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

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

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

2.11.5 Resistance to moulds and bacteria

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

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

2.12 Mechanical support for cement: sand rendering

2.12.1 General

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

2.12.2 Expanded metal lathing

This material should conform to BS 1369-1.

2.12.3 Ribbed lathing

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

2.12.4 Welded wire mesh

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

2.12.5 Galvanized wire netting

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

2.12.6 Corner and stop beads

Beads should conform to BS 6452-1.

2.12.7 Plastics coated glass fibre mesh sheets and plastics netting

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

Section 3. Design

3.1 Backgrounds

3.1.1 General

3.1.1.1 *General*

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

3.1.1.2 *Porosity and suction*

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

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

3.1.1.3 *Mechanical key*

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

3.1.1.4 *Trueness of construction*

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

3.1.1.5 *Moisture movement and thermal movement*

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

3.1.1.6 *Chemical action*

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

3.1.1.7 *Contamination*

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

3.1.1.8 *Physical deterioration*

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

3.1.1.9 *Staining*

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

3.1.2 Classes and types of background

3.1.2.1 *General*

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

3.1.2.2 *Dense, strong and smooth surfaced materials*

These materials (which include high density clay bricks or blocks, dense concrete either pre-cast or in situ, some natural stones, glazed bricks and glazed tiles) have low porosity, little suction and smooth surfaces that offer no mechanical key. Drying shrinkage of dense clay bricks or blocks is negligible. In dense concrete it may vary from low to high according to mix, quality, etc., but is usually no more than moderate, though drying out may be slow.

3.1.2.3 *Moderately strong and porous materials*

Most bricks and blocks, other than the very dense types considered in **3.1.2.2** or lightweight products considered in **3.1.2.4**, fall into this class together with some medium strength natural aggregate concretes and structural lightweight concrete. Materials in this class have relatively high suction and generally provide a good mechanical key and good adhesion for an intermediate substrate if required. Drying shrinkage of concrete is variable and should be taken into consideration.

Most calcium silicate and dense concrete bricks fall within this class but since the strength, porosity and drying shrinkage of these vary considerably, special treatment may be necessary.

3.1.2.4 *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 **3.1.2.3**. It is particularly important that the substrate should be not stronger than the background as otherwise shrinkage is liable to lead to shearing of the surface of the background.

NOTE Lightweight concrete can have a large drying shrinkage movement which may be related to such factors as composition and/or degree of saturation.

Lightweight blocks of a density less than 625 kg/m^3 should not be used as a background for rendering for tiling unless the rendering is reinforced with welded wire mesh secured to the blockwork. (See **3.2.2.1**.)

3.1.2.5 *No-fines concrete*

This type of concrete forms a class by itself. It has many relatively large voids and affords an effective mechanical key for an intermediate substrate. Drying shrinkage and suction vary from low to moderate according to the aggregate used.

3.1.2.6 *Sheets and boards*

Sheets and boards include plasterboard, glass fibre reinforced cement boards, fibre building boards, plywood, chipboard and other composite boards. 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.

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 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.

Sheets and boards to receive natural stone tiles should always be positively fixed, using stainless steel screws to avoid surface staining. 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 clause **6** of BS 5385-4:1992).

3.1.2.7 *Cement: sand rendering*

(See **3.3**.)

3.1.2.8 *Gypsum plaster*

(See **3.4**.)

3.1.2.9 *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 or to support directly-applied ceramic tiling, where the background surface is too weak.

3.1.2.10 *Other backgrounds*

There is a variety of materials and surfaces, particularly in old buildings, that may require tiling to change their appearance and performance. Sometimes they may be too weak in themselves or be too weakly-adhering to the background to support tiling.

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

3.2 Preparation of backgrounds

3.2.1 General

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

a) keying of the surface or the application of a bonding agent to improve the adhesion potential;

b) applying 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) applying an intermediate substrate to provide the necessary measure of accuracy; this intermediate substrate may 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 removed.

Backgrounds not built accurately to a specified plane, or having true surfaces that are uneven, may have deviations from a true flat surface that are 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, it is recommended that 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 will usually be applied directly to the background by means of a suitable thin-bed adhesive. Backgrounds having irregularities exceeding the limit defined in **3.2.4.1** may have to 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 Section 4, 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 thin-bed adhesives which should be spread to a recommended consistent thickness.

Cement: sand rendering provides a much stronger background for tiling than does plaster and wherever possible it should be specified. However, tiles can be fixed satisfactorily to sound plaster surfaces providing the recommendations in this code are observed.

Section 4 and Table 4 show that preference is given to the use of adhesives for the application of tiles to most surfaces, but there are some tiles for which a thin-bed adhesive is unsuitable and they need a thick-bed adhesive or a bed of cement: sand mortar, which generally are not compatible with plaster or most sheet and board backgrounds.

Table 4 — Backgrounds: summary of data and suitable tile beds

a) Dense, strong and smooth backgrounds								
Background	**Drying shrinkage movement**	**Surface characteristic**	**Preparation of backgrounds**		**Additional comments**	**Material for fixing tiles**		
			For direct bedding (see **3.2.4**)	**For rendering or cement: sand mortar bed**		**Cement-based adhesives**	**Organic-based adhesives**	**Cement: sand mortar**
High density clay brickwork and clay blockwork (see **3.1.2.2**)	Negligible	Low suction	Direct fixing with an adhesive may be adopted provided the surface is suitable (see **3.2.4.1**)	Poor key. May require more than raking back of joints, e.g. scabbling, spatterdash, bonding agent, lathing or netting. Keyed bricks need no raking back (see **3.2.2.2.1**)	Where adhesive is used, drying out may be delayed and grouting should be deferred for at least 3 days or as long as practicable	S	S	S
Dense concrete, either precast or in situ (see **3.1.2.2**)	May 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. May require scabbling, spatterdash, bonding agent, lathing or netting (see **3.2.2.2.2**)	New concrete should be left for at least 6 weeks before rendering or direct fixing is commenced. Cement: sand mortar rendering should be left for 2 weeks before tiling is applied	S	S	S
Hard natural stone (see **3.1.2.2**)	Negligible	Low suction		Poor key. May require more than raking back of joints, e.g. scabbling, spatterdash, bonding agent, lathing or netting (see **3.2.2.2.3**)		S	S	S
Glazed brickwork and tiling (see **3.1.2.2**)	Negligible	Very low suction	Clean down existing surface to remove grease, grime, condensation, etc. (see **3.2.4.5**)	Unsuitable	Check that old tiles/bricks are firmly bedded, remedy isolated loose areas. Drying time of adhesive may be extended. Delay grouting as long as practicable.	U	S	U

Key

S Suitable, but all adhesives within a particular group may 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 may vary according to the particular grade and/or free water: cement ratio.

Table 4 — Backgrounds: summary of data and suitable tile beds *(continued)*

b) Moderately strong and porous backgrounds								
Background	**Drying shrinkage movement**	**Surface characteristic**	**Preparation of backgrounds**		**Additional comments**	**Material for fixing tiles**		
			For direct bedding (see **3.2.4**)	**For rendering or cement: sand mortar bed**		**Cement-based adhesives**	**Organic-based adhesives**	**Cement: sand mortar**
Clay brickwork and blockwork (see **3.1.2.3**)	Negligible	Moderate or high suction	Direct fixing with an adhesive may be adopted provided the background is suitable (see **3.2.4.1**)	Rake back joints (see **3.2.2.3.1**)	New concrete, concrete blocks and bricks and calcium silicate bricks should be left for at least 6 weeks and any cement: sand mortar rendering for a further 2 weeks before fixing is commenced	S	S	S
Concrete (natural aggregate) (see **3.1.2.3**)	Low to high[b]	Moderate suction		Poor to fair key. Remove any ridges and fins from in situ concrete before cleaning down. Remove grease and mould oil. May require scabbling, spatterdash, bonding agent, lathing or netting (see **3.2.2.3.2**)		S	S	S
Concrete brickwork and blockwork (natural aggregate)	Low to high[b]	Moderate suction		Rake back joints to form key. With some types of extremely smooth and dense bricks, scabbling, spatterdash, bonding agent, lathing or netting may be used to obtain a good key (see **3.2.2.3.3**)		S	S	U
Calcium silicate brickwork (hard)	Low to High[b]	Moderate suction				S	S	U

Key

S Suitable, but all adhesives within a particular group may 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.

[b] The amount of movement to be expected may vary according to the particular grade and/or free water: cement ratio.

Table 4 — 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 **3.2.4**)	**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[c] (see **3.1.2.4**)	Moderate to high[d]	Moderate to high suction	Direct fixing with an adhesive may be adopted provided the background is suitable (see **3.2.4.1**)	Good key. Spatterdash, bonding agent, lathing or netting may be required (see **3.2.2.4.1** and **3.2.2.4.2**)	Walls should be kept dry and should be at least 6 weeks old before any rendering is applied and left a further 2 weeks before fixing is commenced.	S	S	U
Autoclaved blockwork and lightweight concrete with closed surfaces[c] (see **3.1.2.4**)	Moderate to high[d]	Moderate suction		Poor key. May require spatterdash, bonding agent, lathing or netting (see **3.2.2.4.1** and **3.2.2.4.2**)	The rendering should not exceed 13 mm in thickness	S	S	U
Autoclaved aerated concrete. In situ and panels (see **3.1.2.4**)	Moderate to high[d]	Moderate suction		Poor to fair key. Spatterdash, bonding agent, lathing or netting may be required (see **3.2.2.4.2**)		S	S	U
Soft natural stone (see **3.1.2.4**)	Negligible	Moderate or high suction		May require scabbling, spatterdash, bonding agent, lathing or netting (see **3.2.2.4.3**)		S	S	S
Calcium silicate brickwork (soft)	Low to high[d]	Moderate suction		Rake back joints. With some types of extremely smooth bricks, spatterdash, bonding agent, lathing or netting may be used to obtain a good key (**3.2.2.3.3**)		S	S	U

Key

S Suitable, but all adhesives within a particular group may 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.

[c] Confirm with the concrete block manufacturer that the treatment described is appropriate to the product.

[d] The amount of movement to be expected may vary according to the particular grade and/or free water: cement ratio.

Table 4 — Backgrounds: summary of data and suitable tile beds *(continued)*

d) Other backgrounds								
Background	**Drying shrinkage movement**	**Surface characteristic**	**Preparation of backgrounds**		**Additional comments**	**Material for fixing tiles**		
			For direct bedding (see **3.2.4**)	**For rendering or cement: sand mortar bed**		**Cement-based adhesives**	**Organic-based adhesives**	**Cement: sand mortar**
No-fines concrete (see **3.1.2.5**)	Low to moderate according to aggregate used[e]	Low to moderate suction	Unsuitable	Open textured surface should not require further keying (see **3.1.2.5.1**)	New concrete should be left for at least 6 weeks before rendering. Cement: sand rendering should be left for 2 weeks before tiling is applied	S	S	S
Plasterboard (see **3.1.2.6**)	Negligible	True and smooth	(See **3.2.4.3**)	Unsuitable	All boards should be rigidly fixed. In wet or damp conditions a type 3 plasterboard conforming to BS 1230-1 should be used	C	S	U
Fibre cement board. Wood-based panel products (see **3.1.2.6**)	Moderate to high	True and smooth	Seal exposed edges and back, but not the face, against water absorption, Priming may be necessary. Refer to adhesive manufacturer (see **3.2.4.2**)	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 may 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.

[e] The amount of movement to be expected may vary according to the particular grade and/or free water: cement ratio.

Table 4 — Backgrounds: summary of data and suitable tile beds *(concluded)*

d) Other backgrounds

Background	Drying shrinkage movement	Surface characteristic	Preparation of backgrounds		Additional comments	Material for fixing tiles		
			For direct bedding (see 3.2.4)	For rendering or cement: sand mortar bed		Cement-based adhesives	Organic-based adhesives	Cement: sand mortar
Gypsum plaster (see **3.2.3** and **3.4**)	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 **3.2.4.1**)	Unsuitable	New plasterwork should have been completed at least 4 weeks previously and should be dry throughout. Tiles should only be fixed to the finish coat, never direct to the backing coat. Plasterwork is unsuitable as a background for tiling in wet areas	C	S	U
Paintwork (see **3.2.4.4**)	According to background	Depends upon age and condition Low suction	(See **3.2.4.4**)		If paint is flaking it should be stripped off mechanically. Emulsion paint, limewash, distemper and similar finishes are best removed since they may possess poor adhesion to backing. Solvent-based adhesives should not be used	U	S	U
Metal surfaces (e.g. iron/steel) (see **3.2.4.6**)	Nil	Low suction and poor key	Clean to remove rust, grease, etc. (see **3.2.4.6**)		For metals other than iron/steel or when abnormal conditions apply, obtain advice from adhesive manufacturer	U	S	U

Key

S Suitable, but all adhesives within a particular group may 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.

3.2.2 Treatment of backgrounds to receive cement: sand rendering

3.2.2.1 *General*

Before applying cement: sand rendering it is important to ensure that the substrate has dried out and especially where the background 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 4).

The background should dry out for at least 6 weeks before any rendering is applied.

Any laitance on the surface and contamination by oil, grease 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 may 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 may 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. The bonding agent should be one that does not re-emulsify after application. Bonding agents may 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.

Backgrounds on which bonding agents may be used are included in Table 4.

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 item c)] or bonding agents [see item f)].

3.2.2.2 ***Dense, strong and smooth materials***

3.2.2.2.1 *High density clay brickwork and clay blocks*

Where the joints of brickwork have not been raked back during construction, this should be done 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 **3.2.2.1**). Walls constructed of keyed bricks need no raking back.

3.2.2.2.2 *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 **3.2.2.1**. Joints in new and old concrete block walling should be treated as described for brickwork (see **3.2.2.2.1**).

3.2.2.2.3 *Hard natural stone*

Dense or smooth stone may need to be treated to form a key (see **3.2.2.1**).

3.2.2.3 ***Moderately strong and porous materials***

3.2.2.3.1 *Clay bricks and blocks*

Treatment should be as described in **3.2.2.2.1**.

3.2.2.3.2 *Medium strength natural aggregate concrete*

Treatment should be as described in **3.2.2.1** and **3.2.2.2.2**.

3.2.2.3.3 *Calcium silicate bricks and concrete bricks and blocks*

Joints should be raked back (see **3.2.2.2.1**). With some types of extremely smooth calcium silicate bricks, spatterdash coat, lathing or netting may be required (see **3.2.2.1**).

3.2.2.4 ***Moderately weak and porous materials***

3.2.2.4.1 *Autoclaved aerated concrete blocks and concrete blocks containing lightweight aggregate*

Apart from general cleaning (see **3.2.2.1**) special treatment is seldom necessary as these materials usually have moderate suction and a good key. Some dampening may be required to control suction; the minimum amount of water is to be used to achieve this objective.

Usually, smooth blocks may require treatment as described for brickwork (see **3.2.2.2.1**).

If these blocks have a high or variable suction, preparatory treatments should be specified (see **3.2.2.1**).

3.2.2.4.2 *Autoclaved aerated concrete panels and in situ concrete and panels containing lightweight aggregate*

Special treatment is generally necessary with these materials as described in **3.2.2.1**.

3.2.2.4.3 *Soft natural stone*

This may need to be treated to form a good key (see **3.2.2.1**). Lathing or netting may be most appropriate.

3.2.2.5 ***Other backgrounds***

3.2.2.5.1 *No-fines concrete*

This usually requires no preparation other than cleaning (see **3.2.2.1**).

3.2.2.5.2 *Other substrates*

These 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.

3.2.3. Treatment of backgrounds to receive a gypsum plaster finish

The preparatory treatment necessary for the application of plastering systems to the backgrounds classified in **3.1.2** is similar to the treatment to receive cement: sand rendering described in **3.2.2** (see also clause **37** of BS 5492:1990).

3.2.4 Treatment of backgrounds to receive tiles by direct bedding

3.2.4.1 ***General***

Tiles may be bedded directly to a background using thin-bed or thick-bed adhesive or cement: sand mortar as the bed. Methods of application and suitability of backgrounds to accept these methods are described in Section 4 and Table 4.

The trueness of the background surface required for adhesive beds should be such that, when checked with a 2 m straightedge, any gap behind the straightedge between points of contact does not exceed 3 mm. Where the gap exceeds 3 mm, local correction of the background by dubbing out up to 6 mm thick can sometimes be done using the same adhesive, but advice on this should be sought from the manufacturer of the adhesive. The use of a thick bed may be necessary.

When 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 **3.2.2**.

3.2.4.2 *Sheets and boards*

Sheets and boards include the materials listed in **3.1.2.6** except plasterboards. A very important consideration with this type of background is that the sheets or boards have to be adequately braced to provide a rigid surface, free from any springiness and surface undulations, that will 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. It is good practice to seal all exposed edges and the backs, but not the faces, of such boards 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.

3.2.4.3 *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 1230-1. Where there will be any exposure to moisture, e.g. splash backs, the plasterboard should either be type 3 or preprimed and the perimeter sealed.

The following precautions should be observed:

a) when fixing to timber framing or battening, 12.5 mm board should be specified 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/m^2, 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 10 days before tiling commences;

g) where tiling heights exceed 2 400 mm, reference should be made to the recommendations of the plasterboard manufacturer;

h) where gypsum plasterboard is used as a base for plaster, the plaster finish coat should be applied in accordance with the board manufacturer's recommendations (see **3.4**);

i) dry lining angle beads and the like should not be used if the boards are to be tiled using adhesives.

3.2.4.4 *Painted surfaces*

Painted surfaces are generally unsuitable for natural stone tiles. For ceramic tiles and mosaics, it is very important to make a detailed examination of the painted surface 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, reference should be made to BS 6150.

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, etc.

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 **3.4** apply to plaster used as a base for decoration and subsequent tiling.

3.2.4.5 *Existing glazed tile and glazed brick surfaces*

A sound tiled wall normally presents a surface sufficiently flat to permit its covering with new tiles fixed with an appropriate adhesive. When old tiling is sound, clean down the existing glazed surface to ensure the removal of grease, grime, condensation, etc., before commencing the fixing of new tiles. Check that the old tiles are still firmly adhering to their bed and that the bed is sufficiently strong to support the added weight; all loose tiles should be removed. If only isolated areas of tiling are loose, the face of the original bed, if in sound condition, should be dressed back to sufficient depth to allow the old tiles to be re-fixed flush with the surrounding tiles using a thin-bed adhesive. Alternatively, after removing the loose tiles, the spaces left may be filled in flush with the surrounding tile surface using mortar or plaster, which should be allowed to dry out thoroughly before the new tiles are applied.

Where loose tiling occupies complete walls, it may be convenient to apply the new tiling directly to the original bed where it is sound. This bed may require dressing back or levelling to conform to the trueness of the background required by the bedding method for the new tiles, see **3.2.4.1**.

If the existing bed is not firmly bonded to its backing, or if the backing is not sound even though the bed may be firmly bonded to it, all unsound layers should be removed and the areas made good.

In all cases where the existing work has been made good by any of the means suggested, the materials used should be allowed to set and dry out thoroughly before the new tiling is applied.

Similar considerations to those detailed above apply also to glazed brick backgrounds.

3.2.4.6 *Other backgrounds*

By using a suitable adhesive, tiles may be fixed to most surfaces (those most likely to occur in practice are discussed in **3.1**, **3.2**, **3.3** and **3.4**). Occasionally other backgrounds are encountered, e.g. metals, that pose special problems. In such cases full information should be given of the application and service conditions to a manufacturer of adhesives, whose advice should be sought.

3.3 Cement: sand rendering

3.3.1 General

It is essential that the rendering is compatible with the background to which it is applied and the bedding materials appropriate to the tiling. Recommendations for achieving the best relationship between the component materials in respect of their strength and shrinkage movement factors are included in Table 4.

The rendering should be true, free of hollow-sounding areas and firmly bonded to the background. It should be protected if necessary, to prevent rapid drying-out, for at least the first 3 days after application and should be completed at least 2 weeks (depending on weather, humidity and site conditions) before fixing tiles begins.

NOTE Complete bonding may 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.

3.3.2 Mix for rendering to various backgrounds

3.3.2.1 *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 has been drawn in **3.1.2** to the variation in strength and drying shrinkage movement of the common backgrounds.

Masonry cement and sand mixes may be used. These mixes, providing equivalent strength to the cement: sand mixes described in **3.3.2.2**, **3.3.2.3**, **3.3.2.4** and **3.3.2.5**, should be in accordance with the instructions of the manufacturers of any proprietary materials employed.

Weight batching should be adopted whenever practicable as this will help to ensure uniformity of mix proportions and thus the uniformity of the quality of the material. For further details of batching and mixing see **4.2.3.4**.

3.3.2.2 *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) may 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 may be too weak to support the tile bed mortar.

3.3.2.3 *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.

3.3.2.4 *Mixed backgrounds*

Where tiling is continuous across backgrounds of varying types, their differential movements may induce cracking. This risk may be avoided by incorporating a movement joint in such positions.

3.3.2.5 *Backgrounds subject to dampness*

Where backgrounds can become damp, e.g. by absorption of water through an external wall surface, any soluble salts in them will dissolve. Should the resultant solution be able to evaporate via the tiled face, the dissolved salts may be deposited at an interface such as that between background and rendering and may 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 may 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 may 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. The permanent exclusion of water from the background will usually be found more effective than the use of sulfate-resisting cements, since it will minimize the possibility not only of sulfate attack but also of salt deposition.

3.3.3 Thickness and trueness of rendering

The trueness required of a rendered finish will depend upon the method of tile fixing to be used, i.e. into a mortar or adhesive bed. For bedding in adhesive, a greater accuracy will be required 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 a cement: sand mortar, the trueness of the surface should not deviate more than 6 mm (see **4.2.3.2**).

The thickness and number of render coats needed will be governed by the trueness required of the rendered finish and also by the trueness of the background to be rendered.

Rendering should not have a total thickness in excess of 20 mm as this will result in unduly high shrinkage stresses.

Backgrounds which are built to the accuracies recommended in Table 2 of BS 8000-3:1989 may still not be able to be rendered plumb or to line unless sufficient thickness of render is specified.

No tolerance can be laid down for rendering less than 12 mm thick since this will closely follow the contour of the background.

Nominal 12 mm thick render will 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. The final surface may not be plumb.

Render up to 20 mm thick will overcome backgrounds which are constructed to larger tolerances, but still within the limits permitted by Table 2 of BS 8000-3:1989, and such render surfaces should not deviate by more than 3 mm in any 2 m.

Where suspended ceiling systems (non-plastered type) are to be installed, permanent timber grounds should be specified and 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 about 12 mm thick, but they may need to vary slightly in thickness in order to accommodate slight variations in the trueness of the background. They should not be less than 8 mm nor more than 12 mm thick except in localized areas where the maximum may be 16 mm.

If two coats are required, the first coat should be "combed" before it hardens to provide a key for the following coat. The comb 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. 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 to be 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.

3.4 Plastering

3.4.1 General

Plasterwork should be carried out in accordance with the recommendations given in BS 5492.

The plasterwork should be firmly bonded to its background and be sufficiently strong to support the specified tiling. The maximum weight of tiling which can be supported by a dry, firmly adhered plaster background is 20 kg/m^2, generally equivalent to ceramic tiles with a thickness of 8 mm or natural stone tiles with a thickness of 7 mm.

Before tiling work is undertaken, the plasterwork should be sounded 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 should be 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 4 weeks previously and should be dry throughout before tiling commences.

Excessive trowelling of the plaster should be discouraged, since this practice may result in a dusty surface that is unsatisfactory for tiling and it may also create a denser finish than normal, thus reducing suction.

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

3.4.2 Plastering systems for various backgrounds

Plastering systems appropriate to various backgrounds are given in Table 4 of BS 5492:1990. This table should be read in conjunction with Tables 1 and 2 of BS 5492:1990, in which the characteristics of and mixes for plaster final coats and undercoats are detailed.

3.4.3 Thickness and trueness of the plaster surface

Since an adhesive bed not greater than 3 mm should always be specified 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 will be necessary; this also applies to backgrounds not built accurately to a specified plane, e.g. not upright.

The thickness and number of coats of plaster that are necessary to enable a flat, true and uniform surface to be obtained will depend 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 clause **33** of BS 5492:1990. This guidance is similar to that given in **3.2.3** of this code, but with 13 mm replacing 12 mm in paragraphs 5 and 6.

NOTE Clause **32** of BS 5492:1990 indicates that two coat plastering is defined as being up to a maximum of 13 mm thick and three coat work to a maximum of 19 mm thick excluding keys.

3.5 Movement joints

3.5.1 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.

Stresses occur in the tiled installation as a result of 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, may 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 **2.10**.

3.5.2 Location

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

In detailing the location of movement joints in tiling the designer will normally specify 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.

3.5.3 Back-up materials

From both functional and economic standpoints it is advisable partially to fill the joint with a compressible back-up material before topping up the joint to the final level with sealant.

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 will inhibit 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 will not adhere, or one which may 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 will improve performance. Bondbreaker tapes are generally self-adhesive polyethylene or polytetrafluoroethylene (PTFE) tapes.

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. 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.

3.5.4 Sealants

A summary of the more important properties of recommended sealants is given in Table 3 but the sealant manufacturers' advice should be taken into account as the properties of individual sealants may 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.

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 may collect deleterious matter and should be thoroughly cleaned before sealing.

If the sealing of the joints is to be 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 may be necessary to avoid contamination of the joint.

3.6 Coloured grouts

When deciding whether or not to apply coloured grouts to tiles which may be liable to retain particles of coloured material, it is advisable to check the potential risk of staining, 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 may 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 may not be suitable for natural stone tiles and the manufacturer's advice should always be sought.

Section 4. Application of tiles: methods and materials

4.1 General

4.1.1 Bedding methods

Suitable beds for tiles are:

a) cement-based adhesives (see **4.2.1**);

b) organic-based adhesives (see **4.2.2**);

c) cement: sand mortar (see **4.2.3**).

The backgrounds to which each system is suited are listed in **4.1.1**, **4.1.2**, **4.1.3**, **4.1.4** and **4.1.5** and summarized in Table 4.

For fixing tiles with smooth or shallow keyed backs, methods a) and b) are preferable. For fixing tiles with deep keys, thick-bed adhesives or cement:sand mortar should be used, provided they are compatible with the background.

4.1.2 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.

4.1.3 Compatibility of backgrounds and tile beds

In Section 4 the term "backgrounds" means the surfaces intended to receive the bed directly. These may be the surfaces of structural walls or the surfaces of applied materials such as rendering, plastering, sheets, boards and existing tiles.

The treatment of base surfaces to produce backgrounds conditioned to receive tiling is detailed in Section 3. In **4.2.1.2**, **4.2.2.2** and **4.2.4.2** additional information is given that may 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 Section 3, it should be laid down that these maxima are not exceeded.

Preparatory work in the formation of backgrounds that fails to meet the recommendations of this code 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.

4.1.4 Setting out

It is important to the appearance of the finished wall tiling that unsightly cut tiles are avoided and that joints are of a uniform width. Allowance should be made for an adequate width of joint (see **4.2.1.7**). Cut courses, both vertical and horizontal, should:

a) be determined in advance;

b) be as large as possible;

c) be arranged in the least prominent of alternative locations.

The ideal is to establish a vertical centre line in each wall area on which either a joint or a tile centre will reside, 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 may need guidance from the designer as to the setting out to be adopted. Similar guidance may be required in the positioning of movement joints since they will be predominant and may determine the setting out pattern.

The positioning of horizontal joints and cut courses will depend 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 may 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 may initiate the need for, and frequently dictate the location of, cut courses.

To ensure that rows of tiles are truly horizontal, a level line should be established to position the starting course.

4.1.5 Movement joints

Provision should be made to incorporate movement joints in appropriate positions when setting out the tiling (see **3.5**).

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 which can be removed when the tiling is sufficiently firm. The filler strip may 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 which will prevent proper application of the back-up and sealant and may prevent movement of the joint, resulting in damage or displacement.

4.1.6 Preparation of the tiles

Most bedding methods call for the tiles to be dry. Ceramic tiles fixed in cement: sand mortar may need to be soaked prior to fixing. Neglect of this is almost certain to lead to adhesion failures (see **4.2.3.3**).

4.1.7 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. General guidance is given in **4.2**.

It is not practicable to give similarly precise instructions concerning cement: sand mortar beds. The properties of a sand will depend upon its source and will influence in particular the quantity of water that has 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.

Skilled operators rarely find difficulty in estimating, from considerations such as the ambient temperature, the porosity of the background, the thickness of the bed, the mortar consistency appropriate to a particular application and the minimum water addition necessary to achieve it. The latter aspect is vital in minimizing the drying shrinkage of the mortar and thus any tendency towards adhesion failures.

4.1.8 Tolerances

4.1.8.1 *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, i.e. a tolerance of ±3 mm.

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

4.1.8.2 *Across joints*

There should be no appreciable difference in level across joints 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.

4.1.9 Lighting

The type, direction and intensity of lighting at the time of tile fixing should not be appreciably different from the ultimate permanent lighting. It should be recognized that within the tolerance laid down for the overall plane, there can 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 may be affected and no adjustments can then be made to the tiles to meet the changed circumstances.

4.1.10 Tile joint treatment

To ensure a high standard of finish, careful attention should be given to the selection of the methods and materials to be adopted in filling and finishing the joints. The selection will depend upon the joint widths and the functional requirements of the installation (see **4.2.1.7** and **4.3**).

4.2 Bedding methods

4.2.1 Bedding in cement-based adhesives: thin-bed and thick-bed

4.2.1.1 *General*

The method to be adopted for fixing tiles will vary with the type of background, the nature of the adhesive and the anticipated conditions to which the installation will be subjected in service. The methods described in **4.2.1.3**, **4.2.1.4**, **4.2.1.5**, **4.2.1.6** and **4.2.1.7** are those usually adopted with this group of adhesives, but there are several products available and some variations in fixing procedures exist. Therefore it is important to follow the precise recommendations of the adhesive manufacturers 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 stone tiles. A polymer additive may be necessary in the adhesive for low absorption tiles.

Whichever cement-based adhesive is selected for fixing, its resistance to excessive strain development should conform to clause **8** of BS 5980:1980.

4.2.1.2 *Backgrounds*

Cement-based adhesives are suitable for use on mature rendered surfaces, concrete and brickwork. They are not recommended for use directly onto surfaces such as plaster, wood, metal and glazed surfaces such as existing tiling. A summary of backgrounds and their treatment is given in Table 4.

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

The trueness of the background surface required for adhesives and any necessary treatment are described in **3.2.4.1**.

The preparation of various backgrounds to receive cement-based adhesives and the precautions that should be adopted in each instance are described in Section 3 (see also **4.1.3**).

Some thin-bed 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.

4.2.1.3 *Preparation of tiles*

Tiles are fixed dry; they should not be soaked.

4.2.1.4 *Mixing of the adhesives*

Cement-based adhesives should be mixed with clean water as recommended by the manufacturer to obtain the desired consistency, usually a fairly thick, creamy mix. Where necessary the mixed material should then be left to stand for a period defined by the adhesive manufacturer, during which time it may thicken. No further water should be added after the original mixing but the mixed material should be reworked to restore it to its original consistency before use.

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

4.2.1.5 *Application of adhesive and tiles: thin-bed*

4.2.1.5.1 *Notched trowelling method*

For situations where dry conditions will prevail after tiling is completed, the notched trowelling method should be used. The final bed thickness of the thin-bed cement-based adhesive should not exceed 3 mm. If it is used at a thickness greater than this, excessive stresses may develop possibly resulting in cracking of the tiles and/or adhesion failure.

The adhesive should be applied to the surface as a floated coat with a trowel, pressing the adhesive into the surface, to give a bed thickness of about 3 mm, which should then be combed through with a notched trowel of the type recommended by the adhesive manufacturer. This will give 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.

It is essential that the tiles should be fixed before surface drying of the ribbed adhesive bed prevents the adhesive wetting the back of the tiles. The period of time during which tiles can be adequately bedded after spreading the adhesive is the open time, this will vary according to the prevailing atmospheric conditions and is usually about 20 min. It is important not to spread more adhesive on the wall than can be covered with tiles within the open time of the adhesive.

A suitably designed notched trowel should be used for combing the adhesive. The important point is that whichever type of trowel is used, it should be such that adequate contact between tile and adhesive is assured. 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.

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.

4.2.1.5.2 *Buttering method*

This method may be necessary 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.

4.2.1.5.3 *Notched trowelling and buttering method*

This method combines **4.2.1.5.1** and **4.2.1.5.2** and should be used for fixing large tiles (e.g. 700 cm^2 and above) 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, it is inevitable that there will be a number of small voids.

4.2.1.6 ***Application of adhesive and tiles (thick-bed)***

Where surfaces are not sufficiently flat and true to permit thin-bed fixing, some irregularity in the background may be accommodated by applying some cement-based adhesives as a thick-bed.

NOTE Thick-beds should not be used to make good deficiencies in the surfaces of backgrounds left by preceding trades.

In practice the amount of irregularity that can be taken up will be limited by several factors. Thus, for each adhesive suitable for thick-bed application, the manufacturer will stipulate the maximum thickness at which it should be used and the final bed thickness should not be greater than the maximum thickness. A limit to the thickness of adhesive used may also be imposed by the nature of the background and the circumstances of use. For example a thick bed of adhesive will tend to dry out slowly on a dense or impervious surface, and the bed thickness may have to be limited to prevent possible slumping as tiles are being fixed.

Usually thick-bed adhesives are used at an average bed thickness of about 6 mm, applying a thicker coating by the notched trowelling and buttering method (**4.2.1.5.3**). Some adhesives may be applied using the notched trowelling method described in **4.2.1.5.1**. With other thick-bed adhesives, however, a notched trowel should not be used except perhaps to provide light ribbing only of the surface of the adhesive to facilitate subsequent application of tiles. The manufacturer's instructions should be observed in every instance.

After spreading the adhesive, the open time will vary according to the nature of the adhesive and to the prevailing atmospheric conditions but is usually about 20 min. Manufacturers will specify the correct open time for their particular products and it is essential that tiles are fixed in position before surface drying of the adhesive occurs. It is therefore important not to spread more adhesive on the wall than can be covered with tiles within the open time of the adhesive.

Whichever method of application is adopted, dry tiles should be used and these should be pressed firmly into position to ensure good contact between tile and bed.

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

4.2.1.7 *Tile joints*

Tiles without spacer lugs or without universal edges should never be fixed with butt-joints, as an adequate width of joint is necessary for the relief of any local stress. When universal or spacer lug tiles are used, correct spacing is automatically provided between tiles. For plain edge tiles, 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, whether the tiles have spacer projections or not.

Joint widths should be consistent throughout the installation unless specified otherwise (see also **4.1.4**).

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 **4.3** for grouting materials and procedures).

4.2.2 Bedding in organic-based adhesives: thin-bed and thick-bed

4.2.2.1 *General*

Organic-based adhesives should be used only in adequately ventilated areas, as some may be highly flammable or narcotic. Flammable adhesives should not be used near naked flames, cigarettes, electrical switchgear and other possible sources of ignition. During application of flammable solvent-based adhesives it is dangerous to smoke. The lid should always be replaced on containers immediately after use.

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

4.2.2.2 *Backgrounds*

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. However, solvent-based adhesives are not suitable for use on painted surfaces due to probable interaction between the solvent and the paint. A summary of backgrounds and their treatment and suitability for organic-based adhesives is given in Table 4.

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

The trueness required of the background surface and any necessary treatment are described in **3.2.4.1**.

The preparation of various backgrounds to receive organic-based adhesives and the precautions that should be adopted in each instance are described in Section 3 (see also **4.1.3**).

4.2.2.3 *Preparation of tiles*

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

4.2.2.4 *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.

4.2.2.5 *Application of adhesive and tiles*

Organic-based adhesives are applied by similar methods to those described for cement-based adhesives, i.e. thin-bed as **4.2.1.5** and thick-bed as **4.2.1.6** including the notched trowelling and buttering method as described in **4.2.1.5.3** where required.

4.2.2.6 *Tile joints*

See **4.2.1.7**.

4.2.3 Bedding in cement: sand mortar

4.2.3.1 *General*

This method of fixing is now usually only used for extruded tiles 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 Section 2. Mixing and application are dealt with in **4.2.3.4** and **4.2.3.5**.

4.2.3.2 *Backgrounds*

Backgrounds suitable to receive tiling fixed by cement: sand mortar over a rendered or non-rendered surface are those that are rigid, provide an adequate key as well as suitable suction and whose movements, subsequent to tiling, will be 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 **3.3.1**).

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 Section 3 (see also **4.1.3**). A summary of backgrounds and their treatment is given in Table 4.

4.2.3.3 *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 6431-1:1983 in groups IIb and III require this saturation treatment. Soaking of tiles of groups I and IIa is unnecessary (see Table 1).

4.2.3.4 *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 **2.5** and **4.1.7**). 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 m^3 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 will 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 may lead to inaccurate assessment of the mix proportions and that the use of assumed data may give results which could be at variance with the true mix proportions.

When mixing by machine is not possible, mortars may 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.

4.2.3.5 *Application of cement: sand mortar and tiles*

4.2.3.5.1 *Floating and back filling method*

The mix as described in **4.2.3.4** 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 it is inevitable that there will be a number of small voids.

4.2.3.5.2 *Buttering method*

This 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 will be 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.

4.2.3.5.3 *Finish*

A straightedge should be used to ensure that the surface of the tiling is flat and true as stated in **4.1.8**. 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.

4.2.3.6 *Tile joints*

See **4.2.1.7**.

4.3 Tile joint treatment

4.3.1 General

A wide range of grouts is available (see **2.11**) 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 **4.3.2**, **4.3.3** and **4.3.4**.

When using proprietary grouts, the joint cavities are not usually 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.

4.3.2 Grouting procedure for joints up to 3 mm wide

Grouting of the joints may 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, it is not advisable to delay grouting unduly as the open joints may 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 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.

4.3.3 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 may also be incorporated (see **2.11.3** and **2.11.4**).

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.

Care should be taken when jointing glazed tiling to avoid damage to the surface. In the case of tiles faced with soft glazes which may easily be scratched, it is advisable to protect the glaze adjacent to the joints with masking tape.

4.3.4 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 would enable an alternative grouting procedure to be adopted, or, alternatively, the use of a proprietary tile sealer may be considered. However, tile sealers developed for ceramic tiles may not be suitable for 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.

For colouring cement:sand grout, the pigment (see **2.11.3**) 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 may 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 (see **2.11.3**).

Mineral pigments may 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. Some organic pigments may be suitable for incorporating in epoxide resin-based grouts. With most tiles no problems arise provided surplus coloured grout is cleaned off promptly in accordance with the manufacturer's instructions. However, coloured grouts may 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.

Section 5. Application of mosaics: methods and materials

5.1 General

5.1.1 General

The description of mosaics is given in **2.3**. The recommendations for the application of tiles, including suitable backgrounds and movement joints, given in Section 4 are of equal importance to the success of mosaic installations but some modification is necessary concerning the setting out, preparation of mosaics, placing in position and grouting. 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.

5.1.2 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.

5.1.3 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 **4.1.8.1**.

5.1.4 Mosaic beds

Suitable beds for mosaics are:

a) cement-based adhesive: thin-bed (see **4.2.1**);

b) organic-based adhesives: thin-bed (see **4.2.2**);

c) cement:sand mortar (see **4.2.3**).

NOTE If the background surface to receive the bed and mosaic is not flat and true, the use of adhesive fixing methods may 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 **5.5.1**). The pre-grouting of mesh-backed mosaics is not practical because the mesh may distort or disintegrate.

5.2 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 can 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 will be less noticeable.

The work should be planned to start fixing at the top of the area to be covered (see **5.5.2**).

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.

5.3 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.

5.4 Bedding methods for mosaics

5.4.1 Bedding in adhesives: thin-bed

Both cement-based and organic-based adhesives are suitable and the information given in **4.2.1** and **4.2.2** 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.

5.4.2 Bedding in cement:sand mortar

The mortar mix should be as given in **4.2.3.4** and applied using the technique described in **4.2.3.5.1** 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.

5.5 Application of mosaics

5.5.1 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, it is advisable to mix fine sand with the cement to avoid cracking as the grout dries out. A suitable mix is 1:1 cement:sand by volume.

5.5.2 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.

It is important that horizontal and vertical alignment are 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 will be 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 **5.1.3**.

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.

5.5.3 Grouting of mosaics

The general information given in **4.3** 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.

5.6 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, will affect the shade of the finished work.

Glass mosaics are supplied paper-faced and should always be pre-grouted (see **5.5.1**) before being fixed.

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.

Section 6. Protection, cleaning and maintenance

6.1 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.

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

6.2 Cleaning

6.2.1 General

Adequate instructions from the specifier should be 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.

6.2.2 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 are essential to avoid dust or dirt, which may be on the face of the tiles, being deposited in the joints with resulting discoloration of the grouting[1)].

6.2.3 Unglazed ceramic tiles

Unglazed ceramic tiles may retain a cement film, which is insoluble in water, at the completion of the tiling work. This may 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 is as for glazed tiles (see **6.2.2**).

As a new installation dries out, unglazed ceramic tiles may also develop efflorescence which appears as a white bloom on the surface of the tiles. This will diminish and eventually disappear with repeated washing[1)].

6.2.4 Natural stone tiles

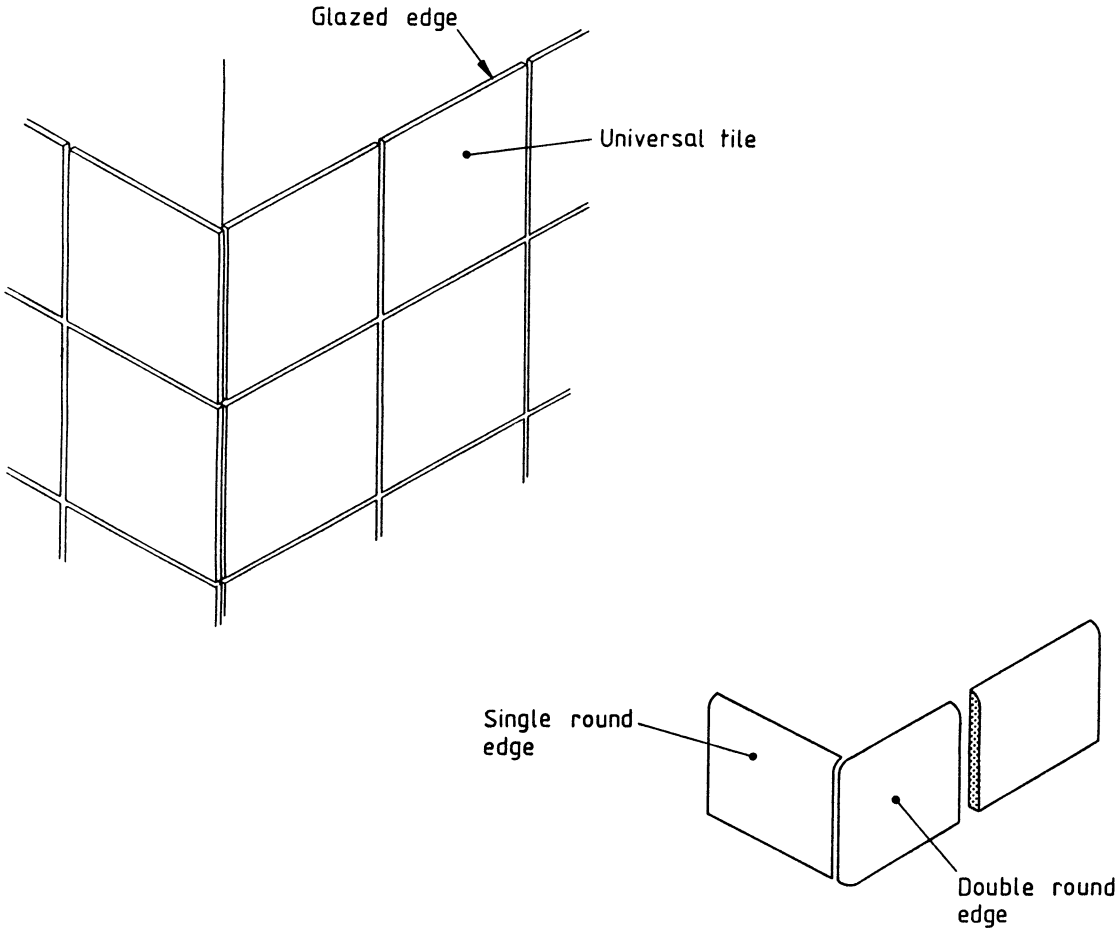
Effective cleaning of natural stone tiles can usually be achieved by normal washing or scrubbing with warm water and a neutral sulfate-free detergent, followed by a final rinsing with clean water.

1) Further information is given in the pamphlet *The Cleaning of Ceramic Tiles* prepared jointly by the British Ceramic Tile Council and the British Institute of Cleaning Science, obtainable from B.C.T.C. Federation House, Station Road, Stoke-on-Trent ST4 2RU.

Annex A (informative)
Ceramic tile fittings

Ceramic tile fittings for use at corners and edges are manufactured to conform to the appropriate parts of BS 6431. The most common types and sizes available are shown in Figure A.1, Figure A.2 and Figure A.3. The tile fittings illustrated indicate only their appearance; individual manufacturers should be consulted about the range of sizes they produce and the availability of any particular size.

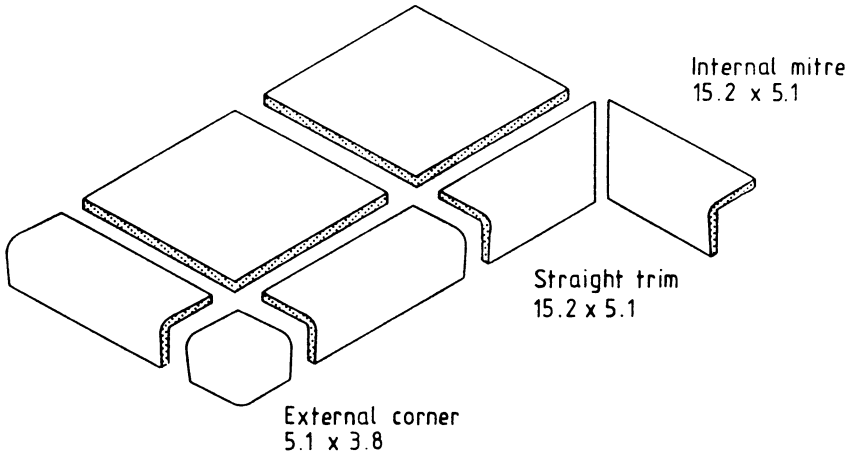
NOTE Modular tile size includes its share of the adjacent joint(s). Non-modular sizes are the nominal manufacturing sizes.



Modular	Non-modular
Co-ordinating size	Nominal size
M 20.0 × 15.0	20.3 × 15.2
M 20.0 × 10.0	15.2 × 15.2
M 10.0 × 10.0	15.2 × 10.8
	10.8 × 10.8
	20.0 × 6.6

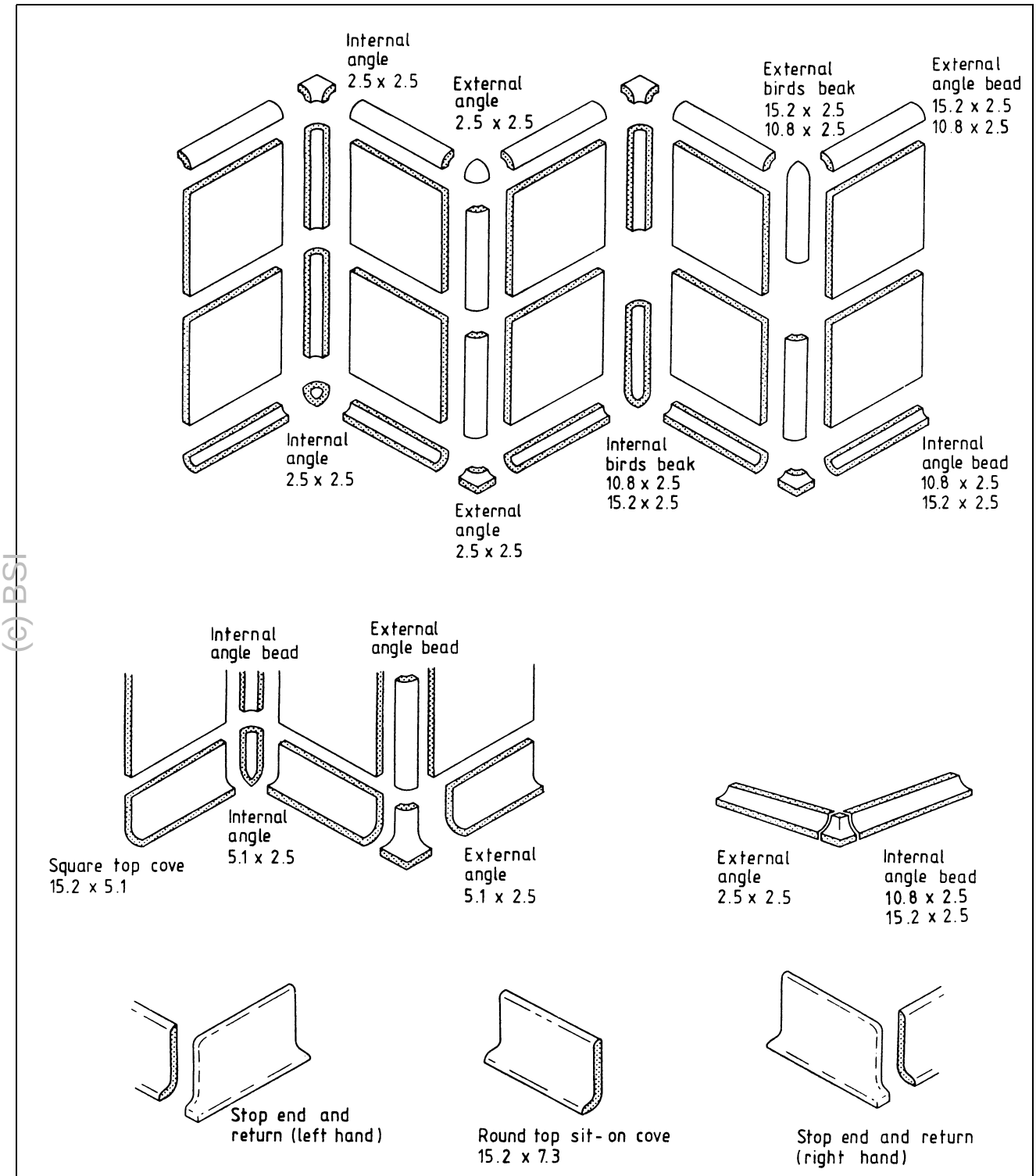
All dimensions are in centimetres.

Figure A.1 — Universal and round edge glazed tile fittings



All dimensions are in centimetres.

Figure A.2 — Worktop trim



All dimensions are in centimetres.

Figure A.3 — Glazed wall tile fittings

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

BS 5385-4 gives recommendations for both wall and floor tiling under the following headings.

Anti-static conditions

Chemical attack

Movement

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

Radioactivity

Sound and thermal insulation

Sterile conditions

Thermal effects (climatic and environmental)

Traffic and load conditions

- compression
- impact
- abrasion
- slipperiness

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
- concrete tanks and service reservoirs
- pools, tanks, and reservoirs of metal construction
- tanks for aggressive liquids
- tanks for liquids at elevated temperatures

List of references (see 1.2)

Normative references

BSI publications

BRITISH STANDARDS INSTITUTION, London

BS 12:1991, *Specification for Portland cements.*
BS 410:1986, *Specification for test sieves.*
BS 443:1982, *Specification for testing zinc coatings on steel wire and for quality requirements.*
BS 729:1971, *Specification for hot dip galvanized coatings on iron and steel articles.*
BS 1191, *Specification for gypsum building plasters.*
BS 1191-1:1973, *Excluding premixed lightweight plasters.*
BS 1191-2:1973, *Premixed lightweight plasters.*
BS 1199 and 1200:1976, *Specifications for building sands from natural sources.*
BS 1230, *Gypsum plasterboard.*
BS 1230-1:1985, *Specification for plasterboard excluding materials submitted to secondary operations.*
BS 1369, S*teel lathing for internal plastering and external rendering.*
BS 1369-1:1987, *Specification for expanded metal and ribbed lathing.*
BS 1485:1983, *Specification for zinc coated hexagonal steel wire netting.*
BS 4027:1991, *Specification for sulfate-resisting Portland cement.*
BS 4551:1980, *Methods of testing mortars, screeds and plasters.*
BS 5224:1985, *Specification for masonry cement.*
BS 5385, *Wall and floor tiling.*
BS 5385-4:1992, *Code of practice for tiling and mosaics in specific conditions.*
BS 5492:1990, *Code of practice for internal plastering.*
BS 5973:1993, *Code of practice for access and working scaffolds and special scaffold structures in steel.*
BS 5980:1980, *Specification for adhesives for use with ceramic tiles and mosaics.*
BS 6100, *Glossary of building and civil engineering terms.*
BS 6100-1, *General and miscellaneous.*
BS 6150:1991, *Code of practice for painting of buildings.*
BS 6431, *Ceramic floor and wall tiles.*
BS 6431-1:1983, *Specification for classification and marking, including definitions and characteristics.*
BS 6431-2:1984, *Specification for extruded ceramic tiles with a low water absorption ($E \leq 3$ %). Group AI.*
BS 6431-3, *Extruded ceramic tiles with a water absorption of 3 % < $E \leq 6$ %. Group AIIa.*
BS 6431-3.1:1986, *Specification for general products.*
BS 6431-3.2:1986, *Specification for specific products (terre cuite, cotto, baldosin catalan).*
BS 6431-4, *Extruded ceramic tiles with a water absorption of 6 % < $E \leq 10$ %. Group AIIb.*
BS 6431-4.1:1986, *Specification for general products.*
BS 6431-4.2:1986, *Specification for specific products (terre cuite, cotto, baldosin, catalan).*

BS 6431-5:1986, *Specification for extruded ceramic tiles with a water absorption of E > 10 %. Group AIII.*

BS 6431-6:1984, *Specification for dust-pressed ceramic tiles with a low water absorption (E ≤ 3 %). Group BI.*

BS 6431-7:1986, *Specification for dust-pressed ceramic tiles with a water absorption of 3 % < E ≤ 6 %. Group BIIa.*

BS 6431-8:1986, *Specification for dust-pressed ceramic tiles with a water absorption of 6 % < E ≤ 10 %. Group BIIb.*

BS 6431-9:1984, *Specification for dust-pressed ceramic tiles with a water absorption of E > 10 %. Group BIII.*

BS 6452, *Beads for internal plastering and dry lining.*

BS 6452-1:1984, *Specification for galvanized steel beads.*

BS 8000, *Workmanship on building sites.*

BS 8000-11, *Code of practice for wall and floor tiling.*

BS 8000-11.1:1989, *Ceramic tiles, terrazzo tiles and mosaics.*

BS 8000-11.2:1990, *Natural stone tiles.*

BS 8212:1988*, Code of practice for dry lining and partitioning using gypsum plasterboard*

Informative references

BSI publications

BRITISH STANDARDS INSTITUTION, London

BS 903, *Methods of testing vulcanized rubber.*

BS 903-A26:1969, *Determination of hardness.*

BS 5262:1991, *Code of practice for external renderings.*

BS 5385, *Wall and floor tiling.*

BS 5385-2:1991, *Code of practice for the design and installation of external ceramic wall tiling and mosaics.*

BS 5385-3:1989, *Code of practice for the design and installation of ceramic floor tiles and mosaics.*

BS 5385-5:1994, *Code of practice for the design and installation of terrazzo tile and slab, natural stone, and composition block floorings.*

BS 6213:1982, *Guide to selection of constructional sealants.*

BS 8000, *Workmanship on building sites.*

BS 8000-3:1989, *Code of practice for masonry.*

BS EN ISO 9000, *Quality management and quality assurance standards.*

Other references

[1] GREAT BRITAIN. SI 94 Construction (Working Places) Regulations 1966. London: HMSO.

[2] GREAT BRITAIN. Factories Act 1961. London: HMSO.

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