

BS 5385-5:2009

Incorporating Corrigendum No. 1



BSI Standards Publication

Wall and floor tiling –

Part 5: Design and installation of terrazzo,
natural stone and agglomerated stone tile
and slab flooring – Code of practice

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Summary of pages

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Foreword

Publishing information

This part of BS 5385 is published by BSI and came into effect on 1 January 2009. It was prepared by Technical Committee B/539, *Ceramic tiles and other rigid tiling*. A list of organizations represented on this committee can be obtained on request to its secretary.

Supersession

This part of BS 5385 supersedes BS 5385-5:1994, which is withdrawn.

Relationship with other publications

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

- Part 1: *Design and installation of internal ceramic, natural stone and mosaic wall tiling in normal conditions – Code of practice*;
- Part 2: *Design and installation of external ceramic and mosaic wall tiling in normal conditions – Code of practice*;
- Part 3: *Design and installation of internal and external ceramic and mosaic floor tiling in normal conditions – Code of practice*;
- Part 4: *Design and installation of ceramic and mosaic tiling in special conditions – Code of practice*.

Information about this document

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

This is a full revision of the standard, and introduces the following principal changes:

- a) guidance on composition block flooring has been deleted and guidance on agglomerated stone has been included;
- b) updated references to take account of the new harmonized European product standards (BS EN 12004 (Adhesives), BS EN 12057 and BS EN 12058 (Natural stone products), BS EN 13748 (Terrazzo tiles) and their supporting suites of test methods);
- c) updated specifications for cements, including European Standard specifications for cements which incorporate a number of cement types and standard strength classes;
- d) updated specifications for sands (aggregates), which are now provided by European Standards for the specification of aggregates (throughout this standard, “sand”, the term commonly used in the UK building and tiling industry, is interchangeable with the term “aggregate” that is used in the European specifications).

Use of this document

It has been assumed in the preparation of this British Standard that the execution of its provisions will be entrusted to appropriately qualified and experienced people, for whose use it has been produced.

Hazard warnings

WARNING. This British Standard calls for the use of substances and/or procedures that can be injurious to health if adequate precautions are not taken. It refers only to technical suitability and does not absolve the user from legal obligations relating to health and safety at any stage.

As a code of practice, this part of BS 5385 takes the form of guidance and recommendations. It should not be quoted as if it were a specification and particular care should be taken to ensure that claims of compliance are not misleading.

Any user claiming compliance with this part of BS 5385 is expected to be able to justify any course of action that deviates from its recommendations.

Presentational conventions

The provisions in this standard are presented in roman (i.e. upright) type. Its recommendations are expressed in sentences in which the principal auxiliary verb is “should”.

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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

1 Scope

This part of BS 5385 gives recommendations for the design and installation of terrazzo tile and slab and natural stone internal and external floorings, and contains recommendations covering the laying of agglomerated stone, a cast manufactured item containing natural stone that is subsequently sawn to size.

The types of bedding methods that can be used and their suitability are given; as well as recommendations for the protection, cleaning and maintenance of the finished floor surface.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS 1521, *Specification for waterproof building papers*

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

BS 4483:2005, *Steel fabric for the reinforcement of concrete – Specification*

BS 5268-2, *Structural use of timber – Part 2: Code of practice for permissible stress design, materials and workmanship*

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

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

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

BS 6100-1, *Building and civil engineering – Vocabulary – Part 1: General terms*

BS 6100-9, *Building and civil engineering – Vocabulary – Part 9: Work with concrete and plaster*

BS 6213, *Selection of construction sealants – Guide*

BS 6399-1, *Loading for buildings – Part 1: Code of practice for dead and imposed loads*

BS 8000-11.2, *Workmanship on building sites – Part 11: Code of practice for wall and floor tiling – Section 11.2: Natural stone tiles*

BS 8102:1990, *Code of practice for protection of structures against water from the ground*

BS 8203, *Code of practice for installation of resilient floor coverings*

BS 8204-1, *Screeds, bases and in situ floorings – Part 1: Concrete bases and cement sand levelling screeds to receive floorings – Code of practice*

BS 8204-3:2004, *Screeds, bases and in situ floorings – Part 3: Polymer modified cementitious levelling screeds and wearing screeds – Code of practice*

BS 8204-5:2004, *Screeds, bases and in situ floorings – Part 5: Mastic asphalt underlays and wearing surfaces – Code of practice*

BS 8204-7:2003, *Screeds, bases and in situ floorings – Part 7: Pumpable self-smoothing screeds – Code of practice*

BS EN 197-1:2000, *Cement – Part 1: Composition, specifications and conformity criteria for common cements*

BS EN 450-1, *Fly ash for concrete – Part 1: Definition, specifications and conformity criteria*

BS EN 459, *Building lime – Part 1: Definitions, specifications and conformity criteria*

BS EN 934-2, *Admixtures for concrete, mortar and grout – Part 2: Concrete admixtures – Definitions, requirements, conformity, marking and labelling*

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

BS EN 12004:2007, *Adhesives for tiles – Definitions and specifications*

BS EN 12057, *Natural stone products – Modular tiles – Requirements*

BS EN 12058, *Natural stone products – Slabs for floors and stairs – Requirements*

BS EN 12326-1, *Slate and stone products for discontinuous roofing and cladding – Part 1: Product specification*

BS EN 12878, *Pigments for the colouring of building materials based on cement and/or lime – Specifications and methods of test*

BS EN 13139:2002, *Aggregates for mortar*

BS EN 13707, *Flexible sheets for waterproofing – Reinforced bitumen sheets for roof waterproofing – Definitions and characteristics*

BS EN 13748-1:2004, *Terrazzo tiles – Part 1: Terrazzo tiles for internal use*

BS EN 13748-2, *Terrazzo tiles – Part 2: Terrazzo tiles for external use*

BS EN 14647:2005, *Calcium aluminate cement – Composition, specifications and conformity criteria*

BRE IP 10/00 (2000), *Flooring, Paving and Setts – Requirements for safety in use*

3 Terms and definitions

For the purposes of this Part of BS 5385 the terms and definitions given in BS 6100-1, BS 6100-6 and the following apply. An illustration of some selected definitions is shown in Figure 1.

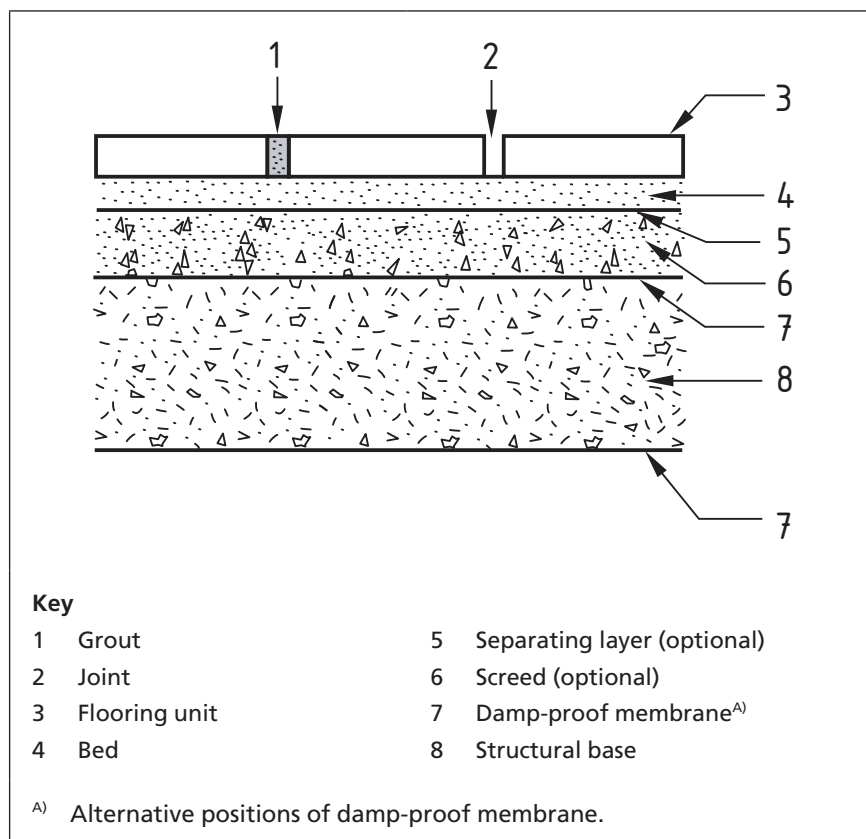
3.1 light loading

low density pedestrian traffic with possibly lightweight soft-wheeled trolleys (e.g. domestic and office locations)

3.2 heavy loading

high density pedestrian traffic and/or a static, moving, dropped or dragged heavy load (e.g. in shopping malls, industrial and engineering premises and garages for heavy vehicles)

Figure 1 Illustration of definitions



4 Exchange of information and time schedules

NOTE Clause 4 deals with the exchange of information for the whole floor, including the flooring, bed, base and screed (if any).

4.1 Exchange of information

The working drawings and specifications should be prepared in sufficient detail to afford proper guidance in the preparation of estimates and the execution of the work. At the tendering stage the following information should be provided by the contract administrator and should be documented.

- a) *Site*. Location and means of access.
- b) *Building*. Nature of building, assessment of type and density of traffic, particulars of corrosive or other potentially damaging conditions to which the installation might be subjected in service.
- c) *Floor*. Structure of floor, type of damp-proof membrane and its location within the floor construction, details of screed (including its surface regularity and the category of soundness required), curing and drying times, particulars of any floor warming installation, separating layer, movement joints, finished floor levels and falls with permissible deviations.

- d) *Associated work.* Services embedded in or passing through the floor, skirtings and abutments, junctions with other adjacent flooring.
- e) *Finishes.* Type of finishing product, bedding and jointing requirements and required surface plane.
- f) *Contract.* Details, if the work is to be completed in any specific order or in sections.
- g) *Health and safety.* Information on articles and substances for use during the work that are liable to be a health hazard.
- h) *Time schedule.* A time schedule for the progress of the work.
- i) *Testing.* Details of any compliance testing required.

4.2 Provision of utilities, facilities and materials

4.2.1 General

To prevent misunderstanding, particularly at the tendering stage, and to avoid possible situations detrimental to installation, it should be made clear whether or not the following 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 areas;
- c) adequate artificial lighting (if required) (see 4.2.2);
- d) safe means of access and places of work;

NOTE 1 Safety considerations might include suitable scaffolding and staging, conforming to BS 5974.

- e) unloading and hoisting facilities;

NOTE 2 Attention is drawn to:

- *Lifting Operations and Lifting Equipment Regulations 1998 [1]*
- *Manual Handling Operations Regulations 1992 [2].*

- 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 5.4 and 5.5;
- i) tiles, adhesives, grouts and movement joint materials.

4.2.2 Lighting on site

At the design stage, the lighting type, direction and intensity to be used during installation should be specified to ensure that work is completed in similar conditions to those in which the finished installation is intended to be viewed.

NOTE If lighting conditions during installation are different from those envisaged for the completed installation, the appearance of the finished floor might be different from that originally intended.

4.3 Time schedule

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

Where a screed is being laid, a minimum of three weeks should be allowed for it to dry. The screed should be covered with impervious sheeting for at least the first seven days of this three week period to prevent rapid surface drying in order to reduce the possibility of cracks appearing. These time periods are for good drying conditions (20 °C and 65% relative humidity). In the UK a longer drying period is normally required.

The drying time required should reflect the type and thickness of the screed and the on-site drying conditions. Where the flooring unit is to be directly bonded to the screed with adhesive, guidance in BS 8204-1 and BS 8203 should be followed.

NOTE Typically, one day of drying can be allowed for each millimetre of (screed) thickness for the first 50 mm, followed by an increasing time for each millimetre above this thickness. It is therefore reasonable to expect a levelling screed 50 mm thick drying under good conditions, to dry sufficiently in about 2 months.

Where underfloor heating is present in the sub-floor then the guidance in Clause 7 should be followed.

Where insufficient drying time and/or unsuitable drying conditions exist, the stone (and any adhesive) should be isolated from the screed below e.g. by using an uncoupling membrane. If at the design stage (see Clause 6) it becomes apparent that only shorter drying periods are available the stone should be set on an unbonded, reinforced semi-dry cement sand bed.

The schedule should also allow time for all cutting of holes and chases in the floor that is to receive the tile bed.

Provision should be made for adjustment to the schedule to allow for suspension of operations due to frost or other unfavourable weather or other conditions that jeopardize the safety of workers and/or the success of the installation.

Alternatively, consideration should be given to the possibility of providing a protective enclosure, e.g. cocooning, to enable work to continue during unfavourable conditions.

5 Materials

5.1 Transport and storage

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

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

5.2 Terrazzo tiles and slabs for internal and external floorings

5.2.1 Terrazzo tiles

The designer should specify that only terrazzo tiles conforming to BS EN 13748-1 for internal floorings and BS EN 13748-2 for external floorings and having a wear layer after grinding of at least 6 mm are to be used.

5.2.2 Terrazzo pre-cast slabs

5.2.2.1 General

The following designation of pre-cast units should be considered by the designer for ordering purposes.

- a) The units should be described as having either a Type A surface for use as stair treads, landings and pavings in positions subject to concentrated traffic or a Type B surface for all other units.
- b) The size of the aggregate in the facing layers, the dimensions and shape of the unit and the surface finish required should be stated. The colour and type of the surface and the size of aggregate should be designated by reference to the manufacturer's sample.
- c) The sizes of the terrazzo aggregate for the purpose of ordering units should be described as follows:
 - 1) up to 5 mm;
 - 2) up to 12 mm;
 - 3) up to 25 mm;
 - 4) random;
 - 5) pebble marble.

Selection of aggregate sizes should take into consideration the finished thickness of the unit.

5.2.2.2 Manufacture

The following characteristics of the manufacture of materials to be used should be considered at the design stage.

- a) *Terrazzo facing.* The terrazzo mix consists of cement and a suitably graded aggregate mixed in a dry state to which the minimum amount of water is added to provide optimum compaction having regard to the method of consolidation being used. The finished terrazzo facing should have a minimum thickness of 10 mm for wearing surfaces and 6 mm for non-wearing surfaces. Where the terrazzo forms an integral part of the structural design the provisions of BS 8204-1 should apply.
- b) *Concrete backing.* The backing concrete should conform to the recommendations for precast structural concrete given in BS 8204-1.
- c) *Fabrication.* Units are cast in suitable moulds using concrete faced with terrazzo on one or more faces or, in special cases, terrazzo alone. The mixes as laid in the moulds should be adequately compacted. The terrazzo facing and the backing or core concrete, where applicable, should be cast monolithically. Where units

are designed for bedding, keyed concrete is used. When the edges of units are required to be terrazzo faced, care should be exercised in casting to ensure that the minimum thickness specified is obtained and that an adequate bond is achieved with the backing concrete. Where structural design considerations require, reinforcement should be accurately positioned within the unit and adequately covered, all in accordance with BS 8204-1. Care should be taken to avoid displacement of the reinforcement during vibration and, if necessary, terrazzo bobbins might be used. The surface is treated by grinding, ensuring sufficient time is allowed between casting and grinding to allow the unit to attain adequate hardness to enable the face to be ground without dislodging the surface aggregate. Any slight surface imperfections are filled by grouting with a neat cement paste coloured to match the original mix and well worked into the surface. The excess of grouting coat is removed by grinding using a stone not coarser than No. 80 grit, no sooner than 72 h after the surface has been grouted. When the operation has been completed the surface is thoroughly washed.

Because the thickness of flooring units increases in proportion to their length, thicknesses should be as follows:

- 1) internal sills, precast treads, fully bedded, up to 1.5 m long 40 mm thick;
 - 2) from over 1.5 m to 2 m long 45 mm thick;
 - 3) from over 2 m to 2.5 m long 50 mm thick;
 - 4) shower trays made to dimensions 750 mm × 750 mm a minimum of 40 mm thick at the outlet.
- d) *Inserts.* Non-slip inserts for pavings and treads should, by agreement between the purchaser and supplier, be set into the wearing surface of the unit. They might be cast in or applied after manufacture, subject to being of a suitable cross section, being securely fixed in position and dimensionally stable. Where cramps, dowels or other fixing devices are required, these should be of non-ferrous metal or non-corrosive stainless steel securely cast into the core of the unit; handling devices might be of alternative material suitable for their purpose.
- e) *Finish.* Units should be supplied either:
- 1) ground and grouted for site finishing;
 - 2) ground, grouted and re-ground to a fine grit finish; or
 - 3) ground, grouted and polished as agreed between the purchaser and the supplier.
- f) *Uniformity of colour.* The overall colour of units is practically uniform for any complete section of a contract, except where special random effects are ordered.

NOTE 1 Owing to variations in the colour of aggregates and cement, and in the processes of manufacture, slight variations in the colour of pre-cast units are unavoidable.

- g) *Tolerances.* Units should not exceed the basic sizes agreed between the purchaser and the supplier and tolerances should be related to work size as follows:

- 1) thickness: ± 1.5 mm on free standing units and ± 3 mm on bedded units;
 - 2) length and width: ± 1.5 mm up to 1.5 m and ± 3 mm above 1.5 m and up to 3 m.
- h) *Flatness, twist, winding and bow.* Units should have a deviation of less than 3 mm from a 1.5 m straight edge placed in any position on a nominally plane surface. For facing slabs the permitted bowing should be all one way on all units supplied for any separate area of cladding as agreed between the supplier and the purchaser.
- i) *Regularity of plan shape.* Units should have a deviation of less than 1.5 mm from the intended true line of the unit in any direction.

The manufacturer's advice should be obtained when close tolerances are required, as those which can be achieved depend on the shape of the unit, the position of any projections, stiffness of the mould, method of assembly and the number of castings from each mould. For irregular, curved or specially shaped units, dimensions and tolerances should be clearly defined at the design stage.

NOTE 2 Particular attention is drawn to the possible difficulties created by an accumulation of tolerances.

- j) *Freedom from defects.* Units should have an even distribution of aggregates over the face with the profiles true and the face free from flaking and/or crazing.
- k) *Age at delivery.* Units should not be delivered until a period of 28 days from the date of manufacture has elapsed.
- l) *Recommendations for handling and storage on site.* The manufacturer's advice for handling and storage should be followed, and as a minimum:
- 1) units should be stacked under cover on clean, level, dry stacking areas;
 - 2) to avoid bowing and/or deflection under self-weight, units should be stacked vertically on edge and non-staining laths or battens should be placed between the units;
 - 3) to avoid discoloration, units should not be prematurely delivered to site nor come into contact with rope, straw, hardwood or other material likely to cause staining, nor should they be exposed to direct sunlight;
 - 4) units should be protected from physical damage both before and after fixing.

5.3 Natural stone for internal and external floorings

5.3.1 General

NOTE 1 BS EN 12440 provides the classification and the correct identification of stone types and origin; however, for the purposes of this standard, the simplified descriptions in Annex A can be considered.

At the planning stage all stone types should be considered individually for their merits in use as flooring.

NOTE 2 There are many different classification schemes for stone, which have prompted the industry to simplify descriptions. This has led to many problems when, for instance, a stone laid as a granite is actually found to be a different stone type altogether and does not perform as expected.

When using natural stone for flooring, consideration should be given to the level of traffic and the desired finished effect.

5.3.2 Stone unit sizes

The suitability of stone unit sizes for various usages should be considered at the design stage as follows:

- a) *Domestic.* Tiles and slabs with calibrated thickness for bedding on adhesive not exceeding 600 mm × 600 mm on face in granite, limestone, marble and slate should be used. Where units 600 mm × 600 mm on face and less than 20 mm thick are offered their ability to accept the imposed loads should be checked. Units $\nless 600\text{ mm} \times 600\text{ mm}$ on face and less than 20 mm thick are offered their ability to accept the imposed loads should be checked. Units $\nless 300\text{ mm} \times 300\text{ mm}$ on face in granite, hard limestone, marble and slate 10 mm thick are suitable for use on existing timber floors.
- b) *Domestic and light commercial.* Calibrated tiles and slabs are suitable for bedding on adhesive. Uncalibrated slabs should be bedded in sand:cement or thick bed adhesive.
- c) *Commercial.* On floors with occasional over run of light maintenance vehicles, slabs not exceeding 600 mm × 600 mm with a minimum thickness of 20 mm and uncalibrated tiles and slabs for setting on semi-dry cement sand beds should be used.

Due to the suitability of units with a length to width ratio exceeding 3:1 being dependent on the material, and as they require special manufacture, handling and bedding, manufacturers' advice should be obtained for these units.

5.3.3 Selection of natural stone

5.3.3.1 General

When selecting natural stone flooring at the design stage, apart from appearance the following should also be considered:

- a) proven track record in a similar environment;
- b) that the stone samples are representative of that to be used, having obtained information from the supplier about any significant variation in appearance that such stone can exhibit;
- c) abrasion and slip resistance;
- d) flexural strength;
- e) shape of stone unit selected;
- f) likely loading conditions.

When the application is unusually demanding or if the designer or installer is not familiar with the type of stone, greater testing (including a petrographic examination) should be carried out.

Granite, marble, limestone, sandstones and slate are available as calibrated tiles, but consideration should be given at the design stage to the required thickness of the flooring unit based on its end use and the bedding technique employed.

NOTE 1 Slab sizes in various thicknesses greater than 12 mm are available, but selection might be limited by the characteristics of the stone, handling and transportation requirements. Due to manufacturing tolerances, smaller slabs and tiles can be laid with greater accuracy and economy, whilst thin tiles and slabs with large facial size might bow during installation.

NOTE 2 The slip resistance of natural stones varies, depending on the mechanically applied surface finish, and whether the stones polish or roughen in use.

Known absorbent stone should be tested for the effects of spilt liquids and an appropriate impregnator applied.

NOTE 3 Some natural stones are absorbent and might be susceptible to staining, e.g. from spilled liquids and absorbed dirt.

NOTE 4 All natural stone will benefit from the application of an impregnator to assist in the cleaning.

Surface treatment of stone might affect the slip resistance, either negatively or positively, and should be considered at the design stage.

Surface treatments should not be used to enhance a low-quality stone.

Consideration should be given at the design stage to the susceptibility of light coloured absorbent stone bedded in conventional mortars and adhesives to water staining due to moisture, minerals and soluble salts.

NOTE 5 The use of rapid drying mortars and adhesives can reduce the risk of water staining (see 9.6.5).

Special attention should be given at the design stage to laying stone floors over any form of underfloor heating (see Clause 7) or onto an existing timber floor (see 6.3.4).

Natural stone tiles are available in a range of sizes and thicknesses, and consideration should be given at the design stage to the thickness of units of any given size as this can be dictated by the type of stone used. Calibrated units up to 0.36 m² can normally be fixed by the adhesive methods described in 9.6.5, and larger units might require different bedding procedures (e.g. see 9.6.1 and 9.6.2), however, advice should be obtained from the supplier or manufacturer.

Slate used should conform to the test requirements in BS EN 12326-1.

5.3.3.2 Sample unit size

A reference sample should be an adequate number of pieces of natural stone of sufficient size to indicate the general appearance of the finished work. The dimensions of individual pieces should be at least 100 mm × 100 mm and should indicate the range of appearance regarding the colouring, the vein pattern, the physical structure and the surface finish. In particular the reference sample should show specific characteristics of the stone, such as holes for travertine, worm holes for marble, glass seams, spots, crystalline veins.

NOTE The reference sample does not imply strict uniformity between the sample itself and the actual supply; natural variations can always occur.

If the processing of the stone involves the use of patching, fillers or other similar products for natural holes, faults or cracks, then the reference sample should similarly display the impact of the same on the finished surface.

All the characteristics shown by the reference sample should be considered typical of the stone and not as flaws, therefore they should not become a reason for rejection, unless their concentration becomes excessive and the typical character of the stone is lost.

The name and address of the producer or the supplier, as well as the denomination of the stone in accordance with the recommendations in BS EN 12057 and BS EN 12058 should be indicated on the reference sample.

Any comparison between production sample and reference sample should be carried out by placing the reference sample against the production sample and viewing them at a distance of about two metres under normal daylight conditions and recording any visible differences in the characteristics of the stones (as BS EN 12057, Figure 2).

5.4 Cement and lime

5.4.1 General

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

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

5.4.2 Cement for cementitious levelling screeds

The cement used for cementitious levelling screeds should be one of the following.

- a) Portland cement (CEM I) conforming to BS EN 197-1.
- b) Sulfate-resisting Portland cement conforming to BS 4027.
- c) Portland slag cement (CEM II/A-S & CEM II/B-S) conforming to BS EN 197-1.
- d) CEM I cement manufactured in the cement mixer from Portland cement and ground granulated blast furnace slag (ggbs) conforming to BS 6699 with a mass fraction of 6% to 34% of combination of ggbs.
- e) Combinations produced in the concrete mixer from Portland cement (CEM I) conforming to BS EN 197-1 and pulverized-fuel ash conforming to BS EN 450-1, where the proportions and properties conform to CEM II/A-V or CEM II/B-V of BS EN 197-1:2000, except Clause 9 of that Standard.
- f) Calcium aluminate cement (high alumina cement) conforming to BS EN 14647.
- g) Proprietary cements, designed to provide rapid drying and hardening properties, for which no British Standard exists. Reference should be made to the manufacturers for guidance on their use.

NOTE 1 Cements and combinations in a) to d) of strength class 42.5 have a compressive strength equivalent to that of ordinary Portland cement conforming to BS EN 197-1.

NOTE 2 Limited experience is available with the use of other types and grades of cement for cement:sand levelling screeds. For example, a cement of strength class 32.5 would probably require an increase in cement content of approximately 10%.

NOTE 3 There are no British Standards for other additions and their suitability might be ascertained from experience of their use in similar mixes.

5.4.3 Cement for cement:sand mortar beds

The cement used for cement:sand mortar beds should be one of the following.

- a) Portland cement (CEM I) conforming to BS EN 197-1.
- b) Sulfate-resisting cement conforming to BS 4027.
- c) Calcium aluminate cement (high alumina cement) conforming to BS EN 14647.

5.4.4 Lime for mortar beds

Lime used should conform to BS EN 459.

Lime used in mortars for gauging with ordinary Portland cement (OPC) should be measured either as a putty prepared from quicklime, hydrated lime or by product lime. Hydrated lime should be used by weight; lime putty should be used by volume.

5.5 Sand

5.5.1 General

Sand used should be protected from rain, frost and any form of contamination.

5.5.2 Sand for cement:sand screeds and mortar beds

Sand used for cement:sand screeds should be as described in BS EN 13139:2002, Annex B.

5.5.3 Sand for grouting

5.5.3.1 For joints of nominal widths 6 mm and above

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

5.5.3.2 For joints of nominal widths 3 mm to 6 mm

Sand used for grouting joints of nominal widths 3 mm to 6 mm should conform to the grading limits given in Table 1.

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

Table 1 Sands for grout for joints 3 mm to 6 mm wide

BS 410-1 sieve	Percentage by mass passing BS 410-1 sieves (%)
mm	
2.36	100
1.18	95 to 100
μm	
600	80 to 100
300	30 to 100
150	0 to 60
75	Not greater than 7

5.6 Water

Water used should be clean and free of materials deleterious to mortar beds in fresh and hardened states (see BS EN 1008). Drinking water is suitable. All containers used for storing or carrying water should be clean.

5.7 Adhesives

Adhesives are proprietary materials and those selected should conform to BS EN 12004.

Cementitious adhesives (BS EN 12004:2007, Type C) should be used as beds for stone tiles and slabs.

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

NOTE 1 Cementitious adhesives are usually proprietary compositions in dry powder form containing cement as the basic ingredient and generally require mixing on site with water or aqueous polymer dispersion.

NOTE 2 Reaction resin adhesives are generally supplied as pre-gauged two component proprietary products, the two components (resin and hardener) being mixed together immediately prior to use on site.

5.8 Admixtures

5.8.1 Admixtures for cement:sand mortar beds and screeds

Admixtures for cement:sand mortar beds and screeds should conform to BS EN 934-2.

5.8.2 Admixtures for adhesives

A polymer additive or other liquid or powdered product should be incorporated into cementitious adhesives to provide greater adhesion, improved resilience or some degree of water resistance. Admixtures should be used strictly in accordance with the manufacturer's instructions and they should not be added to a cementitious adhesive unless approved by the manufacturer of the adhesive.

5.9 Reinforcement

Where light reinforcement is required in a screed or bed it should consist of steel fabric conforming to BS 4483:2005, reference D49 or D98.

Where reinforcement does not have to provide a structural function, adequate tensile stresses can be absorbed by reinforcement of 2.5 mm or 5 mm diameter wire in mesh sizes of 50 mm × 50 mm, 100 mm × 100 mm, 200 mm × 100 mm or 200 mm × 200 mm depending on screed or bed thickness.

Where heavier reinforcement is necessary, i.e. in screeds constructed for structural purposes, it should conform to BS 4483.

5.10 Bonding agents

Bonding agents should be considered where a high level of adhesion of screeds and/or beds to bases is required.

Bonding agents based on polyvinyl acetate or any other polymer affected by moisture should not be used in wet or external locations.

NOTE Manufacturers recommend particular grades and methods of application depending on the materials involved and service conditions, e.g. flooring in heavy duty areas, external applications.

5.11 Separating layers

5.11.1 Polyethylene film

Polythene film should be used in preference to building paper or bituminous felt and should conform to BS 3012. In most conditions a 500 gauge (0.125 mm) polythene film should be used.

5.11.2 Building paper

Building paper should be selected from those specified in BS 1521.

5.11.3 Bituminous felt

Bituminous felt should be selected from those specified in BS EN 13707.

NOTE Bituminous felt might not be suitable for use with natural stone as the oils present might leach through the sand cement screed and bed and bleed in to the stone.

5.12 Sealants and back-up materials for movement joints

5.12.1 Sealants

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

NOTE Flexibility of sealant materials are included in Table C.1. Suitable materials for movement joints in flooring are included in Table C.2.

The selection of the most suitable materials depends upon design considerations (see Clause 6) and the manufacturer's advice should be taken into account.

5.12.2 Back-up materials

Back-up materials should be compressible materials that do not force out the sealant when the joint closes. Materials used should support the sealant and not release bituminous or oily products.

NOTE Suitable materials include cellular rubber and plastics, such as cellular polyethylene, and cork boards, which are available in strip form (see 5.13 and 8.1.6).

5.13 Pre-formed strips

Pre-formed strips are suitable for use in stress-relieving or compression joints where a watertight seal is not critical; cork and cork/rubber compounds strips should be used in light traffic areas; synthetic rubber strips with metal edged supports and PVC should be used in areas more heavily trafficked.

5.14 Grouts

5.14.1 General

Grouts should have good working characteristics, low shrinkage and good adhesion to the sides of the tiles.

NOTE 1 Additional properties might assume special importance, for example, impermeability; resistance to water, heat, cleaning agents and chemical attack; resistance to mould growth and bacteria; resilience and compressibility.

NOTE 2 Flexibility of joint materials is given in Table C.2.

NOTE 3 Sands suitable for grouts are given in 6.3.3.

Proprietary grout materials should be stored and used in accordance with the particular manufacturer's instructions.

5.14.2 Pigments

Pigments should be inorganic and compatible with the grouting materials.

Pigments for cement:sand or cement-based grouts should conform to BS EN 12878.

NOTE Coloured grouts cannot be expected to retain pristine colour and appearance after wear.

5.14.3 Admixtures for grouts

COMMENTARY ON 5.14.3

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

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

6 Design

6.1 General

Solid and suspended floor constructions could be affected by the following factors, and relative importance of these factors should therefore be assessed at the design stage so that due allowance is made for their possible effect on the finished floor:

- a) the load it has to support;
- b) the type of tile used;
- c) the resistance it offers to the passage of liquid water or water vapour either from above or from below (see 6.5);
- d) size changes produced by variations in moisture content and temperature within the floor and the attack of various corrosive agents, e.g. in chemical plants and industrial premises.

Where possible, selection of the type of flooring including its bed should be made at the design stage so that the appropriate depth can be allowed between the base and the finished floor surface.

NOTE The variety of thicknesses in and between flooring units and beds is considerable (see 8.3).

The flooring proposed should be suitable for the conditions contemplated. The anticipated loading likely to occur and the size of the units should be considered.

Where there are specific functional or environmental considerations, reference should be made to BS 5385-4.

6.2 Load considerations

At the design stage, the maximum load the floor might support should be considered, including the flooring installation, and reference should be made to BS 6399-1. Where an existing floor is to be covered by the materials described in Clause 5 a check should be made to ensure that the floor is sufficiently strong and rigid to accept the added load, particularly if the floor is of timber construction (see 6.3.4).

6.3 Bases

6.3.1 General

Concrete and cement:sand screeds are the most common bases over which terrazzo tiles and slab and natural stone floorings are laid but other bases might be encountered, namely timber (see 6.3.4) and asphalt (see 6.3.9). In refurbishing work, it might sometimes be necessary to apply new finishes over existing floors such as ceramic tiles, terrazzo, granolithic, stone, etc. Before the flooring is laid, the following should be checked:

- a) that the correct falls have been incorporated in the base, where required;
- b) that the base is free from contamination, loose areas and significant cracks;
- c) that the base is true to the specified plane (see 9.4).

NOTE Bases suitable to receive flooring and the beds recommended in each case are summarized in Table 2.

Table 2 Suitability of flooring beds for different bases

Base	Cement:sand mortar and cement:lime:sand mortar bonded to the base	Cement:sand semi-dry mix		Adhesives
		Bonded	Unbonded ^{A)}	
New concrete (less than 6 weeks old) (see 6.3.2)	U	U	S	U
New screed (less than 3 weeks old) (see 6.3.3)	U	U	S	U
Mature concrete (see 6.3.2)	S	S	S	S
Mature screed (see 6.3.3)	S	S	S	S
Screed over suspended floor or underfloor heating	U	U	S	C
Suspended in situ concrete				
Rigid and new (less than 6 weeks old)	U	U	S	U
Rigid and mature	S	S	S	S
With significant deflection	U	U	S	C
Timber (see 6.3.4)	U	U	U	C
Asphalt (see 6.3.9)	U	U	S	C
Existing hard floor finishes after preparation (see 6.3.10)				
Terrazzo	C	C	S	C
Unglazed ceramic tile	C	S	S	S
Glazed ceramic tile	C	U	S	C
Granolithic topping	C	C	S	S
Natural stone	C	C	S	S

Key

S Suitable

U Unsuitable

C Confirm suitability with tile or slab manufacturer or supplier

^{A)} Unbonded beds are unsuitable for heavy traffic conditions but see 6.4.2.

In new work the plane of the base in relation to that of the finished floor surface should be specified; usually this is possible only if the flooring units and the appropriate beds are selected at the design stage. The level of the base surface in relation to the finished floor surface should be such that the bed can be of the recommended thickness uniformly throughout the installation.

NOTE An exception can be made when using a semi-dry mix bed (see 9.6.2.4) as this can be applied in varying thicknesses, subject to the minimum of 25 mm, to overcome irregularities and to form falls. The recommended maximum and minimum final thicknesses of beds and their suitability under different floorings are given in Table 3.

In refurbishing work, the new floor surface might be higher than the original and the effect on existing features such as channels, outlets, skirtings, doorways etc. should be determined.