



BSI Standards Publication

Wall and floor tiling

Part 3: Design and installation of internal and external ceramic and mosaic, natural stone and terrazzo flooring, and internal agglomerated stone flooring in normal conditions – Code of practice

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Summary of pages

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Foreword

Publishing information

This British Standard is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on 31 May 2024. 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 the committee manager.

Supersession

This part of BS 5385 supersedes [BS 5385-3:2014](#) and [BS 5385-5:2009](#), which are withdrawn.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 ceramic natural stone and mosaic wall tiling in normal internal conditions – Code of practice;
- Part 2: Design and installation of external ceramic and mosaic wall tiling in normal conditions – Code of practice; and
- Part 4: Design and installation of ceramic and mosaic tiling in special conditions – Code of practice.

Information about this document

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

- a) inclusion of natural stone, resin agglomerated stone and terrazzo;
- b) inclusion of calcium sulfate-based boards;
- c) recommendations on movement joints have been updated;
- d) inclusion of a subclause on steps, stairs and slopes (see [6.2.4](#));
- e) inclusion of a subclause on light reflectance values (see [6.2.5](#));
- f) inclusion of a subclause on the safe handling of materials (see [6.2.6](#));
- g) inclusion of slabs to pedestals; and
- h) updated recommendations on slip resistance.

Assessed capability. Users of this British Standard are advised to consider the desirability of quality system assessment and registration against the appropriate standard in the BS EN ISO 9000 series by an accredited third-party certification body.

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Users may substitute any of the recommendations in this British Standard with practices of equivalent or better outcome. Any user claiming compliance with this British Standard is expected to be able to justify any course of action that deviates from its recommendations.

Presentational conventions

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

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

Where words have alternative spellings, the preferred spelling of the Shorter Oxford English Dictionary is used (e.g. “organization” rather than “organisation”).

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Attention is drawn to the following statutory regulations:

- Building and Construction Regulations under the Factories Act 1961 [1];
- Lifting Operations and Lifting Equipment Regulations (LOLER) 1998 [2];
- Manual Handling Operations Regulations 1992 [3].

Section 1 General

1 Scope

This part of BS 5385 specifies recommendations for the design, installation and maintenance of floor tiling using ceramic tiles, mosaic, terrazzo tile and slab and natural stone internal and external floorings, and agglomerated stone for internal flooring.

NOTE 1 Tiles and slabs can be installed on concrete, cement and sand screed, calcium sulfate-based screeds, timber, flooring grade asphalt or existing hard floor finishes in normal conditions, using the methodology detailed in this British Standard. In addition, terrazzo and natural stone slabs can be laid on a cement:sand or mortar bed. For special conditions, see [BS 5385-4](#). Tile fittings for use as skirting, step treads and channels are given in [Annex A](#).

NOTE 2 Stone tiles and slabs selected for use as external flooring laid only on an adhesive bed are limited to balconies, roof terraces and patios in residential applications. For all other external applications for natural stone flooring/paving, see [BS 7533-101](#).

NOTE 3 Tiles and slabs can be installed on appropriate acoustic floors and pedestal systems.

NOTE 4 Where the floor 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, see [BS 5385-4](#).

NOTE 5 The special conditions described in [BS 5385-4](#), e.g. swimming pools, shower areas, etc. are given in [Annex B](#). [Annex C](#) specifies recommendations for tiling onto underfloor heated substrates and [Annex D](#) contains information on pumped calcium sulfate-based screeds. Recommendations for the design and laying of levelling screeds are given in [Annex E](#). Reference is made to tiles bedded directly to a concrete substrate, however for the design and construction of concrete substrates, see [BS 8204-1](#). [Annex F](#) contains a method for assessing levels and surface regularity and [Annex G](#) has guidance on cement and sand bedding. [Annex H](#) provides guidance on the reduction of slip hazards.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes provisions of this document¹⁾. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

Standards publications

[BS 4483](#), *Steel fabric for the reinforcement of concrete – Specification*

[BS 4551](#), *Mortar – Methods of test for mortar – Chemical analysis and physical testing*

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

[BS 6100-0](#), *Building and civil engineering – Vocabulary – Part 0: Introduction and index*

[BS 6213](#), *Selection of construction sealants – Guide*

[BS 6925:1988](#), *Specification for mastic asphalt for building and civil engineering (limestone aggregate)*

[BS 8000-11](#), *Workmanship on building sites – Part 11: Internal and external wall and floor tiling – Ceramic and agglomerated stone tiles, natural stone and terrazzo tiles and slabs, and mosaics – Code of practice*²⁾

¹⁾ Documents that are referred to solely in an informative manner are listed in the Bibliography.

²⁾ This document also gives informative references to [BS 8000-11:2011](#).

- [BS 8203](#), *Code of practice for installation of resilient floor coverings*
- [BS 8204-1:2003+A1:2009](#), *Screeds, bases and in situ floorings – Concrete bases and cementitious levelling screeds to receive floorings – Code of practice*
- [BS 8204-5](#), *Screeds, bases and in situ floorings – Part 5: Mastic asphalt underlays and wearing surfaces – Code of practice*
- [BS 8204-7](#), *Screeds, bases and in-situ floorings – Part 7: Pumpable self-smoothing screeds – Code of practice*³⁾
- [BS 8218](#), *Code of practice for mastic asphalt roofing*
- [BS 8300-2](#), *Design of an accessible and inclusive built environment – Part 2: Buildings – Code of practice*⁴⁾
- [BS 8579](#), *Guide to the design of balconies and terraces*
- [BS EN 197-1:2000](#), *Cement – Part 1: Composition, specifications and conformity criteria for common cements*
- [BS EN 314](#) (all parts), *Plywood – Bonding quality*
- [BS EN 450-1](#), *Fly ash for concrete: Definition, specifications and conformity criteria*
- [BS EN 636](#), *Plywood – Specifications*
- [BS EN 934-2](#), *Admixtures for concrete, mortar and grout – Part 2: Concrete admixtures – Definitions, requirements, conformity, marking and labelling*
- [BS EN 1264-4](#), *Water based surface embedded heating and cooling systems – Part 4: Installation*
- [BS EN 12004-1](#), *Adhesives for ceramic tiles – Part 1: Requirements, assessment and verification of constancy of performance, classification and marking*
- [BS EN 12057](#), *Natural stone products – Modular tiles – Requirements*
- [BS EN 12058](#), *Natural stone products – Slabs for floors and stairs – Requirements*
- [BS EN 12370](#), *Natural stone test methods – Determination of resistance to salt crystallisation*
- [BS EN 12371](#), *Natural stone test methods – Determination of frost resistance*
- [BS EN 12372](#), *Natural stone test methods – Determination of flexural strength under concentrated load*
- [BS EN 12440](#), *Natural stone – Denomination criteria*
- [BS EN 12620](#), *Aggregates for concrete*
- [BS EN 12670](#), *Natural stone – Terminology*
- [BS EN 13139:2002](#), *Aggregates for mortar*
- [BS EN 13813](#), *Screed material and floor screeds – Screed material – Properties and requirements*
- [BS EN 13748-1](#), *Terrazzo tiles – Part 1: Terrazzo tiles for internal use*
- [BS EN 13748-2](#), *Terrazzo tiles – Part 2: Terrazzo tiles for external use*
- [BS EN 13888-1:2022](#), *Grouts for ceramic tiles – Requirements, classification, designation, marking and labelling*
- [BS EN 14411:2016](#), *Ceramic tiles – Definition, classification, characteristics, assessment and verification of constancy of performance and marking*
- [BS EN 14647](#), *Calcium aluminate cement – Composition, specifications and conformity criteria*

³⁾ This document also gives informative references to [BS 8204-7](#).

⁴⁾ This document also gives informative references to [BS 8300-2](#).

[BS EN 15167-1](#), *Ground granulated blast furnace slag for use in concrete, mortar and grout – Definitions, specifications and conformity criteria*

[BS EN 15651-4](#), *Sealants for non-structural use in joints in buildings and pedestrian walkways – Part 4: Sealants for pedestrian walkways*

[BS EN ISO 10545-12](#), *Ceramic tiles – Part 12: Determination of frost resistance*

[NA to BS EN 1991-1-1](#), *UK National Annex to Eurocode 1: Actions on structures – Part 1-1: General actions – Densities, self-weight, imposed loads for buildings*

[PD 6682-1](#), *Aggregates – Part 1: Aggregates for concrete – Guidance on the use of BS EN 12620*

[PD 6682-3](#), *Aggregates – Part 3: Aggregates for mortar – Guidance on the use of BS EN 13139*

CP 102, *Code of practice for protection of buildings against water from the ground*

3 Terms and definitions

For the purposes of this part of BS 5385, the terms and definitions given in [BS 6100-0](#) and [BS EN 14411:2016](#) and the following apply.

NOTE Illustrations of selected definitions are shown in [Figure 1](#) and [Figure 2](#).

Figure 1 — Illustration of selected definitions – Ceramic tile installation

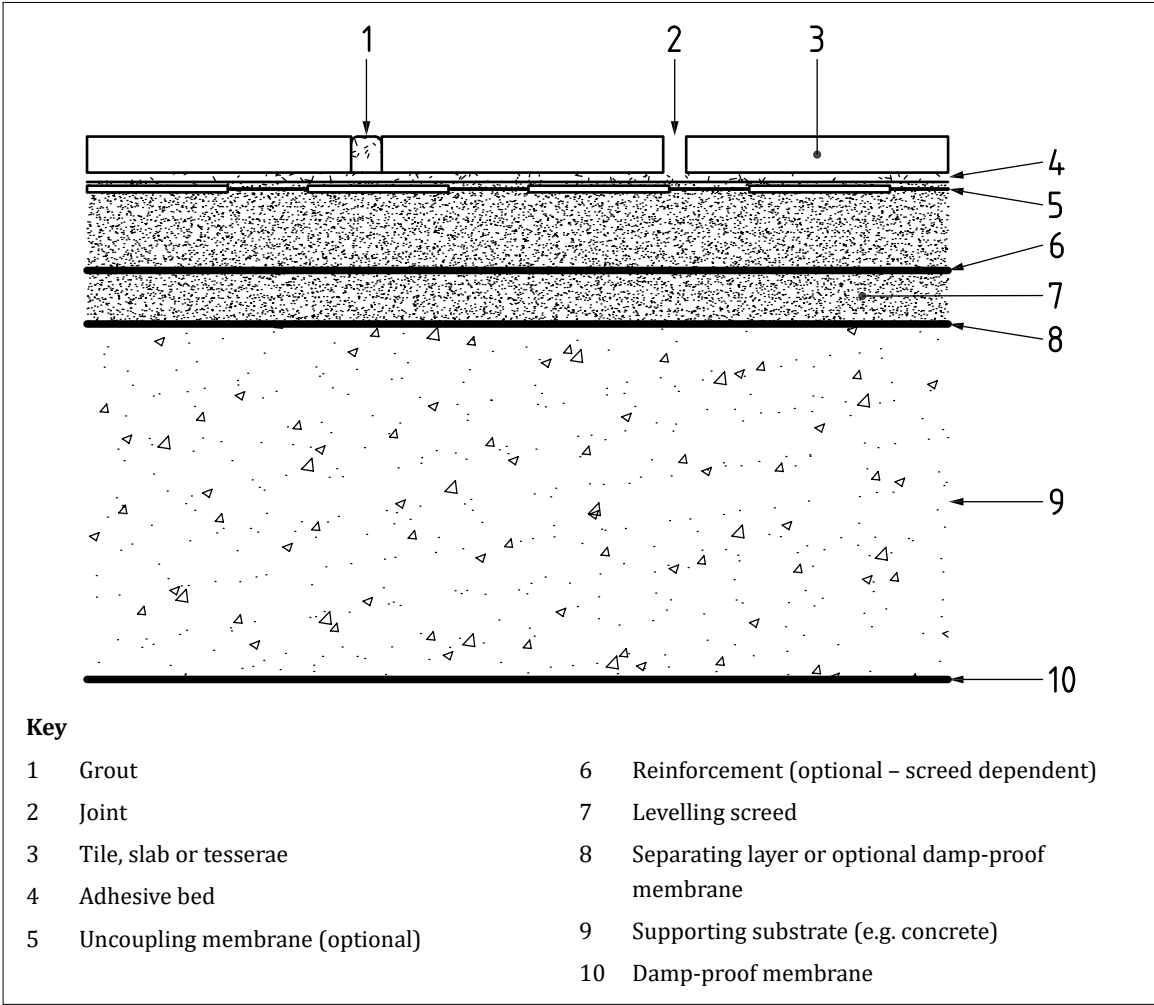
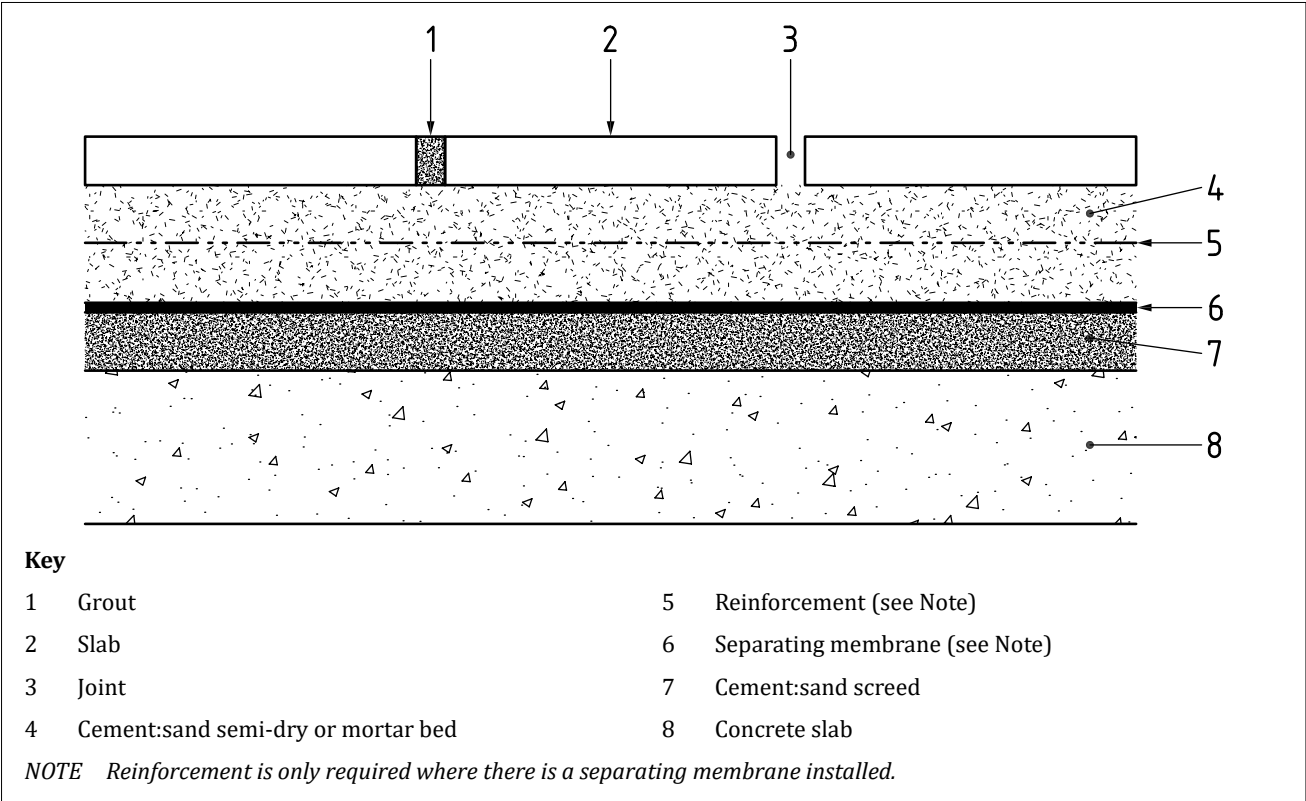


Figure 2 — Illustration of selected definitions – Natural stone/terrazzo installation



3.1 **acoustic batten system**

system designed to eliminate or reduce transmitted sound

3.2 **acoustic mats**

sound insulating material applied to the substrate to minimize both airborne and impact sound from permeating to other areas within a building

3.3 **adhesive**

proprietary composition used to bond tiles and slabs to the substrate

3.4 **agglomerated stone**

composite material made of crushed stone, bound together with a binder

NOTE Most commonly polymer resin, with some versions using cement mix.

3.5 **back-up materials**

material inserted in a movement joint which defines the depth of sealant applied, prevents three-sided adhesion, and defines the back profile of the sealant

3.6 **balcony**

accessible external amenity platform above ground level, exterior to and with direct access from a building

NOTE A balcony is formed above an external space that is not a habitable room. For purposes of fire, a balcony is not a roof.

3.7 **ceramic panel**

ceramic tile with a surface area >1 m², with a tile edge >1 200 mm

3.8 ceramic tile

ceramic tile with a surface area $\leq 0.36 \text{ m}^2$, with no tile edge $> 600 \text{ mm}$

3.9 external flooring

tiles or slabs for pedestrian areas

NOTE Including domestic applications.

3.10 fine concrete

screed consisting of concrete in which the maximum aggregate size is 10 mm

3.11 fire performance

response of a material, product or assembly in a fire

3.12 floating floor

substrate that tiles are installed onto which is not bonded or mechanically attached to the sub-floor

3.13 flight

continuous series of steps or continuous ramp between two landings

3.14 going

horizontal distance between two consecutive nosings, measured along the walking line; horizontal distance between each end of a ramp

3.15 grout

joint filling composition used between tiles and slabs

3.16 hard floor finishes

rigid materials, which do not compress or distort under load

NOTE Examples include ceramic tiles, natural and resin agglomerated stone, terrazzo and quarry tiles.

3.17 large format tile

ceramic tile with a surface area $> 0.36 \text{ m}^2$, with no tile edge $> 1\,200 \text{ mm}$

3.18 levelling screed

screed suitably finished to obtain a defined level, surface regularity and to receive the final flooring

3.19 light reflectance value (LRV)

total quantity of visible light reflected by a surface at all wavelengths and directions when illuminated by a light source

3.20 modular size

dimensions based upon the tile module and their multiples of sub-divisions

3.21 mosaic

compilation of shaped tesserae used to form a decorative pattern or mural, where each tessera can fit into a square area of $4\,900 \text{ mm}^2$

3.22 movement joint

joints permitting movement between adjacent parts

3.23 natural stone slab

flat modular slab formed of stone >12 mm thick

3.24 natural stone tile

flat modular tile formed of stone <12 mm thick

3.25 pedestals

supports which are adjustable for height and level

3.26 primer

liquid polymer applied to a substrate prior to tiling

NOTE This includes epoxy primers and aggregate-blinded epoxy primers.

3.27 raised access floors

composite panels, or interlocking boards supported by pedestals giving either partial or full access to services beneath

3.28 ramp

one or more inclined surfaces with a gradient between 1:20 and 1:12

3.29 rise

vertical distance between the horizontal upper surfaces of two consecutive treads, or between a tread and a floor or a tread and a landing (of ramps) vertical distance between each end of a ramp flight

3.30 riser

vertical component of a step between one tread and another or a landing above or below it

3.31 sealants

material applied in an unformed state which, once cured or dried, has the adhesive and cohesive properties to seal a joint

3.32 skirtings

strip tile or profiled section used at the wall to floor interface

3.33 slab

flat rigid natural stone or terrazzo material with a thickness greater than 12 mm

3.34 slope

inclined surface with a gradient steeper than 1:60 and shallower than in 1:20

3.35 smoothing compound

material applied to a substrate or screed to provide a smooth, even surface suitable for the installation of a floor finish

3.36 solid bedding

adhesive/mortar bed under the ceramic or terrazzo finish which, as far as is practicable, is free of voids so that they are solidly supported

NOTE Devices designed to eliminate lipping of the floor finish during the fixing procedure might reduce the solidity of the tile bed.

3.37 stone specialist

individual or team who is not affiliated to the stone quarrying or stone fixing company and who is experienced in:

- a) assessing the impact of geology on the likely performance of the stone;
- b) stone extraction process and the impact on the stone's quality;
- c) selecting and testing stone, and evaluating results; and
- d) engineering performance and design of natural stone flooring

3.38 substrate

supporting structure beneath the tiles and slabs

3.39 sub-floor

supporting structure beneath the tiles and slabs

3.40 suction coat

layer of cement and sand mortar without admixture, placed monolithically with the wet substrate

3.41 surface damp-proof membrane

material applied to the surface of the substrate to prevent water/moisture ingress into the floor finish

3.42 tanking systems

proprietary sheet membrane or liquid-applied water impermeable product, providing a watertight substrate

3.43 terrace

external accessible surface above an internal space which is above ground level exterior, to and with direct access from a building to occupants for purposes other than exclusively maintenance

NOTE A terrace is a roof for the purposes of fire and waterproofing. Additionally, for fire purposes, a terrace can also perform the function of a floor.

3.44 terrazzo

composite material comprising aggregate chips bound together by cement and/or polymers

3.45 tessera

small piece of shaped ceramic or stone used to form decorative mosaics

NOTE A tessera is typically described as a product that is 70 mm or smaller.

3.46 thin tile

ceramic tile with a thickness ≤ 5.5 mm

3.47 tile module

overall dimension of the tile plus the recommended joint width

NOTE The modular dimension is measured from centre to centre of joints, e.g. nominal size 190 mm tile size + nominal width of 10 mm joint = 200 mm module.

3.48 tile backer boards

rigid, inert proprietary boards suitable for the application of floor finishes, using an appropriate tile adhesive

3.49 tile levelling systems

plastic clips that are adjusted either by the tightening of a plastic cap onto a threaded clip or inserting a wedge in a spacer clip to reduce lipping

3.50 tiling membranes

proprietary systems installed within the assembly to provide a specific or combined function

NOTE Examples include uncoupling, waterproofing, capillary drainage, sound reduction, underfloor heating cable carrier.

3.51 tread

horizontal component of a step

3.52 uncoupling membranes

intermediate layer installed between the tile or slab covering and substrate to accommodate lateral stresses that can occur within the assembly

NOTE Often these membranes have multi-functional uses, e.g. tanking and crack bridging.

3.53 underfloor heating

form of heating that incorporates hot water pipes or electrical heating elements underneath the floor finish within the scope of this British Standard

4 Exchange of information and time schedule

COMMENTARY ON CLAUSE 4

This clause deals with the exchange of information for the whole floor, including the tiles, bed, substrate and levelling screed (if any).

4.1 Exchange of information

The design working drawings, layouts and specifications should be prepared by the architect/structural engineer and provide sufficient detail to afford proper guidance in the execution of the work. At the tendering stage, the following information should be sought and documented:

- a) *site*; location, storage 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 (e.g. mechanical cleaning);
- c) *substrate*; type of structure, type of damp-proof membrane (if required) and its location within the floor construction, details of levelling screed (including its surface regularity and the category of in situ crushing resistance required), curing and drying times, particulars of any floor warming installation, separating layer, finished floor levels and falls with permissible deviations;
- d) *associated work*; services embedded in or passing through the floor, skirting and abutments, junctions with other adjacent flooring;
- e) *finishes*; types and sizes of tiles, panels, slabs and/or mosaics, bedding and jointing requirements and required surface plane;
NOTE For movement joints, see 9.9.
- f) *contract*; details, if the work is to be completed in a specific order or in sections;

- g) *health and safety*; information on handling, articles and substances for use during the work that are liable to be a health risk;
- h) *time schedule*; for the progress of the work (see 4.3); and
- i) *testing*; details of conformity testing, if required (see E.3.2).

4.2 Provision of utilities, facilities and materials

4.2.1 General

To prevent misunderstanding, particularly at the tendering stage, and to avoid situations detrimental to installation, it should be confirmed whether the following is provided and by whom:

- a) clean, dry, lockable storage space protected from frost (if necessary) (see 5.1);
- b) clean water supply adjacent to working areas;
- c) artificial lighting, if required (see 4.2.2);
- d) safe means of access and places of work;

NOTE 1 Attention is drawn to the requirements of the Building and Construction Regulations made under the Factories Act 1961 [1].

- e) unloading and hoisting facilities;

NOTE 2 Attention is drawn to the following:

- a) *Lifting Operations and Lifting Equipment Regulations [2]; and*
- b) *Manual Handling Operations Regulations [3].*

- f) electric power supply adjacent to working areas;
- g) protection of work during and after fixing;
- h) supplies of sand and cement in accordance with 6.1.2, 6.1.3 and 6.1.4;
- i) hard floor finishes, accessories, adhesives, grouts, primers and sealants; and
- j) facilities for the segregation and disposal of waste materials.

A check should be made to confirm that all materials required for the installation are available.

4.2.2 Lighting on site

Lighting on site should be of similar type, direction and intensity as envisaged for the completed installation.

NOTE If this condition is not met, 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.

In preparing the time schedule, each operation should take into account its relation to others. The most efficient use of general plant by all trades should be determined, alongside making sure various trades do not interfere unduly with each other's work.

A minimum of six weeks should be allowed under good drying conditions for the concrete structural floor to undergo initial drying shrinkage. If a levelling screed is subsequently to be applied, the traditional sand/cement (Portland) screeds should be left for at least a further three weeks, while proprietary rapid drying screeds should be left in accordance with the manufacturer's recommendations. These drying times should be considerably extended under slow drying conditions and depending upon the mass of the construction.

NOTE 1 Certain floor finishes might require the application of a surface damp-proof membrane where the residual moisture content of the substrate is higher than that required for the particular floor finish.

NOTE 2 Where tiling is on a separating layer directly over the structural floor, the period of six weeks is not critical.

The schedule should allow time for the cutting of holes and chases and/or other work involving the use of percussion tools in or on the floor that is to receive the tile bed.

The schedule should provide for the completion of necessary subsidiary work, including the commissioning of underfloor heating systems before the fixing of tiles or mosaics begins. Times should be included for commencement and completion of tiling or mosaic work to the different parts of the construction, allowing sufficient time intervals between the operation of the bedding, grouting and final cleaning down.

Provision should be made for adjustment to the time schedule to allow for suspension of operations due to weather (e.g. extreme temperatures or inclement weather) or other conditions that jeopardize the success of the installation. Alternatively, the possibility of providing a protective enclosure, e.g. cocooning, to enable work to continue during unfavourable conditions should be determined.

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.

NOTE 3 These time periods are for good drying conditions (20 °C and 65% relative humidity). A longer drying period is typically 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, this should be carried out in accordance with [BS 8204-1](#) and [BS 8203](#).

NOTE 4 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 approximately two months.

Where underfloor heating is present in the sub-floor, the recommendations in [Annex C](#) should be followed.

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

5 Materials – Transport and storage

5.1 Delivery to site and unloading

The delivery method, time, size of vehicle, unloading method and responsibility for providing carry-out deliveries should be agreed at tender stage. Materials should be delivered in such a way as to minimize handling. Precautions should be taken to guard against damage and to keep the tiles/slabs dry.

5.2 Storage

Location, type and size of storage areas should be agreed at the tender stage. All materials should be stored in accordance with the manufacturer's guidance. Materials should be stored in a clean, dry, frost-free (if necessary) lockable storage area to avoid excessive handling, theft and damage.

5.3 Distribution

The method and route of, and responsibility for, distribution of materials should be agreed at the tender stage, e.g. horizontal and vertical distribution. Excessive handling should be avoided.

6 Bedding and levelling screeds

6.1 Cement

6.1.1 General

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.

The risk of adverse skin and health effects when using and mixing cement should be taken into account. Operatives should wear an approved face fit mask to avoid inhaling dust, with appropriate gloves and barrier cream used.

Measures should be in place to prevent excessive amounts of dust, with suitable vacuum attachments used to remove any dust created.

Suppliers' material safety data sheets obtained at the exchange of information stage, as described in 4.1g), should be used as a basis for assessing and managing the risk associated with its use in a particular application.

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

6.1.2 Cement for cementitious levelling screeds

Cement for cementitious levelling screeds should be one of the following:

- a) Portland cement (CEM I) conforming to [BS EN 197-1](#);
- b) Portland slag cement (CEM II/A-S and CEM II/B-S) conforming to [BS EN 197-1](#);
- c) CEM I cement, manufactured in the cement mixer from Portland cement and ground granulated blast furnace slag (GGBS) conforming to [BS EN 15167-1](#), with a mass fraction of 6% to 34% of combination of GGBS;
- d) 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](#), with the exception of Clause 9 of that standard;

- e) calcium aluminate cement (high alumina cement) conforming to [BS EN 14647](#); and
- f) 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 information is available regarding the use of other types and grades of cement for cement and sand levelling screeds, e.g. a cement of strength class 32.5 would typically require an increase in cement content of approximately 10%.

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

6.1.3 Cement for cement and sand mortar beds

Cement for cement and sand mortar beds should be one of the following:

- a) Portland cement (CEM I) conforming to [BS EN 197-1](#); and/or
- b) calcium aluminate cement (high alumina cement) conforming to [BS EN 14647](#).

6.1.4 Aggregates

6.1.4.1 General

Aggregates should not contain deleterious material in sufficient quantity to adversely affect the surface of a cementitious levelling screed.

NOTE For example, lignite, coal and iron pyrites in the aggregate can cause “pop outs”.

Some aggregates exhibit higher than average drying shrinkage and should not be used, as they can give rise to a greater risk of cracking (see BRE Digest 357 [4] and [BS EN 1367-4](#) for further information).

6.1.4.2 Fine aggregate for cementitious levelling screeds

Fine aggregate for cementitious levelling screeds should conform to [BS EN 13139](#).

NOTE 1 The preferred grading would be a 0/4 fine aggregate with a fines category 1 within the range MP ideally having a grading between 20% to 66% passing the 0.5 sieve.

NOTE 2 This refers to site-mixed screeds up to approximately 40 mm. For thicker screeds, a grading of 0/8 would be more appropriate.

NOTE 3 Further information regarding the selection of suitable aggregate grading can be found in [BS 8204-1:2003+A1:2009](#), Annex B, Table B.2.

6.1.4.3 Aggregates for concrete levelling screeds

Aggregates for fine concrete levelling screeds should be composed of 4/10 material conforming to [BS EN 12620](#) and [PD 6682-1](#); 0/4 fine aggregate should be in accordance with [G.2](#).

6.1.5 Water

Water should be clean and free of materials deleterious to levelling screeds and mortar beds in their fresh and hardened states.

NOTE Potable water is suitable.

Containers for storing or carrying water should be clean.

6.1.6 Reinforcement

Reinforcement for levelling screeds, where applicable, should be a steel fabric of type D49 or A98, conforming to [BS 4483](#).

NOTE 1 Heavier reinforcement might be required by the designer for use in levelling screeds intended for structural purposes.

NOTE 2 D49 is typically supplied in coil form “wrapping grade”. It is unsuitable for screeds in this form. It can, however, be obtained in flat sheet form and only that form is suitable for inclusion in cementitious screeds.

NOTE 3 Where light reinforcement in a screed or bed does not have to provide a structural function, sufficient tensile stresses can be absorbed by 50 mm², 16-gauge wire mesh flat sheets or 2.5 mm or 5 mm diameter wire mesh of 50 mm × 50 mm, 100 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](#).

6.1.7 Bonding agents

COMMENTARY ON 6.1.7

Bonding agents are available to improve the adhesion of levelling screeds and/or tile beds to the substrate or structural slab.

Their use in conjunction with levelling screeds depends on the type of levelling screed required and the conditions the floor is expected to withstand in service. Details of levelling screed type along with recommended mix design and thickness of application are given in [Annex E](#) and further information is also available in [BS 8204-1](#). Similarly for cement and sand mortar tile beds, bonding agents can be used with the appropriate bedding methods detailed in [10.2](#), [Clause 13](#) and [18.4](#).

Bonding agents based on polyvinyl acetate or other polymer adversely affected by moisture should not be used.

The type of bonding agent to be used and its method of application should be in accordance with the manufacturer's recommendations.

6.1.8 Adhesives

6.1.8.1 Cement-based adhesives (cementitious adhesives/hydraulically-hardening mortars)

Cementitious and dispersion/cement adhesives (Type C) should be classified in accordance with [BS EN 12004-1](#).

6.1.8.2 Reaction resin adhesives

WARNING: These products contain resins and hardeners that can cause skin irritation and contact dermatitis.

When using reaction resin adhesives, the manufacturer's instructions should be followed so that, where appropriate, the necessary personal protective equipment is used during mixing and application.

Reaction resin adhesives (Type R) should be classified in accordance with [BS EN 12004-1](#).

6.1.8.3 Admixtures to adhesives

An aqueous polymer dispersion admixture can be incorporated into cementitious adhesives to obtain greater adhesion, improved resilience or some degree of water resistance; such admixtures should be used only with adhesives approved by the manufacturer.

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

6.1.9 Calcium sulfate-based levelling screeds

Calcium sulfate-based levelling screeds should not be used in locations that are damp, frequently wet or have standing surface water.

Installation and conditioning of calcium sulfate-based screeds should be in accordance with [Annex D](#).

NOTE 1 Calcium sulfate-based levelling screeds contain calcium sulfate as the binder.

The binder should be either anhydrous calcium sulfate (known as anhydrite) or as α -hemihydrate, the most common being calcium sulfate α -hemihydrate.

Whichever form of anhydrite or α -hemihydrate is used as the screed binder, it should, when mixed with water, crystallize to form gypsum. All hardened calcium sulfate screeds should be of similar gypsum materials.

To form the screed, the calcium sulfate binder should be pre-mixed with either a well graded sharp sand aggregate and/or an inorganic filler.

NOTE 2 Dependent upon the screed manufacturer, additives and admixtures can also be included.

NOTE 3 See also TTA document "Tiling to Calcium Sulfate Screeds" [5] and "Natural Stone Flooring Code of Practice" [6].

6.2 Separating layers

6.2.1 General

Polyethylene or suitable sheet membrane should be used in preference to building paper or bituminous felt. A minimum thickness of 0.125 mm should be used, the purpose of the separating layer being to prevent the applied screed or concrete adhering to the substrate.

6.2.2 Uncoupling membranes

COMMENTARY ON 6.2.2

Uncoupling membrane systems provide an intermediate substrate between the tile covering and load bearing substrate. They can be used over a variety of substrates which include timber, concrete, cementitious screeds, gypsum-based screeds, raised access/pedestal flooring, heated floors, floating floors, mixed substrates, existing tile and stone coverings, heated overlay boards, etc.

They are bonded to the substrate with an appropriate adhesive (refer to the membrane manufacturer for recommended adhesive types) or some variants have a self-adhesive coating applied to the underside and some are loose-laid (seek further advice from the manufacturer). Uncoupling membranes are designed to neutralize lateral stresses that occur between the substrate and tile covering; they are not designed to accommodate differential vertical movement. The membrane works by preventing stresses from the substrate being transferred into the tile covering; this prevents cracking and possible delamination of the covering material. They are designed to work with tile adhesives where the tile/slab bedding does not exceed 10 mm. For further guidance, refer to the membrane manufacturer.

Various proprietary uncoupling systems are available, which typically are either a cavity mat or a flat membrane manufactured from a plastic type material. Cavity mats are geometrically configured to provide free air space between the tile covering and substrate to facilitate independent lateral stresses between the two elements. Flat membranes typically have a fleece covering, or similar, on both sides to allow tile adhesive to anchor to the membrane. The flexibility of the membrane allows for the absorption of lateral stresses between the substrate and tile. Flat membranes are sometimes referred to as anti-fracture membranes.

Some types of proprietary uncoupling membranes can provide additional functions, these can include waterproofing, moisture and vapour management, impact sound reduction and the incorporation of electrical undertile heating cables. For guidance on function and installation guidelines, refer to the membrane manufacturer.

With a cavity mat uncoupling system there is a minimum tile format which can be used, however flat membranes typically accept most tile formats, e.g. mosaic tiles.

Where high traffic loads are expected, the selected tile/slab or stone covering should have sufficient compressive stability/breaking strength under heavy loads, especially where cavity mat systems are used. The manufacturer of the uncoupling membrane should be consulted for guidance.

NOTE 1 Refer to the chosen manufacturer for guidance on tile selection and limitations.

Uncoupling membranes do not negate the need for movement joints; these should be installed in accordance with this British Standard.

When using agglomerated stone tiles, which are moisture sensitive, an uncoupling membrane should not be used if the tiles and slabs are prone to curling/warping. When determining the use of an uncoupling membrane, the manufacturer's advice should be sought to determine the agglomerated stone's suitability with the particular uncoupling membrane under the service conditions to which it is to be subjected and to the environment to which it is to be exposed.

NOTE 2 Refer to the TTA document "The Installation and Use of Uncoupling Membranes for Internal Floor Tiling" [7] for further advice.

6.2.3 Deflection in substrates

COMMENTARY ON 6.2.3

The accepted minimum requirement for floor rigidity is $L/360$ – before a ceramic tile underlayment is installed. This figure is different to natural stone and terrazzo finishes, where $L/720$ is the accepted minimum.

For figure $L/360$, the floor should not deflect more than the "span" (L) divided by 360 when subjected to the anticipated load, based on calculations carried out by structural engineers, e.g. if the span of the joists is 3.05 m (3 050 mm) between supports, the deflection should not be more than 8.5 mm between the centre and the end when a load is applied. For natural stone and terrazzo finishes, the deflection should be $L/720$.

NOTE 1 Frequently, there is misunderstanding regarding deflection between joists, e.g. while joist manufacturers regularly meet the standard $L/360$ criteria for construction with 600 mm on centre systems, these floors often have deflection between the joists exceeding $L/360$. Research has shown ceramic tiles to fail under conditions where the overall floor is more rigid than $L/360$. Failures at $L/600$ have also been observed. It is for this reason that recommendations for floor rigidity are not solely based on deflection measurements but on empirically established methods found to work over normal construction.

Joists and nogginns should be located at 300 mm centres.

NOTE 2 When installing large format ceramic panels, including large format slim ceramic panels, a deflection of $L/360$ might be considered too great, and a minimum deflection of $L/500$ or better might be required.

When calculating the deflection of substrates, characteristic values and categories should be in accordance with [NA to BS EN 1991-1-1](#).

6.2.4 Installation of floor finishes to steps, stairs and slopes

6.2.4.1 General

Where buildings are to be used by the general public, who might use the built environment in different ways, restrictions and barriers that might prevent a user from making full and independent use of the building should be taken into account. Everyone including disabled and older people with particular access requirements, should be able to enter, use and leave a building easily, comfortably and independently.

NOTE See [BS 8300-1](#) and [BS 8300-2](#) for further guidance.

6.2.4.2 Steps and stairs

NOTE 1 The design of the step is an important consideration in preventing slips or falls. Those with restricted lower body movement are to be taken into account.

The going size should be designed to prevent overstepping, whilst riser heights should not be excessively high and projecting nosings designed to reduce the risk of tripping.

The rise of steps should be between 150 mm and 180 mm and the going between 300 mm and 450 mm. The rise and going of each step within a flight should be uniform. Tapered risers should not be used. The surface material of treads and risers should be free from patterning.

Single steps should be avoided as, even when highlighted using visual contrast, they present a significant trip hazard. Where there is a change in level of less than 300 mm, the change should be accommodated by a ramp alone. Where the change in level exceeds 300 mm, both a stair and ramp should be provided.

Where steps abut a slope, the interface between the slope and the steps should not form part of an access route. In addition, the point at which the tread meets the slope should be clearly identified.

Where practicable, a step should not overlap the one below. If there is an overlap, the nosing should not project over the tread below by more than 25 mm.

Each step nosing should incorporate a durable, permanently contrasting continuous material for the full width of the stair on both the tread and the riser to help people who are blind or partially sighted appreciate the extent of the stair and identify individual treads. The contrasting material should extend 50 mm to 65 mm in width from the front edge of the tread and 30 mm to 55 mm from the top of the riser and should contrast visually with the remainder of the tread and riser.

NOTE 2 It is beneficial that surface material at landings and floors contrast with surface material of stairs, subject to maintaining visual contrast at top and bottom nosings.

The surface materials used for internal steps and stairs should be selected based on ease of maintenance and to be as slip-resistant as possible, especially if surfaces are likely to become wet due to location or use, or if spillage occurs. The whole tread or the nosing should incorporate a slip-resistant material. Where different materials are used for the flights and landings of a stair, their frictional characteristics should be similar in order to minimize the risk of stumbling.

The slip resistance for nosings and treads should be equivalent to that expected for level surfaces.

NOTE 3 A pendulum test value (PTV) of greater than 36 is considered to be suitable.

NOTE 4 The slip resistance of existing step nosings is typically expressed by Rz surface roughness value as PTV is difficult to measure. In such cases a roughness Rz value of 20 µm is suitable.

NOTE 5 The slip resistance of steps and stairs might be estimated from the PTVs obtained on the landings. A comparison of the surface roughness of individual treads and the landings might allow the slip resistance of the treads to be estimated, where the material is the same and the surface roughness is similar.

There should be adequate contrast between nosings and landings.

NOTE 6 Nosings that wrap around the riser might assist people who are blind or partially sighted.

NOTE 7 A proprietary nosing can provide a durable solution that satisfies both visual contrast and slip resistance criteria, see 9.9.4.3.

NOTE 8 Highly patterned surface finishes can be misleading and cause confusion, particularly for people who are blind and partially sighted and those with sensory/neurological processing difficulties.

Each flight and landing of a stepped access route should be well illuminated, providing a clear distinction between each step and riser. The illuminance at tread level should be at least 100 lux.

Lighting that causes glare should be avoided. The use of shiny, polished surface materials that cause glare should be avoided.

The width of a stair should be not less than 1 200 mm, and the width between handrails not less than 1 000 mm. If the width between handrails exceeds 2 m, the stair should be divided into two or more channels.

Treads and risers should be solid and opaque. Riser profiles should be such that people who drag their feet do not trip when ascending.

There should be a minimum 30° change in the direction between flights of stairs if there are more than 40 risers in consecutive flights for internal areas and 36 risers for external areas. Flights on a stepped access route should not contain more than 20 risers and, where practicable, the number of risers in successive flights should be uniform. A level landing should be provided at the top and bottom of each flight of steps. Its length, clear of any door or gate swing, should be not less than the surface width of the flight. In external areas, unless the landing is under cover, it should have a slight cross-fall gradient, not exceeding 1:50, to help drain surface water.

In external areas, to provide advance warning of a step, tactile paving with a corduroy hazard warning surface should be provided at the top and bottom of each flight, excluding intermediate landings with continuous handrails. Where the approach to the stair is wider than the flight, the tactile surface should extend beyond the line of each edge of the flight.

6.2.4.3 Ramps and slopes

If a change in level along an internal circulation route is unavoidable, provision should be made for an alternative means of access, i.e. a slope or ramp, or, if there is insufficient space for a ramp, a non-enclosed vertical lifting platform.

Interior areas in buildings should be designed to avoid, as far as is practicable, the need for ramps or slopes (steeper than 1:60 and shallower than 1:20) on internal circulation routes.

Where slopes are provided, they should have landings not less than 1 500 mm long for the full width of the slope at every 500 mm rise of the route, and at the top and bottom of the slope, clear of any door swing or other obstruction.

The surface of the slope should contrast visually with the landings.

In external areas, the relative levels of the accessible entrances to a building should be designed to eliminate, as far as is practicable, the need for ramped access. Where the change in level is such that a portion of the access route needs to have a gradient of 1:20 or steeper, the access should be ramped. A ramp should have the lowest practicable gradient within the range 1:20 to 1:12 and the maximum corresponding length between landings.

A ramp should not intersect a flight of steps as this creates a tapered riser.

Where ramps are required, they should be clearly visible and in close proximity to the steps.

Where the change in level within a circulation route is greater than 300 mm and accommodated by a ramp, steps should be provided in addition to the ramp. Where the change in level is less than 300 mm, steps should not be used.

A ramp should have the lowest practicable gradient within the range 1:20 to 1:12 and the maximum corresponding length between landings. The gradient of a ramp flight in relation to its going should not be steeper than that shown in [BS 8300-2](#), which gives the maximum gradient and going acceptable for various rises of ramps.

No individual flight of a ramp should have a going greater than 10 m or a rise of more than 500 mm.

The surface width of a ramp should not be less than 1 500 mm. Where wider ramps are divided into separate channels, no channel should have a surface width less than 1 500 mm.

Landings should be provided at the foot and head of a ramp and be at least the width of the ramp and not less than 1 500 mm long. Intermediate landings along a series of flights in a straight line should be at least 1 500 mm long.

Intermediate landings at least 1 800 mm wide × 1 800 mm long should be provided as passing places where there is no clear line of sight from one end of the ramp to the other, or where there are three or more flights.

A landing should be level, except in wet areas where a landing can have a slight cross-fall gradient, not exceeding 1:50, to help drain surface water.

Surface materials should be chosen to be easy to maintain and be as slip-resistant as possible, especially if surfaces are likely to become wet, allowing for rain and other environmental factors in external areas.

NOTE 1 A higher level of slip resistance is required on a sloping surface than on the level to achieve the same degree of safety and to maintain the same degree of traction. The additional slip resistance can be approximated for the gradients recommended for ramps by expressing the gradient as a percentage and adding this to the PTV for an equivalent level surface, e.g. for a 1:20 slope, the gradient is 5% and the required PTV is increased by 5. For a 1:12 slope, the gradient is 8.3% and the PTV needs to be increased by 8.3.

NOTE 2 Where weather or low temperature results in surfaces being covered in snow or ice, the slip resistance of a surface ceases to be effective; therefore, external ramp surfaces need to be kept free of snow or ice as part of the management regime of the external space.

The surface of a ramp should contrast visually with the landings and the edge protection so that its presence is discernible by people who are blind or partially sighted.

To maintain traction, a sloping surface should have a higher slip resistance than an equivalent level surface. The steeper the slope, the greater the friction needed to maintain contact with the ground without slipping.

Where different materials are used for the flights and landings of a ramp, their frictional characteristics should be similar in order to minimize the risk of stumbling.

Tactile warning surfaces should not be used at the top and bottom of ramps.

The use of shiny, polished surface materials that cause glare should be avoided.

NOTE 3 Highly patterned surface finishes can be misleading and cause confusion, particularly for people who are blind and partially sighted and people with sensory/neurological processing difficulties.

The location and orientation of a ramp should be taken into account to avoid, where possible, glare and cross-shadows which can prevent people who are blind or partially sighted distinguishing changes in gradient. Artificial lighting to a ramp should be evenly distributed, with an illuminance at ramp and landing level of at least 100 lux.

6.2.5 Light reflectance values and visual contrast

COMMENTARY ON 6.2.5

Differences in hue (the nature of the colour) or chroma (the intensity of the colour) provide adequate visual contrast for those with good vision. This is not the case for the blind or partially sighted, where the ability to identify differences in colour, is the amount of light the surface reflects, or its light reflectance value (LRV).

The LRV scale runs from 0, which is a perfectly absorbing surface that could be assumed to be totally black, up to 100, which is a perfectly reflective surface that could be considered to be the perfect white. LRV is a measure of the amount of usable light reflected from an illuminated material. It should be noted that materials of different colours might record similar LRV readings.

When designing floor areas in public accessible spaces, visual impairment should be taken into consideration.

There should be a visual contrast between adjacent surfaces such as walls/floors, doorways, fixtures and fittings and step/stair nosings, for example, to allow users with visual disabilities to navigate these areas.

The evidence-based research available allows a degree of variability concerning the minimum LRV difference that is required to provide adequate visual contrast for people who are blind or partially sighted.

To provide a sufficient contrast, there is considerable confidence in recommending a difference in LRV of 30 points or more between adjacent surface materials.

An acceptable contrast is achieved when the difference in LRV between a stair finish and its nosing is greater than 30 points.

There is evidence to suggest that a difference of around 20 points might still be acceptable, provided the illuminance on the surfaces is 200 lux or more. Differences less than about 20 points might not give adequate contrast, even with an illuminance of 200 lux on the surfaces, see [BS 8300-2:2018](#), Annex B for further information.

6.2.6 Safe handling of materials

NOTE 1 Ceramic tiles, natural stone, resin agglomerated stone and terrazzo are inert materials as supplied and in the finished state following additional processing during installation.

NOTE 2 The process of cutting, drilling, chamfering or polishing might release dust dependent on the methods and equipment used. This dust created might contain respirable crystalline silica dependent on the composition of the material.

NOTE 3 Dust is not just a nuisance but could cause lung disease, such as silicosis or asthma if regularly breathed.

NOTE 4 When cutting outside, dust control measures are still necessary.

Prior to commencing any of the processes in Note 2, a risk assessment should be carried out to establish the risks, with steps taken to control those risks.

NOTE 5 Attention is drawn to the Control of Substances Hazardous to Health Regulations (COSHH) [8] regarding risk assessments.

Wherever possible, mechanical processing of the floor finishing products should be carried out using techniques that eliminate dust or generate minimal dust, such as cutting using score and snap equipment or using wet saws. Drilling, chamfering and polishing should also be carried out in the presence of water to prevent dust release.

The correct type of personal protective equipment (PPE) should be worn at all times and should include protective clothing, gloves, footwear, ear and eye protection as well as respiratory protective equipment (RPE), such as face-fit masks fitted with appropriate filters.

Dry cutting, sanding or polishing with, e.g. diamond tipped blades or abrasive discs should only be used if other options are not possible. Vacuum dust extraction attachments/equipment should be used to contain the dust created and to prevent its release into the atmosphere. Local exhaust ventilation (LEV) or on-tool extraction should be used to capture the dust as it is produced.

The use of general vacuums should be avoided.

NOTE 6 Reducing the time taken to carry out processing operations might reduce the quantity of dust created, such as discarding blunt cutting blades and using the appropriate blade for the job.

In addition to dust control measures, handling the cut edges and off-cuts of ceramic tiles, natural stone, resin agglomerated stone and terrazzo should be taken into account as these might contain very sharp pieces, which could lead to personal injury. The correct PPE should be worn.

6.2.7 Cement-based products

COMMENTARY ON 6.2.7

This guidance relates to cement-based powders (tile adhesives, levelling compounds, grouts, etc.).

Prior to using a cement-based product, a risk assessment should be carried out to establish potential risks, with steps taken to control those risks.

NOTE 1 Attention is drawn to the COSHH Regulations [8] regarding carrying out a COSHH risk assessment. See also the material safety data sheet.

PPE should be worn at all times, including protective clothing, gloves, safety footwear, ear and eye protection as well as respiratory protective equipment (RPE), such as face-fit masks fitted with appropriate filters.

A health surveillance regime should be introduced to protect individuals, identify and treat anyone affected and provide early warnings of lapses in the control measures.

In addition to a risk assessment, a manual handling assessment should also be completed for all products.

NOTE 2 Cement is a fine powder and its dust could cause respiratory irritation.

Cement dust can be released during material handling and when mixing with water or admixtures; the risk of dust inhalation should be assessed, with appropriate engineering control measures implemented to reduce the dust to below permissible levels. The mixing of cement-based products should only be carried out in a well-ventilated area.

NOTE 3 Dust is not just a nuisance but inhalation can cause respiratory disease, such as occupational asthma. Rhinitis can also be linked to excessive inhalation of cement dust.

NOTE 4 Contact with wet cement-based products can lead to skin diseases, such as irritant and allergic dermatitis, burns and rashes. Materials containing wet cement are very alkaline and can cause severe burns to the skin or eyes.

Cement-based materials should not be left in contact with the skin.

NOTE 5 Allergic dermatitis is caused by sensitization to the chromium VI present in the cement.

The expiry date of the cement-based materials should be adhered to as the level of chromium VI increases after the expiry date has been exceeded.

NOTE 6 The level of chromium VI is controlled by a reducing agent.

6.2.8 Epoxy resin-based products

NOTE Epoxy resins are used widely in various applications including the composite, building and construction industries. Before curing, the components of epoxy resin systems could show hazardous properties, the main risk being via skin contact. Epoxy resins are safe to handle provided that basic precautions are taken. Epoxy resins are typically mixed with a hardener component before application. After application, a chemical reaction takes place producing an inert final material. The finished hardened epoxy resin does not pose a health risk. Typical situations in the use of the components of uncured epoxy resins/hardeners include the transport and storage of containers, dosing and mixing of components, cleaning tools and the disposal of empty containers and waste materials. Epoxy-containing products can cause sensitization reactions in certain individuals. The most common sign of epoxy sensitization is via rashes that are observed after skin contact. However, irritation to the eyes, nose, throat and lungs could also occur following sensitization. Epoxy sensitization can cause both irritant and allergic dermatitis.

For both the resin component and the hardener component, individual safe handling instructions should be followed so that the user is aware of potential health problems in case of unsuitable exposure.

Users of epoxy resin-based products should be instructed on the nature of the risk to health, including providing supervision and instruction on their use and necessary precautions to be taken.

6.2.9 Polyurethane-based products (diisocyanates)

COMMENTARY ON 6.2.9

Attention is drawn to the requirement for professional and industrial users to be trained and certified in how to handle products containing diisocyanates safely.

Diisocyanates are a family of chemical building blocks mainly used to create polyurethanes. Polyurethane resins are used in many products, including adhesives, coatings and sealants in construction. Diisocyanates are known skin irritants and sensitizers, eye irritants and respiratory sensitizers.

Users of polyurethane-based products (diisocyanates) should be instructed on the nature of the risk to health, including providing supervision and instruction on their use and necessary precautions to be taken.

Prior to using diisocyanates, a risk assessment should be carried out to establish potential risks, with steps taken to control those risks.

NOTE 1 Attention is drawn to the COSHH Regulations [8] regarding carrying out a COSHH risk assessment. See also the material safety data sheet.

NOTE 2 Isocyanates are powerful irritants to the mucous membranes, the eyes and gastrointestinal and respiratory tracts. Direct skin contact can also cause marked inflammation. Isocyanates can also sensitize workers, making them subject to severe asthma attacks if they are exposed again.

PPE should be worn at all times, including protective clothing, gloves, safety footwear, ear and eye protection as well as RPE, such as face-fit masks fitted with appropriate filters.

Isocyanates should only be used in a well-ventilated area or with alternative forms of extraction.

A health surveillance regime should be introduced to protect individuals, identify and treat anyone affected and provide early warnings of lapses in the control measures.

NOTE 3 Preventing exposure to isocyanates is a critical step in eliminating the health hazard.

Engineering controls, such as closed systems and ventilation, should be the principal method for minimizing isocyanate exposure in the workplace.

NOTE 4 Other controls, such as worker isolation and use of PPE, e.g. respirators and personal protective clothing, to prevent dermal exposures might also be necessary. Early recognition of sensitization and prompt and strict elimination of exposures is essential to reduce the risk of long-term or permanent respiratory problems for workers who have become sensitized.

6.2.10 Renovation/refurbishment work

Following the removal of the existing floor finishes, the substrate revealed should be checked for signs of damage and verified as fit for purpose. Adhesive residues and loose or hollow sounding areas should be removed.

Substrates should be checked for signs of degradation, such as those incurred through water ingress, chemical attack and mechanical damage.

In the case of existing concrete and/or screed substrates, loose or damaged areas should be removed, and the areas repaired with a suitable repair mortar following the manufacturer's guidelines. Cracks should be chased out and dust removed by vacuum. The cracks should be repaired using an appropriate system.

The surface of the substrate should be mechanically abraded to remove all contamination using appropriate equipment, such as contained shot-blasting techniques.

NOTE 1 It might be necessary to re-establish levels by the application of a levelling compound.

Damaged board substrates should be replaced with new or an upgraded boarding material capable of withstanding the service conditions especially where a change of use is envisaged for the area.

NOTE 2 Additional waterproofing measures might be required.

Renovation works should only be carried out following the required risk assessment (see [6.2.6](#)).

6.2.11 Slipperiness

COMMENTARY ON 6.2.11

Pedestrian slipping typically occurs because there is insufficient frictional force between the footwear and floor surface to prevent the foot from sliding forwards. A tiled floor (ceramic, natural stone, agglomerated stone or terrazzo) is not slippery when clean and dry. Most slips occur when the floor is contaminated, with, e.g. water, oil or dust. The film of contaminant reduces the frictional forces between heel and floor surface.

Typically, polished surfaces can be expected to provide less slip resistance although there is a misconception that a shiny surface, a light reflection property, is directly related to slipperiness, which might not always be the case.

The slip resistance of a floor in service is dependent upon the nature of its surface. This can change over time and often merely during the process of installation and finishing. Some natural limestones can become “polished” through use so the potential for slip might increase during the period of service. Riven slate and sandstone have usually inherently good slip resistance.

Where it is known that slippery conditions might arise in service and present a significant hazard, tiles with slip resistant finishes suitable for the conditions and location should be used. Flooring materials should not be highly slippery when used in locations that suffer occasional wetting, which increases surface slipperiness, i.e. shopping malls or office receptions. Additional entrance matting should be installed and/or a management regime put in place to deal with such situations.

NOTE 1 The United Kingdom Slip Resistance Group (UKSRG) and the Health & Safety Executive (HSE) currently recommend two types of instrumentation to assess the slip resistance of flooring materials, the pendulum, which measures slip resistance and an appropriate roughness meter, which measure roughness parameters (Rz).

NOTE 2 Measurement of slip resistance values in the wet, by means of the pendulum test method given in [BS EN 16165:2021](#) provide useful information for assessing the likely slip resistance of flooring materials in water wet conditions in service, though results are more difficult to interpret for barefoot applications and for heavily textured surfaces.

There are two standard sliders used with the pendulum equipment:

- a) Slider 96 – provides slip potential readings for shod-foot pedestrians; and*
- b) Slider 55 – provides slip potential readings for barefoot pedestrians.*

NOTE 3 For natural stone, the pendulum test in [BS EN 14231](#) has been adopted as the accepted harmonized test method.

NOTE 4 Monitoring the change in surface roughness (Rz) of a surface due to wear and other factors can be helpful in gauging the likely change in slip resistance, although it is not a substitute for proper measurement of slip resistance. The required surface roughness depends on the type of contaminant, as higher viscosity liquid contaminants might require a higher surface roughness value. Surface irregularities can break up water or other contamination film, establishing contact with the shoe or heel, and in this respect, peaks are more important than troughs.

Some natural stones with rough surfaces, e.g. 0.5 mm to 1.0 mm, might still be slippery when contaminated if the surfaces of individual grains become polished; the macro- and micro-textures of stones should be established when determining slip potential. Natural stone surfaces contaminated with pure water should have a surface roughness (Rz) of at least 10 µm to provide a reasonable level of slip resistance. In circumstances where wetness is normal or expected, this figure should be increased by a factor of two or more.

Instruments used for the interpretation of measurements should be used consistently in order to obtain the correct numerical data, with the proposed installation environment and design taken into account.

NOTE 5 In addition to the relevant standard(s), see also the UK Slip resistance Group Guidelines [9].

Results obtained on factory-fresh/out of the box samples might not be directly comparable to in-service performance, where contamination, wear and cleaning regimes all influence the behaviour of the flooring material, and this should be taken into account. Cleaning procedures should be in accordance with 11.5, 13.5 and Clause 15, both to remove contamination and to verify that cleaning agents are correctly used.

Surface contaminants change the slip characteristics of a floor and therefore the cleaning and maintenance regime is a critical factor in maintaining slip ratings in-situ; floor tiles should therefore be maintained correctly so that the slip resistant qualities of the floor tiles are maintained.

Flooring materials should have a PTV of 36 or more when tested with the contaminants likely to be present on the floor.

NOTE 6 If a floor is only likely to be wet or otherwise contaminated very occasionally, its performance at a PTV less than 36 when contaminated with materials likely to be present might be acceptable.

Where it is known that slippery conditions might arise in service and present a significant hazard, tiles with slip resistant finishes suitable for the conditions and location should be used. Cleaning procedures should be in accordance with Clause 11, both to remove contamination and to verify that cleaning agents are correctly used.

NOTE 7 Walking on sloped surfaces requires more friction than walking on the level; even a 1° slope can have a significant impact on risk.

The target PTV on a slope compared to that of a level walkway should be increased by:

$$100 \times \tan \alpha$$

where α is the slope angle.

NOTE 8 Typically, a shower slope would be 2%, which equates to a 1.15° angle. The calculation gives an increased requirement of 2 PTV when compared with a level location.

As the wet room would be classed as an area of continuous contamination (by water) during the time of use, there should be a minimum PTV of 36 on the level surface, however, as the shower zone is sloped by 2%, this figure should be increased to a minimum of PTV of 38.

NOTE 9 These values place the floor finish in the low slip potential category.

NOTE 10 The criteria for assessing the results of slip resistance tests are based on research carried out by the Building Research Station in the 1950s and supported by investigators over the last 40 years. The long-established ranges of PTV values or Coefficient of Friction (CoF) are familiar to many and are:

Slip potential	PTV value
High	0 – 24
Moderate	25 – 35
Low	36 and above

These categories were determined following studies of slip related incidents, the results of which are tabulated as:

Coefficient of Friction (CoF)	Frequency of slip (people)
0.19	1 in 2
0.24	1 in 20
0.29	1 in 10 000
0.34	1 in 100 000
0.36	1 in 1 million

NOTE 11 $PTV = ca. 100 \times CoF$

When determining floor surface specification, the true slip resistance of the flooring should be taken into account. The expected contamination, the likelihood of that contamination and the nature and volume of foot traffic to which the installed flooring is to be exposed, should be evaluated.

The potential for slipping accidents to occur should include, alongside generated test data, a risk assessment examining other related factors, such as the:

- a) number of people using the area, their demographic;
- b) type of contaminant;
- c) likely level of contamination;
- d) source of the contamination (spillages, leaks, wet shoes/feet);
- e) type of footwear; and
- f) method, frequency and suitability of floor cleaning.

As part of the risk assessment, the following should be taken into account:

- 1) the efficacy of lighting;
- 2) the presence of distractions both visual and oral; and
- 3) how the floor area is to be used.

NOTE 12 For example, will people be pushing or pulling objects over the floor, carrying loads or rushing about; will there be elderly or very young people using the area; is the lighting adequate; will there be unexpected loud noises or other distractions?

NOTE 13 Further advice on the reduction of slip hazards is given in [Annex H](#).

Section 2 Ceramic tiles

7 Ceramic

COMMENTARY ON CLAUSE 7

Requirements for ceramic tiles are specified in [BS EN 14411](#). The categories referred to in this clause, can also be found in [BS EN 14411](#).

7.1 General

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

Advice should be sought from the tile or adhesive manufacturer(s) for large format floor tiles or panels requiring special bedding procedures.

Ceramic tiles of category AIII or BIII should not be used for flooring applications.

Confirmation of their suitability for the envisaged application should be confirmed with the product manufacturer where tiles of categories AII_{b-1}, A11_{b-2} or BIIa, BIIb are being considered.

Ceramic tiles that are to be fixed in locations liable to frost should pass the frost resistance test in accordance with [BS EN ISO 10545-12](#) (Bla and Ala). Where ceramic tiles of category BIIb or AIIb are being considered for installation, the manufacturer's guidance should be sought.

7.2 Thin ceramic tiles and panels (non-mesh backed)

7.2.1 Quality of thin ceramic tiling – characteristics and recommendations

NOTE Although thin ceramic tiles and panels are defined as ≤5.5 mm, this subclause is also applicable for 6 mm material.

Where thin ceramic tiles and thin ceramic panels are considered for installation in areas where the sub-floor is mature and rigid, e.g. existing ceramic or terrazzo, the manufacturer's recommendations should be followed as to their suitability.

The manufacturer's guidance should be sought where 6 mm tiles and panels are considered for installation in a particular environment/application scenario.

7.2.2 Technical information

7.2.2.1 General

Thin ceramic panels should be handled using specially designed equipment and by more than one person during and after removal from the manufacturer's original packaging, as well as for the actual installation of the panels (see [7.2.3](#)).

NOTE Very large thin ceramic panels can deform and fracture if lifted or moved incorrectly.

7.2.2.2 Thin tile joints

Thin tiles and panels should be positioned with regular straight joints, the width of which should be specified, taking into account the:

- thickness, size and dimensional tolerances of the thin tiles or panels;
- characteristics of the substrate;
- installation method; and
- expected end use of the thin tiling and anticipated loads likely to be imposed.

There should be sufficient joint space between the thin ceramic tiles or panels for grout to penetrate to the full depth of the joint. Thin ceramic tiles and panels should not be butt jointed. Joints between thin ceramic panels should be at least 3 mm wide and increase in width pro-rata to panel size (e.g. for 3 m long thin ceramic panels, the minimum joint width between 3 m panels should be 5 mm). The tile manufacturer should be consulted regarding joint widths.

When solidly bedding thin tiles and panels into the adhesive bedding, much of the shallow joint between the thin tiles/panels becomes partially filled with residual adhesive which should, as far as is practicable, be removed from the joints in order to provide sufficient joint depth and volume to receive the specified tile grout.

NOTE 1 Failure to do this can result in unsightly and/or cracked grout and reduced performance.

The grout should be specified, taking into account both the need of protecting thin tile edges, and the destination environment. Grout should be well compacted into the tile/panel joints and finished as flush as is practicable with the surface of the thin tiles/panels.

NOTE 2 The joints between thin ceramic tiles and panels are typically the most vulnerable points of a thin tiling installation; thin tile edges might be less resistant to static, dynamic and impact loads, than the edges of thicker tiles.

7.2.2.3 Movement joints

COMMENTARY ON 7.2.2.3

Thin ceramic tiles and thin ceramic panels (porcelain) have similar coefficient of thermal expansion characteristics to porcelain, as defined in [BS EN 14411](#).

The effect of thermal expansion/contraction on smaller format thin tiles (e.g. 200 mm × 200 mm) is relatively insignificant across a temperature range which could be reasonably anticipated (depending upon area of usage).

For larger format thin tiles and panels, any thermal expansion/contraction is cumulative across the area of the thin tile or panel so that, for, e.g. a ceramic panel of 3 m long, the expansion of the panel across a temperature range of 30 °C equates to approximately 0.65 mm which, as a percentage of a 5 mm wide joint between adjacent panels, equates to an approximately 12.5% compaction/expansion requirement of the joint grouting mortar, as well as a significant lateral deformation capacity of the panel bedding adhesive; depending upon any corresponding temperature change within the substrate structure onto which the panels are installed.

Typically, in normal environments, the temperature of the tiling layer and its substrate (internal tiling) might not vary from each other to such extremes, but where thin tiles and panels, particularly dark coloured ones are installed externally or in areas subject to intense direct sunlight, e.g. sun rooms, conservatories, atria, etc., the thin tiling layer can heat up and cool very quickly whilst the substrate might not.

Conversely, any significant drying shrinkage of the substrate which continues after thin tiles or panels have been installed directly onto it might result in the build up of lateral stresses within the tiling system. The larger the size of thin tile or panels, the greater the degree of “stress” that develops. Failure in the form of fracturing of the thin tiles/panels, or debonding of the tiles/panels from the substrate can result.

The provision of movement joints (structural joints, perimeter joints, intermediate joints) should be determined by the structural engineer at the design stage. The specification for the movement joint should include information on type, materials, construction, dimensions (width and depth) and position.

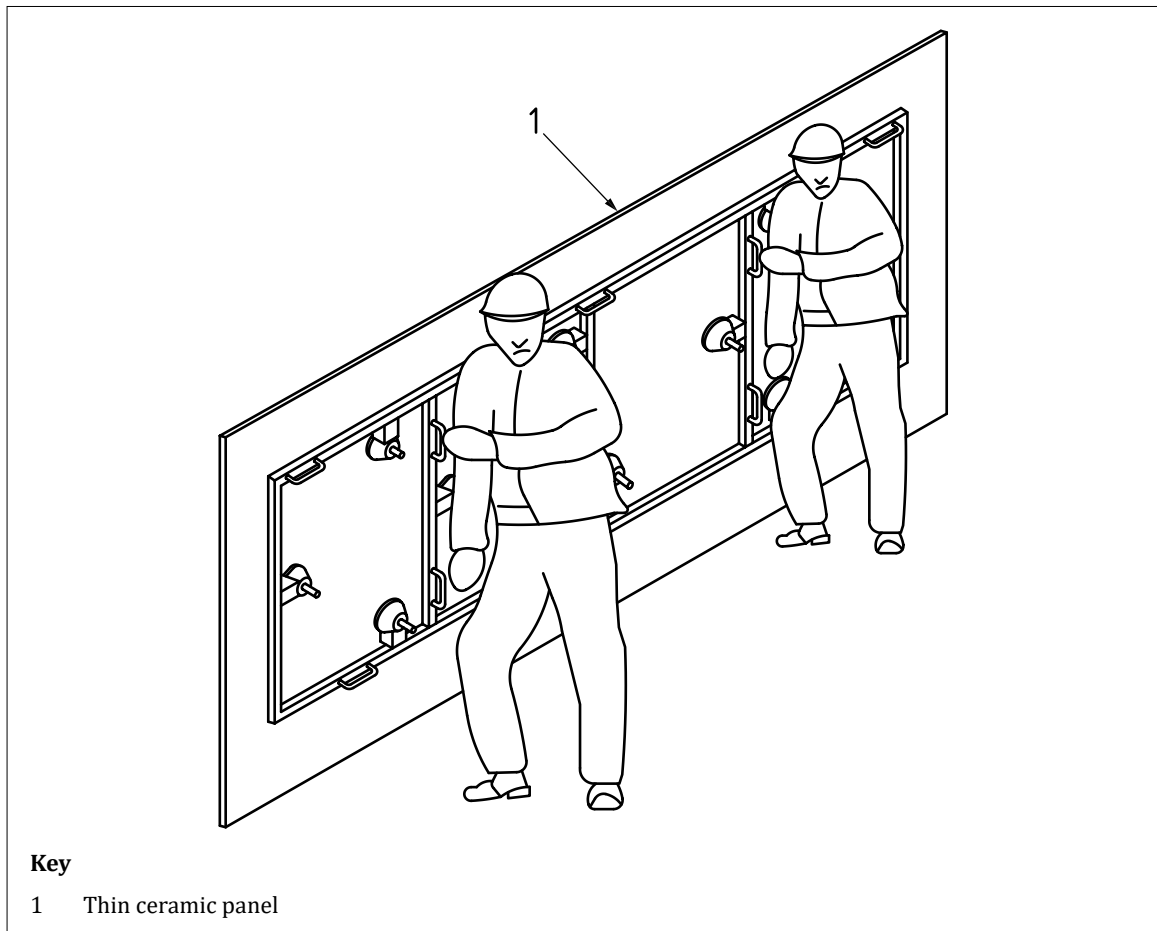
NOTE For further information regarding movement joints, see [9.3](#), [9.9](#) and [10.3.3.3](#), [Annex C](#) and [Annex G](#).

7.2.3 Storage and control of the materials

COMMENTARY ON 7.2.3

Thin ceramic panels should be handled with specially designed equipment for supporting them in order to prevent possible fracture during and after removal from the manufacturer’s original packaging, as well as for the actual installation of the panels (see [Figure 3](#)).

NOTE Very large ceramic thin panels can deform and fracture if lifted or moved incorrectly.

Figure 3 — Example of correct handling of large ceramic panels

7.2.4 Control and preparation of the substrate, preparation of the bedding material, application of bedding thin tiles and panels

Depending upon the size of the panel and the characteristics of the specified bedding adhesive, sufficient bedding adhesive should be spread to install one panel at a time to avoid possible “skinning” of the adhesive which could have a detrimental effect upon the performance of the adhesive/tiling.

NOTE Thin ceramic panels are currently being produced which are larger than 3 m².

In order to achieve solid bedding of large format thin ceramic tiles and thin ceramic panels, the floating and buttering technique should be used, whereby adhesive is applied to both the tile and the substrate (see [10.2.1](#)).

To achieve solid bedding of large format thin tiles and panels, the thin tiles or panels should be sufficiently pressed into the bedding adhesive using a specifically designed tool in order that, as far as it is practicable, there are no voids or trapped air behind the thin tiles or panels.

Substrates should be checked to confirm they have the regularity characteristics in the specification, e.g. the larger the thin tile/panel the greater the importance of the accuracy in planarity of the substrate. Discrepancy from the specification should be communicated to the appropriate parties.

Particular attention should be paid to the application of adhesive to the backs of thin ceramic tiles and panels so that the edges and corners are properly covered with adhesive (see [10.2.1](#)).

8 Inspection

Floor tiling should be inspected on completion, as follows:

- a) the finished tile surface should meet the recommendations given in [10.1.4](#);
 - b) the straightness of the joints between the tiles and slabs should be checked in accordance with [10.1.3.2](#); and
 - c) the finished floor should be viewed perpendicular to the surface at a distance of 1 m with the naked eye or with spectacles if usually worn.
-

9 Protection

9.1 General

Finished and partly finished flooring should be protected from damage or contamination from following trades.

During the laying operation, the areas should only be accessible to the tiling operatives or flooring masons. Completed floor tiling should not be subject to traffic until the tile adhesive or bedding mortar has hardened and sufficient bond strength has developed between the floor substrate, tile adhesive or mortar bedding and the floor tiles or natural stone.

Light pedestrian traffic over the newly laid floors should be allowed when the bedding materials are set, and the floor protected.

Heavier traffic should not be permitted to use the floor for at least seven days for rapid setting tile adhesives and grouts and 14 days for normal setting adhesives and grouts and for cement:sand mortar bedding and grouting following completion.

NOTE 1 The access time can vary, depending on the type of bedding method used and the environmental site conditions. As a general guide at 20 °C, light traffic can be permitted as follows:

- a) normal setting cementitious-based tile adhesives and grouts: 3 days;
- b) rapid setting cementitious tile adhesive and grouts: 1-2 days; and
- c) cement:sand mortar bedding: 4 days.

Unless a rapid hardening grout is used, the four-day period is not to be reduced. For further advice on the setting times for tile adhesives and grouts, contact the manufacturer.

At all times, the floor tiling should be kept clean and free from cement and plaster droppings, and materials likely to cause stains. The flooring should be covered during work carried out on or over the floor involving substances that could cause permanent staining, e.g. oils, grease, paint. Appropriate types of sheets or boards should be laid loosely over the finished floor to protect it. Breather membranes should be used beneath the floor protective boards, where applicable.

If plant likely to cause damage has to be used, parts in contact with the floor surface should be padded; sliding of plant over the surface should not be allowed. When heavy equipment has to be moved over the floor surface, special precautions should be taken, typically involving the use of timber planking, so that the equipment, moving tackle and the protection itself are not allowed to damage the tiled surface by abrasion.

Stair finishings, especially nosings, are vulnerable to damage from following trades and should be protected by temporary casings.

NOTE 2 The recommended drying times of all in situ floor substrates are the minimum required under optimum conditions. These drying times can be considerably extended under adverse drying conditions on site, e.g. low-site temperatures and/or poor drying conditions.

For external applications, work should be protected from frost or other unfavourable weather conditions both during and after completion.

9.2 Grouts for tile joints

9.2.1 General

Grout mortars should have good working characteristics, low shrinkage and good adhesion to the sides of the tiles. It should be possible to clean the grout off the face of the tiles and slabs without undue difficulty as well as fulfilling the aesthetic requirements of the installation. When selecting a grout, the specifier should establish that it is suitable for the conditions to which it is to be exposed.

9.2.2 Proprietary grouts

Proprietary grouting materials should be classified in accordance with [BS EN 13888-1](#).

NOTE 1 BS EN 13888-1 specifies performance criteria for properties, such as abrasion resistance, compressive and flexural strength, shrinkage, water absorption and setting time.

NOTE 2 Additional properties can assume special importance, e.g. resistance to water absorption and abrasion resistance, heat and cleaning agents, resistance to mould growth and bacteria, resilience and compressibility.

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

NOTE 3 For grouting materials used with external flooring, refer to the manufacturer of the grout and their technical documentation, following the guidance for installation and maintenance.

9.2.3 Admixtures to grouts

COMMENTARY ON 9.2.3

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

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

9.3 Sealants and back-up materials for movement joints

9.3.1 General

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

NOTE The selection of the most suitable materials depends upon design considerations and service conditions (see [9.9.1](#)).

9.3.2 Sealants

Joint sealants should be selected and applied in accordance with the guidance given in [BS 6213](#). Sealant manufacturers' advice should be taken into account as the properties of individual sealants might vary. The sealant should accommodate the anticipated amount of movement without loss of adhesion to the sides of the joints and be able to withstand normal service conditions affecting the installation, e.g. resistant to water, ultraviolet light.

The provision of movement joints should be taken into account at the design stage.

NOTE 1 Stresses occur in the tiled installation as a result of movement due to such factors as drying shrinkage and moisture, thermal changes and creep. These stresses can cause loss of adhesion, bulging or cracking of the tiling but they can be localized by incorporating movement joints.

Sealants with a movement accommodation factor (MAF) (see [BS 6213](#)) of at least 25% should be used over structural movement joints. Higher movement sealants should be chosen for smaller joint widths.

NOTE 2 Sealant systems might not be applicable in all cases as structural movement joints might require the use of purpose designed mechanical joints within the tiled finish.

NOTE 3 Guidance on joint design is given in [BS 6093](#).

NOTE 4 For further information on the installation of sealants, see [9.9.2](#).

9.3.3 Back-up materials

Back-up materials should be compressible materials that do not force out the sealant when the joint closes.

NOTE 1 Suitable materials include cellular rubber and plastics, such as closed cell polyethylene. These materials are available in strip form.

The back-up material in the lower part of the joint should be compatible with the sealant being used (see [9.3.1](#)); it should be compressible, should support the sealant and not release bituminous or oily products. It should assist the seal in carrying traffic loads and its compressibility should be such that when the joint closes, the sealant is not forced out.

NOTE 2 For further information on the installation of back-up materials, see [9.9.3](#).

9.4 Substrates

COMMENTARY ON 9.4

Concrete and cement and sand levelling screeds are the most common substrates over which ceramic floor tiles, slabs and mosaics are laid, however other substrates might be encountered, such as calcium sulfate-based screeds (see [Annex D](#) with regard to pumped calcium sulfate-based screeds), timber (see [9.4.4](#)), raised access flooring (see [9.4.7.4](#)), asphalt (see [9.4.6](#)) and metal (see [9.4.7.1](#)).

In refurbishing work, it might be necessary to apply new finishes over old floors, such as ceramic tiles, terrazzo, wearing screeds, stone, etc.

9.4.1 General

Before the tile bed is applied, the:

- correct falls should have been incorporated in the substrate, where required;
- substrate should be free from contamination, loose areas of weak or friable material and cracks liable to subsequent movement; and
- substrate should be true to the specified plane (see also [Annex E](#) regarding cement and sand levelling screeds).

NOTE 1 Substrates suitable to receive floor tiling in each case are summarized in [Table 1](#).

In new work, the plane of the substrate in relation to that of the finished floor surface should be specified; typically, this is possible only if the floor tiles are selected at the design stage. The level of the substrate in relation to the finished floor surface should be such that the bed can be of the recommended thickness uniformly throughout the installation.

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

Where a separating layer is to be incorporated between the substrate and the bed, the substrate should be accurately formed and have a true and smooth surface to enable the tile bed to move freely over the substrate in the event of differential movement.

NOTE 2 For details on separating layers and uncoupling membranes, see 6.2.2.

NOTE 3 Tiles are rarely adhered to a concrete substrate without a levelling screed as it is not typically possible to achieve the required surface regularity (see 9.4.2).

Table 1 — Suitability of tile beds for different substrates

Substrates	Cement-based adhesives (see 10.2)	Cement and sand mortar	Semi-dry cement and sand mix		Reaction resin adhesives ^{A)}	Clause
			Bonded (see G.10)	Bonded (see G.7)	Unbonded (see G.8)	
New concrete (with less than six weeks drying) or levelling screed (less than three weeks old)	U C	U	U	S	U	9.4.1, 9.4.2 and 9.4.3
Unglazed ceramic tile	S	S	S	S	S	9.4.1 and 9.4.7
Glazed ceramic tile	S	S	S	S	S	9.4.1 and 9.4.7
Wearing screed (e.g. granolithic)	S	S	S	S	S	9.4.1 and 9.4.7
Natural stone and terrazzo	S	S	S	S	S	9.4.1 and 9.4.7

A) See 10.2.2.

NOTE 1 S = Suitable (confirm classification/system with the manufacturer); U = Unsuitable; C = Confirm suitable with manufacturer and specialist contractor.

NOTE 2 The tile bed chosen also depends on the traffic conditions.

NOTE 3 See Table G.1 for bed thicknesses.

9.4.2 Concrete

9.4.2.1 General

Where tiles or slabs are to be bedded directly to a concrete substrate without a levelling screed, the concrete should be finished by striking-off level with a straight edge and the surface texture closed. When a bonded bed is required, laitance should be removed using an appropriate mechanized surface preparation equipment.

9.4.2.2 Tolerances on levels and surface regularity

Tolerance on levels and surface regularity for levelling screeds should be in accordance with E.1.7.

9.4.2.3 Preparation

Where a bonded tile bed is specified, the sub-floor should be correctly prepared, and the recommended bonding treatment carried out to provide good adhesion of the tile bed. Concrete surfaces should be suitably prepared so that adhesion is not impaired by surface contamination.

NOTE In most cases, the concrete surface has laitance and lime bloom present that can be removed by light mechanical means.

If the concrete has been treated with a curing agent or has had a film of laitance and fines worked up to its surface during finishing, these barriers to adhesion should be removed by equipment, such as contained shot blasting.

The sub-floor should be inspected prior to tiling so that it is free of contamination, loosely adhered materials or other surface defects.

Where a bonded cement/sand bedding system is used, the sub-floor should be roughened using appropriate mechanized equipment designed specifically for this purpose and the use of a suitable bonding treatment. If the concrete sub-floor is of suspended construction, e.g. a precast concrete plank, measures should be taken so that roughening by mechanized equipment, e.g. by scabbling, does not cause damage to the concrete. In such cases, contained shot blasting with coarse shot should be undertaken.

Where there is a risk of subsequent contamination, the surface preparation should be delayed until shortly before the tile bed is laid.

9.4.2.4 Elimination of construction moisture

Structural concrete should have been cured and then subjected to continuous air drying for a minimum of six weeks before either a bonded levelling screed or direct bedding of the flooring material is applied. The same allowance should be made for concrete with a monolithic levelling screed surface.

NOTE 1 A longer drying period is necessary under adverse site or weather conditions.

NOTE 2 All rigid finishing materials reflect movements arising from supporting substrates. In the early period of a structure's life cycle these arise primarily from drying shrinkage of the slab and this is typically evidenced by longitudinal or transverse construction joints in the slab opening up. The Concrete Society indicates, as a rule of thumb, that a typical slab of span 10 m can experience a drying shrinkage of 3.0 mm irrespective of design, depth, or amount of reinforcement used. This movement can manifest itself through finishes as minor spalling of grouted joints or, in more extreme circumstances, as fracture and major dislocation of the units.

9.4.3 Levelling screeds

COMMENTARY ON 9.4.3

Cracks that occur in screeds can result in reflected cracks appearing in the tile or slab finish. Common causes of cracks to screeds are those induced by rapid drying.

To prevent rapid surface drying after laying, the screed should be covered for at least seven days and then allowed to dry for at least three weeks (inclusive of the seven days being covered).

For natural stone, agglomerated stone and terrazzo, the drying time required should reflect the type and thickness of the screed and the on-site drying conditions. Where the tiles and slabs are to be directly bonded to the screed with adhesive, the recommendations in [BS 8204-1](#) and [BS 8203](#) should be followed. One day of drying should be allowed for each millimetre of (screed) thickness for the first 50 mm, followed by an increasing time for each millimetre above this thickness.

NOTE 1 It is therefore reasonable to expect a levelling screed 50 mm thick drying under good conditions, to sufficiently dry in about two months.

NOTE 2 A levelling screed is often used as an intermediate layer between the structural substrate and tile bed to provide a true and even surface on which to apply tiling. Recommendations for the design and laying of levelling screeds are given in [Annex E](#).

NOTE 3 A method for the assessment of levels and surface regularity is given in [Annex F](#).

9.4.4 Timber substrates

COMMENTARY ON 9.4.4

See [17.3](#) for load considerations.

Additional guidance can be found in *The Tile Association guidance note, Internal Ceramic Tiling to Sheets and Board Substrates* [10].

Fibreboards, whether wet pressed medium density fibreboard (MDF) or dry pressed, oriented strand board (OSB) or chipboard are not suitable flooring substrates to receive ceramic tiling.

Timber substrate sub-floors are unsuitable for exterior locations.

9.4.4.1 General

The design should take into account the initial drying shrinkage of the timber and subsequent movement due to seasonal moisture changes, taking into account the type of heating.

NOTE 1 Failure to observe this can lead to subsequent warping and distortion of the boards with consequential cracking and delamination of the tiling.

Sheets and boards that are subject to movement from changes in moisture content should not be used. Plywood and other wood-based sheets or boards should not be used for direct tiling.

*NOTE 2 The type, selection and installation of plywood, including guidance on fixing centres, is set out in the TRADA publication *Panel Guide V4* [11].*

NOTE 3 The design of timber substrates and load classes for use with limit state to Eurocode 5: Design of timber structures are given in [BS EN 1991-1-1](#):

- a) *Category A: Domestic, this includes houses, bedrooms and wards to hospitals and rooms in hotels;*
- b) *Category B: Office;*
- c) *Category C: Public spaces, etc.; and*
- d) *Category D: Shopping areas, etc.*

For tiling onto plywood and other wood-based sheets or boards, an intermediate layer, such as an uncoupling membrane, reinforced tanking system or tile backer board should be used.

If a timber sub-floor is used as a substrate for floor tiling, it should be rigid and stable with respect to humidity and moisture changes.

NOTE 4 Timber sub-floors are not ideal substrates for floor tiling, especially where heavy static/dynamic loading is likely in service.

NOTE 5 Timber is not a suitable substrate for floor tiling in wet, frequently damp, or high humidity areas.

Where it is necessary to install wood-based sheets and boards, such as plywood, the moisture content of the wood-based sheets and boards should be close to the equilibrium moisture content that prevails under the service conditions. In heated domestic buildings, where the temperature is above 21 °C, to be in equilibrium, the moisture content of wood-based fabricated underlay plywood should be between 6% and 10%.

NOTE 6 For installations in conservatories, on heated timber sub-floors and areas with higher temperatures or lower humidity levels, the equilibrium moisture content might need to be at the lower moisture content value, or even lower, as the average temperatures is higher than those typically experienced in rooms in domestic buildings.

Plywood of an appropriate quality should be used and be correctly stored and, if required, conditioned to the appropriate moisture content before installation.

Glue bond class 3 exterior, in accordance with the BS EN 314 series, should be used.

NOTE 7 The use of a UKCA or CE marked product does not designate that the product is suitable for its intended purpose.

NOTE 8 Noggings might be required between joists to achieve the required rigidity. The limit of deflection typically permitted for domestic timber floors (see [BS EN 1995-1-1](#)) might be too great to avoid damage to tiling systems.

It should be confirmed that ventilation is sufficient and that effective damp-proof courses are correctly located.

Where rigidity is acceptable, but the moisture stability of the floor cannot be assured, the use of an appropriate intermediate water-resistant substrate system designed for use with tiling on timber floors should be installed.

The length of screw fixings should be at least 2.5 times the thickness of the plywood material (e.g. use a minimum 45 mm length screw for 18 mm plywood) so that there is sufficient penetration into the timber sub-floor or joist/strut supports, taking into account underfloor services that could be damaged by oversized screws.

9.4.4.2 New timber substrates

New timber substrates should be constructed with strutting between the joists. Plywood of at least 18 mm thickness should be screwed to both joists and strutting at 300 mm maximum intervals. The lower face and edges of the plywood should be sealed using a suitable sealing product, e.g. polyurethane varnish, styrene butadiene rubber or acrylic. All junctions between boards should be supported by struts or joists. Where it is necessary to further reduce or eliminate the risk of movement, an additional layer of plywood sheets of minimum thickness at least 12 mm, or a proprietary tilebacker board resistant to moisture and thermal movement, should be screwed/bonded over the plywood at 300 mm centres so that the joints in both layers of sheets do not coincide.

The top sheet to receive the tile finish should be laid broken bonded in both directions.

Where the sheet or board has a rough and smooth side, the latter should be used for tiling.

The surface to receive the tiles and slabs should be clean and free from dust and contamination.

Plywood and other wood-based sheets or boards should not be used for direct tiling. For tiling onto plywood and other wood-based sheets or boards, an intermediate layer, such as an uncoupling membrane, reinforced tanking system or tile backer board should be used.

9.4.4.3 Existing timber substrates

Existing timber substrates to be covered by tiles should be sufficiently strong and rigid. They should be examined to determine whether they can carry the additional dead load of up to 0.8 kN/m², and the probable dynamic loading, without excessive deflection. Existing boards should be removed, and the floor stiffened with noggings and joist support sleeper walls before following the recommendations for new timber substrates.

Ceramic tiles should not be installed to wood block flooring (parquet and wood mosaic) or composite block flooring. These types of floor coverings should be removed and the substrate beneath appropriately prepared.

NOTE 1 Timber floors have often behaved satisfactorily for a period of years as a result of surface evaporation of moisture. If this is hindered by the laying of a nearly impervious covering, the moisture content can rise to a level sufficient to promote fungal attack, e.g. dry rot.

NOTE 2 For floors of small area (e.g. a single sheet/board) the required rigidity might be achieved by fixing exterior grade plywood of at least 18 mm thickness over existing boards.

The underside and the edges of the plywood should be sealed, using a suitable sealing product, e.g. polyurethane varnish, styrene butadiene rubber or acrylic, to prevent distortion by changes in atmospheric humidity and screwed to joists and existing boards at 300 mm intervals.

As an alternative to plywood, a suitable tilebacker board should be used and installed in accordance with the manufacturer's guidelines.

The plywood sheets should be laid broken bonded with the long edges running at right angles to the joints between the existing boards.

Plywood and other wood-based sheets or boards should not be used for direct tiling. For tiling onto plywood and other wood-based sheets or boards, an intermediate layer, such as an uncoupling membrane, reinforced tanking system or tile backer board should be used.

9.4.4.4 Adhesives

Proprietary deformable tile adhesives and grouts and water-resistant membrane systems specially formulated for fixing tiles onto timber substrates should be used in accordance with the manufacturer's instructions.

9.4.5 Floating floor

COMMENTARY ON 9.4.5

There are many different types of floating floors, including floating cement and sand and calcium sulfate-based screeds to other sheet- and board-based systems.

Before fixing ceramic tiles or slabs, the following should be checked:

- where applicable, the suitability of proprietary floating floor systems to receive a rigid tiled finish should be confirmed with the manufacturer;
- resilient insulating layer should provide sufficient support;
- the existing structural substrate, i.e. concrete, should be flat, level and smooth with no localized raised areas; and
- the floor should have minimal vertical deflection under load, typically for ceramic tiles, the floor should not deflect more than $1/360$ of the span of the structure. For natural stone tiles or large format ceramic tiles, the floor should not deflect more than $1/720$ of the span.

NOTE 1 This is the case of most natural stone but consult the supplier for further guidance.

NOTE 2 The accepted minimum requirement for floor rigidity is $L/360$ before the tile underlayment is installed.

To avoid shrinkage defects, the moisture content of the various floor elements should match that expected of the finished installation. Tiles should be solidly bedded in accordance with 10.2.

The floating floor to receive a tiled finish should be rigid, stable and capable of taking both the dynamic and static loads imposed upon it without excessive movement or vertical deflection. Vertical deflection and moisture movements should be kept to a minimum, otherwise there might be a risk of tiles cracking, grout disruption or even loss of adhesion.

NOTE 3 Direct fixing of ceramic tiles or slabs to a wood-based floating floor entails a high element of risk and is to be avoided. However, where the floor is deemed to be suitable, the use of a proprietary intermediate substrate, (e.g. uncoupling membrane or tile backing board) can be taken into account.

NOTE 4 For details on separating layers and uncoupling membranes, see 6.2.

9.4.6 Asphalt

Flooring grade asphalt should be laid on a rigid substrate, e.g. concrete or levelling screed, in accordance with [BS 8204-5](#) for internal floors and in accordance with [BS 8218](#) for external locations. Before tile fixing commences, the asphalt sub-floor should be examined to confirm that it is in a suitable condition to receive screed, tiles and slabs.

For internal locations, the grades of asphalt used should conform to [BS 6925:1988](#), Type F 1076 and be suitable for the anticipated loads and conditions.

Floor tiles and slabs should be solidly bedded in cementitious adhesives, in accordance with [10.2](#), such that the bed thickness does not exceed 6 mm.

In dry locations, if the surface of the asphalt has a natural float finish, the surface should be clean and primed in accordance with the adhesive manufacturer's recommendations.

NOTE 1 It might not be necessary to prime the clean asphalt surface if the asphalt surface has a sand-rubbed finish.

NOTE 2 For internal locations, the tiles or slabs can also be bedded in a cement and sand semi-dry mortar bed over a separating layer, if appropriate, for the type of tile being fixed and the required floor finish levels.

For external locations, specialist advice should be sought. This might require the installation of an unbonded or floating cement and sand screed prior to tiling.

NOTE 3 For further information, see Mastic Asphalt Council – Technical guides for roofing [12].

Sheets of the separating layer material should be overlapped and brought up vertically at the perimeter of the semi-dry bed where it abuts upstands and walls.

NOTE 4 In most cases, a movement joint is required at the perimeter. This can be formed with a compressible back-up filler inserted between the upstands and mortar bed, with the movement joint between the perimeter tiles and upstands being finished with a suitable sealant (see [9.3](#) and [9.9](#)).

The asphalt and the semi-dry mortar bed at the lower end of the fall should be free draining into a suitable gully or drainage outlet.

9.4.7 Other substrates

COMMENTARY ON 9.4.7

Existing floor finishes, such as ceramic tiles, terrazzo, natural stone and similar hard surfaces are suitable as substrates provided that they are clean and firmly adhered to their substrate. Seek specialist advice regarding preparation and adhesive selection.

9.4.7.1 Metal

COMMENTARY ON 9.4.7.1

This subclause relates to internal installations only. Where metal substrates are encountered in external locations, specialist advice is required.

Steel substrates might be encountered in the construction of staircases, lift cars or access panels/manhole covers.

Metal substrates should be overboarded. Ceramic tiles, natural stone, resin agglomerated stone tiles and terrazzo should not be bonded directly to galvanized steel.

Prior to commencing tiling, the substrate should be rigid and free from deflection (see [6.2.3](#)).

Where tiles are to be bedded directly to rigid metal, specialist advice should be sought.

In the case of rolled steel staircases, it might be possible to bond directly to the substrate using an appropriate adhesive or there might be a requirement to overboard with a suitable intermediate substrate such as 18 mm exterior grade plywood or a suitable tilebacker board; where this is the case, the overboard material should be mechanically fixed to the metal. Where proprietary boards are used, the product manufacturer should be consulted for installation guidance.

The steel surface should be thoroughly degreased and mechanically abraded prior to the application of primers or adhesives to remove process oils and contamination, such as rust. Rust inhibiting primers should be used where recommended by the adhesive/board manufacturer.

Treads constructed of a steel tray or box should have a welded reinforced section and be filled with an appropriate material, such as a proprietary mortar or screed material. The material should be bonded to the base and sides of the tray (box) using an appropriate bonding agent in accordance with the mortar manufacturer's instructions.

The recessed zone of a manhole cover/access panels should be filled with a proprietary mortar bonded to the base and sides using an appropriate bonding agent in accordance with the manufacturer's instructions.

In the case of lift cars, any void should be filled with an appropriate tilebacker board mechanically fixed to the steel substrate. Where the deflection is greater than that given in 6.2.3, a suitable structural system or a structural board, such as a minimum 18 mm calcium sulphate board or exterior grade plywood should be mechanically affixed.

NOTE Where a structural board is not required, other types of tilebacker board might be used.

9.4.7.2 Calcium sulfate-based sheets and boards

Calcium sulfate-based sheets and boards should be installed at a thickness capable of carrying the anticipated service loads without deflection. They should have tongue and groove edges and individual sheets should be located along these edges and glued together using the appropriate manufacturer's adhesive.

Calcium sulfate-based sheets and boards used as an overboard option to new/existing timber substrates should be installed in accordance with the board manufacturer's guidelines, with allowance for perimeter expansion.

Where the manufacturer's product can be used as a structural board, it might be used directly to joists and should be affixed in accordance with the manufacturer's guidelines. The joist centres should be in accordance with the manufacturer's guidelines.

The required thickness of board should be determined with the board manufacturer.

The sheets and boards should be primed in accordance with the manufacturer's guidance.

9.4.7.3 Calcium sulfate-based levelling screeds

Calcium sulfate-based levelling screeds, i.e. anhydrite or hemihydrate levelling screeds, should not be used for directly overlaying with ceramic tiles or mosaics in cementitious adhesives unless dried, abraded to remove laitance and completely sealed with an appropriate primer to prevent the adhesive from coming into direct contact with the levelling screed.

NOTE 1 See [Annex D](#) for further information on calcium sulfate-based screeds.

NOTE 2 Calcium sulfate bases are not suitable for installations that are frequently wetted, e.g. commercial kitchens, wet rooms, pool surrounds, etc.

9.4.7.4 Raised access floors

Before installing ceramic tiles or slabs, the raised floor construction should be checked to confirm it is rigid and capable of supporting the increased weight. The pedestals should be locked into position and the access panels screwed to the pedestal heads.

When using a metal pan system, the floor should be covered with one layer of minimum 18 mm thick plywood or two layers of 9 mm thick plywood cross laid. The plywood should be secured to the metal pan raised floor using stainless steel screws. An intermediate uncoupling system should be used for fixing of the tile to the plywood, or, alternatively, a tilebacker board should be installed.

Alternatively, the metal pan system should be covered with an interlocking minimum 18 mm structural calcium sulfate-based board installed following the manufacturer's guidelines or where additional structural support is not required, the metal pans should be covered with a proprietary tilebacker board system, screwed, and glued where applicable, to the access system, as recommended by the board manufacturer.

The thickness of the calcium sulfate-based board should be determined through consultation with the board manufacturer so that required design parameters are met.

When using a gypsum fibre core panel, the system selected should be suitable for use with ceramic tiles. The panels should be of the appropriate thickness, tongue and grooved and glued on all edges.

With gypsum fibre core panels, an uncoupling system should be installed.

Partial access flooring systems comprising tongue and groove interlocking calcium sulfate-based boards to a proprietary pedestal/stringer system should be installed in accordance with the manufacturer's guidelines and be of an appropriate thickness and design to support the anticipated service loads without deflection. Guidance should be sought from the board manufacturer regarding the design and positioning of access panels.

Calcium sulfate sheets and boards should be primed in accordance with the manufacturer's instructions.

NOTE See the TTA document, Tiling to raised flooring systems [13], for further information.

9.4.8 Laying ceramic tiles or slabs on acoustic systems

9.4.8.1 General

Where tiles or slabs (including waterproof tanking, where required) are laid directly onto acoustic matting, the mat should not compress under static or dynamic loading nor allow movement under the increased weight of the tiling. A suitable adhesive (or waterproof tanking) recommended by the manufacturer should be used to provide a strong bond.

Where waterproofing is required, this should be applied directly to the acoustic matting.

9.4.8.2 Laying ceramic tiles and slabs on an acoustic batten flooring system

To improve acoustic performance in a building, the use of acoustic cradle systems should be adopted.

NOTE 1 Acoustic cradle systems are designed to eliminate or drastically reduce transmitted sound but some systems might allow some vertical movement.

NOTE 2 Typically, ceramic tiled finishes are not designed to cope with this vertical movement and are liable to fail under normally imposed loads.

Before laying ceramic tiles or slabs onto an acoustic batten floor system, the applied loadings (uniformly distributed loads and point loads) should be established.

The system should have battens and saddles at 300 mm centres with noggings at 300 mm centres.

Minimum 18 mm thick plywood conforming to [BS EN 636](#) should be laid on the battens and secured with wood screws between 150 mm and 300 mm centres to all perimeter joists and 300 mm centres to all intermediate joists and noggings.

The design and installation of the plywood should follow the guidance set out in *Panel Guide V4* [11].

Before installing the ceramic tiles or slabs, the plywood should be overlaid with a backer board or uncoupling membrane and installed in accordance with the manufacturer's instructions.

Ceramic tiles or slabs should not be directly bonded to the plywood.

As an alternative to plywood, a minimum 18 mm tongue and grooved interlocking calcium sulfate board should be used. The thickness of the board should be determined in consultation with the board manufacturer.

9.5 Durability and performance

COMMENTARY ON 9.5

Correctly installed and maintained ceramic floor tiling provides a durable floor finish.

9.5.1 Traffic and load conditions

COMMENTARY ON 9.5.1

For the purpose of this British Standard, traffic loads are categorized as light or heavy.

Floor loading should be classed as heavy if heavy cleaning equipment, hard-wheeled trolleys, access equipment, such as mobile elevated work platforms (MEWPS), scissor lifts, etc. are to be used.

Light loading should be classed as normal low density pedestrian traffic, e.g. domestic and office locations.

Heavy loading areas should be classed as areas where high-density pedestrian traffic, and/or heavy loads, static, moving, dropped or dragged, are likely to occur, e.g. in supermarkets, shopping malls, engineering premises and garages/workshops for heavy vehicles.

Where loads are heavy, the point loads likely to be exerted should be determined, noting the surface area of wheels, runners or plates, e.g. planters, trolleys, etc.

The substrate should be able to support the applied load without deflection. The floor should have minimal vertical deflection under load, typically for ceramic tiles, the floor should not deflect more than $L/360$ of the span of the structure. For natural stone tiles or large format ceramic tiles, the floor should not deflect more than $L/720$ of the span (see 6.2.3).

As the floor tile is a decorative surface finish it should not be designed to be self-supporting.

NOTE 1 The success of the installation is reliant on the strength of the underlying materials and ultimately the strength of the weakest link in the system.

A floor tile should be installed in a void-free bed of adhesive, where stresses exerted on the tile are transferred to underlying substrata within the construction.

NOTE 2 Failure to provide full and stable support might result in damage to the tile finish.

Prior to applying loads, hydraulically or chemically curing materials within the supporting system (adhesives, screeds, etc.) should be correctly applied and compacted, where necessary, and have reached their quoted strengths, i.e. fully cured.

NOTE 3 Applying loads whilst these components are still curing could result in failure as their strengths might still be low.

MEWPs, scissor lifts, cherry pickers or other high level access equipment should have pneumatic tyres, wherever possible. Equipment with metal wheels or solid rubber tyres should either be avoided, or if there is no alternative to this type of equipment, plywood runners of minimum 18 mm, should be positioned on the floor to provide the tiles and slabs with protection from possible damage during use.

High level access equipment typically has metal stabilizing arms, which are provided in order to allow them to access at very high levels; the tiles and slabs should be protected with a plywood pad, approximately 1 m², minimum 18 mm thick plywood, in order to avoid possible impact damage during use.

Inspection covers should accommodate the load of heavy equipment.

9.5.2 Resistance to mechanical failure

9.5.2.1 Resistance of structure

The supporting structure beneath the tile or slab finish should be capable of resisting the anticipated applied dynamic or static loading without distorting, collapsing, deflecting or compressing.

As loading applied to the tiled floor is transferred through to the substrate below, the supporting structure should also be capable of taking the load.

NOTE 1 In addition to making sure that the substrate is sufficiently strong enough to support the applied load, other factors to be taken into account would be the magnitude and the type of load as well as the surface area over which the load would be applied.

A tiled finish is not designed to reinforce or strengthen an inadequate substrate; the tiles and slabs should be bedded in a continuous layer of adhesive with no voids (weak points) present.

Prior to applying a load, underlying hydraulically curing materials (adhesives, screeds, etc.) should have reached their quoted strengths.

NOTE 2 Applying loads whilst these components are still curing might result in failure as their strengths could still be low.

9.5.2.2 Resistance of tile bedding

Tiles should be solidly bedded so that, as far as practicable, they are free from voids, taking into account that a void is a potential point of weakness which could lead to cracked tiles under load.

NOTE 1 See 10.2 regarding the application of adhesives.

Typically, an adhesive bed of between 3 mm and 6 mm should be applied although thicker beds might be necessary.

NOTE 2 Greater resistance to loading can be achieved by the use of thicker flooring tiles with increased impact resistance, compressive and flexural strengths, taking into account that the joints between the tiles and slabs are typically the most vulnerable part of the flooring.

9.5.2.3 Resistance of tiling

COMMENTARY ON 9.5.2.3

Abrasion, compression and impact can operate singly, but are often to be found in various combinations.

The relevant mechanical properties of flooring should be determined, including:

- a) *resistance to abrasion*: physical toughness of the flooring itself and a surface free from irregularity in level;
- b) *resistance to compression*: strength and thickness of tile, solidity and strength of bed and compressive strength of sub-floor;
- c) *resistance to impact*: in addition to the properties given in a) and b), the following factors should be taken into account:
 - 1) within the normal tolerances of the flooring tiles used, the individual tiles should be laid to a true plane. A true substrate to SR1 is a necessary pre-requisite; with large format tiles/panels, a surface regularity of better than SR1 might be required and allowances should be made for self-levelling compounds at the design stage;
 - 2) the flooring tiles should be solidly bedded so that, as far as possible, there are no voids beneath the tiles;

NOTE See 10.2.1 and 10.2.2 regarding adhesive application.