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SANS 10107: THE DESIGN AND INSTALLATION OF CERAMIC TILING

Remarks:

PLEASE NOTE:

- **The technical committee, SABS TC 59: *Construction Standards* responsible for the preparation of this standard has reached consensus that the attached document should become a South African standard. It is now made available by way of public enquiry to all interested and affected parties for public comment, and to the technical committee members for record purposes. Any comments should be sent by the indicated closing date, either by mail, or by fax, or by e-mail to**

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  Any comment on the draft must contain in its heading the number of the clause/subclause to which it refers. A comment shall be well motivated and, where applicable, contain the proposed amended text.

- **The public enquiry stage will be repeated if the technical committee agrees to significant technical changes to the document as a result of public comment. Less urgent technical comments will be considered at the time of the next amendment.**

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Edition 3

SOUTH AFRICAN NATIONAL STANDARD

The design and installation of ceramic tiling

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Table of changes

Change No.	Date	Scope

Foreword

This South African standard was approved by National Committee SABS TC 59, *Construction standards,* in accordance with procedures of the SABS Standards Division, in compliance with annex 3 of the WTO/TBT agreement.

This SANS document was published in xxxx 2011.

This SANS document supersedes SABS 0107:1996 (first revision).

Annexes A and B are for information only.

Contents

Contents *(concluded)*

The design and installation of ceramic tiling

1 Scope

This standard deals with all work involved in the internal and external laying of ceramic wall and floor tiles and mosaics. It deals with the types and classes of backgrounds and substrates and their suitability to receive a bedded finish.

Recommendations are given for the design and installation, under normal conditions, of:

a) internal and external wall tiling;

b) internal and external floor tiling; and

c) mosaics.

NOTE When the installation of tiles involves special conditions such as high traffic, heavy loads, chemical environments, the need for sterile conditions, anti-static behavior or radioactive decontamination, etc., the manufacturer should be consulted for specific recommendations.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies. Information on currently valid national and international standards can be obtained from the SABS Standards Division.

BS 4550-6, *Methods of testing cement. Standard sand for mortar cubes.*

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

BS EN 10223-2, *Steel wire and wire products for fences – Hexagonal steel netting for agricultural, insulation and fencing purposes.*

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

BS EN 13658-1, *Metal lath and beads – Definitions, requirements and test methods – Internal plastering.*

BS EN 13914-1, *Design, preparation and application of external rendering and internal plastering – External rendering.*

SANS 110 (SABS 110), *Sealing compounds for the building industry, two-component, polysulphide base.*

SANS 190-2, *Expanded metal – Part 2: Building products.*

SANS 1024, *Welded steel fabric for reinforcement of concrete.*

SANS 1077, *Sealing compounds for the building and construction industry, two-component, polyurethane-base.*

SANS 1083, *Aggregates from natural sources – Aggregates for concrete.*

SANS 1090, *Aggregates from natural sources – Fine aggregates for plaster and mortar.*

SANS 1305, *Sealing compounds for the building industry, one-component, silicone-rubber-base.*

SANS 1449, *Ceramic wall and floor tiles.*

SANS 10021, *The waterproofing of buildings (including damp-proofing and vapour barrier installation)*

SANS 10109-2, *Concrete floors – Part 2: Finishes to concrete floors.*

SANS 10155, *Accuracy in building.*

SANS 50197-1, *Cement – Part 1: Composition, specifications and conformity criteria for common cements.*

SANS 50413-1, *Masonry cement – Part 1: Composition, specifications and conformity criteria.*

3 Definitions

For the purposes of this document, the following definitions apply.

NOTE Some of the definitions are illustrated in figure 1.

3.1
adhesive
proprietary fixative other than fine aggregate: cement bedding mortar

3.1.1
cement-based adhesive
adhesive in which the principal bonding component is a hydraulic cement (for example, portland cement), modified by the inclusion of such other admixtures as might be necessary to achieve satisfactory bonding of ceramic tiles and mosaics

3.1.2
organic-based adhesive
adhesive that can be supplied as either a one-component or a two-component mix, in which the principal bonding component is an organic material

3.2
background
vertical or horizontal surface that might require some form of treatment before it can receive the tiles or mosaics

3.3
bedding
layer of specified materials in which the tile is set and which bonds the tiles to a background or substrate (see figure 3)

3.4
bonding agent
material that is used to improve adhesion of the bedding material, or of the tile, to its respective background or substrate

3.5
buttering
spreading of an adhesive or bedding material onto the back of a ceramic tile just before the tile is placed

3.6
competent person
person who is qualified by virtue of his education, training, experience and contextual knowledge to make a determination regarding the performance of a building or part thereof in relation to a functional regulation or to undertake such duties as may be assigned to him in terms of these regulations

3.7
crazing
development of random hair-line cracks in the glazed surface of a tile

3.8
creep
slow inelastic deformation of a material under stress

3.9
damp-proof membrane
continuous layer of impervious material that is placed beneath either a concrete surface bed or a screed, to resist the passage of moisture from below (see figure 3)

3.10
datum
reference point

3.11
direct bedding
fixing of a tile direct into a wet substrate or background

3.12
drying time
period of continuous air-drying of the background or substrate before tiling can commence

3.13
frogs
indentations or ribs on the back of a tile

3.14
grouting
grout
operation of, or the material used in, filling the joint cavities between tiles, other than at movement joints (see figure 2 and figure 3)

3.15
joint
space between the edges of adjacent tiles (see figure 2 and figure 3)

3.16
joint sealant
resilient material that is used to fill and seal joints, to prevent the passage of moisture and to allow horizontal and lateral movement at the joint

3.17
keying
mechanical preparation of a surface, to improve adhesion

3.18
laitance
layer of weak non-durable material that contains cement and fines from aggregates and that has been brought to the surface of over-wet concrete or mortar by an upward movement of the water through the concrete or mortar

3.19
lathing
mechanical support for a background or bedding

3.20
mortar
mixture of fine aggregate, cement and water

3.21
movement accommodation factor
MAF
maximum movement that a sealant is capable of tolerating throughout its working life, expressed as a percentage of the joint width

3.22
movement joint
joint between tiles, in backgrounds or substrates, that is designed to accommodate movement in the structure

3.23
no-fines concrete
concrete that consists of large-size aggregate and cement but that contains little or no fine aggregate

3.24
plaster
fine cement:fine aggregate mixture that is applied to the background

NOTE Plastering is also known as rendering.

3.25
primer
substance that is used to coat a substrate or background, in order to seal its surface, reduce its water vapour permeability, or improve its adhesive bonding characteristics

3.26
scabbling
roughening or dressing of a surface by the use of a scabbler

3.27
scratch coat
preparatory layer of mortar that is applied to walls or floors to improve the bonding of a subsequent layer, and that is generally used where excessive thickness of one layer will provide insufficient bond. The surface is left "scratched" to provide a mechanical key for the next coat

3.28
screed
layer of well-compacted material, commonly a mixture of cement and fine aggregates, that is applied to a base in the appropriate thickness and that has a surface suitable for receiving a floor finish

3.29
separating layer
layer of material that isolates the base from the bedded finish (see figure 3)

3.30
spacer lugs
small projections on the edges of tiles which, when in contact with one another on adjacent tiles, regulate the joint width

3.31
spatterdash
cement-rich mixture of cement and fine aggregate, or a proprietary composition, that, in the form of closely spaced globules, is applied over the surface

3.32
substrate
any material that is used as a base onto which a ceramic tile is to be fixed

3.33
tanking
total waterproofing of a contained area

3.34
tessera
individual component of glass or ceramic that is used to form mosaic

3.35
universal edge
descriptive of tiles that have chamfered edges, which, when the tiles are laid in contact, regulate the joint width.

4 Exchange of information and time schedules

4.1 Exchange of information

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

a) site: location and means of access;

b) building: nature of building and particulars of corrosive or other potentially damaging conditions (for example, mechanical cleaning) to which the installation might be subjected in service (see also 5.14.1);

c) walls and floors: type and age of construction, location within the building, type and accuracy of background and need for intermediate substrate;

d) associated work: services embedded in or passing through the wall, skirtings and abutments, junctions with other adjacent finishes;

e) finishes: types of tiles or mosaics, bedding and jointing requirements, and required surface tolerances;

f) contract: particulars if the work is to be completed in a specific order or in sections;

g) health and safety: information on articles and substances for use during the work that are liable to be a health risk;

h) time schedule: a time schedule for the progress of the work (see 4.3); and

i) testing: details of any compliance testing required.

4.2 Provision of utilities, facilities and materials

4.2.1 General

To prevent misunderstanding, particularly at the tendering stage, and to avoid possible situations detrimental to installation, it shall be made clear whether the following will be provided, and by whom:

a) adequate, clean, dry, lockable storage space;

b) clean water supply adjacent to working areas;

c) adequate artificial lighting, if required (see 4.2.2);

d) places of work and safe means of access, and, where required, suitable scaffolding and staging;

e) unloading and hoisting facilities;

f) electric power supply adjacent to working areas;

g) protection of work during and after fixing; and

h) supplies of cement and aggregates to be in accordance with 5.5 and 5.6.

4.2.2 Lighting on site

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

4.3 Time schedules

The time schedule for the entire building work shall be planned in advance before operations begin and, where possible, in consultation with the persons who will be responsible for carrying out the work of each of the trades concerned.

When the time schedule for the work is being prepared, each operation shall be considered in relation to others. Due consideration shall be given to the use of general plant and scaffolding by the various trades, to ensure that they do not interfere unduly with one another's work.

Before tiling commences, the recommended time schedules (see figure 1) should have been adhered to as far as possible. Depending on the conditions on site, the climatic conditions and the mass of the structure, these times might have to be extended.

The schedule shall allow for the cutting of holes and chases in the walls and adjacent floors before any intermediate substrate is applied and tiling commences.

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

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

In the case of newly constructed buildings, tiling shall commence at the highest level and be worked downwards. It might be necessary at each level to work upwards from a horizontal batten.

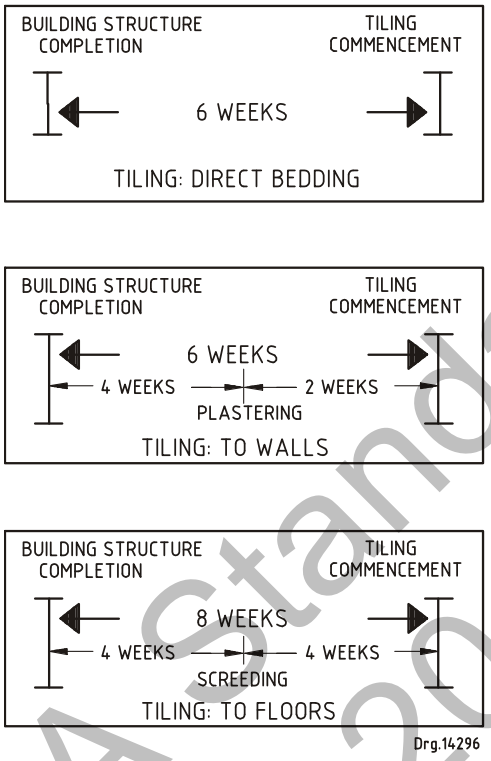


Figure 1 — Recommended time schedules for various types of tiling work

5 Materials

5.1 Transportation and storage

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

Materials shall be stored in a clean, frost-free, dry and lockable storage area, to prevent excessive handling, theft and damage.

5.2 Membranes

Membranes of at least 125 µm is recommended for most conditions.
For tanking and other special applications, modified bitumen sheeting shall be used.

5.3 Tiles

Tiles shall comply with the minimum requirements of SANS 1449.

5.4 Mosaics

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

backing fabric or onto small tabs. Paper-faced mosaics are preferable since they allow full contact to be achieved with the mortar or adhesive bedding.

When sheets are assembled by means of a backing mesh, the mesh shall be made of water-resistant synthetic fabric such as nylon, and not from cotton or paper.

In the case of a mosaic that has been assembled with a backing fabric or tabs,

a) the fabric or tabs and the bonding adhesive shall not occupy more than 25 % of the area of each tessera; the critical factor is the contact of the adhesive with the backs of the tesserae, and

b) the fabric or tabs and the bonding adhesive shall be water resistant, shall not weaken when exposed to moisture and shall be compatible with the mortar or adhesive bed.

5.5 Cement

Cement shall comply with the requirements of SANS 50197-1 or SANS 50413-1, as applicable.

High-alumina cement that complies with the requirements of BS 4550-6 may be used for specific purposes, but shall not be mixed with other types of cement.

Cement shall be stored under dry conditions and used in order of delivery. Cement that contains lumps shall not be used.

5.6 Fine aggregate

5.6.1 General

All stocks of fine aggregate shall be protected from rain, frost and contamination.

5.6.2 Fine aggregate for plaster, screeds and mortar bedding

Fine aggregate for plaster and mortar bedding shall comply with the requirements of SANS 1090.

Fine aggregate for screed bedding shall comply with the requirements of SANS 1083.

5.6.3 Fine aggregate for grouting

Fine aggregate for grouting shall comply with the grading limits given in table 1.

Table 1 — Fine aggregates for grouts for use in joints

1	2	3
Joint width mm	**Sieve aperture size** µm	**Mass passing sieve %**
>6	2360 1180 600 300 150 75	100 95 to100 80 to 100 30 to 100 0 to 60 Not greater than 7
<6	600 300 150 75 45	95 to 100 80 to 95 60 to 80 45 to 55 20 to 30

5.7 Water

Water shall be fresh, clean, potable water. All containers that are used for storing or carrying water or for soaking tiles shall be clean and free from contamination.

5.8 Reinforcement

Where light reinforcement is required in a screed, it shall consist of steel mesh that complies with the requirements of SANS 1024.

5.9 Adhesives

5.9.1 Cement-based adhesives

Cement-based adhesives shall comply with the requirements of BS EN 12004.

5.9.2 Organic-based adhesives

Organic-based adhesives are available in flexible and non-flexible form as a ready-mixed paste and shall comply with the requirements of BS EN 12004.

5.9.3 Two-component adhesives

Two–component adhesives (for example, epoxy resin) shall comply with the requirements of BS EN 12004, and shall be formulated for specific conditions (see 4.1(b)).

5.10 Admixtures to adhesives

A polymer-based material may be incorporated in adhesives to obtain greater adhesion, improved resilience or some degree of water repellency.

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

5.11 Bonding agents

Bonding agents may be used to improve the adhesion of plastering, screeds and tile bedding to backgrounds. Manufacturers recommend particular grades and methods of application, depending on the materials involved and the service conditions, and their instructions shall be followed.

5.12 Sealants and back-up materials for movement joints

Sealants used for back-up materials for movement joints shall comply with SANS 110, SANS 1077 and SANS 1305.

Materials for movement joints shall comprise non-rigid materials that are supplied in the form of either a compound or a preformed strip, and shall combine the properties of permanent resilience or plasticity within the maximum temperature ranges likely to be encountered.

Table 2 provides a guide regarding some sealants in general use. It is recommended that the sealant manufacturer be consulted for the specific application and method of use.

Table 2 — Typical flexible sealants — Summary of properties

1	2	3	4	5
Type	**Movement accommodation factor (MAF) %**	**Hardness** IRHD	**Cure time before serviceable (walking on, washing, etc.)**	**Flexibility**
Epoxide polysulfide and flexibilized epoxide	5 to 10	70 to 95	1 to 7 days Chemically cure. Rate of cure Depends mainly on temperature	Slightly Resilient
Polyurethane (one part and two part)	20 to 25	10 to 25	1 to 7 days Chemically cure. Rate of cure Depends mainly on temperature	Slightly Resilient
Polysufide (two part) High modulus	20	40 to 60	1 to 7 days Chemically cure. Rate of cure Depends mainly on temperature	Vey Resilient
Silicone (one part) High modulus	25	20 to 30	1 to 7 days Chemically cure. Rate of cure Depends mainly on temperature	Very Resilient

5.13 Back-up materials

Back-up materials shall be compressible so that they will not force out the sealant when the joint closes. Suitable back-up materials include closed-cell polyethylene foam, which is available in the form of sheet, strip and circular cord of various sizes.

5.14 Grouts

5.14.1 General

Grouts shall have good working characteristics, low shrinkage and good adhesion to the sides of the joints. When selecting a grout, the specifier shall establish that it is suitable for the conditions it has to meet, for example, hardness, resilience and compressibility, impermeability, resistance to water, heat, cleaning agents and chemical attack, resistance to mould growth and bacteria, or where hygienic conditions are required (see 4.1 (b)).

5.14.2 Types of grout

5.14.2.1 Proprietary grouts

Grouts are generally of one of the following types:

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

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

c) mixes based on two-component materials (for example, epoxy-resin-based grouts) in pre-gauged proportions, which have to be mixed together immediately before use.

Grouts of type (a) above are used in most normal tiling situations. Grouts of type (b) and (c) above find application where special service requirements apply (see 5.14.1).

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

5.14.2.2 Cement: fine aggregate and mortar grouts

Cement:fine aggregate and mortar grouts are sometimes used for grouting joints of width exceeding 3 mm (see 7.2.10.3). Dampness in the joint cavities is necessary to promote good adhesion and such grouts are best suited for use with cement: fine aggregate mortar bedding systems where, if necessary, the joints can be re-wetted without affecting the bedding.

NOTE The physical properties of an on-site mixed cement: fine aggregate mortar grout are dependent on raw material properties such as the grading and type of cement. Proprietary grouts are acceptable. They offer the advantages of controlled formulation and consistency, improved permeability, resistance to mould growth and bacteria, and improved resilience and compressibility. Neat cement mixed with water is not recommended.

5.14.2.3 Coloured grouts

Many proprietary grouts are available in various colours as well as white. Coloured joints may also be achieved by the addition of pigments to proprietary materials and cement: fine aggregate compositions, provided that the pigments are used in accordance with the tile manufacturer's instructions.

Pigments shall be inorganic and compatible with the grout. When used in cement: fine aggregate compositions or in cement-based proprietary materials, they shall also be resistant to alkalis. Some organic pigments might be suitable for incorporating in epoxy-resin-based grouts. Care shall be taken to ensure a uniform mix of the pigment with the grout, to create a homogeneous mixture. The proportioning shall be consistent from one batch to another.

5.14.3 Admixtures for cement-based grouting materials (other than colouring pigments)

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

In all such cases, admixtures shall be used in accordance with the manufacturer's instructions. Most materials that are resistant to chemicals are of proprietary manufacture.

5.14.4 Resistance to moulds and bacteria

For normal internal installations, cement-based proprietary grouts that contain fungicides that offer good resistance to the growth of moulds and bacteria are generally used. Where a high standard of hygiene is essential, for example, in food preparation areas, operating theatres, and pathology laboratories, epoxy-resin-based materials are superior to cement-based mixtures by virtue of their impermeability and ease of cleaning and decontamination.

When tested as described in BS EN 12004, grouts shall not show any evidence of mould growth.

5.15 Mechanical support for plastering

5.15.1 General

Metal used to reinforce plastering shall be galvanized steel or stainless steel and metal fixings shall be compatible and installed in accordance with BS EN 13914-1.

5.15.2 Expanded metal lathing

Expanded metal lathing shall comply with the requirements of BS EN 13658-1

5.15.3 Ribbed lathing

Ribbed lathing shall comply with the requirements of BS EN 13658-1. Ribs are formed integrally with expanded metal, thus providing rigidity.

5.15.4 Welded wire mesh

Plain welded wire mesh that complies with the requirements of SANS 1024 shall either be galvanized or be of stainless steel. It shall be of 25 mm to 50 mm mesh and have wires of diameter of at least 1 mm.

5.15.5 Galvanized wire netting

Galvanized wire netting shall be of 20 mm to 38 mm mesh and shall comply with the requirements of BS EN 10223-2.

5.15.6 Corner and stop beads

Corner and stop beads shall comply with the requirements of BS EN 13658-1.

6 Design considerations

6.1 Wall tiling

6.1.1 Backgrounds

6.1.1.1 General

The nature of the background is a prime consideration in the selection of any intermediate material or other preparatory treatment necessary before tiling. Properties of the background that could influence the choice are indicated in 6.1.2 to 6.1.6 and are also summarized in table 3, 4, 5 and 6.

A typical construction of a tiled wall is shown in figure 2.

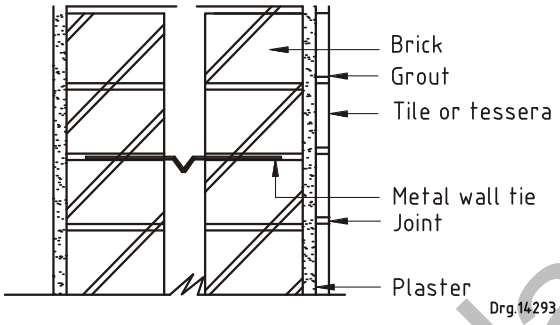


Figure 2 — Typical section through wall

6.1.1.2 Porosity and suction

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

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

Where tiles are to be fixed by direct bedding with proprietary adhesives, the background should be thoroughly dry before the tiles are applied.

6.1.1.3 Mechanical key

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

6.1.1.4 Trueness of construction

Trueness of construction is important because of its effect on the thickness and number of coats of plaster (if any), the type of fixing method and the final appearance of the tiling (see 6.1.5.1).

6.1.1.5 Moisture movement and thermal movement

Moisture movement and thermal movement produce differential contraction or expansion between the background and the tiling system and are potential causes of defects.

Moisture expansion of ceramic tiles occurs as a direct result of adsorption of moisture. Whereas the test method merely yields a single value for moisture expansion, the age of the tiles and their individual expansion kinetics determine their expansion potential once they have been installed. Appropriate measures shall be taken in the planning of a tiling system, to avoid the possibility of excessive expansion.

6.1.1.6 Chemical action

Soluble salts, particularly sulphates, sometime occur in backgrounds and could have a harmful effect on the adhesion of any applied treatment and finish. The risk of defects that arise from this cause is much greater if backgrounds are persistently damp or if excessive water is used, or is permitted to enter the background during or after construction. The waterproofing of the building shall therefore comply with SANS 10021.

6.1.1.7 Contamination

Backgrounds that are subjected to industrial processes and atmospheres could be contaminated by oil, grease, soot and dirt, organic growths, etc., and this could lead to loss of adhesion of the intermediate substrate or of the tiling or of both. Backgrounds previously treated with a decorative coating, for example lime wash or paint, could also cause failure if they have been inadequately prepared.

In the case of cast concrete components, all traces of release agent and laitance shall be removed.

6.1.1.8 Physical deterioration

Backgrounds that have deteriorated because of physical damage or other agencies could have an adverse effect on the adhesion of the intermediate substrate or of the tiling (or of both).

6.1.2 Classes and types of background

6.1.2.1 General

Backgrounds can be conveniently placed into one of the following classes: (See also tables 3, 4, 5 and 6.)

6.1.2.2 Dense, strong and smooth-surfaced materials

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

6.1.2.3 Moderately strong and porous materials

Most bricks and blocks, other than the very dense types considered in 6.1.2.2 or lightweight products considered in 6.1.2.4, fall into this class together with some medium strength natural aggregate concretes and structural lightweight concrete. Materials in this class have relatively high suction and generally provide a good mechanical key and good adhesion for an intermediate substrate, if required.

Drying shrinkage of concrete is variable and shall be taken into consideration.

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

6.1.2.4 Moderately weak and porous materials

Blocks that contain lightweight aggregate and autoclaved aerated concrete, and some bricks of relatively low strength need more care in the selection of an intermediate substrate than do backgrounds classed in 6.1.2.3. It is particularly important that the substrate and the background have similar shrinkage properties, since otherwise shrinkage is liable to lead to shearing of the surface off the background.

NOTE Lightweight concrete might exhibit differential movement which could be related to such factors as composition or degree of saturation (or both). Lightweight blocks of density less than 625 kg/m^3 should not be used as a background for plastering for tiling unless the plastering is reinforced with welded wire mesh secured to the block work (see 6.1.2.9 and 6.1.4.1).

6.1.2.5 No-fines concrete

No-fines concrete forms a class on its own. It has many relatively large voids and affords an effective mechanical key for an intermediate substrate. Drying shrinkage and suction vary from low to moderate, depending on the aggregate used.

6.1.2.6 Sheets and boards

Sheets and boards include plasterboard, glass-fibre reinforced cement boards, fibre building boards, plywood chipboard and timber. Sheets and boards shall be dry before tiling is commenced.

They are mainly used with framed or battened constructions, which shall be designed to provide a rigid surface. To avoid subsequent movement and warping, the backs and edges of sheets or boards, other than plasterboards, shall be treated against the ingress of moisture. The front face of sheets and boards shall be sealed with a suitable non-oil-based sealant, to prevent moisture ingress during the installation of the tiles.

Sheets and boards shall not be used in wet or damp conditions unless they are dimensionally stable in conditions of changing humidity

6.1.2.7 Plastering

Ribbed lathing or welded wire mesh is mainly used with framed construction to provide rigid support to plastering over backgrounds unsuitable for supporting a bonded plaster or for supporting ceramic tiling applied directly, where the background surface is too weak (see SANS 190-2).

6.1.2.8 Gypsum plaster

Gypsum plaster backgrounds are not suitable for ceramic tile installation.

NOTE Gypsum-based skim-coats are generally too soft and because they are very sensitive, may be adversely affected when water-based adhesives are used. Expansion due to outranged formation is also not excluded.

6.1.2.9 Other backgrounds

There are a variety of materials and surfaces, particularly in old buildings, that might require tiling to change their appearance and performance. Sometimes they might be too weak in themselves or might adhere too weakly to the background to be able to support tiling. Additional information shall be obtained from the relevant tile manufacturer about the application of his product in such instances.

6.1.3 Preparation of backgrounds

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

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

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

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

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

Backgrounds not built accurately to a specific plane, or that have surfaces that are uneven, might have deviations from a true flat surface that are too large to be capable of accommodating the recommended thickness of a tile bedding. If such backgrounds are of brick, blocks, stone or concrete, it is recommended that an intermediate substrate be applied, to provide a true surface to receive the tiling.

Where backgrounds are sheets and boards, painted surfaces, tiles or glazed bricks, the tiling can usually be applied direct to the background by means of a suitable adhesive. Backgrounds that have irregularities that exceed the limit defined in 6.1.5.1 might have to be corrected by reinstatement in the case of sheets and boards, or by the application of an intermediate substrate if the background is capable of supporting such a substrate.

Tile bedding of thickness exceeding that recommended shall not be used to accommodate inaccuracies in a background surface, especially if the bedding thickness is not consistent throughout the installation. This could give rise to variable stresses and possible loss of adhesion, and to cracking or to crazing.

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

6.1.4 Treatment of backgrounds to receive tiles by direct bedding

6.1.4.1 General

Tiles can be bedded direct onto a background by means of adhesive, or into mortar. Methods of application and the suitability of backgrounds to accept these methods are described in tables 3, 4, 5 and 6.

The trueness of the background surface required for adhesive bedding shall be such that, when checked with a 2 m straightedge, any gap behind the straightedge, between points of contact, does not exceed 3 mm. Where the gap exceeds 3 mm, local correction of the background by dubbing out to a thickness of up to 6 mm can be done using the same adhesive, but advice on this method shall be obtained from the manufacturer of the adhesive.

When a mortar bedding is to be applied direct to a background, the surface shall be treated as described for plastering.

6.1.4.2 Sheets and boards

An important consideration with this type of background is that the sheets or boards shall be adequately braced to provide a rigid surface, free from any springiness and surface undulations. They shall also not undergo any distortion during and after completion of the tiling.

Wherever possible, the boards shall be screwed, not nailed, to the supporting framework.

In general, where the sheets or boards have a smooth and a rough side, the latter shall be used for tiling. The surface to receive the tiles shall be clean and free from dust and other forms of contamination.

It is also good practice to seal all exposed edges of boards, the back and the face with a suitable sealer, to prevent distortion by atmospheric changes, particularly in the case of wooden surfaces such as chip-board.

NOTE When gypsum plasterboard is required as a background for tiling, choice of an appropriate board grade and of lightweight tiles is a prerequisite.

6.1.4.3 Painted surfaces

It is important to make a detailed examination of a painted surface before deciding if it is suitable to receive tiles. All painted surfaces shall be scabbled or chipped to expose a minimum area of 80 % of the original background.

If the paint is in a poor condition, or on an external face, it shall be removed completely. When it is necessary to plaster decorated backgrounds, for example painted brickwork or concrete, the paint shall be removed and an adequate key provided, or the plastering shall be supported on reinforcement mechanically fixed to the background.

6.1.4.4 Existing glazed tiles and glazed brick surfaces

A sound tiled wall normally presents a surface sufficiently flat to permit its being covered with new tiles fixed with an appropriate adhesive as recommended by the adhesive manufacturer. If the old tiling is sound, clean down the existing glazed surface to ensure the removal of grease, grime, etc., before starting to fix the new tiles. Ensure that the old tiles still adhere firmly to the bedding and that the bedding is sufficiently strong to support the added mass; remove all loose tiles.

If only isolated areas of tiling are loose, the face of the original bedding, if in sound condition, shall be dressed back to a sufficient depth to allow the old tiles to be re-fixed flush with the surrounding tiles, using a thin adhesive. Alternatively, after the loose tiles have been removed, the spaces left can be filled in flush with the surrounding tile surface, using mortar, which shall be allowed to dry thoroughly before the new tiles are applied.

Where loose tiling occupies entire walls, it might be convenient to apply the new tiling direct to the original bedding.

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

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

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

6.1.4.5 Other backgrounds

If a suitable adhesive is used, tiles can be fixed to most surfaces (those most likely to occur in practice are discussed in 6.1.2). Occasionally, other backgrounds are encountered, for example metals, that pose special problems. In such cases, full information on the application and service conditions shall be given to a manufacturer of adhesives, whose advice shall be followed.

6.1.5 Movement joints

6.1.5.1 General

Movement joints serve a useful purpose; they only fulfil a proper function in preventing adhesion failure if the materials in the system are able to accommodate differential dimensional movement without stress build-up to the extent that adhesion failure (notably shear failure) occurs.

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

Stresses occur in the tile installation as a result of movement caused by such factors as drying shrinkage and moisture and thermal changes. Such stresses could cause loss of adhesion, bulging or cracking of the tiling if they are allowed to build up over large areas, but they can be localized and reduced by the incorporation of movement joints.

The movement joints in the tiling, (see figures A.1 and A.2) may extend through the tiling and its bedding, and shall be of width at least 5 mm, in order to accommodate movement.

Sealants for movement joints shall comply with the recommendations in 5.12 (see table 2).

6.1.5.2 Location

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

Movement joints shall be placed in the following locations:

a) over existing or structural movement joints (or both);

b) where tiling abuts other materials;

c) where tiling continues across junctions of different background materials;

d) in interior dry areas,

   1) at all vertical corners,

   2) in large tiled areas;

   Additional joints shall be provided at a maximum of 2,5 m centres, in both directions, horizontally and vertically; and

e) where stresses are likely to be concentrated, for example at changes of alignment.

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

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

6.1.5.3 Back-up materials

The joint shall be partially filled with a compressible back-up material before being topped up to the final level with sealant.

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

The compressible back-up material shall be a material to which the sealant does not adhere, or one that can be covered with a bond-breaker tape to prevent adhesion. Where there is insufficient depth in the joint to accommodate a compressible back-up material, a bond-breaker tape at the bottom of the joint will improve performance. Bond-breaker tapes are generally self-adhesive, for example polyethylene tapes.

The back-up material in the lower part of the joint shall be compatible with the sealant used, shall recover after compression and shall support the sealant. It shall not exude substances detrimental to the sealant or tile, such as bituminous or oily products, and it shall not absorb excessive amounts of moisture. In particular, its compressibility shall be such that, when the joint closes, the sealant is not forced out. A suitable material is cellular polyethylene, which is available in strip form.

The filler material shall be so placed that it allows the application of an adequate depth of sealant into the joint to perform satisfactorily. The minimum sealant depth shall be 6 mm.

6.1.5.4 Sealants

A summary of the more important properties of recommended sealants is given in table 2, but the sealant manufacturer's advice shall be taken into account, since the properties of individual sealants might vary. Generally, a sealant shall be capable of accommodating the anticipated amount of movement without loss of adhesion to the sides of the joints and it shall be able to withstand the normal service conditions that affect the installation, for example, it shall be resistant to water and damage from cleaning processes.

The manufacturer's instructions shall be strictly adhered to, particularly in respect of the use of primers. In most cases, the sealant shall not be applied until the joint spaces are thoroughly clean and dry. Preferably, joints awaiting sealing shall be protected from the ingress of foreign matter by being covered, for example by an adhesive tape or batten, but when moisture or solvents are present in the bedding or in the background, the joints shall be left exposed until all moisture has evaporated and all solvents have dissipated.

Joint spaces left open and uncovered could collect deleterious matter and shall be thoroughly cleaned before sealing.

If the sealing of joints is to be carried out by a specialist, the tiling contractor shall be made aware of any specific jointing requirements in his instructions.

6.1.6 Grouts and coloured grouts

Coloured grouts are vulnerable to staining. It is also advisable to check the potential risk of staining of tiles prior to application. In any doubtful case, an alternative grouting procedure shall be adopted or the use of a proprietary tile sealer considered. Proprietary tile sealers shall be used strictly in accordance with the manufacturer's instructions and shall be applied before grouting is carried out, to provide a protective coating that can readily be removed after completion of grouting.

Table 3 — Backgrounds for wall tiling: summary of data and suitable tile bedding for internal use only — Dense, strong and smooth backgrounds

1	2	3	4	5	6	7	8	9
Background	**Drying shrinkage movement**	**Surface characteristics**	**Preparation of backgrounds**		**Additional comments**	**Material for fixing tiles on prepared backgrounds**		
			For direct bedding (see 6.1.4)	**For mortar bedding or cement-based adhesives**		**Cement-based adhesives**	**Organic-based adhesives**	**Cement: sand mortar**
High density clay brickwork and clay block work (see 6.1.2.2)	Negligible	Low suction	Direct fixing with an adhesive may be adopted provided the surface is suitable (see 6.1.4.1)	Poor key. Might require more than raking back of joints, e.g. scabbling, bonding agent, lathing or netting. Keyed bricks need no raking back.	Where adhesive is used, drying out might be delayed and grouting shall be deferred for at least 3 days or for as long as is practicable	S	S	S
Dense concrete, either pre-cast or in-situ (see 6.1.2.2)	May vary from low to high[a)]	Low suction		Poor key. Remove any ridges and fins from in-situ concrete before cleaning down. Remove debris and release agents. Might require scabbling, bonding agent, lathing netting or spatterdash	Refer to figure 1	S	S	S
Hard natural stone (see 6.1.2.2)	Negligible	Low suction		Poor key. Might require more than raking back of joints, e.g. scabbling, bonding agent, lathing or netting.		S	S	S
Glazed brickwork and tiling (see 6.1.2.2)	Negligible	No suction and poor key	Clean down existing surface to remove grease, grime, condensa-tion, etc. (see 6.1.4.4)	Check that old tiles/bricks are firmly bedded, remedy isolated loose areas. Drying time of adhesive might be extended. Delay grouting as long as is practicable		S[b)]	S[b)]	U

NOTE 1 Properties of backgrounds indicate only relative characteristics of the materials.
NOTE 2 S denotes 'suitable', but not all adhesives within a particular group are necessarily suitable.
NOTE 3 U denotes 'unsuitable', but not all adhesives within a particular group are necessarily unsuitable.

a) The amount of movement to be expected could vary according to the particular grade or free water or both.
b) See manufacturer's recommendations for surface preparation.

Table 4 — Backgrounds for wall tiling: summary of data and suitable tile bedding for internal use only — Moderately strong and porous backgrounds

1	2	3	4	5	6	7	8	9
Background	**Drying shrinkage movement**	**Surface characteristics**	**Preparation of backgrounds**		**Additional comments**	**Material for fixing tiles on prepared backgrounds**		
			For direct bedding (see 6.1.4)	**For plaster mortar bedding or cement-based adhesives**		**Cement-based adhesives**	**Organic-based adhesives**	**Cement: sand mortar**
Clay brickwork and clay block work (see 6.1.2.3)	Negligible	Moderate or high suction	Direct fixing with an adhesive may be adopted, provided that the background is suitable (see 6.1.4.1)	Rake back joints	Refer to figure 1 for recommended time schedules	S	S	S
Concrete (natural aggregate) see 6.1.2.3)	Low to high[a)]	Moderate suction		Poor to fair key. Remove any ridges and fins from in-situ concrete before cleaning down. Remove debris and release agents. Might require scabbling, bonding agent, lathing or netting		S	S	S
Concrete brick-work and concrete block work (natural aggregate) (see 6.1.2.3)	Low to high[a)]	Moderate suction		Rake back joints to form key With some types of extremely smooth and dense bricks, scabbling, bonding agent, lathing or netting can be used to obtain a good key		S	S	
Calcium silicate brickwork (hard) (see 6.1.2.3)	Low to high[a)]	Moderate suction				S	S[b)]	S
NOTE 1 Properties of backgrounds indicate only relative characteristics of the materials. NOTE 2 S denotes 'suitable' but not all adhesives within a particular group are necessarily suitable.								
a) The amount of movement to be expected could vary according to the particular grade or free water or both and type of coarse or fine aggregate or both used. b) See manufacturer's recommendations for surface preparation.								

Table 5 — Backgrounds for wall tiling: summary of data and suitable tile bedding for internal use only — Moderately weak and porous backgrounds

1	2	3	4	5	6	7	8	9
Background	**Drying shrinkage movement**	**Surface characteristics**	**Preparation of backgrounds**		**Additional comments**	**Material for fixing tiles on prepared backgrounds**		
			For direct bedding (see 6.1.4)	**For plaster mortar bedding or cement-based adhesives**		**Cement-based adhesives**	**Organic-based adhesives**	**Cement: sand mortar**
Autoclaved block work and lightweight aggregate concrete with open surfaces[a] (see 6.1.2.4)	Moderate to high[a]	Moderate to high suction	Direct fixing with an adhesive may be adopted provided that the background is suitable (see 6.1.4.1)	Good key bonding agent, lathing or netting might be required	The plastering shall not exceed 13 mm in thickness Refer to figure 1	S	S	S
Autoclaved block work and lightweight aggregate con-crete with closed surfaces[a] (see 6.1.2.4)	Moderate to high[a]	Moderate suction		Poor key. require spatter-dash, bonding agent, lathing or netting		S	S	S
Autoclaved aerated concrete in situ and panels (see 6.1.2.4)	Moderate to high[a]	Moderate suction		Poor to fair key, bonding agent, lathing or netting might be required		S	S	S
Soft natural stone (see 6.1.2.2)	Negligible	Moderate or high suction		Require scabbling, bonding agent, lathing or netting		S	S	S
Calcium silicate brickwork (soft) (see 6.1.2.3)	Low to high[a]	Moderate suction		Rake back joints. With some types of extremely smooth bricks, bonding agent, lathing or netting can be used to obtain a good key		S	S	S

NOTE 1 Properties of backgrounds indicate only relative characteristics of the materials.
NOTE 2 S denotes 'suitable' but not all adhesives within a particular group are necessarily suitable.

a) The amount of movement to be expected could vary according to the particular grade or free water: cement ratio or both.

Table 6 — Backgrounds for wall tiling: summary of data and suitable tile bedding for internal use only — Other backgrounds

1	2	3	4	5	6	7	8	9
Background	**Drying shrinkage movement**	**Surface characteristics**	**Preparation of backgrounds**		**Additional comments**	**Material for fixing tiles on prepared backgrounds**		
			For direct bedding (see 6.1.4)	**For plaster mortar bedding or cement-based adhesives**		**Cement-based adhesives**	**Organic-based adhesives**	**Cement: sand mortar**
No-fines concrete (see 6.1.2.5)	Low to moderate according to aggregate used[a)]	Low to moderate suction	Unsuitable	Open textured surface shall not require further keying	Refer to figure 1	S	S	S
Plasterboards (see 6.1.2.6)	Negligible	True and smooth		Not applicable	All boards shall be rigidly fixed. In wet or damp conditions, plaster shall not be used.	C	S	U
Fibre cement board (see 6.1.2.6)	Moderate to high	True and smooth	Seal exposed edges and back, and the face, against water absorption. Priming might be necessary. Refer to adhesive manufacturer	Not applicable	All boards shall be rigidly braced. Sheets and boards shall not be used in wet or damp areas unless they are dimensionally stable	C	S	U
Wood-based panel products (see 6.1.2.6)	Moderate to high	True and smooth	Seal exposed edges and back, and the face, against water absorption. Priming might be necessary. Refer to adhesive manufacturer	Not applicable	All boards shall be rigidly braced. Sheets and boards shall not be used in wet or damp areas unless they are dimensionally stable	C	S	C

NOTE 1 Properties of backgrounds indicate only relative characteristics of the materials.
NOTE 2 S denotes 'suitable' but not all adhesives within a particular group are necessarily suitable. U denotes 'unsuitable' and C denotes that confirmation of an adhesive's suitability should be sought from the manufacturer.

a) The amount of movement to be expected could vary according to the particular grade or free water or both.

Table 6 (*concluded*)

1	2	3	4	5	6	7	8	9
Background	**Drying shrinkage movement**	**Surface characteristics**	**Preparation of backgrounds**		**Additional comments**	**Material for fixing tiles on prepared backgrounds**		
			For direct bedding (see 6.1.4)	**For plaster mortar bedding or cement-based adhesives**		**Cement-based adhesives**	**Organic-based adhesives**	**Cement: sand mortar**
Adhesive contaminated surfaces (see 6.1.3)	According to background	Poor key and low suction			Chip or scabble thoroughly to expose at least 80 % of the original background, and then prime the exposed surface with a binding liquid to manufacturer's specification	S	S	S
Paintwork (see 6.1.4.3)	According to background	Depends upon age and condition. Low suction	See 6.1.4.3		Remove all paint finishes to expose at least 80 % of the original background and then prime the exposed surface with a bonding liquid to manufacturer's specification [a)]	S	S	S
Metal surfaces (e.g. steel) (see 6.1.4.5)	Nil	Low suction and poor key	Clean to remove rust, grease, etc., and apply a rust inhibiting primer (see 6.1.4.5)		In all conditions obtain advice from adhesive manufacturer	U	C	U

NOTE 1 Properties of backgrounds indicate only relative characteristics of the materials.
NOTE 2 S denotes 'suitable' but not all adhesives within a particular group are necessarily suitable. U denotes 'unsuitable' and C denotes that confirmation of an adhesive's suitability should be sought from the manufacturer.
NOTE 3 U denotes 'unsuitable'.
NOTE 4 C denotes that confirmation of an adhesive's suitability should be sought from the manufacturer

a) See manufacturer's recommendations for surface preparation.

6.2 Floor tiling

6.2.1 Substrate preparation

6.2.1.1 General

In solid and suspended floor constructions, the stability and durability of the floor is dependent on a number of factors, including the load it has to support, the resistance it offers to the passage of water or of water vapour either from above or from below, the dimensional changes produced by variations in moisture content and the temperature within the floor, and the attack of various corrosive agents, for example in chemical plants and in industrial premises. These factors shall be assessed at the design stage so that due allowance can be made for their possible effect on the finished floor.

Where possible, selection of the tiles or mosaics and the bedding method shall also be made at the design stage so that the appropriate depth can be allowed between the base and the finished floor surface. The variety of thicknesses in and between tiles, pavers, mosaics and tile beddings is considerable.

A typical construction of a floor section is given in figure 3

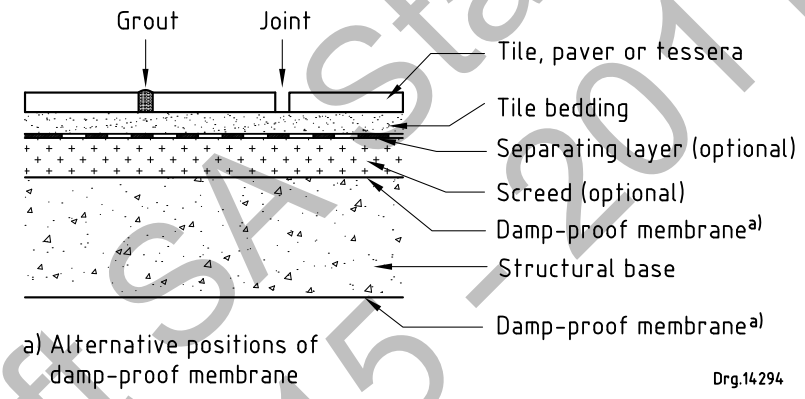


Figure 3 — Flexible joint over structural movement joint

6.2.1.2 Finished floor level

Floor surfaces are usually required to be level or laid to a given fall. Some variations in surface level could be allowed without detriment to the satisfactory use of the floor, and this shall be specified.

NOTE 1 Insistence on very close limits could result in unwarranted technical difficulties.

NOTE 2 Where the flooring is applied using an adhesive, very little correction, if any, for variations in the base can be made; consequently the tolerance required of the surface has to apply to the substrate. It is important that there be no appreciable difference in level across joints, especially in areas where loads are likely to be moved. For floor level and across-joint tolerances, see 7.3.4

6.2.1.3 Alignment of wall and floor joints

Alignment of joints between wall tiles and floor tiles is sometimes possible if appropriately sized coordinating modular tiles are specified. However, the practical difficulties involved in achieving alignment shall not be underestimated. Careful consideration shall be given to the greater accuracy that is required in the setting out and construction of the walls to suit the tile module, and all walls shall be at right angles (or parallel) to each other.

6.2.2 Load considerations

When a floor is being designed, due allowance shall be made for the ultimate load it might have to bear, including the flooring installation. Where an existing floor is to be covered by the tiles and bedding given in this standard, the floor shall be sufficiently strong and rigid to accept the added load, particularly if the floor is of timber construction.

6.2.3 Substrates

6.2.3.1 General

Concrete and screeds are the most common substrates over which ceramic floor tiles and mosaics are laid but other substrates might be encountered, such as timber or metal. In refurbishing work, it might sometimes be necessary to apply new finishes over existing floors such as ceramic tiles, terrazzo, granolithic finish, and stone.

Before the tile bedding is applied, it is essential to check that:

a) the correct falls have been incorporated in the substrate;

b) the substrate is free from contamination, loose areas and cracks; and

c) the substrate is true to the specified plane (see 7.3.3).

Substrates suitable to receive tiling and in each case the suitable tile bedding, are summarized in table 7. In new work it is necessary to specify the plane of the substrate in relation to the finished floor surface, and usually this is possible only if the floor tiles and the appropriate bedding are selected at the design stage. The level of the substrate surface in relation to the finished floor surface shall be such that the bedding can be of the recommended thickness throughout the installation. An exception may be made when a semidry mix bedding is to be used, since this can be applied in varying thicknesses to overcome irregularities and to form the required falls, subject to the minimum thickness stated in 7.3.7.1.

The recommended maximum and minimum final tile bedding thicknesses are given in table 8.

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

If a separating layer is to be interposed between the substrate and the tile bedding, it is important that the substrate be accurately formed and have a true and smooth surface to enable the tile bedding to slide freely over the base in the event of differential movement.

6.2.3.2 Concrete

6.2.3.2.1 Surface finish

When tiling is bedded direct into a concrete substrate without a screed, the finish of the concrete shall be struck off level with a straightedge, and the surface texture closed. When a bonded bedding is required, laitance shall be removed by mechanical means. To receive a cement: fine aggregate bonded bedding, the prepared concrete surface shall be wetted down prior to the application of the bedding. If a separating layer is to be interposed between the bedding and a concrete substrate, the surface of the layer shall be free of ridges or steps that would impair the sliding movement between the two elements (see SANS 10109-2).

6.2.3.2.2 Tolerances on levels and surface regularity

The tolerances on levels and surface regularity for concrete substrates are the same as those for screeds and shall comply with SANS 10155.

6.2.3.2.3 Reduction of construction moisture

Structural concrete shall be subjected to continuous air drying after the end of curing for a period of at least 6 weeks before either a screed or direct bedded tile bedding is applied. The same allowance shall be made for concrete with an integral screed surface. A longer period might be necessary in wet weather.

6.2.3.3 Screeds

A screed is usually used as an intermediate layer between the structural substrate and the tile bedding, to provide a true and even surface on which to apply tiling. Recommendations for the design and laying of screeds are given in SANS 10109-2. A method for the assessment of levels and surface regularity is given in SANS 10155.

6.2.3.4 Other substrates

Existing floor finishes such as ceramic tiles, terrazzo, natural stone and similar hard surfaces are suitable as substrates, provided that they are appropriately cleaned of surface contamination and adhere firmly to the substrate. However, the choice of tile and type of bedding can be influenced by the change in level available, from existing to new. Tiles can also be bedded direct onto rigid metal, subject to the adhesive manufacturer's recommendations.

Table 7 — Suitability of tile bedding[a] for different bases

1	2	3	4	5	6	7
Bases	**Screed**		**Cement:sand semi-dry mix**		**Adhesive** (see 7.3.8)	**Resins and mortars resistant to chemicals**
	Bonded (see 7.3.6.1)	**Unbonded** (see 7.3.8.1)	**Bonded** (see 7.3.7.1)	**Unbonded** (see 7.3.7.3)		
New concrete (more than 6 weeks old) or screed (more than 4 weeks old)	U	S	U	S	U	U
Mature concrete or screed	S	S	S	S	S	S
Screed over suspended floor or under-floor heating	U	S	U	S	C	C
Timber	U	U	U	U	C	C
Existing hard floor finishes after preparation						
Terrazzo	S	S	U	S	C	C
Unglazed ceramic tile	S	S	S	S	S	U
Glazed ceramic tile	S	S	U	S	C	U
Granolithic topping	S	S	S	S	S	C
Natural stone	S	S	S	S	S	U
Metal	U	U	U	U	C	S

NOTE Key: S Suitable; U Unsuitable; C Confirm suitability with manufacturer or reputable source

[a] The tile bedding chosen will also depend on the traffic conditions (see 6.2.5).

Table 8 — Final tile bedding thicknesses

1	2	3
Tile bedding	**Thickness** mm	
	Minimum	**Maximum**
Mortar (see 7.3.6.1)	20 (15 [a])	25 (20[a])
Cement: sand semi-dry mix (see 7.3.7.1)	40	70
Cement: sand over a separating layer (see 7.3.7.3 and 7.3.8.2)	20 [b]	30 [b]
Adhesive (see 7.3.8)	> 3	c)
a When tiles are not more than 10 mm thick. b Refer to manufacturer. c See SANS 10109-2.		

6.2.4 Durability and performance

Floor tiling can deteriorate because of defects in the structure, mechanical failure of the materials, the action of frost or the use of unsuitable cleaning agents (see 9.6). Tiled floors could also be unsatisfactory because they have become slippery, or stained, or the grout or sealants (or both) have deteriorated.

6.2.5 Traffic abrasion and load conditions

6.2.5.1 General

Ceramic tile floors normally offer a marked resistance to abrasion caused by pedestrians and vehicle traffic. As it is essential that the floor withstand the loads that will be placed on it during service conditions, it is preferable that the floor base be of concrete construction, especially in areas subject to moderate to heavy traffic. Apart from the inherent abrasion-resistant properties of the tiles, the following factors shall also be considered:

a) the type of traffic: if pedestrian, the type of shoe heel and sole, and, if vehicular, the type (i.e. rubber or metal) and the size of the wheel;

b) the amount of traffic, i.e. the number of pedestrians or vehicles; and

c) the frequency of traffic over the area.

6.2.5.2 Abrasion resistance - Classes of tile

6.2.5.2.1 Suitability for use of glazed tiles

The abrasion resistance of glazed tiles can be expressed in terms of the classes defined below, and the designer of a floor shall select tiles of the appropriate class:

a) **Class I tiles:** suitable for low-traffic domestic areas, where normally only soft or elastic footwear, free from abrasive dirt, is worn. Such areas include bathrooms and toilets. The tiles are not suitable for floors adjoining outside areas direct, where the possibility exists of bringing in abrasive dirt that could lead to scratching of the tiles.

b) **Class II tiles:** suitable for domestic areas where normal footwear is worn and where there is the possibility that a small amount of abrasive dirt could be brought in from outside. The tiles are not suitable for use in kitchens, halls and on stairs.

c) **Class III tiles:** suitable for the entire domestic area, including entrance halls, corridors, bathrooms, kitchens and patios, and also for light commercial areas that are subject to low traffic.

d) **Class IV tiles:** suitable for areas that are exposed to frequent traffic, with normal footwear, in public buildings such as shops, hospitals, garages, restaurants, and also in industrial kitchens and similar applications.

6.2.5.2.2 Suitability for use of unglazed tiles (see SANS 1449)

In areas where heavy traffic is anticipated, such as in shopping centres, supermarkets, railway stations and sports stadiums, use either unglazed extruded tiles that comply with the abrasion-resistance requirements for group A1 or A2, or unglazed dust-pressed tiles that comply with the abrasion-resistance requirements of group B1.

NOTE Where doubt exists as to the suitability of a particular class of tile for the amount of traffic anticipated, contact the tile manufacturer.

6.2.5.3 Resistance to mechanical failure

The relevant mechanical properties of flooring are as follows:

a} **resistance to surface wear:** physical hardness of the flooring itself and a surface free from irregularity in level;

b) **resistance to loading:** strength and thickness of tile, solidity and strength of bedding and compressive strength of base;

c) **resistance to impact:** in addition to the properties given in (a) and (b) above, the following factors are also important:

1) Within the normal tolerance of the flooring units used, the individual units shall be laid to a true plane. Therefore a true base is a necessary prerequisite.

2) The flooring units shall be solidly bedded so that there are no voids.

3) Joints between ceramic floor tiles shall be as narrow as possible, in accordance with the manufacturer's recommended values for the type of tile used, with a minimum of 3 mm.

Ensure that joints are at least as deep as the thickness of the tiles. The maximum width shall not exceed 10 mm when conventional cement: fine aggregate grouts are used because such joints possess lower impact resistance and abrasion resistance than do the tiles. In the case of joints wider than 10 mm, consideration shall be given to the use of proprietary grouts specially formulated with enhanced resistance to impact, abrasion and low shrinkage (see 7.3.9.3.2).

6.2.5.4 Resistance to frost

Acceptable assurance about frost resistance shall be obtained from suppliers of both tiles and bedding materials, in areas where frost could occur. Tiles selected shall be of class A1 or B1, as classified in SANS 1449.

6.2.5.5 Resistance to slip

Unglazed floor tiles (other than porcelain tiles) are not usually slippery when clean and dry, but if water, oil, grease or wax is present on the surface, potentially slippery conditions will be created.

Glazed tiles shall not be used in areas likely to become wet unless the tiles are designed to be slip resistant.

Floor surfaces could become slippery in time, through the polishing action of traffic. When it is known that, in service, slippery conditions could arise and present a significant hazard, especially on steps and where floors are laid to falls, tiles or inserts with slip-resistant finishes shall be used.
Special attention shall be paid to correct cleaning procedures as described in clause 9, both to remove contamination and to ensure that cleaning agents that could otherwise attack the surface are rinsed away.

The resistance to slip is influenced by factors such as the nature of usage, location, changes of floor types, the gait and physiological condition of pedestrians, and tile wear, and also environmental and ergonomic considerations.

6.2.5.6 Resistance to staining

Glazed floor tiles are generally resistant to staining and are usually more easily cleaned than unglazed tiles. The degree of resistance to staining of unglazed tiles depends mainly on the porosity of the tile, i.e. a fully vitrified tile will have a high degree of resistance, whereas a porous tile will stain more easily. The classes of ceramic tiles with low, medium and high water absorption are given in SANS 1449.

6.2.5.7 Grouts, joints and sealant materials

The resistance of grouts and jointing materials to various liquids that might be in contact with them for a short time is shown in table 9, which also indicates their flexibility. Spillages shall be cleaned off as soon as possible.

Where coloured grouts are used, they cannot always be expected to retain their colour and appearance after usage. A summary of properties of flexible sealants is given in table 2.

Table 9 — Grout and joint materials: flexibility, resistance to intermittent contact with various chemicals

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Grouts and joint materials	**Lemon juice**	**Vinegar**	**Acidic soft drink**	**Alcoholic drink**	**Tea and coffees**	**Sugar solution**	**Lactic acid**	**Olive oil**	**Disinfectant (phenolic)**	**Disinfectant (hypochlorite)**	**Acid**	**Detergent (neutral)**	**Ammonia (10 % solution)**	**Paraffin oil**	**Acetone**	**Butyl acetate**	**Carbon tetrachloride**	**Urine**	**Sea water**	**Animal fat**	**Flexibility**
Portland cement mortar	P	P	P	F/G	G	F	P	G	F	F/G	P	G	F	G	G	G	G	F/G	F	P	Rigid
High alumina cement mortar	P	F	F	F/G	G	F	F	G	F	F/G	P/F	G	F	G	G	G	G	F/G	G	P/F	Rigid
Polymer modified cement	P	F/G[a]	P/F	F/G[a]	F/G[a]	F/G	F/G[a]	G	F/G[a]	F/G	P/F	G	F	G	G	G	G	F/G	G	P/F	Slightly resilient
Furane resin	P	P/F	F	G	G	G	G	G	G	G	P/F	G	G	G	G	G	G	G	G	G	Rigid and tough
Epoxy resin	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	G	Rigid and tough

NOTE 1 Key: P : Poor
P/F : Poor/fair
F : Fair
F/G : Fair/good
G : Good

NOTE 2 This table should be regarded as a general guide to the properties of the materials listed. Pre-use details of corrosive conditions should be obtained from specialists.

[a] The higher resistance is obtained with certain synthetic rubbers.

6.2.6 Passage of liquids through floors

6.2.6.1 General

Floors that consist of concrete substrate or floors of suspended construction (other than those of metal, with an asphalt covering or with tile joints sealed by an impervious grout) and the bedded flooring dealt with in this standard are not completely impervious to liquids, nor do they offer substantial resistance to the passage of water vapour.

In many situations, continuous transmission of moisture is tolerable but account shall be taken of effects that make it desirable to use some form of moisture-resistant construction. Waterproofing of floors shall therefore comply with SANS 10021.

6.2.6.2 Passage of liquids from below

Ground moisture and the water used in construction can be transmitted through solid floors by capillary action and by evaporation to the air above, thus leaving the floor surface apparently dry.

Evaporation will be impeded by additional floor coverings that are less permeable than those discussed here or by fittings or stored goods in direct contact with the floor. Local dampness could consequently be so severe as to encourage mould growth and to rot or corrode materials that come into contact with it.

Moisture that rises through a solid floor could contain soluble salts from the subsoil, the hard fill and the concrete of the floor itself. These will tend to accumulate in increasing concentration at or near the floor surface as long as they are being replenished from below.

In the worst possible case, i.e. where the subsoil or the fill is contaminated with acids or high concentrations of soluble sulfate compounds which attack cement, the safety of the whole floor could well depend on adequate damp-proofing below the substrate. In less aggressive situations, damp-proofing that serves only as a capillary barrier is still justified as a precaution against persistent efflorescence at the floor surface and against possible attack on the concrete by sulfates.

6.2.6.3 Passage of liquids from above

Tiles and bedded finishes, even when the joints are filled with impervious grout, cannot be guaranteed to eliminate entirely the passage of liquids downwards. Defects in workmanship and movement in the structure can cause fissures through which liquids readily pass.

In ground floor situations, aggressive chemicals in solution that pass through the floor could attack a concrete base, leading to severe disruption.

In the case of suspended floors, and when attack on the structure by chemicals has taken place, water that passes downwards could cause dampness on walls and ceilings below and, in the worst case, lead to flooding. If more than occasional spillage of liquids is anticipated, the tiled surface shall be laid to falls and drains shall be designed to collect the run-off.

The most satisfactory method of preventing the downward movement of liquids is by providing a damp-proof membrane between the substrate and the tiling. The membrane shall usually be covered by an inert screed.

The substrate shall be so constructed to a fall that any liquid that reaches the membrane flows down to a drain. The membrane shall be impervious and chemically resistant to the liquids that could come into contact with it and shall also be sufficiently flexible and strong to resist movement in the structure and loads, without rupturing. The membrane shall be continuous around upstands and at points where services pass through the floor. The most commonly used membrane materials

are mastic asphalt, polyethylene, modified bitumen, polymer, synthetic rubber sheets and liquid applied systems such as polyurethane.

Where the damp-proof membrane method creates impractical levels, a reinforced liquid applied system that is compatible with the adhesive system can be used.

6.2.7 Variations in moisture content and temperature

Moisture expansion of ceramic tiles occurs as a direct result of absorption of moisture. Whereas the test method (see SANS 1449) merely yields a single value for moisture expansion, the actual expansion potential of the installed tile will be determined by its age and its individual expansion kinetics. The effects of this behaviour are essentially analogous to those produced by an increase in temperature. Appropriate measures, such as the selection of tiles that have a low moisture expansion, shall be taken in the planning of a tiling system, in order to counteract any effects of excessive expansion.

In solid and suspended floors, the base and the floor tiling usually have different dimensional reactions to changes in moisture content and temperature.

Probably the most extreme relative moisture movements occur when a new concrete floor or screed is covered before most of the drying shrinkage has taken place. The shrinkage of the substrate or screed persists for some time after the tiling has reached equilibrium, with the result that compression forces might ultimately crack the tiles or break down the adhesion between the tiles and the bedding. Vibration, impact and thermal shock could produce early failure while the floor tiling is in the stressed condition, as could further contraction and creep of the substrate, for example in very cold weather.

6.2.8 Movement joints

6.2.8.1 General

Movement joints serve a useful purpose. They prevent adhesion failure by accommodating differential dimensional movement without stress build-up. They therefore prevent adhesion failure (notable shear failure).

Movement joints for floor tiling are incorporated as follows:

a) structural movement joints, that is flexible joints aligned to structural movement joints in the substrate (see figure 4);
b) tile panel joints, that is flexible joints that accommodate smaller movements in the tiling but not in the substrate (see figure 5);
c) perimeter joints, that is flexible joints (see figures A.1 and A.8) between a fixed building element (for example, walls and columns) that might be or are not covered with a tiling system, and an edge of the floor tiling system under consideration. Figure 6 and figure 7 show perimeter joints between the floor tiles and either wall tiles or skirting tiles. In figure 6, the skirting goes right down to the floor substrate, resulting in a non-compressible contraction joint that acts essentially only horizontally. In figure 7, the wall/skirting tiles end at the top level of the floor tiling, resulting in a limited movement joint that can act both horizontally and vertically, especially if the optional bond-breaker is incorporated.

NOTE Further possibilities for movement joints are given in annex A.

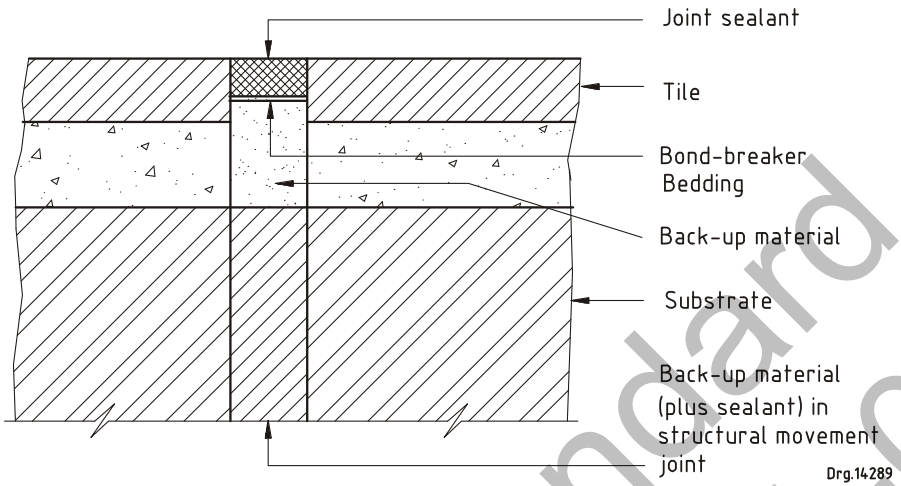


Figure 4 — Flexible joint over structural movement joint

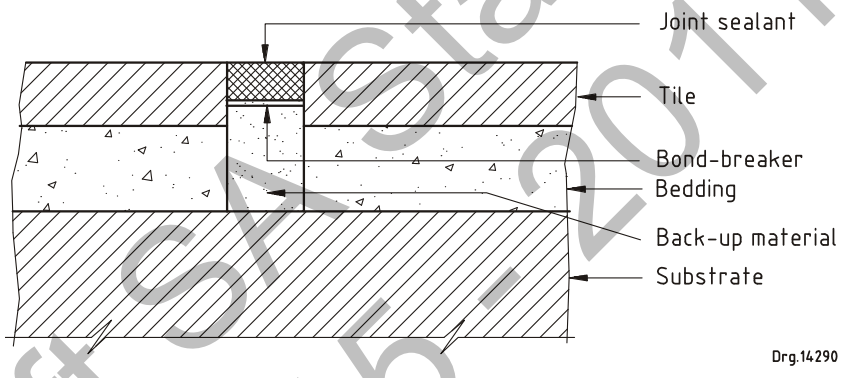


Figure 5 — Flexible tile panel joint over continuous structural substrate

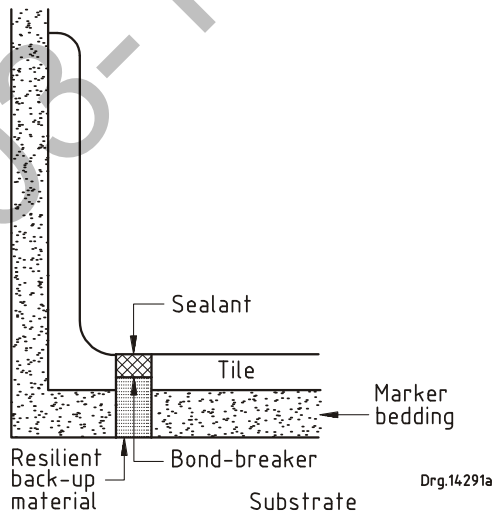


Figure 6 — Perimeter joint between skirting and floor tiling (see also figure A.7)

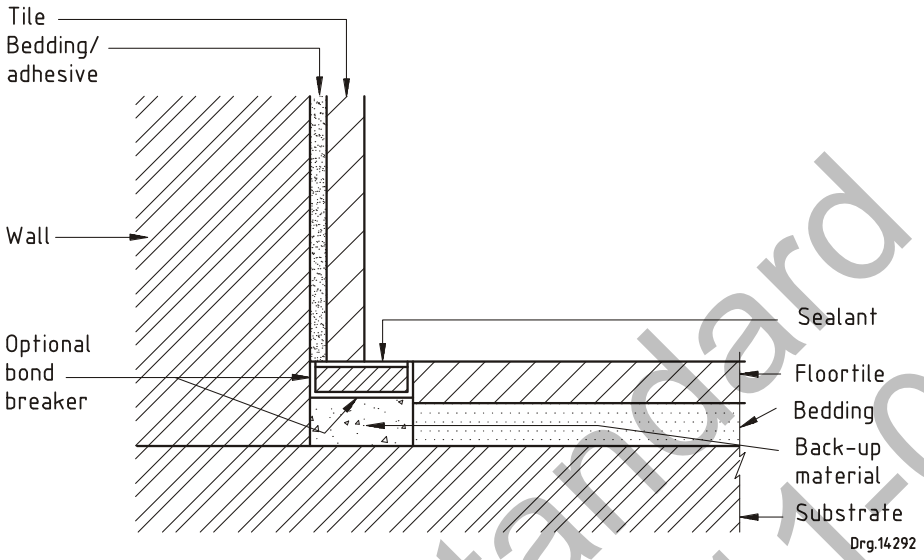


Figure 7 — Perimeter joint between wall tiling and floor tiling

6.2.8.2 Structural movement joints

Structural movement joints in the bedding and tiling shall be sited directly over and be continuous with, and of the same width as, structural movement joints in the substrate.

6.2.8.3 Other movement joints

Tile panel movement joints (see figure 5) shall be inserted over supporting walls and beams at intermediate positions, to accommodate deflection of the substrate and movements in the flooring.

Contraction joints (see figure 6) may be used instead of tile panel joints over supporting walls and beams. Flexible joints of either type shall be used at floor perimeters and to divide the floor into bays at the intervals recommended (see 7.3.5.4). Wherever possible, they shall coincide with structural features (for example, columns or door openings), or they can be planned to provide a decorative panelled effect. Where temperature changes are expected, for instance around boilers, over heating installations or from strong sunlight, an assessment of the likely temperature range and corresponding linear changes in the flooring shall be made, to determine whether any additional allowance for movement is necessary.

In floors that have to withstand hard-rimmed wheel traffic or the dragging of heavy loads, the position of movement joints shall, when possible, be so planned that they do not occur in the traffic area. Where this is not practicable, the joints shall be of types that have their edges reinforced with metal or rigid plastics sections (see annex A).

Joints other than those that are protected by metal or rigid plastics edging, and that are subject to traffic heavier than light pedestrian, shall not be wider than 10 mm. Information on the permissible maximum and minimum joint widths shall be obtained from the manufacturer of the particular joint filling material.

NOTE The illustrations in figures 4, 5 and 6 indicate the basic principles of the types of joints referred to in 6.2.8.3. Prefabricated materials (as shown in the examples in annex A) are available that embody the principles shown, but they might differ in detail.

6.2.8.4 Typical movement joints around columns

6.2.8.4.1 General

Isolation joints permit horizontal and vertical movement between adjacent slab bays and fixed elements of the structure (see figure 8). The main features of isolation joints are:

a) they are generally used where the floor meets fixed parts of the building, such as columns, walls, and machinery bases; and

b) these joints can be used where the internal floor slab meets the external pavement.

6.2.8.4.2 Joint layout

A suitable joint layout is determined by a combination of requirements that include:

a) provision of isolation joints between fixed elements of the structures (for example, columns, walls, or machinery bases) and adjacent slab bays;

b) location of construction joints (see figure A.6) where the bay length and width are dictated by the construction method; and

c) location of contraction joints dictated by bay length and width.

A suitable pattern of right-angled rectangular panels or bays is then selected. A typical joint layout is shown in figure 8.

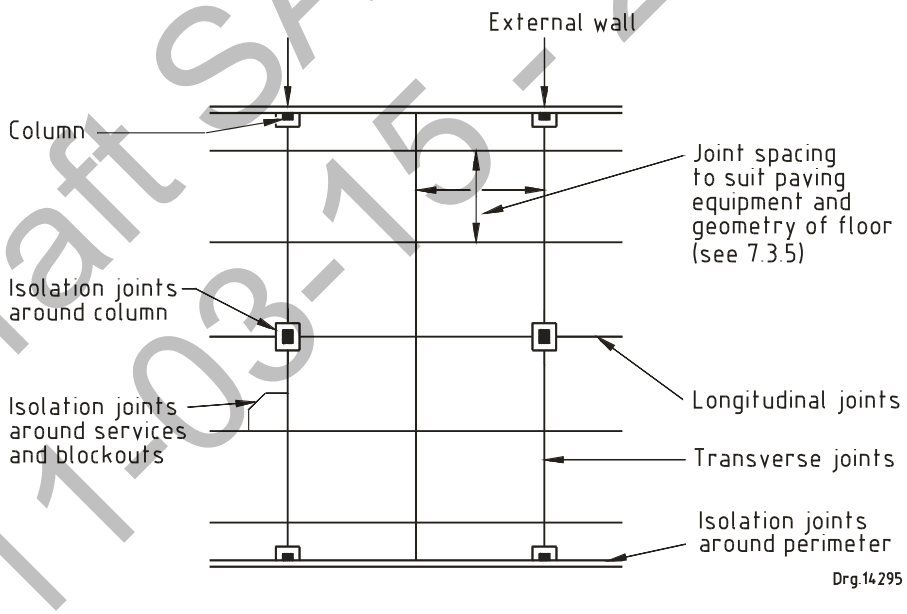


Figure 8 — Right rectangular joint layout

6.2.8.5 Sealants

The choice of sealant will depend upon many factors, including extensibility, resistance to chemicals, wear resistance, penetration of grit and contamination, resistance to damage from cleaning processes, and ease of placing. In each case, the sealant manufacturer's advice shall be taken into account.

A summary of the more important properties of recommended sealants is given in table 2.

6.2.8.6 Back-up materials

The back-up material in the lower part of the joint shall be compatible with the sealant being used; it shall be compressible, shall support the sealant and shall not give off bituminous or oily products. In particular, it shall assist the seal in carrying traffic loads, and its compressibility shall be such that, when the joint closes, the sealant is not forced out. Suitable materials include, for example, cellular polyethylene.

Where sealants with a large movement capability are used, it is essential that they do not stick to the back-up material, since the ability of the sealant to accommodate movement will be reduced by any restriction of its under-face. To prevent this, a bond-breaking tape shall be applied between the back-up material and the sealant.

6.2.8.7 Preformed strips

Preformed strips are suitable for use in stress-relieving or compression joints where a watertight seal is not critical. Synthetic rubber strips with metal edge supports and PVC are suitable for use.

Strips shall be inserted between tiles as the tiles are laid. They shall be fitted to the combined depth of the tiles and bedding, and keyed into the bedding by the shape of the strip section.

Where waterproof tiling is required, it is preferable that preformed strips be omitted and an appropriate sealant used.

6.2.9 Skirtings

Skirtings can be used for protecting the base of wall surfaces, for ease of cleaning, to assist in forming a liquid-tight system at the junction of floors and walls, or for aesthetic reasons.

Where it is important that the installation be resistant to the passage of water or other liquids, and especially where "tanking" is necessary (see 6.2.6), a coved base skirting shall be used (see figure 6). This allows a perimeter to be positioned between the foot of the coved base and the adjacent floor tile, to accommodate movement and which, when filled with an impervious sealant, will contribute to a smooth uninterrupted resistant surface from horizontal to vertical

7 Installation methods and materials

7.1 General

7.1.1 Bedding methods

A suitable bedding for tiles might be one of the following:

a) a cement-based adhesive (see 7.2.9.1);

b) an organic-based adhesive (see 7.2.9.2); or

c) mortar (see 7.2.9.3).

The backgrounds to which each system is suited are summarized in table 3, 4, 5 and 6.

For fixing tiles with smooth or shallow-keyed backs, methods (a) and (b) above are preferable. For fixing tiles with deep keys, a thick-bedding adhesive or mortar shall be used, provided it is compatible with the background.

7.1.2 Workmanship

The application of ceramic tiling requires effective supervision and the employment of skilled operatives, working safely and using protective clothing and equipment where appropriate.

Recommended tiling procedures are given in Annex B.

7.2 Wall tiling

7.2.1 Compatibility of backgrounds and tile beddings

The treatment of base surfaces to produce backgrounds ready to receive tiling is detailed in clause 6. In 7.2.9.1.2. and 7.2.9.2.2, additional information is given that might be specific to a bedding method.

Preparatory work in the formation of backgrounds that fail to meet the recommendations of this standard shall be completed before tiling is commenced. Sufficient additional time shall be allowed for curing, commensurate with the extent of making good, before the contemplated bedding system is used.

7.2.2 Setting out

To enhance the appearance of the finished wall tiling, it is essential that unsightly cut tiles be avoided and that the joints be of uniform width. Allowance shall be made for an adequate width of joint (see 7.2.9.1.6).

Cut courses, both vertical and horizontal, shall:

a) be determined in advance;

b) be as large as possible; and

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

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

Where wall surfaces are interrupted by features (for example, windows, access panels or sanitary fittings), the tile fixer might need guidance from a competent person as to the setting out to be adopted. Similar guidance might be required in the positioning of movement joints, since they will be predominant and could determine the setting-out pattern.

The positioning of horizontal joints and cut courses will depend on several factors, of which the following are examples:

a) Tiled areas that adjoin or are adjacent shall be so set out that horizontal joints are aligned.

b) The upper or lower (or both) extremities of a wall might not be level, requiring a course or courses to be cut with a raking edge. Wherever possible, the horizontal joints shall be so positioned that the whole of the rake can be taken up within the height of the tile in the cut course.

c) If it is thought desirable to align a joint with a feature, this could initiate the need for, and frequently dictate the location of, cut courses.

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

7.2.3 Movement joints

When the tiling is being set out (see 6.1.5), provision shall be made to incorporate movement joints in appropriate positions.

All joints shall be rectangular in section, with straight, smooth edges, free from cavities and irregularities.

When the joints are being formed, it is useful to insert a temporary filler strip that can be removed when the tiling is sufficiently firm. The filler strip can be wrapped in polyethylene film to ensure smooth, clean joint faces and to assist in its removal. Care shall be taken to prevent grout and other materials from becoming trapped in the joint cavity, which will prevent proper application of the back-up and sealant, and can prevent movement in the joint, resulting in damage or displacement.

7.2.4 Preparation of tiles

Tiles to be fixed with proprietary adhesives shall be kept dry, in accordance with the manufacturer's instructions.

Certain tiles, when fixed in mortar, might require soaking in water prior to fixing, depending on their porosity (see 7.2.9.3.3).

7.2.5 Mixing of tile bedding materials

When a proprietary adhesive is used, strict attention shall be paid to the manufacturer's instructions. General guidance is given in 7.2.9.

It is not practicable to give similarly precise instructions concerning mortar bedding. The properties of a sand will depend upon its source and will in particular influence the quantity of water that has to be added to the mortar batch in order to give it the desired consistency.

The sand therefore has to be selected with care to obtain optimum performance from the cement: fine aggregate mortar.

Proper dry and wet mixing is essential for optimum performance. The ambient temperature, the porosity of the background, and the thickness of the bedding shall be considered in order to estimate the optimum water content necessary to achieve the desired mortar consistency for a particular application. This is vital to minimize drying shrinkage, to obtain maximum strength of the mortar and to limit adhesion failures.

7.2.6 Tolerances

7.2.6.1 Finished tile surfaces

The finished tile surface shall be true, such that, when it is checked with a 2 m straightedge with feet of thickness 3 mm at each end, the straightedge is not obstructed by the tiles and no gap exceeds 6 mm.

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

7.2.6.2 Level across joints

The maximum deviation between the surfaces on the two sides of a joint (including movement joints) shall be as follows:

a) for joints of width less than 6 mm: 1 mm; and

b) for joints of width 6 mm or more: 2 mm.

7.2.7 Lighting during fixing

The type, direction and intensity of lighting at the time of tile fixing shall be equal to the ultimate permanent lighting. Within the tolerance laid down for the overall plane, there could be minute differences of plane between adjacent tiles, and shading can be rendered visually insignificant in the ambient lighting by adjustments of the tiles during fixing. If the finished tiling is subsequently exposed to lighting from a different source and intensity, its appearance could be affected and no adjustments can then be made to the tiles to meet the changed circumstances.

7.2.8 Tile joint treatment

To ensure a high standard of finish, careful attention shall be given to the selection of the methods and materials to be adopted in the proper filling and finishing of the joints. The selection will depend upon the joint width and the functional requirements of the installation (see 7.2.9.1.6 and 7.2.10).

7.2.9 Bedding methods

7.2.9.1 Bedding in cement-based adhesives

7.2.9.1.1 General

The method to be adopted for fixing tiles will vary with the type of background, the nature of the adhesive, the type of tile and the anticipated conditions to which the installation will be subjected in service.

There are several proprietary products available and some variations in fixing procedures exist.

It is therefore important to follow the recommendations of the adhesive manufacturer concerning, for example, the type of trowel, the mixing procedure, the working time after spreading and the suitability of the background.

7.2.9.1.2 Backgrounds

Cement-based adhesives are suitable for use on cured plastered surfaces, concrete and brickwork. They are not recommended for use direct onto flexible surfaces. Consult the adhesive manufacturer for recommendations in this regard. A summary of backgrounds and their treatment is given in table 3, 4, 5 and 6.

The background shall be clean, dry and free from dust and all forms of contamination, and the surface shall not be dampened before the adhesive is applied (see 6.1.1).

7.2.9.1.3 Preparation of tiles

The water absorption of the tiles will determine whether they should be soaked. Tiles with water absorption lower than 3 % need no soaking.

7.2.9.1.4 Mixing of adhesive

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

The open time of the mix and the working time will be stated by the manufacturer, and these time limits shall be strictly observed.

7.2.9.1.5 Application of adhesive and tiles

7.2.9.1.5.1 Buttering method

This method might be necessary for occasional awkward tiling positions, for example, around openings and restricted areas where a notched trowel cannot be used. Where this technique has to be adopted, a trowel shall be used to spread the adhesive evenly over the whole of the back of each dry tile. The bedding thickness shall be slightly greater than the final thickness required so that the correct thickness is achieved when each tile is pressed or tapped firmly into position. The thickness shall not exceed the maximum recommended by the manufacturer of the adhesive. Care shall be taken to ensure that no voids are left behind the tiles.

7.2.9.1.5.2 Notched-trowelling and buttering method

This method combines the method given in 7.2.9.1.5.1 and the trowelling method, as used for walls, and shall be used to fix large tiles (for example, 700 cm^2 and bigger) and tiles with ribbed, deep keyed or heavy buttoned back profiles. The deep keys shall be filled with a coating of adhesive buttered over the backs before the tiles are placed in position on the combed adhesive bed. There shall be no significant increase in the bedding thickness.

NOTE This method is aimed at achieving a solid bedding.

7.2.9.1.6 Tile joints

Tiles, including tiles with spacer lugs and universal edges, shall never be butt jointed. Joints of approximately 2 mm shall be left around every tile by the insertion of tile spacers of suitable thickness between the tiles as fixing proceeds.

If, for design reasons, wider joints are required, the same technique shall be adopted. Joint width shall be consistent throughout the installation unless specified otherwise (see also 7.2.2).

Surplus bedding material on the surface of the tiles or in the joint spaces shall be removed before it hardens in order to prepare the joints for grouting (see 7.2.10 for grouting materials and procedures).

7.2.9.2 Bedding in organic-based adhesives

7.2.9.2.1 General

Organic-based adhesives shall only be used in adequately ventilated areas, since some are highly flammable, narcotic or carcinogenic. Flammable adhesives shall not be used near naked flames, cigarettes, electrical switchgear and other possible sources of ignition, and the lid shall always be replaced on a container immediately after use.

NOTE It is dangerous to smoke during the application of solvent-based adhesives.

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

7.2.9.2.2 Backgrounds

Organic-based adhesives are suitable for use on cured plastered surfaces, concrete, brickwork, various sheets and boards, metal surfaces, correctly prepared painted surfaces, and existing tile and glazed brick surfaces. Solvent-based adhesives are not suitable for use on some painted surfaces because of possible interaction between the solvent and the paint.

A summary of backgrounds and their treatment and the suitability of organic-based adhesives is given in table 3, 4, 5 and 6.

The background shall be dry, clean, and free from dust and all forms of contamination, and the surface shall not be dampened before the adhesive is applied (see 6.1.1).

The trueness required of the background surface and any necessary treatment are described in 6.1.1.4 and 6.1.4.1.

7.2.9.2.3 Preparation of tiles

Tiles shall not be soaked before being fixed.

7.2.9.2.4 Preparation of adhesive

Most organic-based adhesives are supplied ready for use. Some require prior mixing of components and the manufacturer's instructions shall be followed in each case.

7.2.9.2.5 Application of adhesive and tiles

Organic-based adhesives are applied by methods similar to those described for cement-based adhesives, including, where required, the notched-trowelling and buttering method as described in 7.2.9.1.5.2.

7.2.9.2.6 Tile joints

See 7.2.9.1.6.

7.2.9.3 Bedding in mortar

7.2.9.3.1 General

Portland cement based mortars are acceptable for the laying of tiles. The cements shall conform to at least the 32,5 N strength class. Mixing and application are dealt with in 7.2.9.3.4 and 7.2.9.3.5.

7.2.9.3.2 Backgrounds

Backgrounds suitable to receive internal ceramic wall tiling fixed by mortar over a plastered or non-plastered surface are those that are rigid and provide an adequate key and also suitable suction. Plastered surfaces shall have been applied at least 2 weeks before tiling is started (see figure 1). Dry background surfaces shall be wetted just sufficiently to prevent excessive absorption of water from the mortar bedding.

The preparation of various backgrounds to receive mortar bedding and the precautions that shall be adopted in each instance are described in 6.1. (see also 7.2.1.). A summary of backgrounds and their treatment is given in table 3, 4, 5 and 6.

7.2.9.3.3 Preparation of porous tiles

To prevent too rapid suction and subsequent failure to bond with the mortar bedding, porous tiles shall be soaked before fixing. The tiles shall be removed from their cartons and completely immersed in clean water for at least 30 min. After soaking, they shall be stacked tightly together (with the end tiles face outwards) on a clean surface, and allowed to drain. Tiles classified in SANS 1449 as groups A3, A4, B3 or B4 require this saturation treatment. Soaking of tiles of groups AI, A2 and B2 is unnecessary.

7.2.9.3.4 Mix materials, proportions and method

Mortars shall be adequately cohesive and water retentive and shall be between 1:3 and 1:4 cement: fine aggregate by volume (1:3,4 to 1:4,5 by mass). Within these limits, the choice of the proportions shall be governed by the need to produce a mortar that has the required properties with the minimum water content (see 7.2.5). If the fine aggregate is damp, due allowance shall be made for this. Care shall be taken that the use of admixtures, such as plasticizers, waterproofers and fungicides, does not adversely influence the adhesion strength, contraction or expansion of the mortar.

Once the proportions have been established, every attempt shall be made to minimize random variations. Materials shall be batched by mass wherever possible and the water addition shall be controlled.

Where exact mass batching is impracticable, mortar batches shall be based on multiples of an entire bag of cement (50 kg approximating to 0,035 m^3 or 35 L). In such cases, the fine aggregate and water shall be measured by volume, using correctly made gauge boxes or other suitable containers of fixed measurable volume. This method allows water addition to be checked and thus permits approximate mix proportions to be established and maintained.

Batching by the shovelful shall never be allowed, since it eliminates the possibility of establishing and controlling mix proportions. Wherever it is practicable, mixing of mortars shall be by machine, preferably of the forced action type.

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

Mortar shall be discarded once it becomes unworkable and no attempt shall be made to reconstitute it in any way. No additional water shall be added.

7.2.9.3.5 Application of mortar and tile bedding

7.2.9.3.5.1 Floating and back-filling method

The mix as described in 7.2.9.3.4 shall be trowelled onto the background to a thickness not exceeding 10 mm and shall be finished with a wooden float. The bedding shall be allowed to stiffen slightly before any tiles are applied, to assist it in supporting the added mass.

A mix of 1 part of cement and 1 part of fine sand shall be prepared with sufficient water to produce a thin (1 mm to 2 mm) bonding coat. This shall be trowelled over the backs of the tiles before they are placed into position on the floated bed and tapped back firmly.

Care shall be taken to ensure that tiles that have deep keys, ribs or heavy buttoned back profiles are filled with the 1:l cement: fine aggregate mortar (by volume) before they are placed in position on the floated wall.

NOTE All mortar bedding systems are aimed at achieving a solid bedding but, in practice, it is inevitable that there will be a number of small voids.

7.2.9.3.5.2 Buttering method

This method shall only be used for small areas of tiling or in situations where it would be impracticable to float the wall.

Tiles shall be evenly buttered with the mortar mix and tapped back firmly into position, in order to ensure that, as far as possible, the bedding is solid over the whole of the backs of the tiles, including the corners. Deep keys or frogs in the backs of tiles shall be filled during buttering. The resultant thickness of the bedding behind the tiles shall generally be 6 mm but not more than 12 mm; the depth of mortar in keys or frogs is additional to these values.

This method shall not be used to fix tiles of thickness less than 5,0 mm, because of the risk of their cracking.

7.2.9.3.5.3 Finishing

A straightedge shall be used to ensure that the surface of the tiling is flat and true, as defined in 7.2.6. Any adjustment of tiles shall be made within 10 min of fixing.

A damp cloth should be used to clean the tiling down before any cement smears and surplus mortar begin to harden on the surface or in the joint spaces, and care shall be taken to avoid disturbance of the tiles during the setting of the bedding.

7.2.9.3.6 Tile joints

See 7.2.9.1.6.

7.2.10 Tile joint treatment

7.2.10.1 General

A wide range of grouts is available (see 5.14) for filling the joints between tiles. The methods to be employed in using these products for treating the joint spaces between tiles, other than movement joint spaces (which require different and special treatment), are described in 7.2.10.2, 7.2.10.3 and 7.2.10.4.

Grouts shall be compressible. When proprietary grouts are being used, the joint cavities shall not be wetted.

When mortar is being used for grouting, the joint cavities shall be damp. If the cavities have dried out in the interval between the completion of tile fixing and the start of grouting, they shall be rewetted.

7.2.10.2 Grouting procedures for joints of width up to 3 mm

Proprietary grouts are recommended and shall be mixed and applied in accordance with the manufacturer's instructions.

Grouting can be carried out at any time to suit the convenience of the work, but is essential that adequate setting of the bedding is ensured, to prevent disturbance of the finish during the grouting operation. However, grouting shall not be delayed unduly, since the open joints can collect dust and deleterious material.

The grout shall be applied to as large an area as possible before hardening starts, this being dependent on climatic conditions. The grout shall be applied with a rubber squeegee or a grouting trowel, and shall be worked back and forth over the area until the joints are completely filled. Surplus grout shall be removed from the tiles with the aid of a rubber squeegee or a grouting trowel and a damp cloth. The joints shall then be tooled with a piece of wood or other material of suitable size and shape. After the grout has dried, a clean, dry cloth shall be used to give the tile surface a final polish.

7.2.10.3 Grouting procedures for joints of width exceeding 3 mm (allow for masonry cement mixes too)

Proprietary grouts are recommended for wide joint filling because of the danger of scratching glazed tiles with cement: sand mortars, and the grouts shall be prepared and applied in accordance with the manufacturer's instructions.

Where mortar is used for wide joint filling, it shall be a stiff, slump-free mix that consists of 1 part of cement and 3 parts (by mass) of fine aggregate mixed with the minimum of water necessary to achieve workability (see table 1). Admixtures may also be incorporated (see 5.15).

To avoid damage to the surface, care shall be taken when the joints between glazed tiles are being filled. In the case of tiles faced with soft glazes that scratch easily, it is advisable to use masking tape to protect the glaze adjacent to the joint.

The wider the joint, the greater shall be the stiffness of the mix. The joint shall be well filled to a uniform depth and the surface shall be even.

A rubber float or similar tool shall be used to apply the mortar over the surface of the finished work to as large an area as can be worked before hardening starts.

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

7.2.10.4 Application of coloured grout

Where coloured grouts are required, it is advisable to check the potential risk of staining by applying the grout to a few tiles in a small trial area. In any doubtful case, this would enable an alternative grouting procedure to be adopted. Alternatively, the use of a proprietary tile sealant could be considered. Proprietary tile sealants shall be used in accordance with the manufacturer's instructions and shall be applied before grouting is carried out, in order to provide a protective coating that can readily be removed after completion of grouting.

For the colouring of cement: fine aggregate grout, a mineral pigment (see 5.14.2.3) shall be thoroughly mixed with the dry cement before this is added to the mix, in order to obtain the best staining power and homogeneity. In the case of proprietary cement: fine aggregate grouts, these are pre-pigmented by the manufacturer, and no additional pigment need be added.

For the colouring of epoxy-resin-based grouts, mineral pigments can be incorporated in accordance with the recommendations of the resin manufacturer. In the case of proprietary epoxy-resin-based grouts, these are pre-pigmented by the manufacturer and no additional pigment need be added.

With most tiles, no problems arise, provided that surplus coloured grout is cleaned off promptly in accordance with the manufacturer's instructions.

However, coloured grouts might prove more difficult to remove from matt glazed tiles, tiles with textured surfaces and some unglazed tiles and, in general, grouts that contain finer-grained pigments are likely to prove more troublesome in this respect than those containing coarser-grained pigments.

7.3 Floor tiling

7.3.1 Preparation of substrates to receive tile bedding

7.3.1.1 General

The bond between the bedding and the substrate depends to a great extent upon the conditions of the surface of the substrate at the time that the bedding is laid. Where the flooring is likely to be subject to heavy traffic or other rigorous service conditions, good adhesion to the substrate shall be ensured by providing a mechanical key or using a suitable bonding agent, depending on the base and bedding system.

Where there is a risk of further accumulation of dirt, preparation of the substrate shall be delayed until shortly before the bedding is to be laid.

7.3.1.2 In situ concrete substrates

The bonded bedding method used shall comply with SANS 10109-2. The laitance on the concrete surface shall first be entirely removed by suitable mechanized equipment, in order to expose clearly the coarse aggregate. All loose debris and dirt shall be removed by thorough sweeping or, preferably, by vacuum equipment. Before the mortar bedding is laid, the reasons for any cracking of the substrate shall be diagnosed and appropriate remedial treatment carried out. Cracked and loose or hollow portions shall be cut out and made good.

Special precautions shall be taken when direct bedding on a power-floated substrate is carried out. This might not be necessary for trowelled finishes.

7.3.1.3 Precast concrete units

Where the substrate is a concrete layer over precast concrete units, it shall be prepared as in 7.3.1.2.

NOTE If the concrete layer is thin (for example less than 100 mm) and roughening by heavy mechanical scabbling is likely to damage it or the precast units below, the use of shot blasting or grit blasting equipment is an alternative.

Where a mortar bedding is to be laid directly onto precast units, the surface of the units left rough during production shall be thoroughly cleaned and washed, for example by wire brushing.

7.3.1.4 Bonding mortar bedding

Before a mortar bedding is laid, concrete shall be wetted and excess water brushed off before slurrying. Within a period of 30 min before the mortar bedding is to be laid (less in hot weather), a thin layer of neat cement slurry of creamy consistency shall be brushed into the surface of the concrete. It is essential that the mortar bedding be compacted onto the substrate while the slurry is still wet.

NOTE A proprietary bonding agent can be used or a proprietary bonding mixture can be added to the slurry in accordance with the manufacturer's instructions. Roughening of the base should still be carried out.

7.3.2 Setting out

When setting out, it is essential to establish the correct datum level for the floor. The level of the finished work shall be controlled by a series of spot levels. A gauge rod shall be made that indicates the overall measurement of a given number of tiles and the specified joint widths. With the use of this rod, the tiling contractor can determine the best method of setting out in order to avoid unsightly cut tiles. Whole tiles shall be used to the greatest possible extent. If cutting is necessary, then cut tiles shall be fixed as unobtrusively as possible and shall achieve symmetry with regard to cut tiles in the total area.

Setting out might have to be related to the siting of existing structural movement joints and intended tile panel movement joints, which are usually detailed on working drawings, but it is sometimes necessary that their positioning be left to the discretion of the tiling contractor. The principles to be observed for siting movement joints are given in 6.2.8.

7.3.3 Tolerances on finished floor level

Floor surfaces are usually specified to be level or to be laid to a given fall. Some variations in surface level may be permitted, but shall not exceed the tolerances allowed in the overall project specification, including the following:

a) local variations in level for a nominally flat floor shall be such that, when the floor is checked with a 2 m straightedge that has 3 mm thick feet at each end, the straightedge is not obstructed by the tiles and no gap exceeds 6 mm; and

b) the maximum deviation between tile surfaces on either side of a joint, including movement joints, shall be as follows:

    1) for joints of width less than 6 mm, 1 mm; and

    2) for joints of width 6 mm or more, 2 mm.

NOTE Where the tiling is bedded in an adhesive, the tolerance for the base should conform to that required for the finished floor.

7.3.4 Joints

The width of joints in ceramic floor tiling shall be at least 3 mm for pressed tiles and at least 6 mm for extruded tiles, in accordance with the manufacturer's recommendation. Wider joints of up to 10 mm might be required in the case of extruded tiles, to accommodate dimensional irregularities in the tiles, to maintain modular discipline or to provide a decorative effect. However, because the joints are usually the part of the tiling most vulnerable to rupture, wear and contamination, it is most important that the depth of the joints be at least equal to the thickness of the tiles.

Recommendations for joint filling materials and procedures are given in 7.3.9.

7.3.5 Movement joints

7.3.5.1 General

Types of movement joints and stress relieving joints are given in 6.2.8 and are illustrated in figures 3, 4 and 5.

7.3.5.2 Structural movement joints

Structural movement joints shall be inserted in the bedding tiles over movement joints or contraction joints in the base (see 6.2.8.2).

7.3.5.3 Perimeter joints

Perimeter movement joints (see figures A.7) shall be inserted where the flooring abuts restraining surfaces such as perimeter walls, columns, curbs, steps and plant fixed to the base. In floors of dimensions 2 m or less, perimeter joints are not necessary unless the conditions that could generate stresses are likely to be extreme, for example, extreme temperature changes or prolonged immersion in liquid.

7.3.5.4 Intermediate joints

The need for intermediate joints between perimeter joints depends on the dimensions of the floor, with the exception of floors in suspended construction. In the case of floors with less than 5 m between perimeter joints or free edges, no intermediate joints are necessary, but in larger floors, joints shall be used to divide the area into bays.

In the case of interior large floors, it is advisable that movement joints that form bays be incorporated at intervals of not more than 5 m, divided by tile panel joints (see figure 5).

On suspended floors, stress-relieving tile panel joints shall be inserted where flexing is likely to occur, for example over supporting walls or beams.

7.3.6 Bedding in mortar bonded to a substrate

7.3.6.1 Mixing and application of mortar

The mortar mix shall neither be stronger than 1 part of portland cement to 3 parts of clean sharp fine aggregate by volume (1 :3,4 by mass) nor be weaker than 1 part of portland cement to 4 parts of clean sharp fine aggregate by volume (1 :4,6 by mass). The materials shall be thoroughly mixed.

The thickness of the bed shall not be less than 15 mm and not more than 20 mm. Where, however, tiles of thickness 10 mm or less are used, the thickness of the bedding shall be 10 mm to 15 mm. The mix shall be of a stiff plastic consistency and shall contain the appropriate quantity of water, so that when the bedding is tamped and fully compacted into place, free water does not bleed to the surface.

The mortar shall be spread between wooden fillets and levelled with a draw float drawn across the containing fillets, sufficient area being laid for two to three hours of tiling work.

7.3.6.2 Preparation of porous tiles

To prevent too rapid suction and subsequent failure to bond with the mortar bedding, porous tiles shall be soaked before fixing. The tiles shall be removed from their cartons and completely immersed in clean water for at least 30 min. After soaking, they shall be stacked tightly together (with the end tile face outwards) on a clean surface, and allowed to drain. Tiles classified as A3, A4, B3 or B4 in SANS 1449 require this saturation treatment. Soaking of tiles of groups A1, A2, B1 and B2 is unnecessary.

7.3.6.3 Application of tiles

Immediately before the soaked tiles are bedded, any excess water shall be removed. The mortar bedding shall be dusted with dry cement sprinkled on with a fine sieve and lightly trowelled level

until the cement becomes damp. Alternatively, a slurry of neat cement and water shall be applied to the backs of the tiles, covering them completely.

Bonding can be improved by incorporating a water-resistant bonding agent in the slurry. The tiles shall then be laid on the mortar bedding with joints of width at least 3 mm between them and tapped level (or as specified by the manufacturer).

7.3.6.4 Movement joints

Siting of movement joints shall be as given in 7.3.5.

7.3.7 Bedding in cement: sand semi-dry mix

7.3.7.1 General

Where a uniformly thick bedding can be applied to achieve the required level of the tile surface, a bedding of maximum thickness 70 mm is usually the most practical.

Where falls have to be formed entirely in the bedding, its greatest thickness may be 100 mm. In all cases, the minimum thickness shall be at least 40 mm. Semi-dry ingredients shall be mixed to achieve a uniform mix.

7.3.7.2 Semi-dry mix

The mix shall consist of 1 part of cement to 3,5 to 4 parts of fine aggregate by volume (1:4 to 4,6 by mass). The fine aggregate shall comply with SANS 1090.

A trial mix shall first be batched by mass. In order that a water: cement ratio of between 0,55 and 0,60 by mass (about 27,5 L of water per 50 kg of cement (one bag)) can be achieved, the proportion of water in the fine aggregate shall be determined beforehand, but if this is not possible the correct water content in the mix shall be established by means of both of the tests given in (a) and (b) below:

a) when a sample of mortar is squeezed in the hand, the sample shall retain its shape and not crumble, the hand being left slightly moist; and

b) when a sample of mortar is compacted on the base, no film of water shall form on the surface.

7.3.7.3 Application of semi-dry mix

Before the bedding is laid, the base shall be brushed clean and, if there is likely to be excessive suction, the base shall be slightly dampened. The finished floor level shall be established by means of datum points. For bonded beddings only, a slurry, as described below, shall be spread over the base.

The mix shall then be spread to a thickness of roughly 10 % to 15 % greater than required for the actual bedding, and thoroughly tamped and drawn off to the required level. No greater area of mix shall be spread than can be tamped and topped with slurry and tiles in one continuous operation.

A slurry that consists of 1 part of cement to 1 part of fine aggregate or of neat cement, after being mixed with water, shall immediately be spread and trowelled over the bed in an even layer of thickness approximately 2 mm.

Alternatively, the backs of tiles may be totally coated with slurry, to combine with the slurry on the semidry mix bed.

When tiles are laid on slurries that contain proprietary additives recommended for this purpose, the manufacturer's instructions shall be followed.

7.3.7.4 Application of tiles

To prevent porous tiles from absorbing excessive moisture from the bedding, it will be necessary first to immerse them in clean water, and to drain off surface water before placing them into position (see 7.3.6.2).

Tiles that have uneven or deep back patterns, such as some extruded tiles, shall have the depressions filled with a suitably stiffened mortar of 1 part of cement to 2 parts of fine aggregate before the tiles are laid. Tiles shall be fixed with joints of width at least 3 mm and in accordance with the tile manufacturer's instructions.

Extruded tiles shall be fixed with joints of nominal width 6 mm to 10 mm. The tiles shall be placed on the slurried bedding, care being taken to avoid depressing one of the corners; the tiles shall be tapped firmly into position, a useful tool for this purpose being a rubber mallet. Special care shall be taken to ensure that when tiles of thickness less than 10 mm are being tapped into the semi-dry bed, excessive material is not forced up into the tile joint, since this will restrict the thickness of grout which can be applied later, resulting in a significant reduction in the capacity of the joint to withstand point loading. The joints to receive grout shall be of depth at least 6 mm unless tiles thinner than 6 mm are used (see 7.3.5).

The traditional "beating-in" of tiles involves thoroughly tapping the tiles with a flat faced wooden block which, dimensionally, is usually of size approximately 300 mm × 100 mm × 50 mm. Alternatively, some floor tiling contractors use vibrating machines for "beating-in". During this operation, the tile joints shall be regulated and an occasional check made to establish that full contact is being achieved between tiles and the slurried bedding, by lifting a tile out at random; any slurry or mortar disturbed shall be made good before the tile is replaced.

It is important that there be no delay between spreading the slurry on the semidry mix bedding, placing the tiles, and tapping them in. Where tiles have been bedded using a vibrating machine, placement shall be completed within 4 h.

7.3.7.5 Movement joints

Siting of movement joints shall be as given in 7.3.5.

7.3.8 Bedding in adhesives

7.3.8.1 General

Only adhesives manufactured specifically for floor tile laying shall be used. Cement-based adhesives are usually proprietary compositions in dry powder form that contain cement as the basic ingredient and generally require mixing on site with water only. Organic-based adhesives are usually proprietary products of diverse composition and are manufactured either as a ready-for-use mixture or have several components that have to be mixed on site shortly before use.

7.3.8.2 Bedding in cement-based adhesives

The recommendations of the adhesive manufacturer shall be followed concerning the mixing procedure, the method of use, the maximum thickness of the bedding, the working time before and after spreading, and the suitability of the base.

The base shall be clean, dry and prepared to suit the adhesive being used. The surface being adhered to shall not be dampened before the adhesive is applied.

Proprietary cement-based adhesives shall be applied with a minimum bedding thickness of 5 mm and a maximum bedding thickness in accordance with the manufacturer's instructions.

Dry powder adhesives shall be mixed with clean water, or with an approved admixture (or with both), any specific instructions being carefully followed to obtain the required consistency, usually a fairly thick creamy mix. Other types of adhesives shall be used strictly in accordance with the manufacturer's instructions. Notched trowels that provide a grooved surface to achieve a solid adhesive bedding in accordance with the manufacturer's recommendations, shall be used. Deep keys or frogs in the backs of the tiles shall be filled with adhesive immediately before the tiles are laid. Tiles shall be dry (not soaked). It is essential that the bedding be compacted and the tiles thoroughly tapped down into it, so that, as far as possible, voids beneath the tiles are eliminated. Any voids will be potential points of weakness under load and, in exterior situations, water might accumulate in voids and give rise to frost damage.

Random tiles shall be removed temporarily to establish that a solid bedding has been achieved. Joints between tiles shall be at least 3 mm wide and in accordance with the tile manufacturer's instructions. (See also 7.3.4.)

7.3.8.3 Bedding in organic-based adhesives

Because of the diverse nature of organic-based adhesives, it is important that the manufacturer's instructions be closely followed when these materials are being used. Organic-based adhesives shall only be used in adequately ventilated areas since some are highly flammable or poisonous. Flammable adhesives shall not be used near naked flames, cigarettes, electrical switch-gear and other possible sources of ignition, and the lid shall always be replaced on containers immediately after use.

NOTE It is dangerous to smoke during the application of solvent-based adhesives

The base shall be dry. Manufacturers of some adhesives might recommend that particular types of base be primed.

These adhesives and the tiles are applied by methods similar to those described for cement-based adhesive installation in 7.3.8.2. Flexible adhesives shall be spread as thinly as is practicable because of their low impact resistance.

7.3.8.4 Movement joints

Siting of movement joints shall be as given in 7.3.5.

7.3.9 Grouting

7.3.9.1 General

Some bedding methods require that grout be applied within a prescribed interval after the tile-laying operation. With these exceptions, grouting shall be carried out not sooner than 12 h and not later than 48 h after the completion of the laying of the tiles; sufficient time shall be allowed to elapse to ensure adequate setting of the bedding in order to limit disturbance of the tiles during the grouting operation. On non-absorbent backgrounds, it might be necessary to wait up to 3 d before the tile adhesive is firm enough to permit grouting. When tiles are being fixed in adhesive (for example, rapid setting products), these periods might not be applicable and the adhesive manufacturer's site work instructions shall be followed. It is advisable not to delay the grouting unduly, since open joints could collect dirt and debris.

In most normal tiling situations, a proprietary cement-based grout shall be used. These grouts combine the properties of low shrinkage and good adhesion with high compressive strength and ease of application.

Special service requirements might call for additional properties, such as impermeability; resistance to water, heat, cleansing agents and chemical attack; resistance to mould growth and bacteria; and resilience and compressibility. When one or more of these properties are required, a suitable proprietary material shall be selected (see 5.14.2).

7.3.9.2 Grouting materials

7.3.9.2.1 General

Grouts shall have good working characteristics, low shrinkage and good adhesion to the edges of the tiles.

7.3.9.2.2 Cement: sand grout

Cement: sand grout shall consist of portland cement and sand mixed with the minimum of water necessary to achieve a paste consistency; too wet a mix might result in cracking in the joints as the grout dries out.

The proportions of cement and fine sand shall be 1:3 by mass for joints wider than 3 mm. This grout requires dampness in the joint cavities to promote good adhesion, and is best suited to the mortar bedding methods given in 7.3.6.1 to 7.3.6.3, in which the tiles will have been dampened or soaked prior to being laid and where joints can be re-wetted, if necessary.

NOTE When tiles are bedded in adhesive, wetting of the joints prior to grouting is not necessary

7.3.9.2.3 Proprietary grouts

See 5.14.2.

7.3.9.2.4 Admixtures

See 5.14.3.

7.3.9.2.5 Pigments

See 5.14.2.3.

7.3.9.3 Grouting procedure

7.3.9.3.1 Grouting with mortar

There shall be dampness in the joint cavities and, if, in the interval between the completion of tile-laying and the start of grouting, the cavities have dried out, they shall be re-wetted. The mortar, mixed as described in 7.3.6.1, shall be spread over the surface and worked into the joint cavities until they are filled solidly, using a rubber squeegee or a similar tool; grouting machines are available for this purpose that can be used to advantage on large floors. For the filling of joints wider than 6 mm, the mortar mix shall be stiffer than that for narrower joints and shall not be spread but shall be trowelled into the joint cavities.

The grout shall be brought flush with the tile surface, as nearly as is practicable. Surplus grout shall be removed from the floor surface before the grout sets too firmly; on no account shall sawdust be used for this purpose, since there is a danger that if sawdust enters moist grout, it could break down

the strength of the grout. After the removal of surplus grout and when the grout in the joints has hardened sufficiently, the surface of the work shall be washed down with water and left clean. If any grout residue resists removal by water, it shall be cleaned off as recommended in 9.2.

7.3.9.3.2 Grouting with proprietary grouts

The recommendations of the manufacturer of these materials shall be followed regarding their mixing and application, removal of surplus grout and cleaning off the floor surface. The procedure when cement-based material (see 5.14.2.1 (a)) is being used is as described in 7.3.9.3.1, except that the joints are not wetted.

As a rule, it is not necessary to wet the joints, but this point shall be checked by reference to the manufacturer's instructions.

The application of chemically resistant grouts in situations where the floor will be subject to attack from aggressive substances shall be as described in BS 5385-4.

8 Installation of mosaics: methods and materials

8.1 General

Mosaics are described in 5.4. The recommendations for the application of tiles, including suitable backgrounds and movement joints, given in clause 6 are of equal validity in mosaic installations but some modifications are necessary concerning the preparation of mosaics, the setting out, placing in position and grouting.

8.2 Workmanship

The application of mosaics requires effective supervision and the employment of skilled operatives, working safely and using protective clothing and equipment, where appropriate. In the finished work, the outline of the individual sheets of mosaic shall not be apparent; the joints between them shall be the same as those between the tesserae. Joints within the mosaic sheets are defined in manufacture and are usually less than 3 mm wide.

8.3 Tolerance for finished mosaic surfaces

Unless an uneven surface is specified or the tesserae are made with irregular or distorted faces, there shall be no significant visible change of plane between adjacent tesserae. Surface tolerances shall comply with 7.2.6.

8.4 Mosaic beds

Suitable beds for mosaics are:

a) cement-based adhesives;

b) organic-based adhesives; and

c) mortar (see 7.2.9.3).

8.5 Setting out

8.5.1 General

Drawings provided for designs and for murals shall be checked before any fixing commences. A gauge rod shall be made that indicates the overall measurement of a given number of sheets of mosaic and the specified joint widths. With the use of this rod, the best arrangement of sheets can be so determined that, as far as possible, uncut tesserae occur at external corners and prominent features, and cut tesserae are located at internal corners where they will be less noticeable.

8.5.2 Walls

The setting out of the finished work shall be controlled from a given datum. To ensure that the rows of tesserae are truly horizontal, a level line shall be established to position the starting row of sheets. The work shall be planned to start fixing at the top of the area to be covered. Any attempt to minimize cutting of the tesserae by adjusting joint widths where the bedding has partly set could break the bond between the tesserae and the bedding. This condition could arise if a long interval has elapsed between the fixing and the removal of any paper facing.

8.5.3 Floors

When setting out, it is essential to establish the correct datum level for the floor. The level of the finished work shall be controlled by a series of spot levels.

8.6 Movement joints

The principles to be observed for sitting movement joints shall follow those given in 6.2.8 and 7.3.5. Setting out shall be related to the sitting of movement joints.

8.7 Preparation of mosaics

All mosaics shall be inspected, and damaged tesserae removed and replaced. Designs and murals shall be laid out prior to fixing. The paper of pre-faced mosaics shall be clear of the edges, to assist with joint alignment whilst the sheets are being fixed.

8.8 Bedding methods for mosaics (other than glass mosaics)

8.8.1 Bedding in adhesives

Both cement-based and organic-based adhesives are suitable and the information given in 7.2.9.1, 7.2.9.2, 7.3.9.2 and 7.3.9.3 is relevant. The precise recommendations of the adhesive manufacturer shall be followed concerning the suitability of the background, the mixing procedure, the method of use, the thickness of adhesive, and the open time after spreading.

8.8.2 Bedding in mortar

The mortar mix shall be as given in 7.2.9.3.4 and shall be applied onto the prepared background, using the technique described in 7.2.9.3.4, and finished with a wood float. The bedding shall be allowed to stiffen slightly before any mosaic is applied but shall not be left more than 2 h before fixing commences.

8.9 Application of mosaics

8.9.1 Pre-grouting

Ideally, paper-faced mosaics shall be pre-grouted. It is not always practical to pre-grout mosaics bedded in adhesives but paper-faced mosaics bedded in mortar shall always be pre-grouted with a cement-based grout. Where the joints are wider than 2 mm, or the mosaic thickness exceeds 4 mm, it is advisable to mix fine aggregate (see table 1 for joints <6 mm) with the cement, to avoid cracking as the grout dries out. A suitable mix is 1:1 cement: fine aggregate by volume.

8.9.2 Sequence and method of fixing

Sheets of mosaics shall be fixed in position as accurately as possible and so tapped with a laying-on trowel, or a wooden beater, that full contact with the bedding is achieved. In the case of walls, sheets shall be fixed in horizontal lines, starting at a suitable position.

Joint alignment shall be checked as the work proceeds. The joint width between the tesserae established when the mosaics were assembled shall be maintained between the sheets, otherwise the overall appearance of the mosaic will be marred by the outline of the sheets (see 8.2).

Sheets of mosaic that have been pre-grouted shall have the joints between them filled with grout as the work proceeds. A straightedge shall be used to ensure that the surface of the mosaic is true as defined in 7.2.6.1.

After the sheets have been firmly tapped into place, any facing paper shall be removed by soaking and sponging and, before the bedding sets, tesserae or joints shall be adjusted if necessary. Any surplus grout or adhesive that remains on the face of the mosaic shall be removed before it sets.

8.9.3 Grouting of mosaics

The general information given in 7.2.10.1 for the treatment of tile joints is relevant. In the case of fixing mesh-backed mosaics to proprietary cement-based adhesive, the manufacturer's recommendations shall be followed with regard to bedding-in the sheets, so that the grouting is carried out in a single operation with bedding material.

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

After the grout has hardened sufficiently, the surface of the tiling shall be washed down with water and left clean. When a proprietary grouting material is used, the manufacturer's instructions for cleaning shall be followed.

8.10 Glass mosaics

The preferred method of fixing glass mosaics is with a proprietary adhesive, and the recommendation of the adhesive manufacturer shall be obtained before fixing commences.

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

9 Protection, cleaning and maintenance

9.1 General

Tiling work shall be scheduled as late as is practical in the building programme, in order to reduce the danger of damage and soiling by following trades. Whilst tiles are being fixed and grouted, consideration shall be given to the protection of work already completed by others.

During the laying operation, the areas shall be accessible to no-one but the tiling operative. Completed floor tiling shall not be subjected to traffic until the bedding has stiffened and sufficient bond has developed between the bedding and the tiles. Light pedestrian traffic can be allowed on floors bedded in non-rapid-setting adhesive and in mortars 4 d after completion of laying and grouting, but heavier traffic shall not be permitted to use the floor for 14 d after completion. Where tiles are laid in a rapid-setting adhesive, the floor might be able to take traffic earlier than 4 d after completion.

Unless a rapid-hardening grout is used, it would be inadvisable to reduce the 4 d period. The precise times at which a floor can be safely put to service vary for different rapid-hardening products, and the manufacturer's recommendations shall be followed.

9.2 Cleaning of tilework

9.2.1 General

Adequate instructions from the specifier shall be provided to ensure that the use of incorrect cleaning materials is avoided. Advice about cleaning tiles and about suitable cleaning materials shall be available from the appropriate manufacturers. Staff responsible for maintenance and cleaning shall be given full information concerning any particular risks of misuse likely to occur, and also recommendations for cleaning.

At all times, floor tiling shall be kept clean and free from cement and plaster droppings, and all material likely to cause stains. The flooring shall be covered when work carried out on or over the floor that involves substances (for example oils, grease or paint) that could cause permanent staining is being carried out. Sheets or boards of an appropriate type shall be laid loosely over the finished floor to protect the tiling.

If plant likely to cause damage has to be used, any parts in contact with the floor surface shall be padded, and the sliding of plant over the surface shall not be allowed. When heavy equipment has to be moved over the floor surface, special precautions shall be taken, if necessary involving the use of timber planking, to ensure that the equipment, the moving tackle and the protection itself do not damage the tiled surface by abrasion or point loads.

Stair finishing, especially nosings are vulnerable to damage from following trades and shall be protected by temporary casing. A floor finish could be damaged by misuse or incorrect maintenance because of inadequate instructions initially.

Ceramic floor finishes require little maintenance and are easily kept clean by regular sweeping, then washing with warm water to which a proprietary detergent has been added, and finally rinsing with clean water. Unglazed finishes will not be damaged by the occasional use of scouring powder or pumice blocks to remove particularly stubborn blemishes. However, it shall be noted that regular use of scrub and rinse cleaning machines fitted with abrasive pads other than the finest grades, is likely to damage the surface and could result in a gradual loss of thickness in the wear layer.

Care is necessary to ensure that cleaning agents are not allowed to come into contact with adjacent fixtures and wall surfaces. Apart from normal usage or obvious misuse, surface contamination can arise from:

a) efflorescence;

b) residual cement layers;

c) surface sealing materials;

d) the reaction of cleaning agents with hard water; and

e) unsuitable cleaning agents, including highly alkaline or highly acidic detergents and chemicals.

9.2.2 Glazed tiles

The routine cleaning of ceramic glazed wall tiles and mosaics shall be carried out with warm water or a weak solution of a detergent or proprietary cleaner. Clean water and clean utensils are essential to prevent dust and dirt on the face of the tiles from being deposited in the joints, with resulting discoloration of the grouting.

9.2.3 Unglazed tiles

Unglazed tiles could retain a cement film, which is insoluble in water (see 9.4). Routine cleaning is as for glazed tiles (see 9.2.2). As a new installation dries out, unglazed tiles could also develop efflorescence (see 9.3).

9.3 Efflorescence

Efflorescence is aggravated by damp conditions after installation, or by prolonged delay in drying out and can be persistent if it is caused by rising moisture where the construction is not sufficiently damp-resistant. The deposits shall disappear with washing but can reappear after drying; they should diminish with progressive washing. The most effective treatment is to increase the frequency of washing until the deposit ceases. Persistent deposits can be treated with appropriate proprietary cleaners, but in such cases, the floor shall be wetted and the free water removed before the application of the cleaning agent. It is important that such treatment be followed immediately by thorough rinsing with clean water.

9.4 Residual cement film

Some floor surfaces might retain a cement film which is insoluble in water. This can be removed only by treatment with appropriate proprietary acid cleaners. The floor shall be wetted and free water removed before the application of the cleaning agent. It is important that such treatment be followed immediately by a thorough rinsing with clean water.

9.5 Surface sealing materials

The application of a surface sealing composition or of a polish is not recommended, since these materials are not absorbed into the surface and tend to make the surface slippery and difficult to clean.

Temporary tile sealers can be used to facilitate cleaning-off after laying and grouting; these proprietary compositions can be readily removed after completion of the grouting operation, by the use of proprietary detergents and rinsing with clean water. Where temporary sealers are employed they shall be used in accordance with the manufacturer's instructions.

For the sealing of unglazed tiles, only proprietary penetrating sealants shall be used in accordance with the tile manufacturer's instructions.

9.6 Cleaning agents

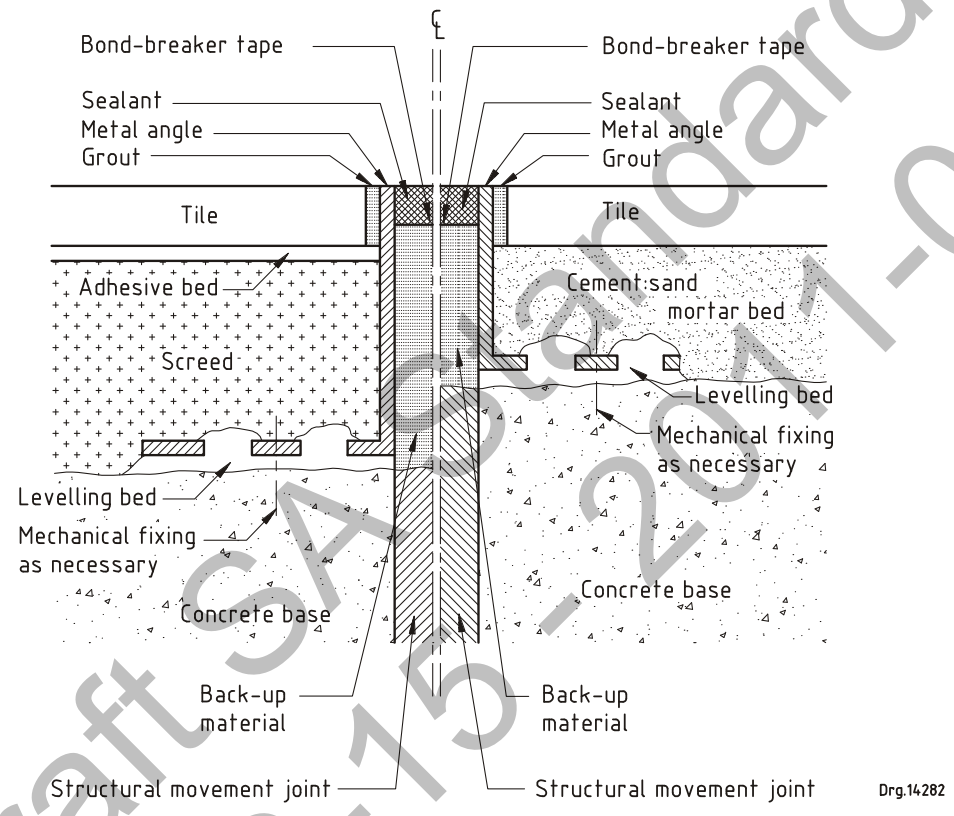
Effective cleaning can usually be achieved by normal washing or scrubbing with warm water and a neutral sulfate-free detergent. Greasy deposits can be removed by a detergent that incorporates an organic solvent or a highly alkaline detergent (pH value > 9), but these detergents shall only be used for occasional cleaning. It is essential that a detergent that is used regularly be of a type recommended for cleaning ceramic floors. The occasional use of abrasive cleaners can be beneficial but shall be restricted to unglazed floor finishes.

It is important to ensure that the cleaning agent is completely removed by a final rinsing with clean water. Household soaps are not recommended, since they tend to leave a slippery scum, particularly in hard water areas.

Annex A
(informative)

Examples of movement joint designs

Examples of movement joints are shown in figures A.1 to A.8.



NOTE The drawing illustrates principles only.

Figure A.1 — Type A: Joint aligned to structural movement joint

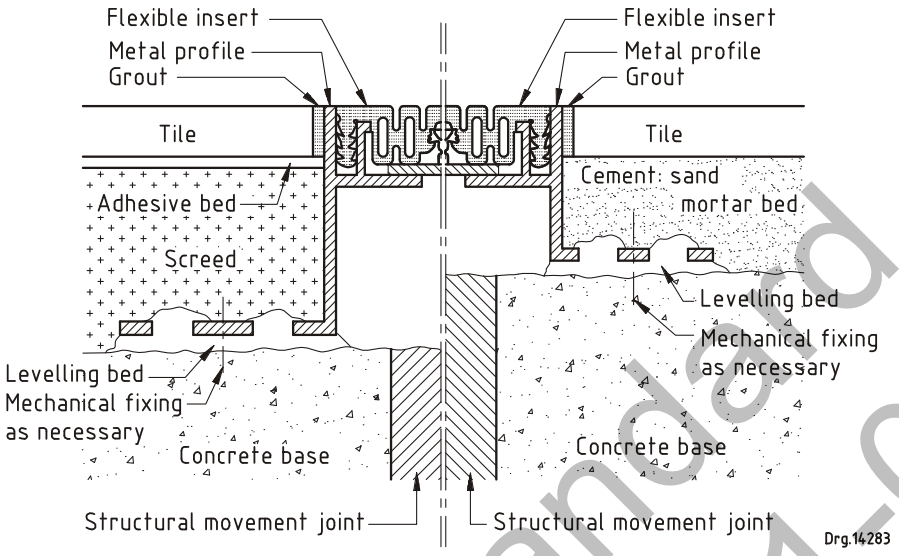
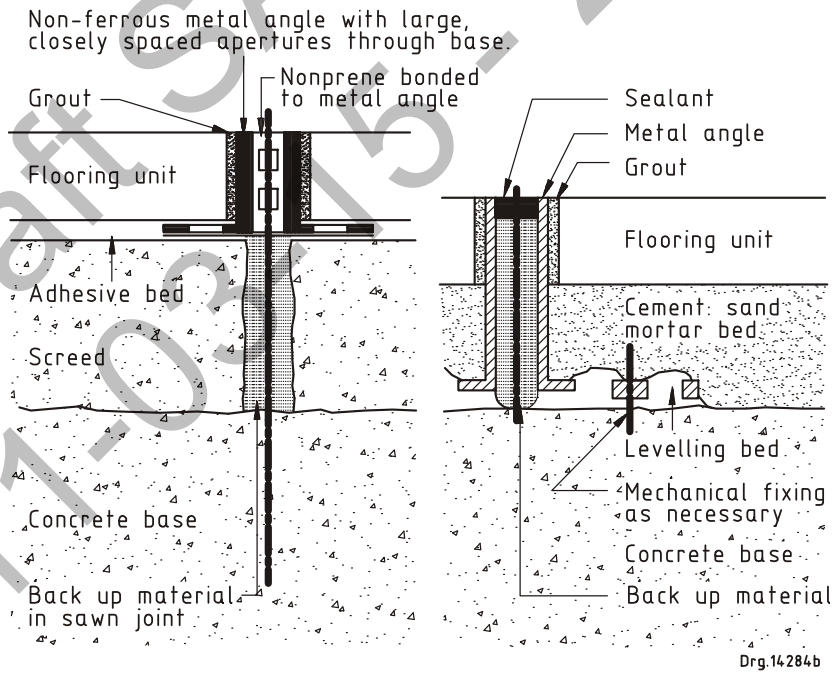


Figure A.2 — Type B: Prefabricated joint with reinforced edges and lapping over structural movement joint

NOTE 1 Semi-dry mix beds have movement joints similar to those shown for screeds.

NOTE 2 The drawing illustrates principles only.



NOTE The drawing illustrates principles only.

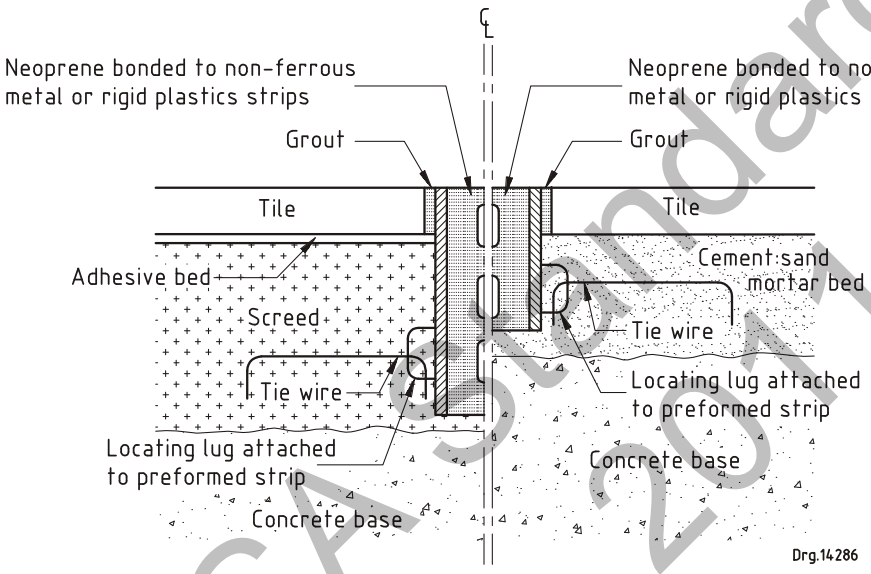
Figure A.3 — Type C — Flexible joint in bed, with or without separating layer

NOTE 1 Large apertures in metal angle allow adhesive through to bond edge of flooring unit to screed.

NOTE 2 Semi-dry mix beds have movement joints similar to those shown for cement: sand mortar beds.

NOTE 3 The drawing illustrates principles only.

Figure A.4 — Type D: Flexible joint with reinforced edges



NOTE The drawing illustrates principles only.

Figure A.5— Type E: Slightly flexible joint: preformed strip with reinforced edges

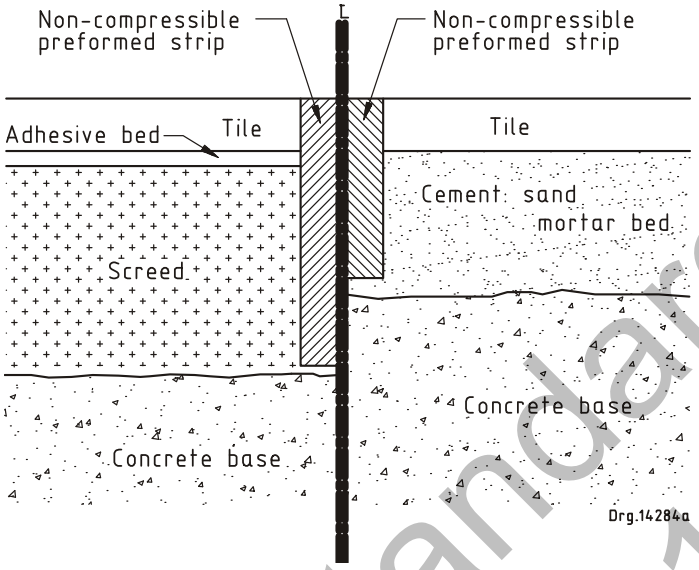
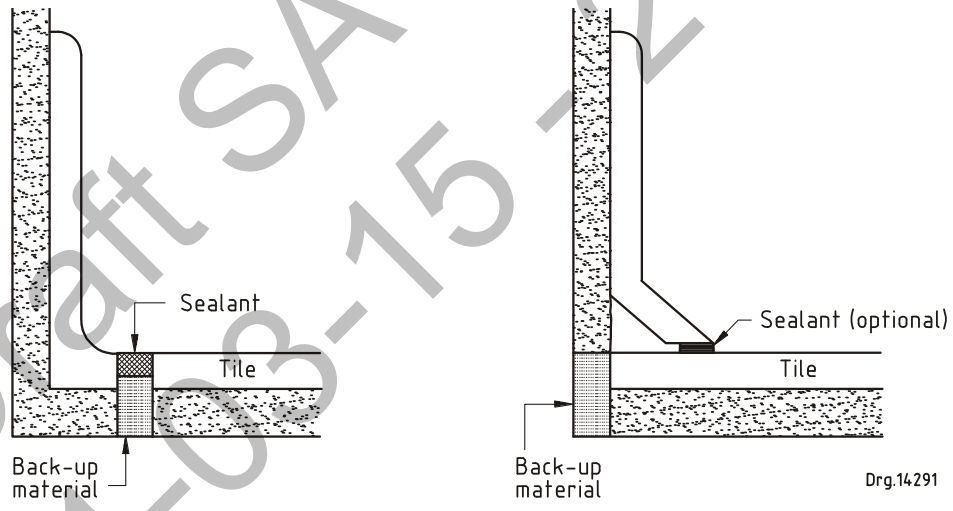


Figure A.6 — Type F: Contraction joint: preformed strip



NOTE The drawing illustrates principles only.

Figure A.7 — Type G: Alternative perimeter joints

Annex B
(informative)

Recommended tiling procedures

B.1 General

The complete batch of tiles should be checked before installation (defects, patent, tonality and colour). Once tiles have been installed, they are deemed to comply with the requirements of the purchase contract and the instructions on the containers.

Recommended tiling procedures are given in B.2 to B.5.

B.2 Checking the batch

Batches of tiles should be inspected as follows:

a) check that the containers are delivered as ordered and that they are correctly invoiced;

b) check that all references on the containers are the same (dates, calibre, shading, tonality);

c) check that sufficient product has been purchased to complete the project and that provision is made for cuttings, breakages and wastage;

d) check that the type of product is fit for purpose (PEI ratings, wall or floor tiles). Porous products are not suitable in freezing conditions.

e) allow for a sufficient curing time.

B.3 Physical inspection

a) Randomly inspect at least seven boxes from a number of pallets for defects;

b) See that all tiles conform to norms, standards and specifications (.cover aspects such as grade, skewness, warping, size variation and bowing);

c) See that the colour and tonality of tiles are acceptable;

d) See that 95% of 1 m^2 of tiles has no visible defects.

B.4 Preparation

a) Plan layout and tiling carefully. Locate the positions of movement or expansion joints. Check where cuttings should be made. Check the straightness of the wall or floor.

b) Prepare the floor properly for mortar or adhesive fixing methods (see the manufacturer's instructions). Ensure that no contaminants (old paint, bitumen, etc.) are found on the surfaces to be tiled.

c) See that the correct adhesive is used;

d) Competent tillers should do the tiling using proper cutting and laying tools.

e) The “spot method” of laying tiles should not be used while using adhesive or mortar.

f) Tiles with defects should not be laid.

B.5 Tiling

a) Completed floor tiling should not be subjected to traffic (see 9.1).

b) Allow sufficient time to lapse after fixing the tiles in order to ensure adequate drying before grouting commences.

c) Clean the floors or walls continuously during tiling and immediately after grouting.

d) Ensure that the correct cleaning materials are used. Some acids can cause damage.

e) Ensure that the tiles are protected from sand, abrasive materials, heavy machinery and damage during construction.

e) Ensure that floors are correctly maintained.

Bibliography

BS 5385-1, *Wall and floor tiling. Design and installation of ceramic, natural stone and mosaics wall tiling in normal internal conditions. Code of practice*