AS 3958.1—2007

Australian Standard®

Ceramic tiles

Part 1: Guide to the installation of ceramic tiles

This Australian Standard® was prepared by Committee BD-044, Fixing of Ceramic, Natural and Reconstituted Stone Tiles. It was approved on behalf of the Council of Standards Australia on 20 October 2006.
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- Association of Consulting Engineers Australia
- Australian Chamber of Commerce and Industry
- Australian Industry Group
- Australian Stone Advisory Association
- Australian Tile Council
- Building Diagnostics
- CSIRO, Manufacturing & Infrastructure Technology
- Ceramic Tile Manufacturers Association
- Master Builders Australia
- Master Tile Layers Association of SA
- Opus International Consultants Limited New Zealand
- Plastics and Chemicals Industries Association
- TAFE N.S.W.

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AS 3958.1—2007
(Incorporating Amendment No. 1)

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Ceramic tiles

Part 1: Guide to the installation of ceramic tiles

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PREFACE

This Standard was prepared by the Standards Australia Committee BD-044, Fixing of Ceramic Tiles, to supersede AS 3958.1—1991.

This Standard incorporates Amendment No. 1 (March 2010). The changes required by the Amendment are indicated in the text by a marginal bar and amendment number against the clause, note, table, figure or part thereof affected.

This Standard is part of a series that covers ceramic tiles, as follows:

AS 3958	Ceramic tiles
AS 3958.1	Guide to the installation of ceramic tiles (this Standard)
AS 3958.2	Guide to the selection of a ceramic tilting system
AS 3958.3	Guide to the selection of a stone tiling system

Figure 5.1 has been reproduced, with permission, from BS 5385.4, *Wall and floor tiling*, Part 3: *Code of practice for tiling and mosaics in specific conditions*.

This Standard has been reviewed concurrently with the significant changes to AS 4992.1 and AS 4992.2 and with the current AS 2358 in mind. These significant changes are mainly due to the fact that some products that were classified as organic-based adhesives are now classified as cementitious adhesives. The new adhesive Standards are far more demanding in terms of performance. The concept of thin-bed and thick-bed adhesives will be subject to change.

Where the term ‘screed’ is used in this document, it primarily refers to non-proprietary screeds. A wide range of proprietary screeds have been developed since this Standard was first published. When using proprietary materials, it is quite probable that the next tiling phase can be undertaken within a shorter timeframe than is recommended in this Standard. Advice should be sought from the manufacturers of the products involved.

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APPENDICES

STANDARDS AUSTRALIA

Australian Standard
Ceramic tiles

Part 1: Guide to the installation of ceramic tiles

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

This Standard provides guidance on the preparation of the background and the fixing and grouting of floor and wall tiles and mosaic tiles. It also provides information on the application of tile in swimming pools, gradients on floors, screeds and rendering, and cleaning and maintenance.

Specialized applications such as the need for chemical resistance and the use of epoxies are not considered in detail.

This Standard applies to all work involved in the internal and external laying of ceramic wall and floor tiles. It deals with the types and classes of backgrounds and substrates and their suitability to receive a bedded finish using the following fixing methods, which are also described in the relevant sections:

(a) Bedding in sand/cement mortar on rendering or as a direct bedding method.

(b) Bedding in cement-based adhesives on an intermediate substrate or as a direct bedding method.

(c) Bedding in organic-based adhesives on an intermediate substrate or as a direct bedding method.

(d) Bedding in other adhesives on an intermediate substrate or as a direct bedding method.

Mosaic tiles constitute a specialized form of tiling and those aspects of fixing that require particular treatment are dealt with in this Standard.

The recommendations relate to mosaics assembled in the form of sheets, the separate pieces being glued either face down to paper or bedding, side down to nylon adhesive strips, fabric net or other material.

Where tiling is to be carried out in wet areas, the recommendations in AS 3740 should be considered, particularly with regard to the preparation of the background.

The designer should make know to the tiling contractor any structural or environmental conditions such as excessive deflection or the likelihood of excessive or delayed shrinkage onset of the substrate.

Recommendations for tiling in situations where with specific functional or environmental requirements are provided in BS 5385.4.

1.2 REFERENCED DOCUMENTS

The following documents are referred to in this Standard:

AS

1303 Steel reinforcing wire for concrete

1304 Welded wire reinforcing fabric for concrete

1379 Specification and supply of concrete

1478 Chemical admixtures for concrete (all parts)

1672 Limes and limestones
1672.1 Part 1: Limes for buildings

1684 Residential timber-framed construction
1684.2 Part 2: Non-cyclonic areas
1684.3 Part 3: Cyclonic areas
1684.4 Part 4: Simplified—Non-cyclonic areas

1884 Floor coverings—Resilient sheet and tiles—Laying and maintenance practices

2358 Adhesives—For fixing ceramic tiles

2701 Methods of sampling and testing mortar for masonry constructions

2758 Aggregates and rock for engineering purposes
2758.1 Part 1: Concrete aggregates

2870 Residential slabs and footings—Construction

3600 Concrete structures

3610 Formwork for concrete

3700 Masonry structures

3735 Concrete structures retaining liquids

3740 Waterproofing of wet areas within residential buildings

3958 Ceramic tiles
3958.2 Part 2: Guide to the selection of a ceramic tiling system

3972 Portland and blended cements

4662 Ceramic tiles—Definitions, classification, characteristics and marking

4992 Ceramic tiles products for installation
4992.1 Part 1: Adhesives: Definitions and specifications
4992.2 Part 2: Adhesives: Test methods
4992.3 Part 3: Grouts: Definitions and specifications

AS/NZS

1859 Reconstituted wood-based panels (all parts)

1860 Particleboard flooring (all parts)

2270 Plywood and blockboard for interior use

2271 Plywood and blockboard for exterior use

2588 Gypsum plasterboard

2589 Gypsum linings in residential and light commercial construction—Application and finishing
2589.1 Part 1: Gypsum plasterboard

AS/NZS
2589.2 Part 2: Fibre reinforced gypsum plaster

4534 Zinc and zinc/aluminium-alloy coatings on steel wire

4671 Steel reinforcing materials

ISO
13006 Ceramic tiles—Definitions, classification, characteristics and markings
13007-1 Part 1: Ceramic tiles—Grouts and adhesives. Part 1: Terms, definition and specifications for adhesives
13007-2 Part 2: Ceramic tiles—Grouts and adhesives. Part 2: Test methods for adhesives

BS
747 Reinforced bitumen sheets for roofing. Specification

915 Specification for high alumina cement. Metric units

1521 Specification for waterproof building papers

3148 Methods of test for water for making concrete (including notes on the suitability of the water)

5385 Wall and floor tiling
5385.4 Part 4: Code of practice for tiling and mosaics in specific conditions

5980 Specification for adhesives for use with ceramic tiles and mosaics

6213 Selection of constructional sealants. Guide

ASTM
C630 Standard specification for Water-Resistant Gypsum Backing Board

HB
50 Glossary of building terms

197 An introductory guide to the slip resistance of pedestrian surface materials

Engineered wood products Association of Australia

Technical Manual Tongued and grooved structural plywood—Design manual—1985

1.3 DEFINITIONS

For the purpose of this Standard the definitions below apply.

1.3.1 Adhesive

Proprietary bedding material other than sand/cement bedding mortar.

1.3.2 Adhesive, cement-based

An adhesive in which the principal bonding component is a hydraulic cement, e.g., Portland cement, modified by the inclusion of such other admixtures as may be necessary in order to achieve satisfactory bonding of ceramic tiles and mosaics.

1.3.3 Adhesive, organic-based

An adhesive, which may be supplied as either a one-part or a two-part mix, in which the principal bonding component is an organic material. The term includes only those organic adhesives capable of application by either the thin-bed or the thick-bed fixing technique.

1.3.4 Adhesive, thick-bed

Adhesive bedding exceeding 3 mm in thickness.

1.3.5 Adhesive, thin-bed

Adhesive bedding not exceeding 3 mm in thickness.

1.3.6 Background

A substrate requiring some form of surface treatment in readiness for the bedded finish.

1.3.7 Base

The material on which bedding or the separating layer is laid (see Figure 1.1).

1.3.8 Bedded finish

The tile finish including its bedding (see Figure 1.1).

1.3.9 Bedding

A layer of specified materials in which the tile is set and which bonds the tiles to a substrate (see Figure 1.1).

1.3.10 Bond breaker

A system that prevents the membrane bonding to the substrate, bedding or lining.

1.3.11 Bonding agent (bond coat)

A material used to improve the adhesion of the bedding material, background or tile to its respective substrate (see also Clause 1.3.35).

1.3.12 Butter

To spread an adhesive or bedding material on the back of a ceramic tile just before the tile is placed.

1.3.13 Creep

A slow inelastic deformation or movement of material under stress.

1.3.14 Concrete

A mixture of cement, aggregates, and water with or without the addition of chemical admixtures.

1.3.15 Contact coverage

The proportion of the tile back or background that is in contact with the adhesive after the tile has been set into position.

1.3.16 Dip fixing

The fixing of a tile by dipping it in water and buttering it with mortar.

1.3.17 Direct bedding

The application of a bedded finish to a substrate.

1.3.18 Dry fixing

The fixing of a dry tile by buttering with a ‘wet’ mortar mix.

1.3.19 Drying time

The period of continuous air-drying at the end of concrete curing before tiling can commence.

1.3.20 Expanded metal

Mesh that acts as a key and reinforcing agent for the scratch or mortar coat.

1.3.21 Fixative

Bedding material other than sand/cement bedding mortar.

1.3.22 Float coat

A layer of mortar applied to walls or floors to bring a background to a true and even surface.

1.3.23 Frost-free area

A storage area isolated from ambient weather conditions such that the temperature is prevented from falling below freezing.

1.3.24 Grouting/grout

The operation of, or the material used in, filling the joint cavities between tiles other than at movement joints (see Figure 1.1).

1.3.25 Joint

A space between the edges of adjacent tiles (see Figure 1.1).

1.3.26 Lippage (lipping)

A condition where one edge of a tile is higher than an adjacent tile, giving the finished surface an uneven appearance.

1.3.27 Modified mortar

A mortar containing a specified organic additive in a specified quantity in accordance with the additive manufacturer's instructions.

1.3.28 Moisture membrane

A continuous layer of impervious material placed beneath either a concrete slab or a screed to resist the passage of moisture from the subgrade (see Figure 1.1).

1.3.29 Movement accommodation factor (MAF)

The maximum movement that a sealant is capable of tolerating throughout its working life, expressed as a percentage of the joint width.

1.3.30 Movement joint

A joint, usually wider than the normal joint between tiles or slabs, designed to accommodate lateral movement in the base or bedded finish and which is filled with materials having special properties (see Figure 1.1).

1.3.31 Performance levels

Anticipated loading and wear parameters. Three performance levels are considered, as follows:

(a) Industrial—heavy-duty applications subject to heavy loads such as fork trucks, requiring high strength and abrasion resistance, typical of factories.

(b) Commercial—subject to continuous foot traffic and occasional heavy loads such as small fork trucks or light vehicles, typically in shopping centres, hospitals and commercial kitchens.

(c) Residential—subject to irregular foot traffic and occasional moderate loads, typical of domestic and light applications.

1.3.32 Primer

Substance used to coat substrate to seal its surface and reduce its water vapour permeability, or improve its adhesive bonding characteristics.

1.3.33 Scratch coat

A preparatory layer of mortar applied to walls or floors to improve the bonding of a subsequent layer. Generally used where excessive thickness of one layer will provide insufficient bond. The surface is left 'scratched' to allow a mechanical key for the next coat.

1.3.34 Screed

A layer of material, usually cement based, of defined minimum thickness which sets in situ and which may be interposed between the structural base and the bedded finish (see Figure 1.1).

1.3.35 Screeding

The act of spreading and levelling off a layer of mortar to provide a true surface.

1.3.36 Sealant

Elastomeric material used to fill and seal joints, preventing the passage of moisture and allowing horizontal and lateral movement at the joint.

1.3.37 Separating layer

A layer of material that isolates the base from the bedded finish (see Figure 1.1).

1.3.38 Slurry coat

A strong wash of neat cement mixed with water or a bonding agent or both, used to improve adhesion between surfaces.

1.3.39 Spacer lugs

Small crushable projections on the edges of tiles, which, when in contact with each other on adjacent tiles, regulate the joint width.

NOTE: Spacer lugs should not be confused with other non-crushable projections.

1.3.40 Substrate (or previously referred to as subfloor)

Any material used as a base over which a ceramic tile is to be fixed. May be—

(a) without treatment—suitable to receive the bedded finish by a direct bedding method; or

(b) already treated—to receive the bedded finish.

1.3.41 Underlays

A layer of material, which may be permeable or impermeable, located beneath the tiling system to which the tiles are fixed. Various underlay systems are as follows:

(a) Rigid—a stiff sheet material used mainly with timber floors to provide an even, smooth substrate for direct application of tiling.

(b) Acoustic—Functional layer installed to reduce the transmission of airborne and impact sound.

(c) Bonded—which may be either—

  (i) flexible—a seamless, lightweight and flexible sheet material fixed to the floor to accommodate normal movement between the tiling and the background; or

  (ii) in situ—a setting material applied to a floor to provide a base for the tiling.

(d) Unbonded—sheet membrane or liquid applied membrane.

NOTE: Some liquid applied membranes are regarded as unbonded underlays or separating layers unless they are adhered to both the substrate and the overlying finish.

1.3.42 Universal tiles

Tiles with chamfered edges which regulate the joint width where laid in contact.

1.3.43 Waterproof membrane

A layer, usually of seamless polymeric material, placed beneath the tiling to prevent penetration of liquid water into the background.

NOTE: Some waterproofing membranes are incompatible with fixatives and the tile system would become an unbonded system.

1.3.44 Wet area

1 The room(s) or space(s) within a building that houses water-using fixtures or appliances (see HB 50).

2 An area within a residential building supplied with water from a water supply system, excluding kitchens and similar areas.

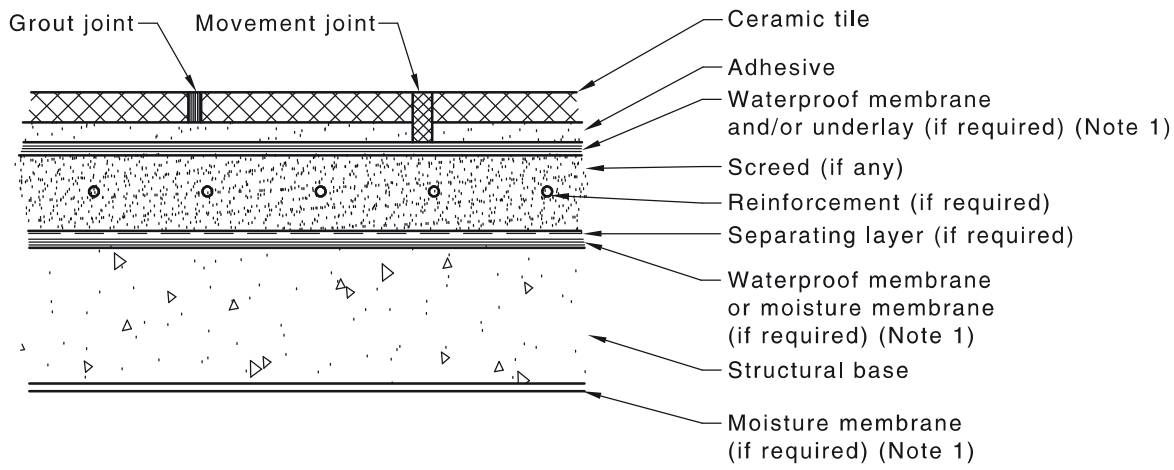
3 Areas in food premises where the walls, floors and ceilings resist frequent contact with steam, water or other liquids.

4 Areas in commercial buildings or industrial premises where wet processes are undertaken (e.g., toilets) and in situations where flooding may occur.

1.4 SYNONYMS

The following terms are understood to refer to identical materials or conditions:

UK	*USA*	*Australia*
Cement: sand mortar	Cement mortar	Cement mortar
Cement-based adhesive	Dry-set mortar	Cement-based adhesive
Rubber-latex: cement mortar	Latex-Portland cement mortar	Modified mortar
Lipping	Lippage	Lipping/Lippage



NOTES:

1 Waterproof membrane or moisture membrane may be used directly under tiles or substrate.

2 This Figure shows the recommended sequence of elements in a tiling system. It is not a construction detail. If the upper layer of waterproof membrane and/or underlay is not installed, the movement joint must continue through the screed

FIGURE 1.1 ILLUSTRATION OF DEFINITIONS

SECTION 2 MATERIALS

2.1 SCOPE OF SECTION

This Section considers the materials to be used in the fixing of ceramic and mosaic tiles, their mixing, where appropriate, and their storage and handling.

NOTE: In this Standard where batching of mixes is expressed in proportions, or ratios, these proportions or ratios are in terms of volume.

2.2 CERAMIC AND MOSAIC TILES

2.2.1 General

Floor and wall tiles should comply with AS 4662. Tile fittings may be specified in accordance with BS 5385.4.

The wall tiling referred to in this Standard consists of glazed and unglazed ceramic tiles other than those requiring clamping or other mechanical fixing, and of mosaic tiles of various types. Their compatibility with the materials or methods recommended for fixing and their suitability for application to the various backgrounds and in environments described in this Standard will depend on such factors as their composition, weight and accuracy of shape.

2.2.2 Mosaic tiles

There are several different types of mosaic tiles available in a variety of shapes and sizes, including glazed and unglazed ceramic mosaics and glass. To facilitate ease of handling, mosaic tiles are assembled as sheets, the separate pieces of tile being glued either face side down to paper (paper-faced mosaics), or bedding side down to nylon adhesive strips or nylon fabric net (nylon-backed mosaics) or other suitable material.

Before selecting a particular system, the advice of the mosaic tile suppliers or fixing specialists should be obtained as to the appropriate fixing method and the suitability of a particular type of mosaic for a particular environment.

When sheets are backed with nylon strip, nylon fabric net, paper net or similar materials, the backing will be embedded in the bedding medium, i.e., mortar or adhesive. These forms of sheeted mosaic tile may be precluded from use externally or in immersed conditions if the sheet backing adversely affects the development of adequate and permanent adhesion between the mosaic tile and the bedding medium. This situation can arise when—

(a) the exposed areas of individual mosaic tiles are not sufficient to permit the bedding from making contact over an adequate proportion of the area of each mosaic tile;

(b) the strips or net or the glue used to bond them are of types that will deteriorate in service or are not compatible with the bedding medium; and

(c) the glue is spread on to the backs of individual mosaic tiles instead of being confined to the strips or net.

NOTE: In the absence of any advice from the tile manufacturer, the exposed (glue and mesh-free) areas of individual mosaic tiles should be a minimum of 80%. Refer to Clause 5.6.4.2 for tiling adhesive coverage.

2.3 PRIMERS

In considering the use of primers, attention is drawn to the need for complete compatibility between—

(a) the substrate and all primers used on the substrate; and

(b) the particular adhesive used to fasten tiles to the substrate.

NOTES:

1 Adequate time should elapse between the application of the sealers or primers and the adhesive to enable satisfactory drying and, where necessary, curing of the materials prior to the application of the subsequent applied materials.

2 Guidance should be sought from the manufacturer of the relevant products.

2.4 ADHESIVES

All adhesives for the fixing of ceramic and mosaic tiles should comply AS 4992.1 and AS 4992.2 or ISO 13007.1 and ISO 13007.2.

NOTES:

1 Some adhesives carry a warning that they may react adversely with certain types of tiles. If these adhesives are to be used, they should be first tested for compatibility (see AS 2358).

2 Where adhesives are required to have water-resistant properties, the extent of these properties should be confirmed. Additional information is available in AS 3958.2.

2.5 GROUTING MATERIALS

2.5.1 General

Grouting materials should have good working characteristics, low shrinkage and good adhesion to the sides of the joints. Grout should be of the types given in Clauses 2.5.2 to 2.5.4, unless otherwise specified in project specifications. The colour of grout should be as designated in project specifications.

2.5.2 Cementitious grout

Cementitious grout should be mixed and applied in accordance with the following:

(a) *Wall tiles* Grout for use with wall tiles should be a proprietary cementitious grout.

(b) *Floor tiles* Grout for floor tiles should be 1 part Portland cement, and 2–4 parts sand, mixed with water to a stiff consistency that can be forcibly compressed into the joints. Up to 1/5 part lime may be added if additional workability is required. Other admixtures should only be used strictly in accordance with the manufacturer's recommendations.

(c) *Ceramic mosaic tile* Grout for ceramic mosaic tile should be 1 part Portland cement and 2–4 parts fine sand mixed with water to a creamy consistency.

(d) *Glass mosaic tile* Glass mosaic tiles should be grouted on the back immediately prior to fixing, using either a proprietary Portland cement grout, or a suitable Portland cement mix, which may include up to 50% lime.

NOTE: This method may be used for some paper-faced ceramic mosaic tiles, particularly on vertical surfaces.

Where flexibility is required, a latex additive may be added to sand/cement grouts.

2.5.3 Proprietary cementitious grout

Proprietary cementitious grout preferably certified by the manufacturer to AS 4992.3, and mixed in accordance with that manufacturer's directions, may be used in lieu of any of the sand/cement mixes given in Clause 2.5.2.

2.5.4 Proprietary reaction resin grouts

Proprietary reaction resin grouts preferably certified by the manufacturer to AS 4992.3, and mixed in accordance with that manufacturer's directions, may be used in lieu of cementitious grouts.

2.6 BACKGROUND MATERIALS

2.6.1 Plywood

Plywood to be used as a substrate for floor and wall tiling should have a minimum thickness of 10 mm and comply with—

(a) AS/NZS 2270 where it is to be used in dry-area applications; and

(b) AS/NZS 2271 where it is to be used in wet areas.

2.6.2 Structural particleboard flooring

Structural particleboard flooring to be used as a substrate for floor tiling should have a minimum thickness of 19 mm and comply with AS/NZS 1859.

2.6.3 Fibre-cement sheet

Fibre-cement sheets to be used as an underlay for floor tiling or as a substrate for wall tiling should have a minimum thickness of 6 mm. For heavy-duty commercial applications, fibre-cement sheets for wall tiling should have a minimum thickness of 9 mm.

For external façade tiling over fibre cement sheet, the sheet manufacturer should be referred to for suitability of the product for the application.

2.6.4 Compressed fibre-cement sheets

Compressed fibre-cement sheets to be used as a substrate should have a minimum thickness of 15 mm for floor tiling and 9 mm for wall tiling.

2.6.5 Gypsum plasterboard sheets

Gypsum plasterboard sheets to be used as a substrate for wall tiling should have recessed linerboard-bound longitudinal edges and a minimum thickness of 10 mm. Where used in dry-area applications the plasterboard should comply with AS/NZS 2588. For use in wet-area applications (see AS 3740) or areas subject to frequent wetting, e.g., kitchens, bathrooms and laundries, it should comply with the performance requirements specified in ASTM C630 and the material and general specifications of AS/NZS 2588.

2.6.6 Furring and studs

The material to be used for furring or studs, including dimensions of material, should be in accordance with the appropriate sheet manufacturer's specifications.

2.7 MOVEMENT JOINT MATERIALS

2.7.1 General

Movement joints are provided to permit movement between adjacent building components. Movement joints may comprise—

(a) prefabricated movement joints that are installed prior to the laying of the tiles; or

(b) an in situ joint that is sawn or formed between the building components and filled either with—

  (i) a formed polymeric backing strip or gasket and a suitable sealant; or

  (ii) a sealant alone.

2.7.2 Prefabricated movement joints

The selection of the most suitable systems will depend on the design considerations. In all cases the manufacturer's advice should be taken into account.

2.7.3 Back-up materials

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

2.7.4 Pre-formed strips

Pre-formed strips are suitable for use in stress-relieving or compression joints where a watertight seal is not critical. Cork and cork/rubber compound strips are suitable for use in light traffic areas. Synthetic-rubber strips with metal-edge supports and PVC are suitable for use in more heavy-traffic areas. Prior to installation, polymeric backing strips should have a width of not less than 120% of the width of the open joint.

2.7.5 Sealants

Sealants should be either—

(a) polysulfide sealants, manufactured and installed in accordance with the appropriate standard; or

(b) accredited polymeric sealants meeting the requirements of the particular application in terms of chemical resistance, abrasion resistance and adhesion.

It is essential that the sealant selected be capable of expanding, to allow the full movement anticipated in the joint without failure of adhesion.

2.8 BONDING AGENTS

In the selection and use of a bonding agent, the manufacturer's recommendations should be complied with.

Various proprietary materials are available as follows:

(a) *Organic polymer-based materials* These include materials based on styrene-butadiene, polyvinyl acetate, acrylic resins, and other resins. These materials differ in their properties, particularly in respect of resistance to moisture, and it is essential that the correct material for the application be selected, and used in accordance with the manufacturer's recommendations. Some material will need to be mixed with cement and sand, or cement only, and applied as a wet wash or stipple immediately prior to the application of the mortar. Application of the bonding agent as a neat film is not generally recommended and should not be attempted with materials such as polyvinyl acetate, or acrylic resins that are affected by moisture.

(b) *Cement-based materials* These are proprietary materials having properties similar to the traditional spatterdash of rich cement mortar and have been used successfully as a wet wash or stipple immediately prior to the application of the mortar.

Gypsum plaster should not be used as a bonding agent in any circumstances.

2.9 CEMENT, SAND AND LIME

2.9.1 Cement

The cements referred to in this Standard should be used in accordance with the manufacturer's instructions and should comply with AS 3972.

Other cements such as high-alumina cement complying with BS 915 may be used for particular purposes.

High-alumina cement should not be mixed with other types of cement.

Cement showing signs of deterioration (e.g., hard lumps) should be rejected.

2.9.2 Sand

All sand used should be washed and be in accordance with AS 2758.1. Sand used for grouting should be of a quality and grade suitable for plastering.

2.9.3 Lime

Lime should comply with AS 1672.1, and be properly hydrated or slaked.

Lime may be measured either as putty prepared from quicklime, hydrated lime or by-product lime, or as dry hydrated lime. Equal volumes of the lime putty and the dry hydrated lime are regarded, for practical purposes, as containing the same amount of lime.

2.10 WATER

Water should comply with BS 3148 and be fresh, clean and drinkable. All containers used for storing or carrying water or for soaking tiles should be clean. Seawater should not be used.

2.11 SEPARATING LAYER FOR FLOORS

Separating layers may comprise any of the following:

(a) *Polythene film*—a 500 grade polythene film is recommended for most conditions.

(b) *Bituminous felt*—bituminous felt should be selected from those specified in BS 747.

(c) *Building paper*—building paper should be selected from those specified in BS 1521.

2.12 UNDERLAYS

Underlays may be either bonded or rigid as follows:

(a) *Bonded*—liquid and in situ flexible underlays should be mixed, where appropriate, and applied in accordance with the manufacturer's recommendations.

(b) *Rigid*—rigid underlay sheets should also be used and installed in accordance with the manufacturer's recommendations.

NOTE: In some instances an underlay may serve the same purpose as a separating layer.

2.13 REINFORCEMENT

Welded wire mesh should comply with AS/NZS 4671. It should have a mesh size between 25 × 25 mm and 75 × 50 mm and should be fabricated with wire of between 1.2 mm and 2.0 mm diameter.

NOTE: 'Chicken wire' can often be used to provide an improved key, but should not be used in place of reinforcement.

Metal reinforcement should be galvanized in accordance with AS/NZS 4534.

Fixings should be austenitic stainless steel.

2.14 STORAGE

2.14.1 Tiles

Tiles should be stored under cover away from damp and should be protected from freezing unless otherwise recommended by the manufacturer.

2.14.2 Cement

Cement should be stored under dry conditions, either in bags, or, if in bulk, in airtight containers. Where large quantities are involved, deliveries should be kept separate and used in sequence. If a delivery is still warm from the manufacturing process it should be allowed to cool before use.

NOTE: Cement packed in the customary multi-wall paper sacks remains usable for considerable periods if supported, out of contact with the floor, in a dry cool store.

2.14.3 Lime

Dry slaked lime should be kept dry. Lime putty should be kept from drying out.

2.14.4 Sand

Sand for mortar should be stored in a damp condition (sufficient to retain its shape when cut vertically) and should be protected from the weather to ensure that it is kept clean and not allowed either to freeze or dry out. Sand for sand/cement grout should be kept dry.

2.14.5 Adhesives and jointing materials

Adhesives and jointing materials should be stored under conditions such that they will not deteriorate in storage. Manufacturer's instructions for storage should be followed.

2.14.6 Temperature extremes

All components to be used in the construction should, prior to erection, be stored in moderate conditions, i.e., frost-free and in temperatures not exceeding 35°C. Adhesives in particular should not be stored in areas susceptible to high temperature.

2.15 MIXING OF MATERIALS

2.15.1 General

In the proportioning and mixing of the materials used in the preparation of base, bedding or other coats, buckets should be used for measuring out the component materials. Shovels should not be used for this purpose.

2.15.2 Mixing by mechanical means

The material should be thoroughly and efficiently mixed by means of force action mixers.

NOTE: Ribbon mixers and pan-paddle mixers have been found to be suitable for all types of mortar.

Free-fall drum mixers have been found to produce inconsistent mixing of semi-dry mortars and their use is not recommended for mixing mortar for the semi-dry bedding method given in Clause 5.5.5.1.

2.15.3 Mixing by hand

Sand/cement bedding mortar may be mixed by hand, provided such mixing is thorough.

SECTION 3 TILING SYSTEMS

3.1 SCOPE OF SECTION

This Section provides recommendations for tiling systems based on substrate, tile type, adhesive and intended application.

3.2 FLOOR TILING INSTALLATION GUIDE

For the purpose of this Standard, 'light' traffic is considered equivalent to the normal domestic use of a floor (foot traffic) or the passage of lightweight soft-wheeled trolleys.

Heavy traffic conditions are those often experienced in industrial premises involving heavy loads, whether static or moving, abrasion by the dragging of loads, or impact by the dropping of loads. Commercial and institutional premises generally fall between light and heavy service conditions and should be considered on their merits.

NOTE: Separating layers are generally not suitable for use in industrial situations.

Table 3.1 provides a summary of the recommended floor tiling systems for the various service requirements.

TABLE 3.1

FLOOR TILING INSTALLATION GUIDE

Service requirements	Concrete floor	Framed floor
Performance level and installation method	**Clause number**	**Clause number**
Industrial: Subject to heavy loads such as forklift trucks and requiring high strength and abrasion resistance (e.g., factories, dairies, food plants)	3.3.1.1 3.3.1.2 3.3.3.1 3.3.3.2	
Commercial: Subject to continuous foot traffic and occasional heavy loads such as fork-lift trucks and light vehicles (e.g., shopping malls, stores, commercial kitchens)	3.3.2.3 3.3.3.3 3.3.3.4	3.3.2.2* 3.3.4.1* 3.3.4.2* 3.3.4.4* 3.3.4.5*
Residential: Subject to irregular foot traffic and occasional moderate loads (e.g., kitchens, bathrooms, foyers)	3.3.2.1	3.3.4.3

* Not suitable where heavy loads are anticipated.

NOTES:

1 Any system may be used for a less severe application.

2 Consideration should also be given to the following:

(a) The wear properties of the surface of the tile selected.

(b) The fire-resistant properties of the installation and backing.

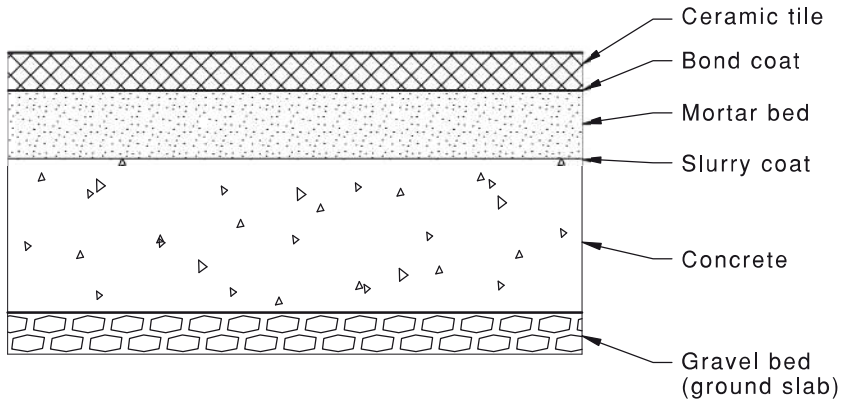
(c) The slip resistance of the surface of the tile selected.

(d) The structural base—Surfaces have to be structurally sound, stable and rigid enough to support ceramic/stone tiles and similar finishes. Substrate deflection under all live, dead and impact actions including concentrated loads must not exceed $L/360$ for thin bed ceramic installations or $L/480$ for the bed stone installation, where L = span length.

3.3 FLOORS

3.3.1 Exterior floors—General applications

3.3.1.1 *Cement mortar—Bonded*



The following guidelines should be observed for cement mortar bonded exterior floor:

(a) *Performance levels:*

(i) Industrial.

(ii) Commercial.

(iii) Residential.

(b) *Recommended uses*:

(i) Exterior floors or patios where membrane is not used and where positive drainage below slab is provided.

(ii) On properly cured structural slabs where deflection does not exceed 1/360 of span.

(c) *Materials*:

(i) Grout—1 part Portland cement, 2–4 parts dry sand (see Clause 2.5).

(ii) Movement joints (see Clause 2.7).

(iii) Bond coat (see Clause 2.8).

(iv) Portland cement (see Clause 2.9.1).

(v) Sand (see Clause 2.9.2).

(vi) Water (see Clause 2.10).

(vii) Mortar—1 part Portland cement, 3–4 parts damp sand.

(d) *Preparation by other trades*:

(i) Subsurface drainage to be provided.

(ii) Slab to be sloped for complete drainage.

(iii) Slab to be float finished to a uniform grade. Maximum variation to not exceed tolerance given in Table 4.3.

(iv) Slab to be well cured and dry, dimensionally stable and free of waxy or oily films (see Clause 4.3).

(v) Gravel bed or other means of drainage below a ground slab is essential.

(e) *Installation*:

(i) A slurry coat of Portland cement paste to be applied to the concrete immediately prior to application of the mortar.

(ii) Mortar bed ideally to be uniform 25 mm thickness; however, 15–30 mm is acceptable. Where tiles are less than 10 mm thick and the area is to be used for light traffic only, the bed thickness may be reduced to 10–15 mm.

(iii) Movement joints are essential (see Clause 5.4.5).

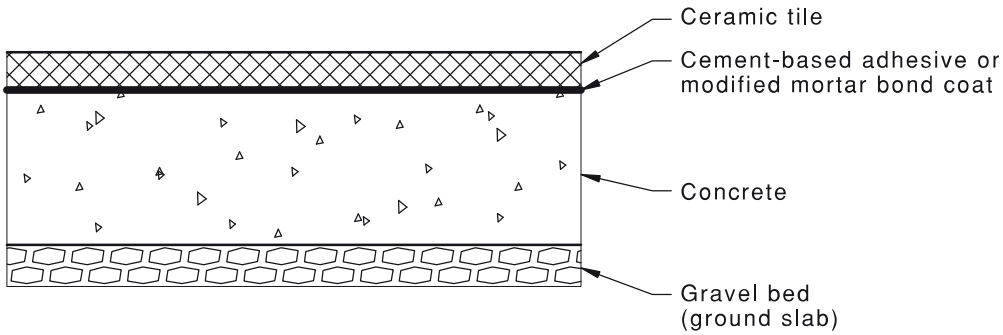
(iv) The work to be covered and kept damp for a minimum of 3 days.

(f) *Installation specifications*:

(i) Tiles (see Clause 5.5.5).

(ii) Grout (see Clause 5.7).

3.3.1.2 *Cement-based adhesive or modified mortar*



The following guidelines should be observed for cement-based adhesive or modified mortar exterior floor:

(a) *Performance levels*:

(i) Cement-based adhesives:

(A) Industrial.

(B) Commercial.

(C) Residential.

(ii) Modified mortar:

(A) Commercial.

(B) Residential.

(b) *Recommended uses*:

(i) Exterior floors, decks or patios where a membrane is not used and where positive drainage below the slab is provided.

(ii) On properly cured structural slabs where deflection does not exceed 1/360 of span.

(c) *Materials*:

(i) Cement-based adhesive (see Clause 2.4).

(ii) Modified (see Clause 2.4).

(iii) Grout type to be specified (see Clause 2.5).

(iv) Movement joints (see Clause 2.7).

(v) Bond coat (see Clause 2.8).

(d) *Preparation by other trades*:

(i) Subsurface drainage to be provided.

(ii) Slab to be sloped for complete drainage.

(iii) Slab to be wood-float finished to a uniform grade. Maximum variation to not exceed the tolerance given in Table 4.3.

(iv) Slab to be well cured and dry, dimensionally stable and free of waxy or oily films (see Clause 4.3).

(v) Gravel bed or other means of drainage below a ground slab is essential.

(e) *Installation*:

(i) Movement joints are essential (see Clause 5.4.5).

(ii) Bedding may be thick-bed or thin-bed.

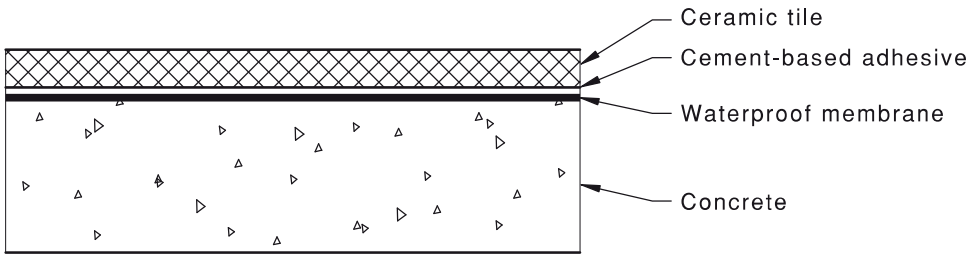
(f) *Installation specifications*:

(i) Tiles (see Clause 5.6.5).

(ii) Grout (see Clause 5.7).

3.3.2 Exterior floors, decks and roofs

3.3.2.1 *Cement-based adhesive with bonded waterproof membrane*



The following guidelines should be observed for cement-based adhesive with bonded waterproof membrane for exterior floors, decks and roofs:

(a) *Performance level* Residential.

(b) *Recommended uses*:

(i) Exterior floors or patios where membrane is used.

(ii) On properly cured structural slabs where deflection does not exceed 1/360 of span.

(c) *Materials*:

(i) Cement-based adhesive (see Clause 2.4).

(ii) Latex-cement mortar (see Clause 2.4).

(iii) Grout type to be specified (see Clause 2.5).

(iv) Movement joints (see Clause 2.7).

(d) *Preparation by other trades*:

(i) Subsurface drainage to be provided.

(ii) Slab to be sloped for complete drainage.

(iii) Slab to be float finished to a uniform grade. Maximum variation to exceed tolerance given in Table 4.3.

(iv) Slab to be well cured and dry, dimensionally stable and free of waxy or oily films (see Clause 4.3).

(v) Gravel bed or other means of drainage below a ground slab is essential.

(e) *Installation*:

(i) Movement joints are essential (see Clause 5.4.5).

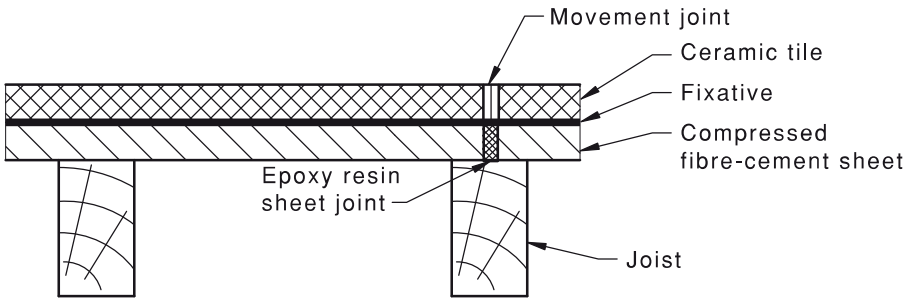
(ii) Adhesive bedding may be thick-bed or thin-bed.

(f) *Installation specifications*:

(i) Tiles (see Clauses 5.6.5 and 5.6.6).

(ii) Grout (see Clause 5.7).

3.3.2.2 *Compressed fibre-cement decks on timber joists*



The following guidelines should be observed for compressed fibre-cement or timber joists for exterior floors, decks and roofs:

(a) *Performance levels*:

(i) Organic adhesive or cement-based adhesive—residential.

(ii) Modified mortar—commercial.

(b) *Recommended uses*:

(i) Exterior decks on timber joists.

(ii) Deflection should not exceed 1/360 of span.

(c) *Materials*:

(i) Flexible organic adhesive (see Clause 2.4).

(ii) Modified mortar (see Clause 2.4).

(iii) Epoxy resin adhesive (see Clause 2.4).

(iv) Grout type to be specified (see Clause 2.5),.

(v) Compressed fibre-cement sheet, minimum 15 mm thick (see Clause 2.6.4).

(vi) Movement joints (see Clause 2.7).

(d) *Preparation by other trades*:

(i) Compressed fibre-cement sheets to be screw fixed at 450 mm centres on all edges and within the body of the sheet.

(ii) All compressed fibre-cement sheet edges to be treated as movement joints.

(iii) Slope, where essential, to be in subfloor.

(e) Installation:

(i) Movement joints are essential (see Clause 5.4.5).

(ii) The surface should be primed in accordance with adhesive manufacturer's recommendations.

(iii) Epoxy resin adhesive should be used to joint the compressed fibre-cement sheets.

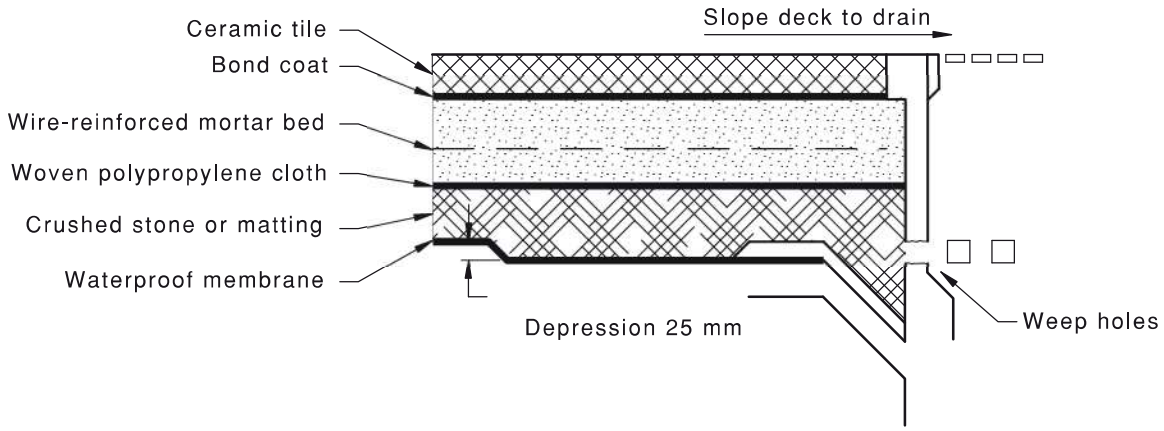
(f) *Installation specifications*:

(i) Compressed fibre-cement sheets (see Clause 4.4.5).

(ii) Tiles (see Clauses 5.6.5 and 5.6.6).

(iii) Grout (see Clause 5.7).

3.3.2.3 *Cement mortar on drained waterproof membrane*



The following guidelines should be observed for cement mortar on drained waterproof membrane for exterior floors, decks and roofs:

(a) *Performance levels*:

(i) Commercial

(ii) Residential.

(b) *Recommended uses*:

(i) Exterior roofs of concrete, steel or timber where a waterproof membrane is essential.

(ii) Not suitable for tiling over flat decks.

(iii) Not recommended in areas where the mortar bed will be subjected to freeze/thaw cycles.

(c) *Materials*:

(i) Grout—type to be specified (see Clause 2.5).

(ii) Movement joints (see Clause 2.7).

(iii) Bond coat (see Clause 2.8).

(iv) Portland cement (see Clause 2.9.1).

(v) Sand (see Clause 2.9.2).

(vi) Water (see Clause 2.10).

(vii) Reinforcement (see Clause 2.13).

(viii) Mortar—1 part Portland cement, 5 parts damp sand.

(ix) Mortar bed thickness—nominal 32 mm.

(x) Ceramic tile, as approved by manufacturer.

(xi) Crushed stone—maximum size 13 mm.

(xii) Crushed stone bed—25 mm minimum thickness.

(xiii) Woven polypropylene cloth.

(xiv) Matting—10–16 mm or 20–32 mm matting nylon and carbon black spinnerette extended 630 g/m^2. Fabric to be installed side up.

(d) *Preparation by other trades*:

(i) Stone bed to be sloped to obtain pitch to drain.

(ii) Drains to provide complete drainage at membrane level by use of weep holes, as shown above or other methods.

(iii) Roof drain to be surrounded with broken pieces of tile to prevent stone or mortar from blocking weep holes.

(e) *Installation*:

(i) Reinforcing mesh essential.

(ii) Movement joints are essential (see Clause 5.4.5).

Movement joints to not go through the gravel bed; they should extend only to the bottom of the fixative.

(iii) The completed tile work to be covered and kept damp for 3 to 7 days.

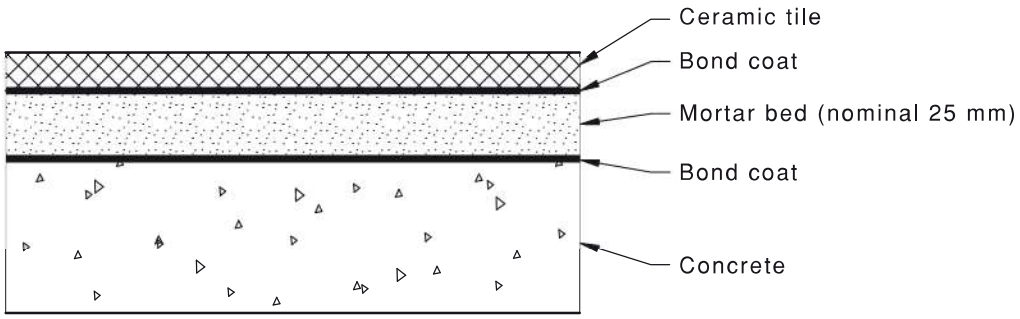
(f) *Installation specifications*:

(i) Tiles (see Clause 5.5.5).

(ii) Grout (see Clause 5.7).

3.3.3 Interior floors—Concrete subfloors

3.3.3.1 *Cement mortar—Bonded*



The following guidelines should be observed for bonded cement mortar used in interior floors with concrete subfloors:

(a) *Performance levels:*

(i) Industrial

(ii) Commercial

(iii) Residential.

(b) *Recommended uses*:

(i) On ground-slab construction where negligible bending stresses occur.

(ii) On properly cured structural slabs where deflection does not exceed 1/360 of span.

(c) *Materials*:

(i) Grout—type to be specified (see Clause 2.5).

(ii) Movement joints (see Clause 2.7).

(iii) Bond coat (see Clause 2.8).

(iv) Portland cement (see Clause 2.9.1).

(v) Sand (see Clause 2.9.2).

(vi) Water (see Clause 2.10).

(vii) Mortar—1 part Portland cement, 3–4 parts damp sand.

(d) *Preparation by other trades*:

(i) Concrete finish to be free of cracks, waxy or oily films, and curing compounds (see Clause 4.3).

(ii) Slope, when essential, to be in subfloor.

(iii) Maximum variation to not exceed tolerance given in Table 4.3.

(e) *Installation*:

(i) Mortar bed to be ideally uniform 25 mm thickness; however, 15–30 mm is acceptable.

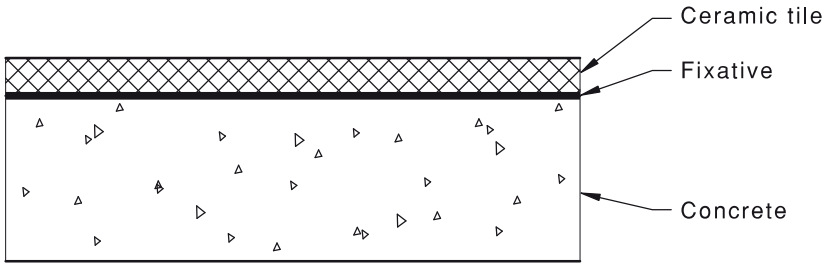
(ii) Movement joints are essential (see Clause 5.4.5).

(f) *Installation specifications*:

(i) Tiles (see Clause 5.5.5).

(ii) Grout (see Clause 5.7).

3.3.3.2 *Cement-based adhesive, modified mortar or organic adhesive*



The following guidelines should be observed for cement-based adhesive, modified mortar or organic adhesive for exterior floor, decks and roofs:

(a) *Performance levels*:

(i) Cement-based adhesive:

(A) Industrial.

(B) Commercial

(C) Residential.

(ii) Modified mortar—commercial, residential.

(iii) Organic adhesive:

(A) Light commercial

(B) Residential.

(b) *Recommended uses*:

(i) On level, clean concrete.

(ii) On ground slab construction where negligible bending stresses occur.

(iii) On properly cured structural slabs where deflection does not exceed 1/360 of span.

(c) *Materials*:

(i) Cement-based adhesive (see Clause 2.4).

(ii) Modified mortar (see Clause 2.4).

(iii) Organic adhesive (see Clause 2.4).

(iv) Grout—type to be specified (see Clause 2.5).

(v) Movement joints (see Clause 2.7).

(vi) Water (see Clause 2.10).

(d) *Preparation by other trades*:

(i) Slab to have wood-float finish and be free from waxy and oily films (see Clause 4.3).

(ii) Slope, when essential, to be in subfloor.

(iii) Maximum variation to not exceed the tolerance given in Table 4.3.

(iv) Slab to be well cured, dimensionally stable and free of cracks, waxy or oily films, and curing compounds.

(e) *Installation*:

(i) Bedding may be thick-bed or thin-bed.

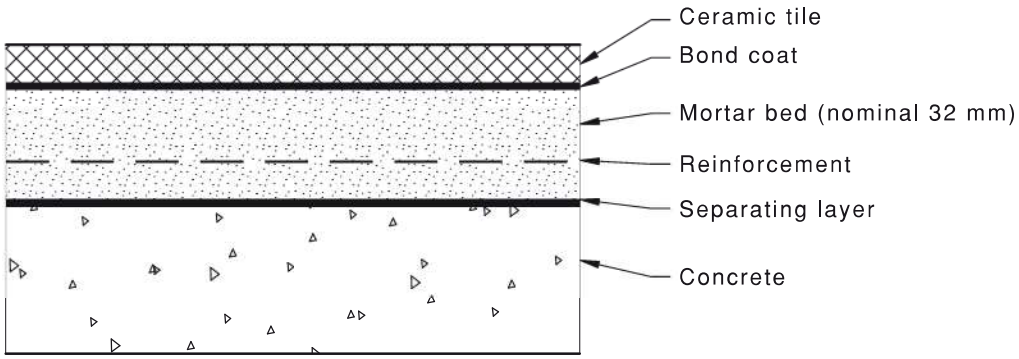
(ii) Movement joints are essential (see Clause 5.4.5).

(f) *Installation specifications*:

(i) Tiles (see Clauses 5.6.5 and 5.6.6).

(ii) Grout (see Clause 5.7).

3.3.3.3 *Cement mortar—Separating layer*



The following guidelines should be observed for separating layer of cement mortar, used in exterior floors, decks and roofs:

(a) *Performance levels:*

(i) Commercial

(ii) Residential.

(b) *Recommended uses* Over structural floors subject to bending and deflection.

(c) *Materials*:

(i) Grout—type to be specified (see Clause 2.5).

(ii) Movement joints (see Clause 2.7).

(iii) Portland cement (see Clause 2.9.1).

(iv) Sand (see Clause 2.9.2).

(v) Water (see Clause 2.10).

(vi) Separating layer (see Clause 2.11), polythene film, trowelled-on membrane, or bitumen and hessian.

(vii) Reinforcement (see Clause 2.13).

(viii) Bond coat—Portland cement slurry on a mortar bed, or cement-based adhesive or latex-Portland cement mortar on a cured bed.

(ix) Mortar—1 part Portland cement, 3–4 parts damp sand.

(d) *Preparation by other trades*:

(i) Slabs to be wood-float finished to a uniform grade. Maximum variation to not exceed the tolerance given in Table 4.3.

(ii) Slope, when essential, to be in subfloor.

(iii) Slab to be well cured and dry, dimensionally stable and free of waxy or oily films (see Clause 4.3).

(e) *Installation*:

(i) Reinforcing mesh essential.

(ii) Separating layer essential.

(iii) Mortar bed to be ideally uniform 25 mm thickness; however 15–30 mm is acceptable.

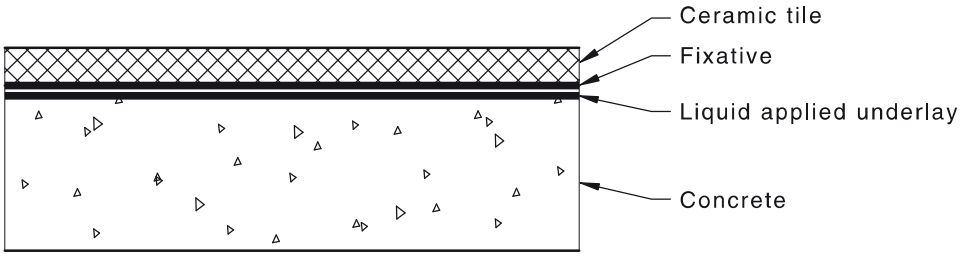
(iv) Movement joints are essential at 3 m centres on a grid pattern (see Clause 5.4.5).

(f) *Installation specifications*:

(i) Tiles (see Clause 5.5.5).

(ii) Grout (see Clause 5.7.

3.3.3.4 *Cement-based adhesive or organic adhesive—Liquid applied underlay*



The following guidelines should be observed for liquid applied cement-based adhesive or organic adhesive as underlay for exterior floors, decks and roofs:

(a) *Performance levels*:

(i) Cement-based adhesive—commercial.

(ii) Organic adhesive:

(A) Light commercial.

(B) Residential.

(b) *Recommended uses* Over structural floors subject to deflection movements.

(c) *Materials*:

(i) Cement-based adhesive (see Clause 2.4).

(ii) Organic adhesive (see Clause 2.4).

(iii) Grout—type to be specified (see Clause 2.5).

(iv) Movement joints (see Clause 2.7).

(v) Liquid applied underlay (see Clause 2.12).

(d) *Preparation by other trades*:

(i) Slab to be wood-float finished to a uniform grade. Maximum variation to not exceed tolerance given in Table 4.3.

(ii) Slope, when essential, to be in subfloor.

(iii) Slab to be well cured and dry, dimensionally stable and free of waxy or oily films (see Clause 4.3).

(e) *Installation*:

(i) Movement joints are essential (see Clause 5.4.5).

(ii) Liquid applied underlay compound to be installed in accordance with manufacturer's recommendations.

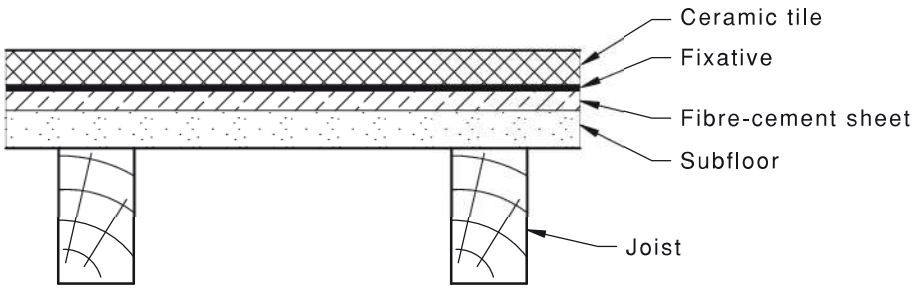
(f) *Installation specifications*:

(i) Tiles (see Clauses 5.6.5 and 5.6.6).

(ii) Grout (see Clause 5.7).

3.3.4 Interior floors—Framed substrates

3.3.4.1 *Timber substrates overlaid with fibre-cement sheet*



The following guidelines should be observed for timber substrates overlaid with fibre-cement sheet for interior floors and framed substrates.

(a) *Performance level* Residential, commercial.

(b) *Recommended uses*:

(i) Renovation of existing timber floors by tiling over.

(ii) Deflection to not exceed 1/360 of span.

(c) *Materials*:

(i) Flexible organic adhesive (see Clause 2.4).

(ii) Grout—type to be specified (see Clause 2.5).

(iii) Fibre-cement underlay sheet, 6 mm thick (see Clause 2.6.3).

(iv) Movement joints (see Clause 2.7).

(d) *Preparation by other trades*:

(i) Floor to be sanded and levelled as necessary.

(ii) Underlay sheets to be fixed (see Clause 4.4.4.5).

(e) *Installation*:

(i) Movement joints are essential (see Clause 5.4.5).

(ii) Surface to be primed in accordance with adhesive manufacturer's recommendations.

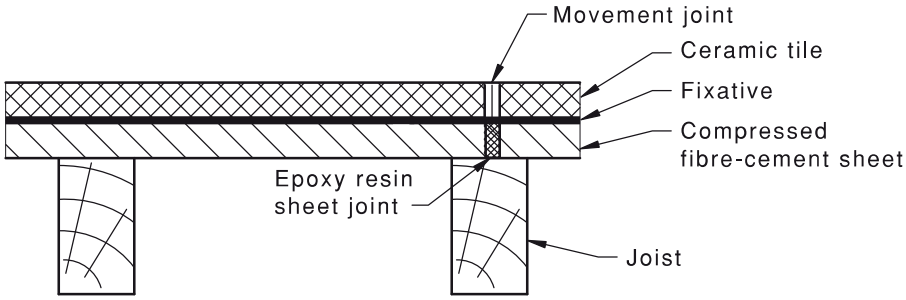
(f) *Installation specifications*:

(i) Underlay sheets (see Clause 4.4.4.5).

(ii) Tiles (see Clauses 5.6.5, 5.6.6).

(iii) Grout (see Clause 5.7).

3.3.4.2 *Compressed fibre-cement substrates on timber joists*



The following guidelines should be observed for compressed fibre-cement substrates on timber joists for internal floors and framed substrates.

(a) *Performance level*:

(i) Organic adhesive or cement-based adhesive—residential.

(ii) Modified mortar—commercial.

(b) *Recommended uses* Deflection to not exceed 1/360 of span.

(c) *Materials*:

(i) Flexible organic adhesive (see Clause 2.4).

(ii) Modified mortar (see Clause 2.4).

(iii) Grout—type to be specified (see Clause 2.5).

(iv) Minimum 15 mm thick compressed fibre-cement sheet (see Clause 2.6.4).

(v) Movement joints (see Clause 2.7).

(vi) Water-based epoxy adhesive for jointing the compressed fibre-cement sheets.

(d) *Preparation by other trades*:

(i) Compressed fibre-cement sheets to be screw-fixed at 450 mm centres on all edges and within the body of the sheet.

(ii) Slope, where essential, to be in subfloor.

(e) *Installation*:

(i) Movement joints are essential for large areas and where changes in direction occur (see Clause 5.4.5).

(ii) Surface to be primed in accordance with adhesive manufacturer's recommendations.

(iii) Water-based epoxy resin adhesive to be used to joint the compressed fibre-cement sheets.

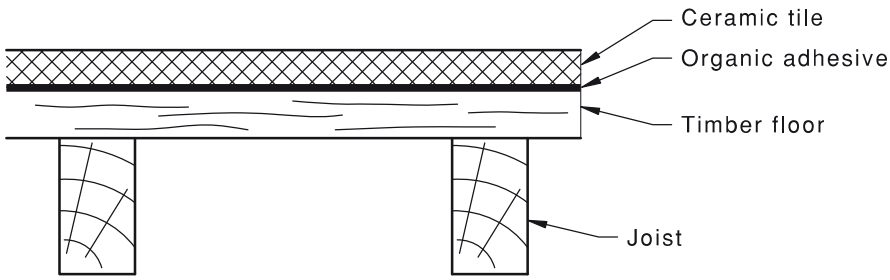
(f) *Installation specifications*:

(i) Compressed fibre-cement sheets (see Clause 4.4.5).

(ii) Tiles (see Clauses 5.6.5 and 5.6.6).

(iii) Grout (see Clause 5.7).

3.3.4.3 *Timber substrates tiled with organic adhesive*



The following guidelines should be observed for timber substrates tiled with organic adhesive for internal floors and framed substrates.

(a) *Performance level* Residential only.

(b) *Recommended uses*:

(i) Over structurally sound timber floors.

(ii) Deflection to not exceed 1/360 of span.

(c) *Materials*:

(i) Organic adhesive (see Clause 2.4).

(ii) Grout—type to be specified (see Clause 2.5).

(iii) Movement joints (see Clause 2.7).

(d) *Preparation by other trades*:

(i) Subfloor to be minimum 16 mm plywood, 19 mm structural particleboard, or 16 mm tongued and grooved flooring (see Clause 4.4.4).

(ii) Timber floors to be structurally sound and free from any waxy or oily films or loose dirt.

(e) *Installation*:

(i) Adhesive to be selected and applied in accordance with manufacturer's recommendations.

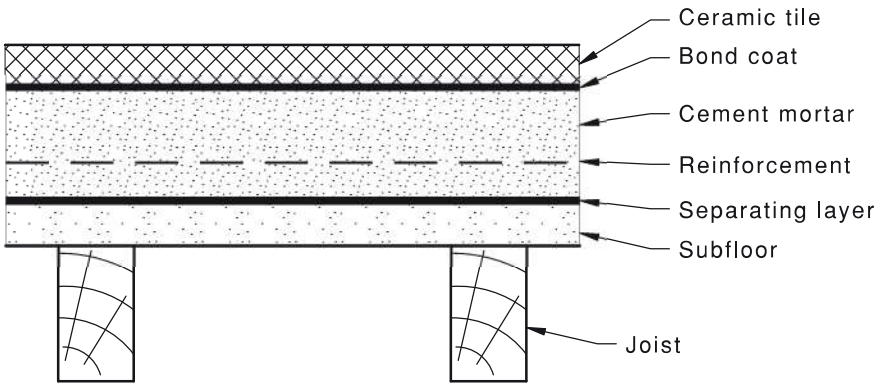
(ii) Sheeting to be warranted by the floor sheeting manufacturer for direct bonding of tiles.

(f) *Installation specifications*:

(i) Tiles (see Clause 5.6.6).

(ii) Grout (see Clause 5.7).

3.3.4.4 *Timber substrates with cement mortar separating layer*



The following guidelines should be observed for timber substrates with cement mortar separating layer for internal floors and framed substrates.

(a) *Performance levels:*

(i) Light commercial.

(ii) Residential.

(b) *Recommended uses*:

(i) Over structurally sound timber floors.

(ii) Deflection to not exceed 1/360 of span, including live and dead loads.

(c) *Materials*:

(i) Grout—type to be specified (see Clause 2.5).

(ii) Movement joints (see Clause 2.7).

(iii) Bond coat (see Clause 2.8).

(iv) Portland cement (see Clause 2.9.1).

(v) Sand (see Clause 2.9.2).

(vi) Water (see Clause 2.10).

(vii) Separating layer (see Clause 2.11).

(viii) Reinforcement (see Clause 2.13), mortar, 1 part Portland cement, 3–4 parts damp sand (see Clause 2.13).

(d) *Preparation by other trades* Subfloor to be minimum 16 mm plywood, 19 mm structural particleboard, or 16 mm tongued and grooved flooring (see Clause 4.4.4).

(e) *Installation*:

(i) Primer, separating layer or waterproof membrane is essential.

(ii) Reinforcement is essential.

(iii) Movement joints are essential (see Clause 5.4.5).

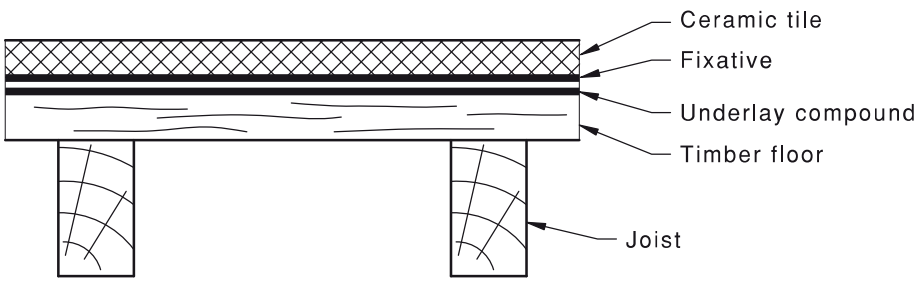
(f) *Installation specifications*:

(i) Timber floor (see Clause 4.4.4).

(ii) Tiles (see Clause 5.5.5).

(iii) Grout (see Clause 5.7).

3.3.4.5 *Timber subfloors tiled with underlay compound and adhesive*



The following guidelines should be observed for timber subfloors tiled with underlay compound and adhesive for internal floors and framed substrates.

(a) *Performance levels:*

(i) Residential.

(ii) Commercial.

(b) *Recommended uses* Over structurally sound timber.

(c) *Materials*:

(i) Cement-based adhesive (see Clause 2.4).

(ii) Organic adhesive (see Clause 2.4).

(iii) Grout—typed to be specified (see Clause 2.5).

(iv) Movement joints (see Clause 2.7).

(v) Liquid applied underlay compound (see Clause 2.12).

(d) *Preparation by other trades* Timber floors to be structurally sound and free from waxy or oily films.

(e) *Installation*:

(i) Movement joints are essential (see Clause 5.4.5).

(ii) Adhesive to be applied in accordance with manufacturer's recommendations.

(iii) Liquid applied underlay compound to be applied in accordance with manufacturer's recommendations.

(f) *Installation specifications*:

(i) Tiles (see Clauses 5.6.5 and 5.6.6).

(ii) Grout (see Clause 5.7).

3.4 WALL TILING INSTALLATION GUIDE

Table 3.2 provides a summary of the recommended wall tiling systems for the various service requirements.

TABLE 3.2

WALL TILING INSTALLATION GUIDE

Service requirements and installation method that meets or exceeds it	Masonry or concrete	Timber or metal stud
	Clause number	Clause number
Exterior	3.5.1.1 3.5.1.2	3.5.1.3
Commercial—Wet areas: group showers, baths, showers, laundries	3.5.4.1 3.5.4.2 3.5.4.3*	3.5.5.1 3.5.5.2*
Commercial	3.5.2.1 3.5.2.2	3.5.3.1 3.5.3.2
Residential and light commercial—Wet areas: bath enclosures and showers	3.5.4.1 3.5.4.2 3.5.4.3*	3.5.5.1 3.5.5.2*
Residential and light commercial	3.5.2.1 3.5.2.2 3.5.2.3	3.5.3.1 3.5.3.2

* Not group showers

NOTES:

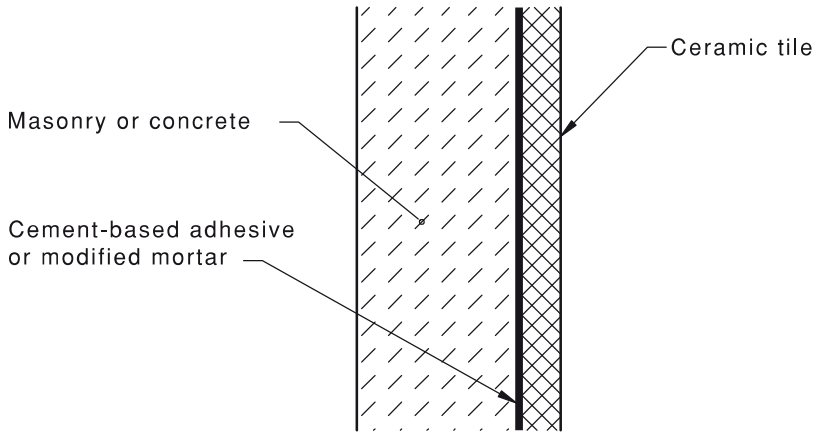
1 Any system may be used for a less severe application.

2 Where gypsum plasterboard is to be used in wet areas or in situations where limited water exposure is anticipated, only water-resistant plasterboard should be used

3.5 WALLS

3.5.1 Exterior walls—Masonry, concrete or framed construction

3.5.1.1 *Masonry with cement-based adhesive or modified mortar*



The following guidelines should be observed for masonry with cement based adhesive or modified mortar for exterior walls, masonry, concrete and framed construction:

(a) *Recommended uses* Over clean, sound, dimensionally stable masonry or concrete.

(b) *Materials*:

(i) Cement-based adhesive (see Clause 2.4).

(ii) Modified mortar (see Clause 2.4).

(iii) Grout—typed to be specified (see Clause 2.5).

(iv) Movement joints (see Clause 2.7).

(c) *Preparation by other trades*:

(i) Surface to be free of coatings, oil and wax.

(ii) Maximum variation to not exceed the tolerance given in Table 4.5.

(iii) Expanded mesh to be fixed over previously coated or superficially cracked surfaces, then rendered to a true surface.

(iv) Over structurally cracked surfaces, cracks to be repaired and a method from Clause 3.5.1.2 to be used.

(v) Release agents or curing compounds to be removed before tiling. (Alternatively, adhesives compatible with those compounds may be used.)

(d) *Installation*:

(i) Adhesive to be applied in accordance with the manufacturer's recommendations.

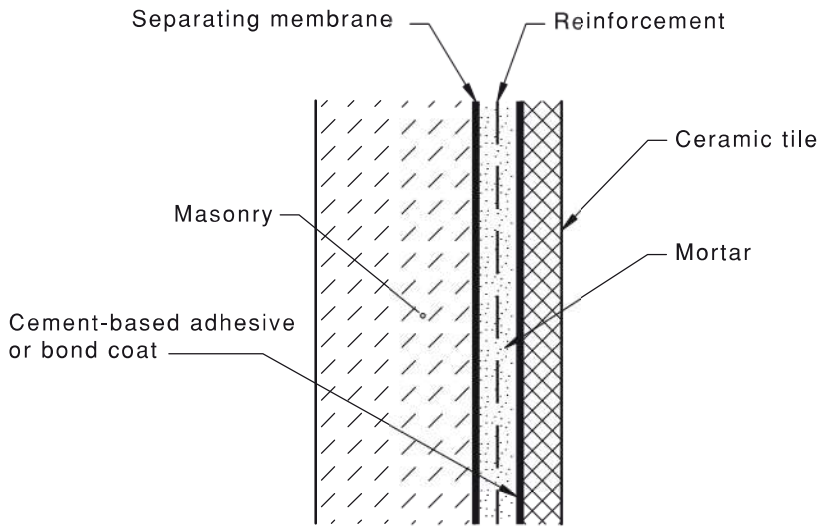
(ii) Movement joints are essential (see Clause 5.4.5).

(e) *Installation specifications*:

(i) Tiles (see Clause 5.6.5).

(ii) Grout (see Clause 5.7).

3.5.1.2 *Masonry with mortar over a separating layer*



The following guidelines should be observed for masonry with mortar over a separating layer for exterior walls, masonry, concrete and framed construction.

(a) *Recommended uses*:

(i) Over structurally sound masonry that may be cracked, excessively oily or dirty.

(ii) Not recommended in areas where the mortar bed will be subjected to freeze/thaw cycles.

(b) *Materials*:

(i) Grout—type to be specified (see Clause 2.5).

(ii) Movement joints (see Clause 2.7).

(iii) Bond coat (see Clause 2.8).

(iv) Portland cement (see Clause 2.9.1).

(v) Sand (see Clause 2.9.2).

(vi) Water (see Clause 2.10).

(vii) Reinforcement (see Clause 2.13).

(viii) Mortar—1 part Portland cement, 5 parts damp sand.

(ix) Mortar bed thickness—nominal 32 mm.

(x) Ceramic tiles as approved by manufacturer.

(c) *Preparation by other trades* Maximum variation to not exceed the tolerance given in Table 4.5.

(d) *Installation*:

(i) Separating membranes to be fixed in accordance with manufacturer's recommendations.

(ii) Reinforcing mesh essential; to be mechanically fixed.

(iii) Movement joints are essential (see Clause 5.4.5).

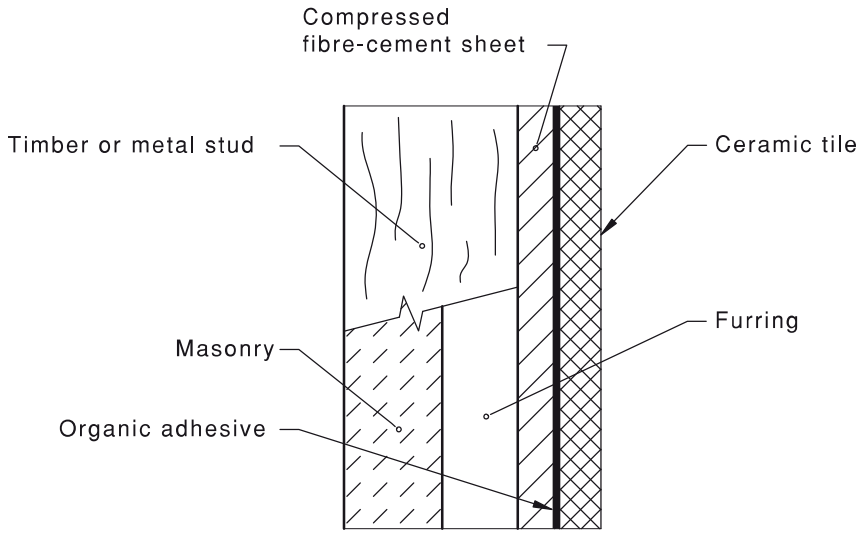
(iv) The completed tile work to be covered and kept damp for 3 to 7 days.

(e) *Installation specifications*:

(i) Tiles (see Clause 5.5.6).

(ii) Grout (see Clause 5.7).

3.5.1.3 *Compressed fibre-cement sheet on framed construction or on furring over masonry with organic adhesive*



The following guidelines should be observed for compressed fibre-cement sheet on framed construction over masonry with organic adhesive for exterior walls, masonry and concrete-framed construction.

(a) *Recommended uses* On external walls over compressed fibre-cement sheets on timber or metal studs or on furring over masonry.

(b) *Materials*:

(i) Organic adhesive (see Clause 2.4).

(ii) Compressed fibre-cement sheet, minimum 9 mm thick (see Clause 2.6.4).

(iii) Grout—type to be specified (see Clause 2.5).

(iv) Furring (see Clause 2.6.6).

(v) Movement joints (see Clause 2.7).

(c) *Preparation by other trades*:

(i) Installation of furring.

(ii) Installation of compressed fibre-cement sheeting (see Clause 4.6.4).

(iii) All compressed fibre-cement sheet edges to be treated as movement joints.

(iv) Maximum variation to not exceed the tolerance given in Table 4.5.

(v) The gap between compressed fibre-cement sheets and concrete kerbs or floors to be sealed with water-resistant flexible sealant.

(d) *Installation*:

(i) Adhesive to be applied in accordance with the manufacturer's recommendations.

(ii) Vertical and horizontal movement joints are essential (see Clause 5.4.5).

(iii) When recommended by adhesive manufacturer, the surface to be primed before applying adhesive.

(iv) A minimum of 12 h to be allowed after tile is set for adhesive curing before grouting.

(e) *Installation specifications*:

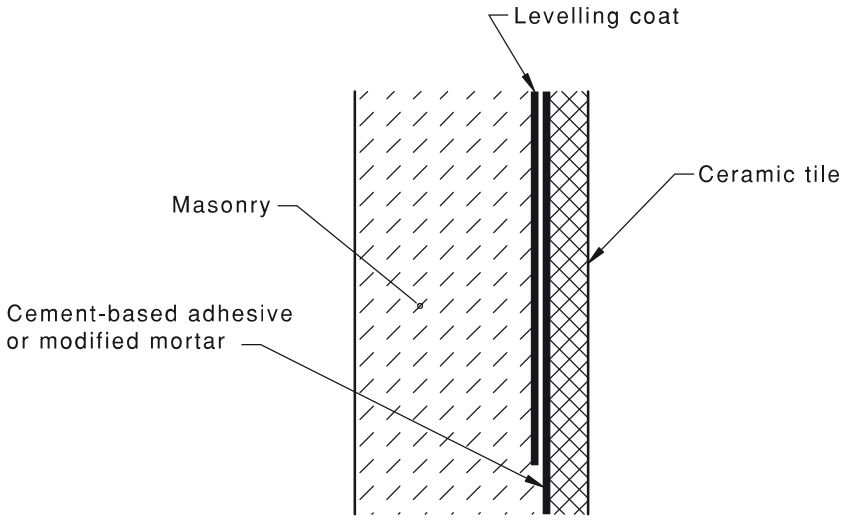
(i) Compressed fibre-cement sheets (see Clause 4.6.4).

(ii) Tiles (see Clause 5.6.6).

(iii) Grout (see Clause 5.7).

3.5.2 Dry interior walls—Masonry or concrete

3.5.2.1 *Cement-based adhesive or modified mortar*



The following guidelines should be observed for cement-based adhesive or modified mortar for dry interior walls, masonry and concrete.

(a) *Recommended uses* On dry interior walls over dimensionally stable masonry or concrete.

(b) *Materials*:

(i) Cement-based adhesive (see Clause 2.4).

(ii) Modified mortar (see Clause 2.4).

(iii) Grout—type to be specified (see Clause 2.5).

(iv) Movement joints (see Clause 2.7).

(c) *Preparation by other trades*:

(i) Maximum variation to not exceed the tolerance given in Table 4.5.

(ii) Over previously coated or superficially cracked surfaces, expanded mesh to be fixed and the surface rendered true before tiling.

(iii) Over structurally cracked surfaces, cracks to be repaired and a method from Clause 3.5.1.2 to be used.

(iv) Release agents or curing compounds to be removed before tiling. (Alternatively, adhesives compatible with those compounds may be used.)

(d) *Installation*:

(i) Adhesive to be applied in accordance with manufacturer's recommendations.

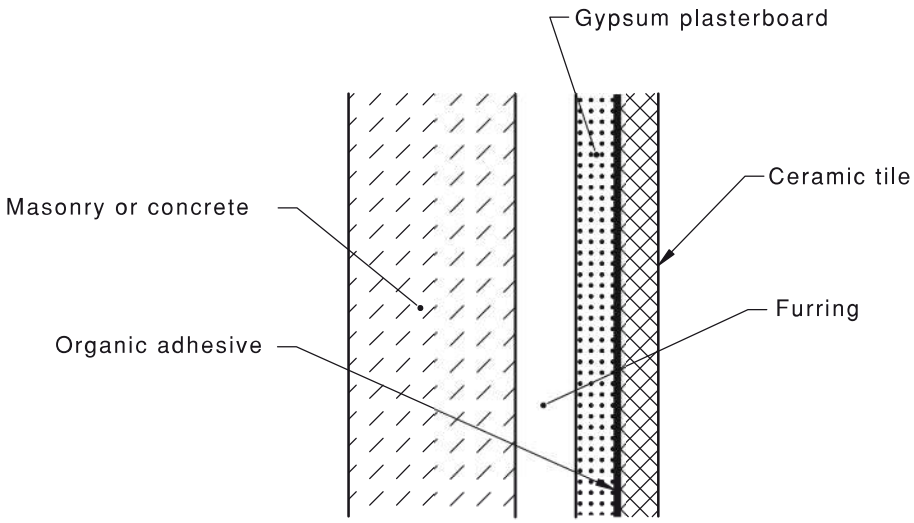
(ii) Movement joints are essential (see Clause 5.4.5).

(e) *Installation specifications*:

(i) Tiles (see Clause 5.6.5).

(ii) Grout (see Clause 5.7).

3.5.2.2 *Mechanically fixed gypsum plasterboard backing with organic adhesive*



The following guidelines should be observed for mechanically fixed gypsum plasterboard backing with organic adhesive for dry interior walls, masonry and concrete.

(a) *Recommended uses* Over internal masonry walls where a gypsum plasterboard backing is desired.

(b) *Materials*:

(i) Organic adhesive (see Clause 2.4).

(ii) Grout—type to be specified (see Clause 2.5).

(iii) Gypsum plasterboard (see Clause 2.6.5):

(A) Minimum 10 mm thick.

(B) Kitchens, laundries, bathrooms—water-resistant grade.

(iv) Furring (see Clause 2.6.6).

(v) Movement joints (see Clause 2.7).

(vi) Ceramic tiles to not exceed 12.5 mm thickness or 32 kg/m^2 mass.

(c) *Preparation by other trades*:

(i) Furring to be fixed at maximum of 600 mm centres.

(ii) Installation of gypsum plasterboard (see Clause 4.6.5).

(iii) Maximum variation to not exceed the tolerance given in Table 4.5.

(d) *Installation*:

(i) When recommended by adhesive manufacturer, the surface to be primed before applying adhesive.

(ii) Adhesive to be applied in accordance with manufacturer's recommendations.

(iii) Movement joints are essential (see Clause 5.4.5).

(iv) A minimum of 12 h should be allowed after tile is set to cure adhesive before grouting.

(e) *Installation specifications*:

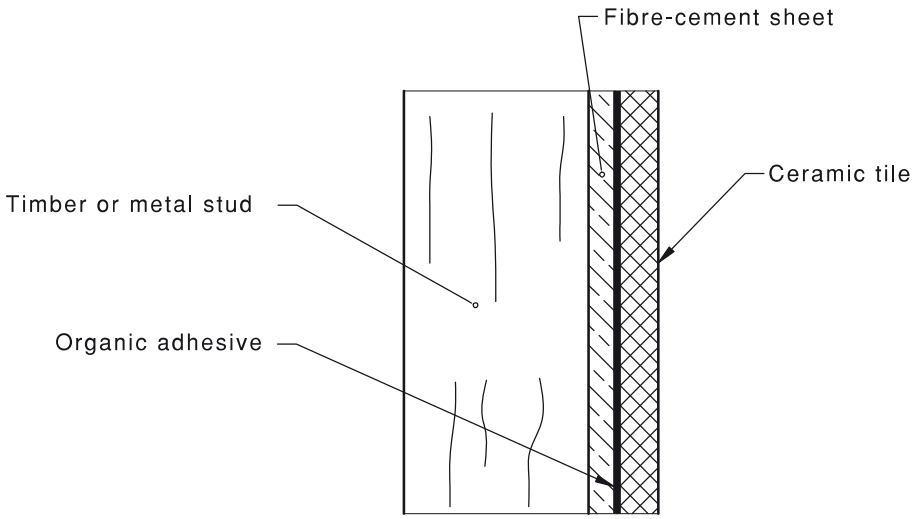
(i) Gypsum plasterboard (see Clause 4.6.5).

(ii) Tiles (see Clause 5.6.6).

(iii) Grout (see Clause 5.7).

3.5.3 Dry interior walls—Framed construction

3.5.3.1 *Fibre-cement sheet with organic adhesive*



The following guidelines should be observed for fibre-cement sheet with organic adhesive for dry interior walls of a framed construction.

(a) *Recommended uses* Any interior wall over framed construction and fibre-cement sheets.

(b) *Materials*:

(i) Flexible organic adhesive (see Clause 2.4).

(ii) Grout—typed to be specified (see Clause 2.5).

(iii) Movement joints (see Clause 2.7).

(iv) Interior grade fibre-cement sheet with chamfered edge (see Clause 2.6.3).

(A) Commercial—9 mm heavy duty.

(B) Commercial or domestic—6 mm light duty.

(c) *Preparation by other trades*:

(i) Installation of fibre-cement sheets (see Clause 4.6.3).

(ii) Maximum variation to not exceed the tolerance given in Table 4.5.

(d) *Installation*:

(i) When recommended by the adhesive manufacturer, the surface to be primed before applying adhesive.

(ii) Adhesive to be applied in accordance with manufacturer's recommendations.

(iii) Movement joints are essential (see Clause 5.4.5).

(iv) A minimum of 12 h to be allowed after tile is set for adhesive curing before grouting.

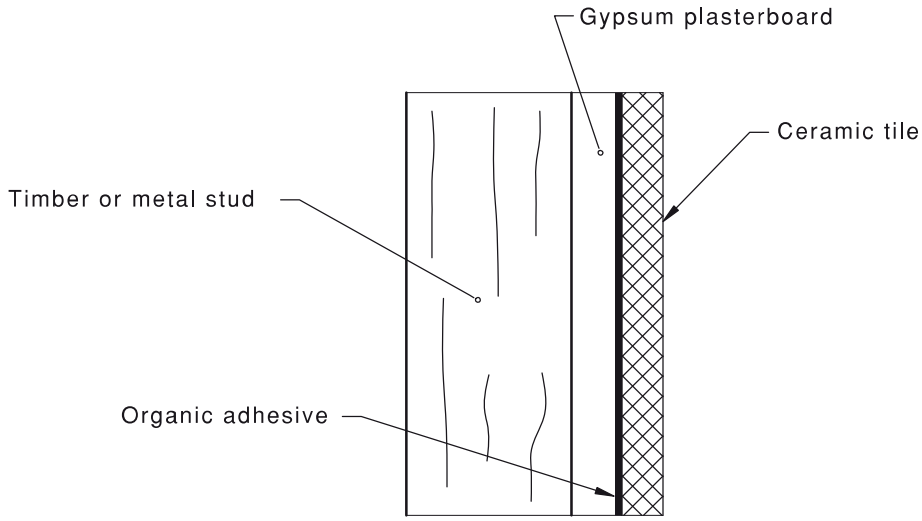
(e) *Installation specifications*:

(i) Fibre-cement sheet (see Clause 4.6.3).

(ii) Tiles (see Clause 5.6.6).

(iii) Grout (see Clause 5.7).

3.5.3.2 *Gypsum plasterboard with organic adhesive*



The following guidelines should be observed for gypsum plasterboard with organic adhesive for dry interior walls of framed construction.

(a) *Recommended uses* Over gypsum plasterboard fixed to timber or metal studs, single or double layer.

(b) *Materials*:

- (i) Organic adhesive (see Clause 2.4).
- (ii) Grout—type to be specified (see Clause 2.5).
- (iii) Gypsum plasterboard (see Clause 2.6.5):
  - (A) Minimum 10 mm thick.
  - (B) Kitchens, laundries, bathrooms—water-resistant grade.
- (iv) Ceramic tiles to not exceed 12.5 mm thickness or 32 kg/m^2 mass.
- (v) Studs (see Clause 2.6.6).

(c) *Preparation by other trades*:

- (i) Minimum stud width 64 mm; maximum spacing 600 mm.
- (ii) Installation of gypsum plasterboard (see Clause 4.6.5).
- (iii) Maximum variation to not exceed the tolerance given in Table 4.5.

(d) *Installation*:

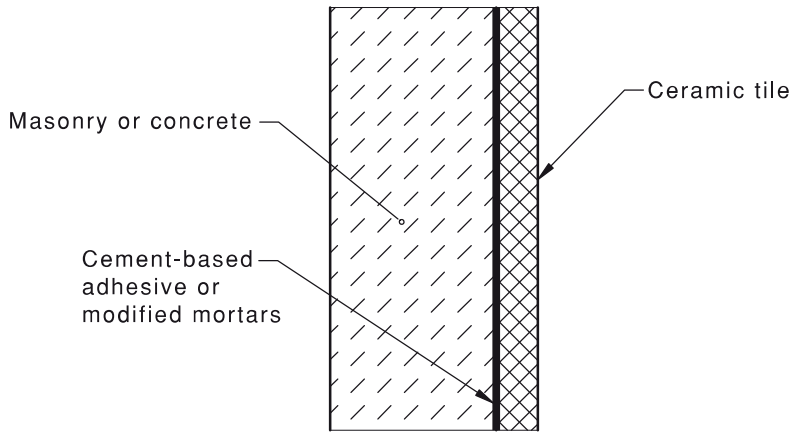
- (i) When recommended by adhesive manufacturer, the surface to be primed before applying adhesive.
- (ii) Adhesive to be applied in accordance with manufacturer's recommendations.
- (iii) Movement joints are essential (see Clause 5.4.5).
- (iv) A minimum of 12 h to be allowed after tile is set to cure adhesive before grouting.

(e) *Installation specifications*:

- (i) Gypsum plasterboard (see Clause 4.6.5).
- (ii) Tiles (see Clause 5.6.6).
- (iii) Grout (see Clause 5.7).

3.5.4 Wet area interior walls—Masonry or concrete

3.5.4.1 *Cement-based adhesives or modified mortar*



The following guidelines should be observed for cement-based adhesive or modified mortar for wet area interior walls of masonry or concrete.

(a) *Recommended uses* Over clean, sound, dimensionally stable masonry or concrete.

(b) *Materials*:

(i) Cement-based adhesive (see Clause 2.4).

(ii) Modified mortar (see Clause 2.4).

(iii) Grout—type to be specified (see Clause 2.5).

(iv) Movement joints (see Clause 2.7).

(v) Waterproof membrane.

(c) *Preparation by other trades*:

(i) Surface to be free of coatings, oil or wax.

(ii) Maximum variation to not exceed the tolerance given in Table 4.5.

(iii) Expanded mesh to be fixed over previously coated or superficially cracked surfaces, then rendered to a true surface.

(iv) Over structurally cracked surfaces, cracks to be repaired and a method from Clause 3.5.1.2 to be used.

(v) Release agents or curing compounds to be removed before tiling. (Alternatively, adhesives compatible with those compounds may be used.)

(vi) Waterproof membranes to be installed in accordance with the manufacturer's recommendations.

(d) *Installation*:

(i) Adhesive to be applied in accordance with manufacturer's recommendations.

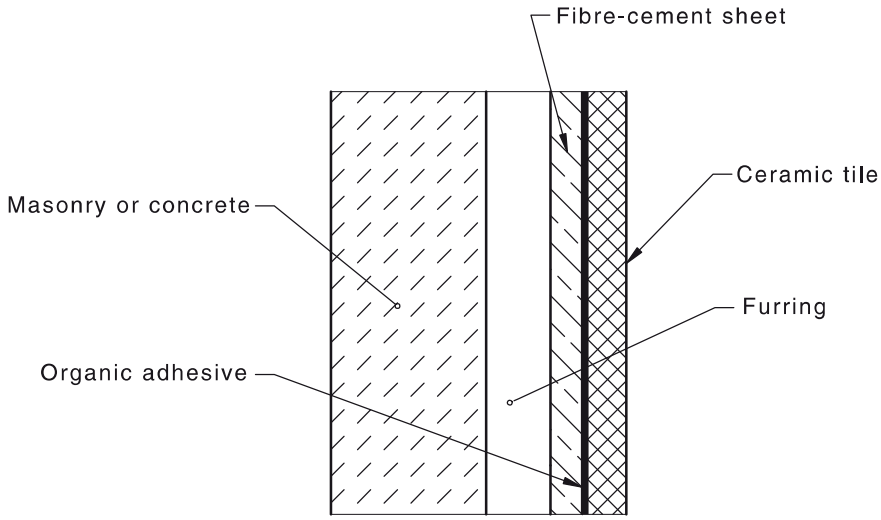
(ii) Movement joints are essential (see Clause 5.4.5).

(e) *Installation specifications*:

(i) Tiles (see Clause 5.6.5).

(ii) Grout (see Clause 5.7).

3.5.4.2 *Fibre-cement sheet on furring over masonry with organic adhesive*



The following guidelines should be observed for fibre-cement sheet on furring over masonry with organic adhesive for wet area interior walls of masonry or concrete.

(a) *Recommended uses* On internal walls over fibre-cement sheet on furring.

(b) *Materials*:

(i) Organic adhesive (see Clause 2.4).

(ii) Grout—type to be specified (see Clause 2.5).

(iii) Interior grade fibre-cement sheet with chamfered edge (see Clause 2.6.3):

(A) Commercial—9 mm heavy duty.

(B) Commercial or domestic—6 mm light duty.

(iv) Furring (see Clause 2.6.6).

(v) Movement joints (see Clause 2.7).

(vi) Waterproof membrane.

(c) *Preparation by other trades*:

(i) Installation of furring—maximum spacing 600 mm.

(ii) Installation of water-resistant gypsum plasterboard—fixed horizontally (see Clause 4.6.5).

(iii) All gaps between plasterboard and plumbing penetrations and fixtures to be sealed as specified by the gypsum plasterboard manufacturer.

(iv) All gypsum plasterboard face-layer joints, angles and fastener heads to be treated with either water-resistant or conventional jointing system (bedding coat only) as specified by gypsum plasterboard manufacturer.

(v) In shower enclosures, gypsum plasterboard surface, including treated joints, to be sealed with waterproof sealer as and where recommended by gypsum plasterboard manufacturer.

(vi) Maximum variation in the finished water-resistant gypsum plasterboard wall surface to not exceed 4 mm in 2 m.

(vii) Waterproof membranes to be installed in accordance with the manufacturer's recommendations.

(d) *Installation*:

(i) When recommended by adhesive manufacturer, the surface to be primed before applying adhesive.

(ii) Adhesive to be applied in accordance with the manufacturer's recommendations.

(iii) A minimum of 12 h to be allowed after tile is set to cure adhesive before grouting.

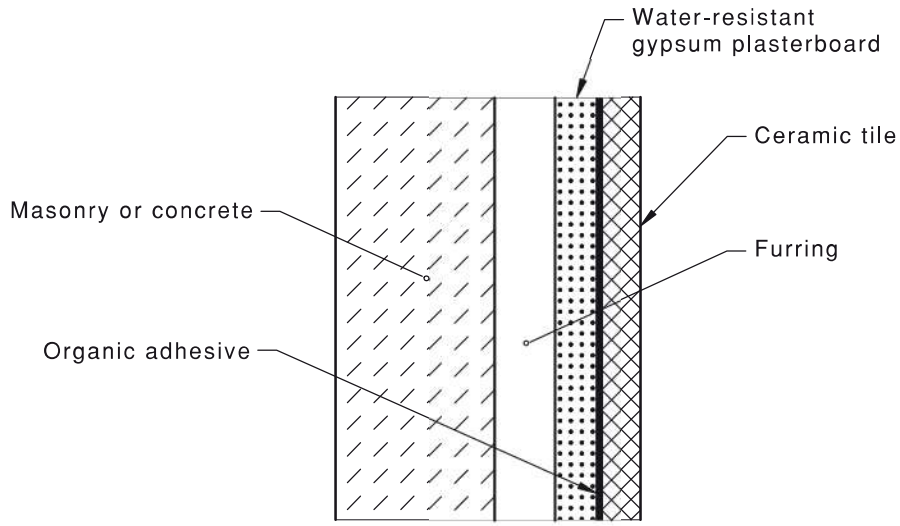
(e) *Installation specifications*:

(i) Fibre-cement sheet (see Clause 4.6.3).

(ii) Tiles (see Clause 5.6.6).

(iii) Grout (see Clause 5.7).

3.5.4.3 *Gypsum plasterboard on furring over masonry or concrete with organic adhesive*



The following guidelines should be observed for gypsum plasterboard on furring over masonry or concrete with organic adhesive for wet area interior walls, masonry, concrete.

(a) *Recommended uses*:

(i) Wet areas over water-resistant gypsum plasterboard on furring over masonry or concrete.

(ii) Not suitable for group showers.

(b) *Materials*:

(i) Organic adhesive (see Clause 2.4).

(ii) Grout—type to be specified (see Clause 2.5).

(iii) Water-resistant gypsum plasterboard, minimum 10 mm thick (see Clause 2.6.5).

(iv) Furring (see Clause 2.6.6).

(v) Movement joints (see Clause 2.7).

(vi) Ceramic tiles should not exceed 12.5 mm thickness or 32 kg/m^2 mass.

(vii) Waterproof membrane.

(c) *Preparation by other trades*:

(i) Installation of furring—maximum spacing 600 mm.

(ii) Installation of water-resistant gypsum plasterboard—fixed horizontally (see Clause 4.6.5).

(iii) All gaps between plasterboard and plumbing penetrations and fixtures to be sealed as specified by the gypsum plasterboard manufacturer. Maximum variation to not exceed tolerance given in Table 4.5.

(iv) In shower enclosures, gypsum plasterboard surface, including treated joints, to be sealed with waterproof sealer as and where recommended by gypsum plasterboard manufacturer.

(v) Maximum variation in the finished water-resistant gypsum plasterboard wall surface to not exceed 4 mm in 2 m.

(vi) Waterproof membranes to be installed in accordance with the manufacturer's recommendations.

(d) *Installation*:

(i) When recommended by adhesive manufacturer, the surface to be primed before applying adhesive.

(ii) Adhesive to be applied in accordance with the manufacturer's recommendations.

(iii) Movement joints are essential (see Clause 5.4.5).

(iv) A minimum of 12 h to be allowed after tile is set to cure adhesive before grouting.

(e) *Installation specifications*:

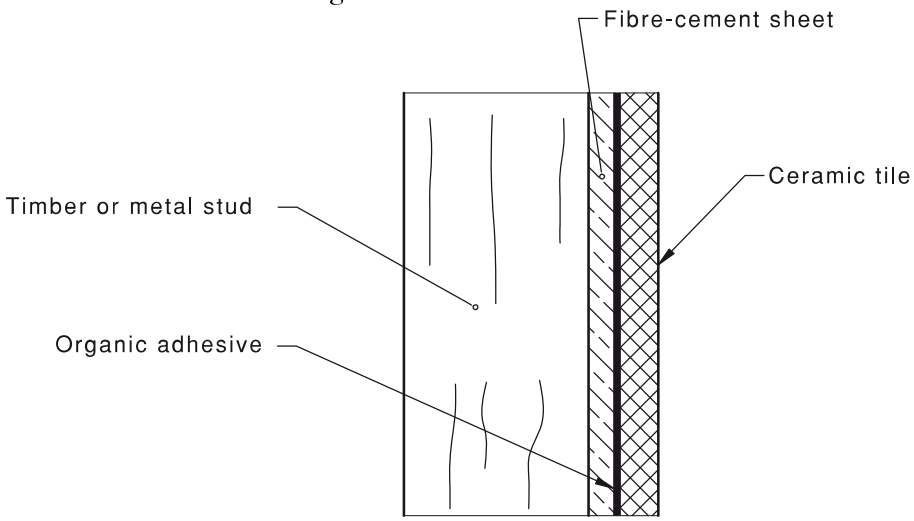
(i) Water-resistant gypsum plasterboard (see Clause 4.6.5).

(ii) Tiles (see Clause 5.6.6).

(iii) Grout (see Clause 5.7).

3.5.5 Wet-area interior walls—Framed construction

3.5.5.1 *Fibre-cement sheet with organic adhesive*



The following guidelines should be observed for fibre-cement sheet with organic adhesive for wet area interior walls of framed construction.

(a) *Recommended uses* Any interior walls over framed construction and fibre-cement sheets.

(b) *Materials*:

(i) Organic adhesive (see Clause 2.4).

(ii) Grout—type to be specified (see Clause 2.5).

(iii) Water-resistant gypsum plasterboard—minimum 10 mm thick (see Clause 2.6.5).

(iv) Movement joints (see Clause 2.7).

(v) Waterproof membrane.

(c) *Preparation by other trades*:

(i) Installation of fibre-cement sheet (see Clause 4.6.3).

(ii) All joints to be taped and set with jointing (bedding) compounds. No finish coat to be applied to the joints.

(iii) Waterproof membranes to be installed in accordance with the manufacturer's recommendations.

(d) *Installation*:

(i) When recommended by the adhesive manufacturer, the surface to be primed before applying the adhesive.

(ii) Adhesive to be applied in accordance with the manufacturer's recommendations.

(iii) All penetrations for plumbing fittings in the fibre-cement sheet to be filled with a water-resistant flexible sealant.

(iv) Movement joints are essential (see Clause 5.4.5).

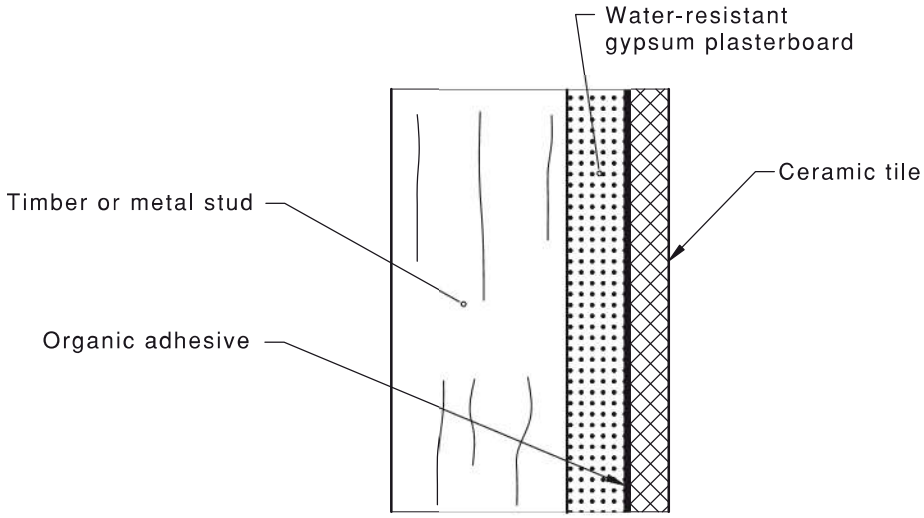
(e) *Installation specifications*:

(i) Fibre-cement sheets (see Clause 4.6.3).

(ii) Tile (see Clause 5.6.6).

(iii) Grout (see Clause 5.7).

3.5.5.2 *Gypsum plasterboard with organic adhesive*



The following guidelines should be observed for gypsum plasterboard with organic adhesive for wet area interior walls of a framed construction.

(a) *Recommended uses*:

(i) Wet areas over water-resistant gypsum plasterboard on timber or metal studs.

(ii) Not suitable for group showers.

(b) *Materials*:

(i) Organic adhesive (see Clause 2.4).

(ii) Grout—type to be specified (see Clause 2.5).

(iii) Water-resistant gypsum plasterboard, minimum 10 mm thick (see Clause 2.6.5).

(iv) Movement joints (see Clause 2.7).

(v) Ceramic tiles to not exceed 12.5 mm thickness or 32 kg/m^2 mass.

(vi) Waterproof membrane.

(c) *Preparation by other trades*:

(i) Minimum stud width 64 mm; maximum spacing 600 mm.

(ii) Installation of water-resistant gypsum plasterboard—fixed horizontally (see Clause 4.6.5).

(iii) All gaps between plasterboard and plumbing penetrations and fixtures to be sealed as specified by the gypsum plasterboard manufacturer.

(iv) All gypsum plasterboard face-layer joints, angles and fastener heads to be treated with either water-resistant or conventional jointing system (bedding coat only) as specified by gypsum plasterboard manufacturer.

(v) In shower enclosures, gypsum plasterboard surface, including treated joints, to be sealed with waterproof sealer as and where recommended by gypsum plasterboard manufacturer.

(vi) Maximum variation to not exceed tolerance given in Table 4.5.

(vii) Waterproof membranes to be installed in accordance with the manufacturer's recommendations.

(d) *Installation*:

(i) When recommended by adhesive manufacturer, the surface to be primed before applying adhesive.

(ii) Adhesive to be applied in accordance with the manufacturer's recommendations.

(iii) Movement joints are essential (see Clause 5.4.5).

(iv) A minimum of 12 h to be allowed after tile is set to cure adhesive before grouting.

(e) *Installation specifications*:

(i) Water-resistant gypsum plasterboard (see Clause 4.6.5).

(ii) Tiles (see Clause 5.6.6).

(iii) Grout (see Clause 5.7).

SECTION 4 PREPARATION OF BACKGROUNDS FOR TILING

4.1 SCOPE OF SECTION

This Section covers the preparation of backgrounds for tiling. The following types of backgrounds are considered:

(a) Concrete floors.

(b) Framed floors.

(c) Concrete/masonry walls.

(d) Framed walls.

(e) Other floor/wall materials.

Specific recommendations for background preparation for wet areas are detailed in AS 3740.

As the preparation of the background is normally carried out by other trades, the tiler should not proceed unless he considers that the preparatory work is satisfactory.

Particular care should be taken where the systems used will be subsequently hidden by this preparatory work, e.g., flashings and waterproofing of shower compartments.

4.2 GENERAL

4.2.1 Wet areas

Construction in wet areas should be in accordance with—

(a) AS 3740; and

(b) the relevant Australian Standard AS/NZS 4858; or

(c) the manufacturer's installation specifications.

Should any conflict arise, AS 3740 should take precedence.

4.2.2 Screeds

A screed is often used as an intermediate layer between the structural base and the tile bed to provide a true and even surface on which to apply the tiles. Recommendations on the design and laying of screeds are provided in Appendix A.

Where proprietary screed mixes are used, they should be used in accordance with the manufacturer's recommendations.

4.2.3 Separating layer

When a separating layer is to be used, the surface of the concrete should be free of ridges or projections that would form a key and impair the sliding action between the two elements. The tile should then be fixed using either a screed, or one of the thick-bed methods.

4.2.4 Liquid and flexible in situ underlays

When a liquid or flexible in situ underlay is to be used, the surface of the concrete should be clean, dry, and prepared in accordance with Table 4.3.

4.2.5 Rigid underlays

The timber surface should be free from any protrusions such as nail heads. All floor coverings should be removed and any loose boards should be re-nailed firmly. If any boards are badly cupped or deformed the surface should be rough sanded to a uniform finish.

The sheets should be fixed at 75 mm centres around the periphery and at 150 mm centres in the interior of the sheets, using 25 mm × 2.5 mm annular threaded nails. The sheets should also be fixed to structural particleboard or plywood flooring with an appropriate adhesive.

4.3 CONCRETE FLOORS

4.3.1 General

Concrete floors to be used as a background for tiling should be constructed in accordance with AS 2870, particularly with regard to shrinkage control, or AS 3600, where appropriate, and prepared in accordance with Clauses 4.3.2 to 4.3.4. Construction in wet areas should be in accordance with Clause 4.2.

The maximum variation in the surface should comply with Table 4.3.

4.3.2 New concrete floors

New concrete floors intended for tiling should be provided with an appropriate finish to suit the method of fixing to be used, as specified in Table 4.3.

Structural concrete should have been subjected to continuous air-drying for the time set out in Table 4.3 before either screed or a directly bedded finishing product is applied. The same allowance should be made for concrete with an integral screed surface. A longer period may be necessary in wet weather.

Some tiling failures have been linked to the failure to adequately remove formwork release agents from concrete surfaces. It is essential that these contaminants, some of which are extremely difficult to detect, be either chemically or mechanically removed prior to the commencement of tiling. Where adhesive is to be used to fix the tile, the manufacturer's recommendations on surface preparation should be followed.

NOTE: Guidance on the removal of contaminants would normally be available from the adhesive manufacturer.

When a Portland cement mortar bed is to be used, it may be either bonded or fixed using a separating layer (see Clause 4.2.3). Where it is to be bonded, the bed may either be—

(a) fixed to a screed (see Clause 4.2.2); or

(b) fixed directly to the slab, where the slab has been wood-float finished, and contaminants such as waxy or oily substances or curing compounds removed.

TABLE 4.3

CONCRETE FLOOR PREPARATION

Fixing method		Applicability of finish				Minimum drying time of concrete	Maximum variation in plane of concrete*
Fixative	System	Screed	Wood float or broom	Power float	Steel trowel		
Mortar	In situ underlay	Yes	Yes	Yes	Yes	4 weeks	5 mm in 3 m
	Separating layer	Yes	Yes	Yes	Yes	4 weeks	5 mm in 3 m
	Sand/cement mortar bed	Yes	Yes	No	No	6 weeks	20 mm in 3 m
Adhesive	Thick-bed	Yes	Yes	Yes	No†	6 weeks	10 mm in 3 m
	Thin-bed	Yes	Yes	Yes	No†	6 weeks	5 mm in 3 m
	In situ underlays‡	Yes	Yes	Yes	No†	4 weeks	5 mm in 3 m

* Unless concrete surface is prepared in accordance with adhesive manufacturer's requirements.
† Surface preparation may make this surface satisfactory.
‡ Refer to manufacturer's instructions for installation.

4.3.3 Existing concrete floors

Where a bonded Portland cement mortar bed is to be used and the surface is uncontaminated, an appropriate method from Table 4.3 should be used. Where the surface has an unsuitable finish, mechanical equipment should be used to scabble the surface of the slab to expose the coarse aggregate. All loose debris and dirt should be removed by thorough sweeping, or preferably by vacuum equipment. Alternatively a screed (see Clause 4.2.2) or a separating layer may be used (see Clause 4.2.3).

Where the slab is sound and true with a suitable trowel or float finish but is contaminated by grease, oil, paint, curing compounds, etc., these should be mechanically removed, or the surface of the slab should be cleaned with a suitable wash and allowed to dry, prior to the application of the adhesive (see Clause 4.3.2(b)).

4.3.4 Concrete floors with existing finish

Where possible, all existing finishes should be removed in accordance with Clause 4.3.2(b). Where this is not possible, a separating layer should be used. Where the existing finish is sound (see Clause 5.4.7) and where a suitable fixative is available for bonding to the surface, removal of the existing finish may not be necessary.

NOTES:

1 Localized patching may be necessary.

2 In some instances ceramic or vinyl tiles may be suitable for overlaying.

4.4 FRAMED FLOORS

4.4.1 General

Construction of the substructure and the fixing of sheet materials as a background for floor tiling should be in accordance with this Clause (4.4). Construction in wet areas should be in accordance with AS 3740.

4.4.2 Ventilation of subfloor spaces

4.4.2.1 *Joist-supported ground floors*

Joist-supported ground floors should be provided with permanent through-ventilation in accordance with AS 1684.2, AS 1684.3 and AS 1684.4.

NOTE: Attention is drawn to the special requirements for subfloor ventilation given in AS/NZS 1860.

4.4.2.2 *Joist-supported upper floors*

Joist-supported upper floors should be provided with permanent through-ventilation parallel to the joists.

4.4.3 Construction of joist-supported floors

4.4.3.1 *Bearers and joists*

Bearers and joists forming the suspended structural timber floor framing should comply with AS 1684.1, AS 1684.2 and AS 1684.3.. Where bearers and joists are to support structural sheet flooring, the joists should be set out so that sheet edges will butt centrally over them.

4.4.3.2 *Trimmers*

Trimmers fixed between the joists should be provided to support free ends and edges except as permitted in AS/NZS 1860 for particleboard flooring.

4.4.4 Preparation for tiling over timber floors

4.4.4.1 *General*

When tiling is to be carried out over timber, plywood or structural particleboard floors, a primer and underlay or separating layer would normally be used. Specialized products are, however, also available, and should be used in accordance with the manufacturer's recommendations.

4.4.4.2 *Timber tongued and grooved flooring*

Timber tongued and grooved flooring used as a substrate or background for tiling should be fixed in accordance with AS 1684.1, AS 1684.2 and AS 1684.3. be firmly nailed in place and be flat and free from nails or other protrusions. If necessary it should be sanded down.

4.4.4.3 *Plywood*

Plywood used as a substrate or background for floor tiling should comply with Clause 2.6.1. Plywood should be fixed in accordance with AS 1684.1, AS 1684.2 and AS 1684.3 and the recommendations set out in the, *Technical Manual Tongue and Grooved Structural—Design Manual*—1985.

4.4.4.4 *Structural particleboard flooring*

Structural particleboard flooring used as a substrate or background for floor tiling should comply with Clause 2.6.2. Structural particleboard flooring should be fixed in accordance with AS/NZS 1860.

4.4.4.5 *Fibre-cement sheets*

Fibre-cement sheets to be used on timber floors as a substrate for floor tiling should comply with Clause 2.6.4. Fibre-cement sheets should be fixed in accordance with the sheet manufacturer's recommendations.

4.4.5 Preparation for tiling on compressed fibre-cement sheets

Compressed fibre-cement sheets to be used as a substrate for floor tiling should comply with Clause 2.6.4. They should be fixed in accordance with the sheet manufacturer's instructions. Where compressed fibre-cement sheet is to be used internally, particular attention should be paid to the following:

(a) The compressed sheet to be fixed to all joists with zinc-plated or cadmium-plated screws at 450 mm centres.

(b) The joints between the sheets to be jointed with an approved adhesive.

(c) The edges of the sheet to be screw-fixed, taking care that the holes for the screws are not closer than 12 mm from the edge of the sheet or closer than 50 mm from a corner.

(d) Movement joints to be provided in accordance with Clause 5.4.5.

Where the compressed fibre-cement sheets form part of an external deck, in addition to the recommendations set out above, particular care should be paid to the movement joints, as follows:

(i) Movement joints should be sealed with a flexible jointing system in accordance with the sheet manufacturer's recommendations.

(ii) Movement joints should be carried through the tiling.

4.5 CONCRETE/MASONRY WALLS

4.5.1 General

Concrete or masonry walls to be used as a background for ceramic tiling should comply with the following, where appropriate:

(a) Concrete structures—AS 3600.

(b) Concrete surface finish, where specified—AS 3610.

(c) Masonry—AS 3700.

4.5.2 New concrete walls

In addition to the recommendations of Clause 4.5.1, structural concrete should be subjected to continuous air-drying for four weeks before rendering or direct bedding is carried out. Care should be taken to ensure that all surface contaminants are removed (see Clause 4.3.2).

4.5.3 Existing concrete/masonry walls

4.5.3.1 *General*

Existing concrete/masonry walls to be used as a background for tiling should be prepared in accordance with Table 4.5. Construction in wet areas should be in accordance with Clause 4.2.1. Where cleaning of the surface is required prior to the application of mortar, it should be carried out in accordance with Clause 4.3.3.

TABLE 4.5

SUBSTRATE AND BACKGROUND PREPARATION FOR WALL TILING

Fixing method		Background preparation										Maximum variation in plane of background
		Concrete			Masonry							
Fixative	System	Concrete wall	Cement render	Plaster	Concrete block	Clay brick	Cal/sil brick	Paint	Stone	Contaminated (soot, oil)	Tiled surfaces	
Mortar	Buttering	C	—	—	G	A	B/G	D	G/B	D	—	8 mm in 2 m
	Render and lay (mosaics)	C	—	—	A	A	A	D	G/B	D	G	4 mm in 2 m
Adhesive	Thick-bed	F	F	F	B	F	F	F	F	F	F	4 mm in 2 m
	Thin-bed	F*	F	F	B	—	—	F	F	F	F	4 mm in 2 m
	Framed construction plus adhesive	E	E	E	E	E	E	E	E	E	E	4 mm in 2 m

* Class 3 concrete finish or better—thin-bed fixing possible

LEGEND:

A = brush off loose dirt and damp down
B = apply cement render
C = apply slurry of bond coat
D = expose sufficient of underlying surface to form a key
E = follow sheet manufacturer's recommendations
F = follow adhesive manufacturer's recommendations
G = apply scratch coat

NOTE: The maximum variations in plane noted in Table 4.5 do not include the mortar joints in brickwork.

4.5.3.2 *Procedures*

Details of some of the methods of preparation noted in Table 4.5 are set out below. The various procedures are as follows:

(a) *Brickwork (clean)* Use either thick-bed or thin-bed fixing:

(i) *Thick-bed*—brush and wash down.

(ii) *Thin-bed*—follow the adhesive manufacturer's recommendations, but this would normally require the prior application of a render coat of 4:1:½ sand, cement, lime. Allow the render coat to dry for 7–10 days then lightly brush or scratch to form a key.

(b) *Brickwork (painted)* Scratch the surface and rake out the joints to gain a key to at least 60% of the surface. Remove any loose paint flakes and dust. As this type of surface has very little suction, further preparation will be necessary. Either render or paint as follows:

(i) *Render*—render [see Item (a)(ii)] and tile using thick-bed or thin-bed fixing.

(ii) *Paint*—paint the surface with a bonding agent, scatter coarse sand onto the surface to provide a key, and tile using the thick-bed method.

(c) *Render* Apply tiling to render using either the thick-bed or thin-bed method as follows:

(i) *Thick-bed*—scratch to provide key.

(ii) *Thin-bed*—leave wall clean and dry and follow adhesive manufacturer's recommendations.

Guidance on the application of cement render may be found in Appendix B.

(d) *Concrete* Treat concrete by either of the following methods:

(i) *Expose* Clean off or remove any laitance on the surface, or any oil, grease or other contaminants that would destroy the key for subsequent operations.

(ii) *Slurry/bond coat/spatterdash* This treatment depends on the porosity of the walls. Spatterdash low porosity walls prior to rendering or buttering. Treat other walls with a slurry or bond coat.

(e) *Existing tiles* Tile over existing tiles by first removing any loose or drummy tiles and patching, score the face of the remainder with a tungsten scriber to provide a key, then use a suitable adhesive in accordance with the manufacturer's recommendations.

(f) *Concrete blocks* Render and tile with either thick-bed or thin-bed adhesive.

4.6 FRAMED WALLS

4.6.1 General

The fixing of sheet materials as a background for wall tiling should be in accordance with this Clause (Clause 4.6). Construction in wet areas should be in accordance with Clause 4.2.1.

4.6.2 Fixing of plywood substrates

Plywood to be used as a substrate for wall tiling should comply with Clause 2.6.1. Plywood should be fixed in accordance with AS 1684 and the recommendations set out in the *Technical Manual Tongued and Grooved Structural Plywood—Design manual* 1985.

4.6.3 Fixing of fibre-cement sheets

Fibre-cement sheets to be used as a substrate for wall tiling should comply with Clause 2.6.3. Fibre-cement sheets should be fixed in accordance with the sheet manufacturer's instructions. Particular attention should be paid to the following:

(a) Where sheets are fixed horizontally, noggings to be provided behind every horizontal sheet joint. Where single sheets are fixed vertically, noggings should be provided at 600 mm centres maximum.

(b) Sheets to be fixed at 150 mm centres on all framing members with 30 mm × 2.8 mm fibre-cement sheet nails.

(c) Sheets to be fixed 6 mm clear of the floor.

(d) Sheet joints at vertical corners within 1.5 m of a shower rose and around a bath (see AS 3740) to have a clearance of 2 mm which should be sealed with a suitable sealant or be backed with a flashing strip to the manufacturer's specification.

(e) Movement joints to be provided in walls greater than 4.2 m in length.

4.6.4 Fixing of compressed fibre-cement sheets

Compressed fibre-cement sheets to be used as a substrate for wall tiling should comply with Clause 2.6.4. Compressed fibre-cement sheets should be fixed in accordance with the manufacturer's instructions. Particular attention should be paid to the following:

(a) Stud centres to not exceed 600 mm.

(b) Sheets to be fixed with countersunk head zinc-plated or cadmium-plated screws at 300 mm centres around the perimeter of the sheet and along all intermediate studs and noggings.

(c) The edges of the sheet to be screw-fixed, taking care that the holes for the screws are no closer than 12 mm from the edge of the sheet or 50 mm from a corner.

4.6.5 Fixing of gypsum-plasterboard sheets

Gypsum plasterboard sheets to be used as a substrate for wall tiling should comply with Clause 2.6.5. In dry-area applications, sheets should be fixed in accordance with AS/NZS 2589.1 with fastener centres and joint finish coat as specified by the gypsum plasterboard manufacturer. For wet-area applications, sheets should be fixed in accordance with AS 3740 and the gypsum plasterboard manufacturer's recommendations.

In addition to wet-area applications, water-resistant gypsum plasterboard sheets should also be used in areas subject to infrequent wetting, such as kitchens, laundries and general bathroom areas.

Gypsum plasterboard sheets of any grade are not recommended for use in group showers.

Particular attention should be paid to the following:

(a) The minimum recommended single layer plasterboard thickness to be 10 mm.

(b) Stud or furring centres to not exceed 600 mm.

(c) Gypsum plasterboard sheets used as a substrate for tiling to be fixed to the framing with nails or screws. Adhesive fixing is not acceptable.

(d) Water-resistant sheets to be fixed horizontally.

(e) In dry-area applications, all gypsum plasterboard face-layer joints should be taped and filled with one 100 mm wide coat of joint compound (no finish coat). All face-layer internal and external angles should also be treated with tape bedded in joint compound (no finish coat). Fastener heads should be treated with one or two coats only (no finish coat) as specified by the gypsum plasterboard manufacturer.

(f) In wet-area applications, all gypsum plasterboard face-layer joints, internal and external angles, and fastener heads should be treated as in Item (e) or with a water-resistant jointing system (bedding coat only) as specified by the gypsum plasterboard manufacturer.

(g) In shower enclosures, the gypsum plasterboard surface, including treated joints, should be sealed with a waterproof sealer as and where recommended by the gypsum plasterboard manufacturer.

(h) In both dry- and wet-area applications as follows:

(i) For wall tiles 6.5 mm thick or less, gypsum plasterboard should be fixed along each stud at 200 mm maximum centres in the field of the board, and at 150 mm maximum centres for corners, openings, edges and butt joints.

(ii) For wall tiles more than 6.5 mm thick, fasteners should be spaced along each stud at 100 mm maximum centres in the field of the board, and at corners, openings, edges and butt joints.

(iii) Gypsum plasterboard sheets adjoining floors to all areas, except shower recesses, to be fixed 10 mm clear of the finished floor.

(i) Where a skirting is used with gypsum plasterboard in wet areas, (i.e., showers) the skirting should be fixed in accordance with AS 3740.

(j) Neat cut-outs for taps, outlets and other penetrations should be provided, leaving as small a gap as possible between cut edges and the penetrations. The gaps should be filled with sealant as specified by the gypsum plasterboard manufacturer.

SECTION 5 INSTALLATION OF CERAMIC TILES

5.1 SCOPE OF SECTION

This Section sets out the recommended methods for installing ceramic tiles. These recommendations are based on the various alternative bedding methods which are available.

5.2 PRELIMINARY CONSIDERATIONS

5.2.1 General

All bedding methods listed are suitable for the installation of tiles with shallow-key backs; however, thin-bed adhesives are not suitable for the fixing of tiles with backs incorporating deep keys or ribs. For these, sand/cement mortar or thick-bed adhesives should be used to butter the tiles, subject to their being compatible with the background.

If tiles are not of uniform thickness or if the background surface to receive the bedding is uneven, the use of thin-bed fixing methods may be precluded.

The methods described for the bedding of tiles in adhesives are those usually adopted, but there are some variations in fixing procedures for several of the products available. Therefore, it is important that the adhesive manufacturer's precise recommendations for selection and application be followed.

Unless otherwise recommended by the adhesive manufacturer, it is recommended that only adhesives that cure by chemical reaction be used where it is intended to tile over—

(a) non-porous backgrounds with a low absorption tile; or

(b) the walls of impervious internal shower trays.

NOTE: Premixed adhesives that cure by the evaporation of water are generally not suitable, whereas cement-based adhesives, modified mortars and epoxies are.

5.2.2 Compatibility of backgrounds and bedding systems

5.2.2.1 *General*

Throughout this Section of the Standard, the term 'background' means the surface intended directly to receive the bedding after the appropriate preparatory treatment. Preparation of background should be in accordance with Section 4. In Clauses 5.5.2 and 5.6.2 additional information, which may be specific to the bedding method being described, is provided.

5.2.2.2 *Residual moisture content*

The residual moisture content of the background should be within the range specified by the adhesive manufacturer. Information on the various methods available to assess the moisture content of a concrete floor is available in Appendix B of AS 3958.2.

5.2.3 Delivery, storage and handling of materials at the project site

The delivery of tiles and other materials should be so arranged as to minimize handling. Packaged materials should be stored in original unopened containers with labels intact until time of use.

Materials should be stored and handled in a manner to prevent damage, extremes of temperature or contamination by water or foreign matter.

5.2.4 Site protection

During the laying operation, the areas should be accessible to no one but the tilers. Completed floor tiling should not be subject to traffic until the bed has stiffened and sufficient bond has developed between the bed and tiles.

Light pedestrian traffic may be allowed on floors bedded in slow-setting adhesive and in sand/cement mortars two days after completion of laying and grouting; however, heavier traffic should not be permitted to use the floor for 7 days after completion of the tiling.

Where tiles are laid in a rapid-setting adhesive, the floor may take traffic earlier than two days after completion; however, unless a rapid-hardening grout is used, it would be inadvisable to reduce the 7 day period. The precise times to which a floor may be safely put into service vary for different rapid-setting products, and the manufacturer's recommendations should be followed.

5.3 MATERIALS

Materials should be in accordance with Section 2. Proprietary materials should be mixed and used in strict accordance with the manufacturer's recommendations unless otherwise specified in this Standard or in the project specifications.

Class C1 adhesives should be used for fixing low porosity tiles such as B1a tiles.

5.4 GENERAL CRITERIA FOR INSTALLATION OF TILES

5.4.1 General

All surfaces should be dry, clean and firm, free of laitance, efflorescence, or oily or waxy films. Concrete surfaces should also be free of form oil and curing compounds.

Grounds, anchors, plugs, hangers, door frames, electrical, mechanical, plumbing and other work in or behind the tile should be installed before tile work is started.

Installation work should not proceed until satisfactory conditions are provided including, where appropriate, the correct 'falls in the base' (see Clause 4.1).

Unless otherwise specified by the adhesive manufacturer, tile bedding materials should not be applied to surfaces that contain frost. Tiles should not be installed when—

(a) the air temperature is not maintained above 5°C during the installation; or

(b) the temperature of the substrate or tiling materials is above 40°C.

The maximum variation in surfaces to receive tile should be as shown in Tables 4.3 and 4.5.

All vertical finished tile surfaces should be plumb and true with square corners.

The preparation of various backgrounds and the precautions that should be adopted in each instance are set out in Section 4.

In addition to the recommendations set out in this Clause, specific recommendations are provided in Clauses 5.5, 5.6, 5.7 and 5.8.

5.4.2 Setting out

5.4.2.1 *General*

The setting out should be related to the siting of movement joints. Movement joints should be detailed on working drawings, but it is sometimes necessary for their positioning to be left to the discretion of the contractor. In such circumstances these movement joints should be installed as recommended in Clause 5.4.5.

5.4.2.2 *Floor tiles*

When setting out it is essential to establish the correct datum level for the floor. Whole tiles should be used to the greatest possible extent. If cutting is necessary, then cut tiles should be fixed as unobtrusively as possible.

5.4.2.3 *Wall tiles*

It is important for the appearance of the finished wall tiling that unsightly cut tiles be minimized and that joints be even in width. Allowance should be made for an adequate width of joint (see Clause 5.4.6). The necessity for cut courses, both vertical and horizontal, should be determined in advance and the work set out so that such courses are as large as possible and arranged in the least prominent of alternative locations.

Where wall surfaces are interrupted by fixtures, e.g., windows, access panels or sanitary fittings, the tile fixer may need guidance from the architect as to the setting out to be adopted. Similar guidance may be required in the positioning of movement joints since they will be predominant and may determine the setting-out pattern.

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

(a) Tiled areas that adjoin or are adjacent will need to be set out so that horizontal joints are aligned.

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

(c) If it is required to align a joint with a fixture, this may initiate the need for, and frequently dictate the location of, cut courses.

Where the tile sizes are such that alignment of wall and floor joints is not possible, it is usually better to break joint completely rather than start an alignment that cannot be maintained.

5.4.2.4 *Placement of cuts*

The minimum amount of cuts should be made consistent with the aesthetics of the overall job.

Where possible, cuts should not be smaller than half size and all cuts should be made on the perimeter of the job.

5.4.3 Fitting

The cutting and fitting of tiles and accessories should be carried out as follows:

(a) Cut edges smooth and install the tile without jagged or flaked edges.

(b) Fit the tile closely where the edges will be covered by trim, escutcheons or other similar devices.

(c) Do not install single tiles in more than one piece unless no alternative is possible.

(d) Unless otherwise specified, maintain the heights of wall tile work in full courses to the nearest obtainable dimension.

(e) With due allowance to tolerances for the tiles, make the corners of all tiles flush and level with corners of adjacent tiles.

(f) Keep all joint lines, including mitres, straight and of even width, with due allowance for the tolerance of the tile.

(g) Fully bed all trim units, moulded or shaped pieces, nosings, covers and other accessories with an appropriate bedding material. Do not bed these accessories in more than 3 mm of neat cement.

(h) Fix accessories in tile work level, plumb and true to the designated projection. Where specified, install accessories at the appropriate locations and heights.

Finished tile work should be clean and free of pitted, chipped, cracked or scratched tiles resulting from the fixing operation.

NOTE: A limited number of tiles with defects such as those noted above may be found in batches of tiles that comply with AS 4662. Such tiles are normally used where cut tiles are required.

5.4.4 Lighting

Where possible, the lighting at the time of applying the tiles should not be appreciably different from the ultimate permanent lighting, as minute differences of plane between adjacent tiles can be highlighted significantly by some forms of oblique lighting.

5.4.5 Movement joints

5.4.5.1 *General*

Movement joints are discontinuities in the tiled surface, filled with permanently deformable material, which are intended to perform the following functions:

(a) Separation of the tiled surface from fixed elements such as columns and walls.

(b) Subdivision of large areas of tiled surface into smaller sections to compensate for induced strain from various causes.

(c) To interrupt the tiled surface to match discontinuities in the substrate such as construction joints and movement joints.

It is essential that movement joints be carried through the tile and the bedding.

Movement joints should be filled with permanently deformable materials, such as polystyrene, and sealed with materials that are equally deformable as well as resistant to chemical and physical attack.

All joints should be rectangular in section with firm, straight, smooth edges, free from cavities and irregularities. When forming the joints it is useful to insert a fillet to ensure smooth clean faces to the joints, and remove it only when the cladding is sufficiently firm. Care should be taken to avoid grout or other materials becoming trapped in the joint cavity, as these will prevent the proper application of the back-up and sealant.

Unless otherwise specified, movement joints should be constructed as shown in Figures 5.1 and 5.2 and as detailed in Clauses 5.4.5.2 and 5.4.5.3. Where it is essential that the watertightness of the movement joint and tiling system be maintained, specific guidance should be sought with regards to width to depth ratio, priming and special nature of sealant materials.

5.4.5.2 *Floors*

In floors that have to withstand hard-rimmed wheel traffic or the dragging of heavy loads, the position of movement joints should, where possible, be planned so that they do not occur in the traffic area. Where this is not practicable the joints should be of types having their edges reinforced with metal or rigid plastics sections (see Figure 5.1 (a), (b), (d) and (e)).

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

NOTE: The illustrations in Figure 5.1 indicate the basic principles of the types of joints referred to above. Prefabricated joints of types (b) and (e), which embody the principles above are available, but they may differ in detail.

Movement joints should be located and installed in accordance with the manufacturer's recommendations, as follows:

(a) *Structural movement joints* Movement joints type (a) or (b), as shown in Figure 5.1, should be inserted in the bed, with tiling immediately over, as be continuous with, movement joints or contraction joints in the base and should be of sufficient width to permit the joint filling to accommodate the anticipated movement. If the base joints are not true (e.g., not straight and parallel), or their layout does not coincide with that of the tiles, the siting of the movement joints in the finish, as stated, may not be acceptable and a decision as to any alternative procedure should be obtained from the specifier.

(b) *Intermediate movement joints* Intermediate joints type (c), (d) or (e), as shown in Figure 5.1, should be inserted at intermediate positions to accommodate deflections of the base and movements in the flooring.

They should be provided in evenly spaced positions at approximately 4.5 m centres, or at locations where stress might reasonably be expected in—

(i) internal floors, where any dimension exceeds 9 m or 6 m if subjected to sunlight; and

(ii) external floors where any dimension exceeds 4.5 m.

On suspended floors, stress-relieving joints type (e), as shown in Figure 5.1, should be inserted where flexing is likely to occur (e.g., over supporting walls or beams).

Consideration should be given to the provision of additional movement joints in internal rooms either partly or wholly subjected to strong sunlight.

In very large floors it is advisable to incorporate movement joints forming bays divided by type (c) or (d) joints, as shown in Figure 5.1, at 24 m to 30 m intervals, each bay being subdivided into smaller bays by stress-relieving joints type (e) shown in Figure 5.1, at 8 m to 10 m intervals. Floors that are not so large should be divided into bays by the insertion of type (e) joints as shown in Figure 5.1, at 8 m to 10 m intervals.

(c) *Perimeter joints* Movement joints type (c), as shown in Figure 5.1, should be inserted where the tiling abuts restraining surfaces such as perimeter walls, columns, curbs, steps and plant fixed to the base. In floors of less than approximately 10 m^2, perimeter joints may be deleted if it is considered that the hygiene, waterproofing or aesthetics of the installation will be adversely affected. If perimeter joints are deleted, floor tiles should finish a minimum of 3 mm from restraining surfaces. Perimeter joints are recommended in all areas where conditions that may generate stresses are likely to be extreme, as in rapid, large temperature changes (e.g., underfloor heating).

(d) *Contraction joints* Contraction joints are non-compressible joints used to relieve tension (see Figure 5.1(f)). They may be used as perimeter joints, over supporting walls or beams, or to subdivide large floors into smaller bays.

5.4.5.3 *Walls*

Movement joints should extend through the cladding and its bedding and be a minimum of 6 mm wide, but where substantial movement may be anticipated in any part of the installation they should be carried through any intermediate substrate to the face of the structural wall (see Figure 5.2).

Movement joints should be installed at the following locations:

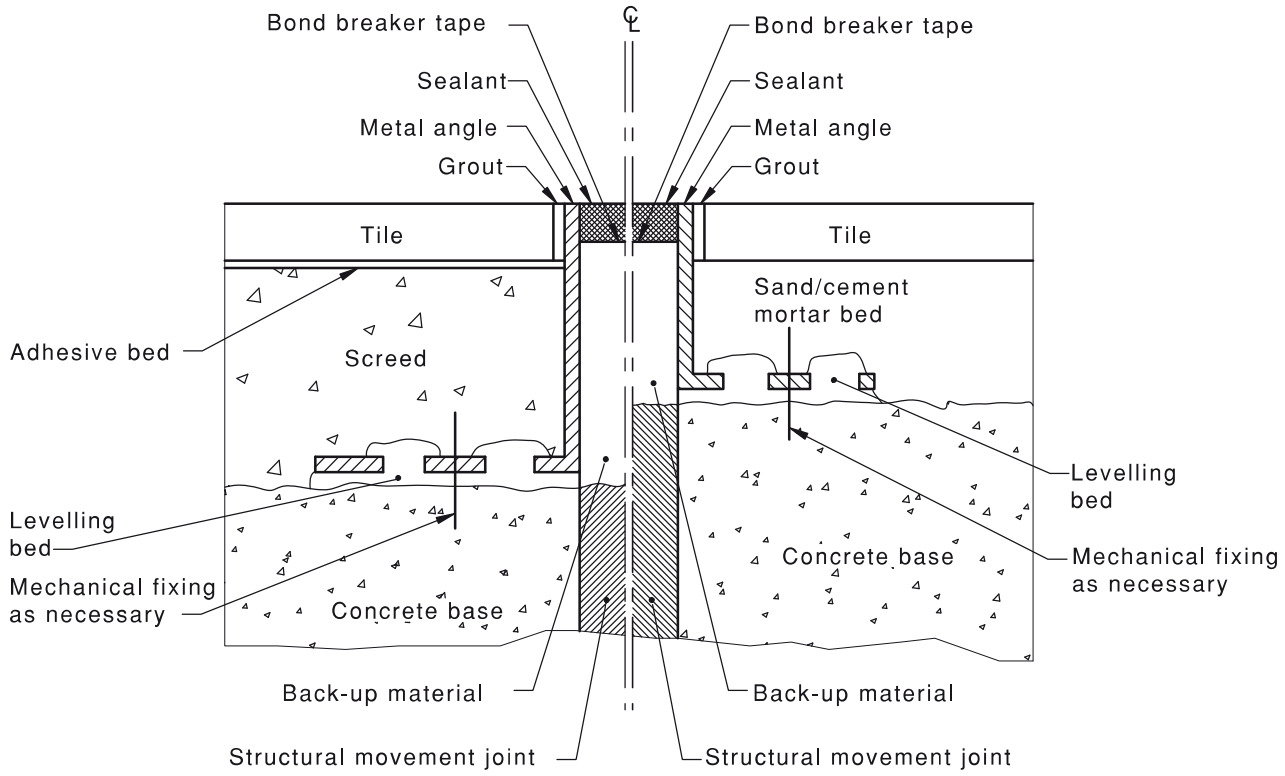
(a) Over existing movement joints.

(b) Where cladding abuts other materials.

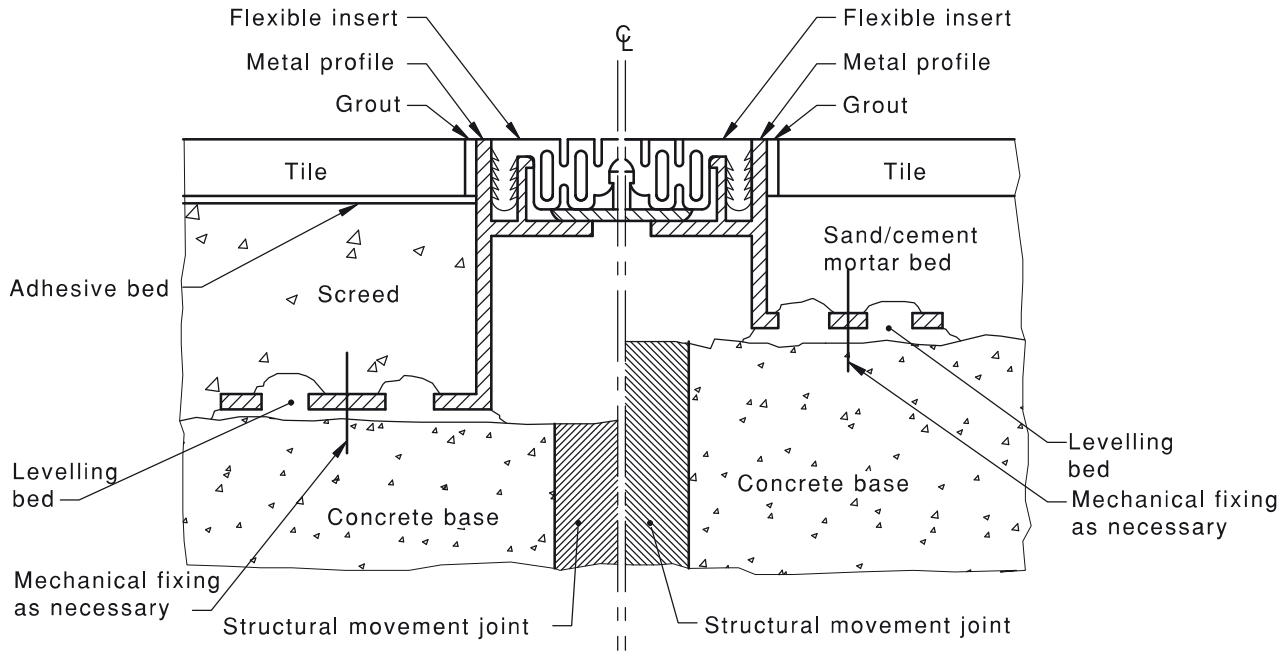
(c) At junctions between different background materials, when cladding is continuous across varying types of background.

(d) At storey heights horizontally and approximately 3 m to 4.5 m apart vertically. Ideally, they should be located over movement joints in the structural background and at structural material changes, for example the horizontal joint at the bottom of floor slabs, vertical joints at internal corners and at junctions with columns.

(e) At vertical corners in shower compartments (see AS 3740).

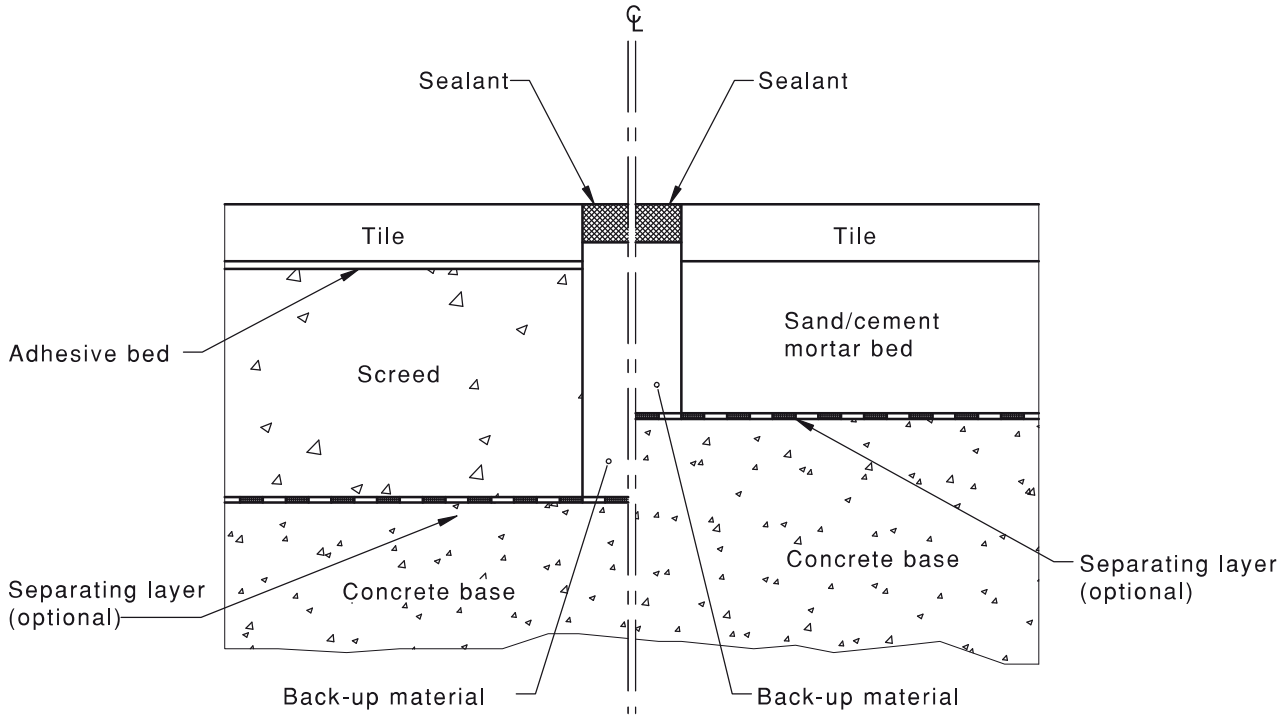


(a) Joint aligned to structural movement joint

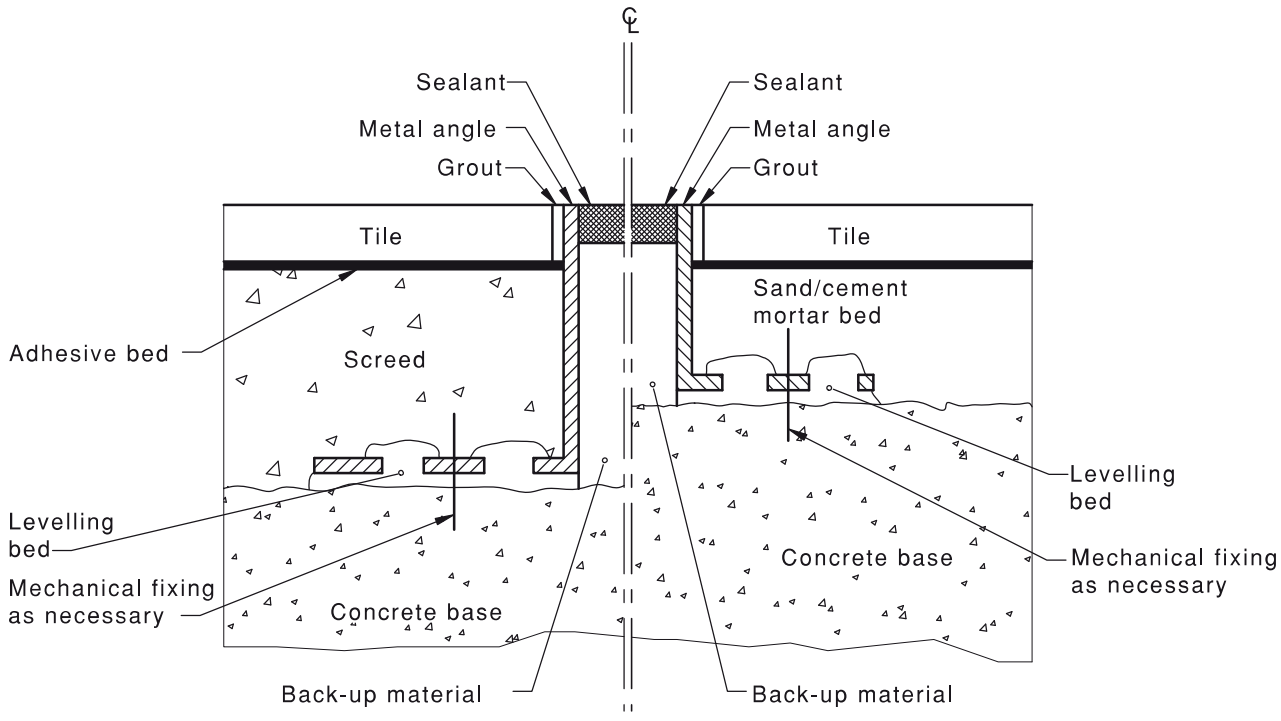


(b) Prefabricated joint with reinforced edges and capping over structural movement joint

FIGURE 5.1 (in part) TYPICAL MOVEMENT JOINT SYSTEMS FOR FLOORS

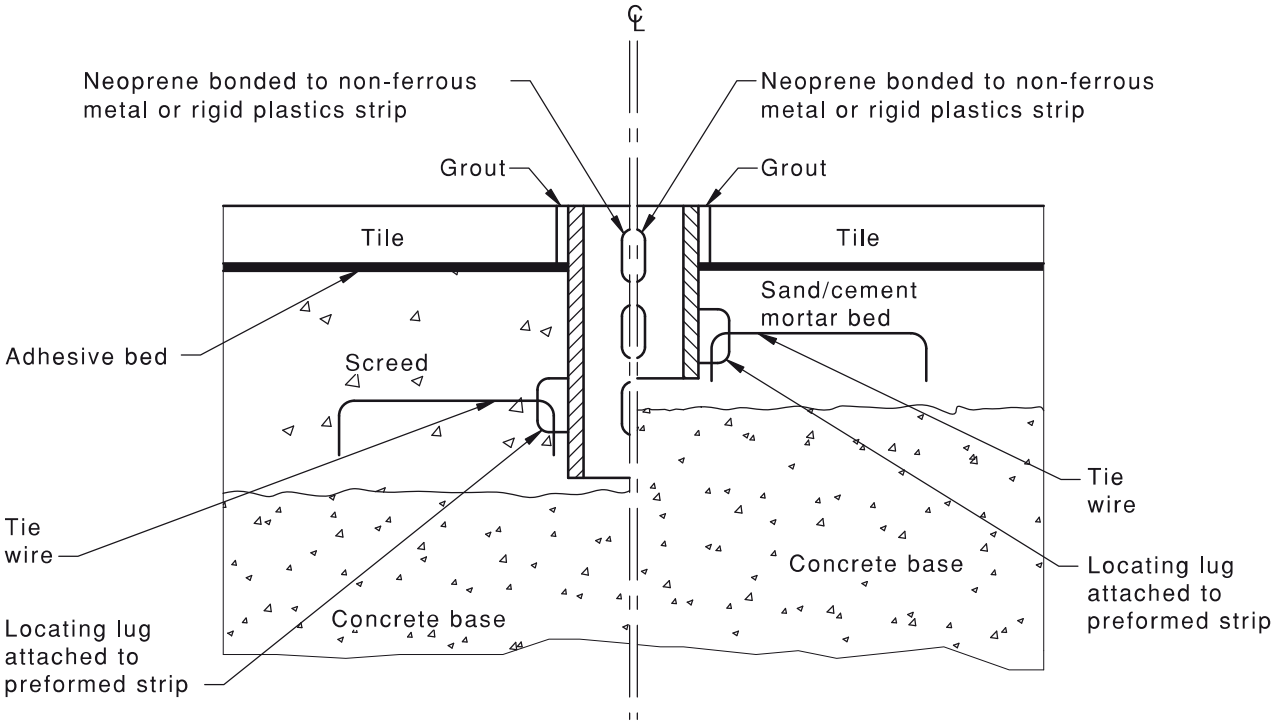


(c) Flexible joint in bed, with or without separating layer

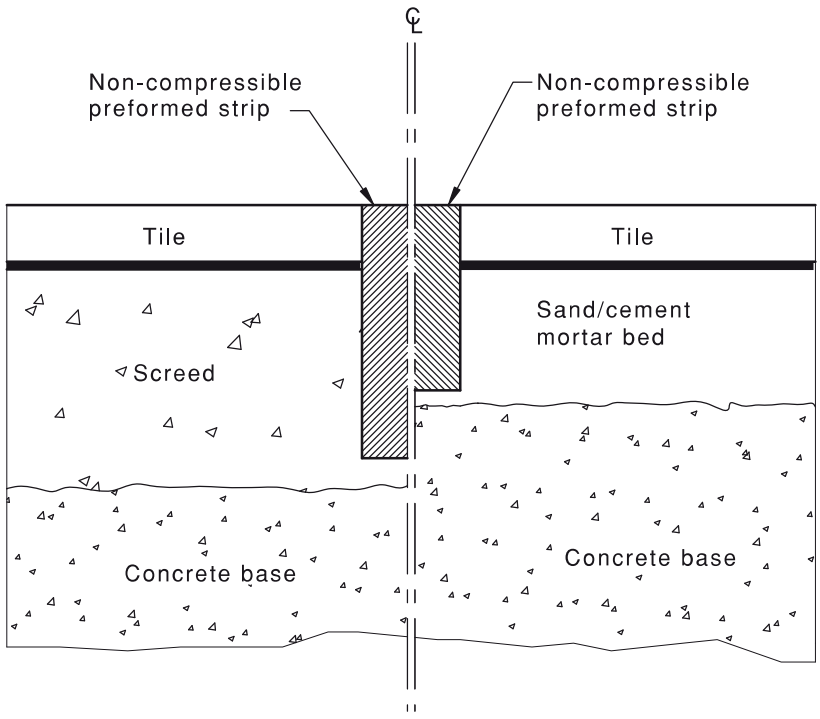


(d) Joint aligned to structural movement joint

FIGURE 5.1 (in part) TYPICAL MOVEMENT JOINT SYSTEMS FOR FLOORS



(e) Slightly flexible joint preformed strip with reinforced edges



(f) Contraction joint preformed strip

FIGURE 5.1 (in part) TYPICAL MOVEMENT JOINT SYSTEMS FOR FLOORS

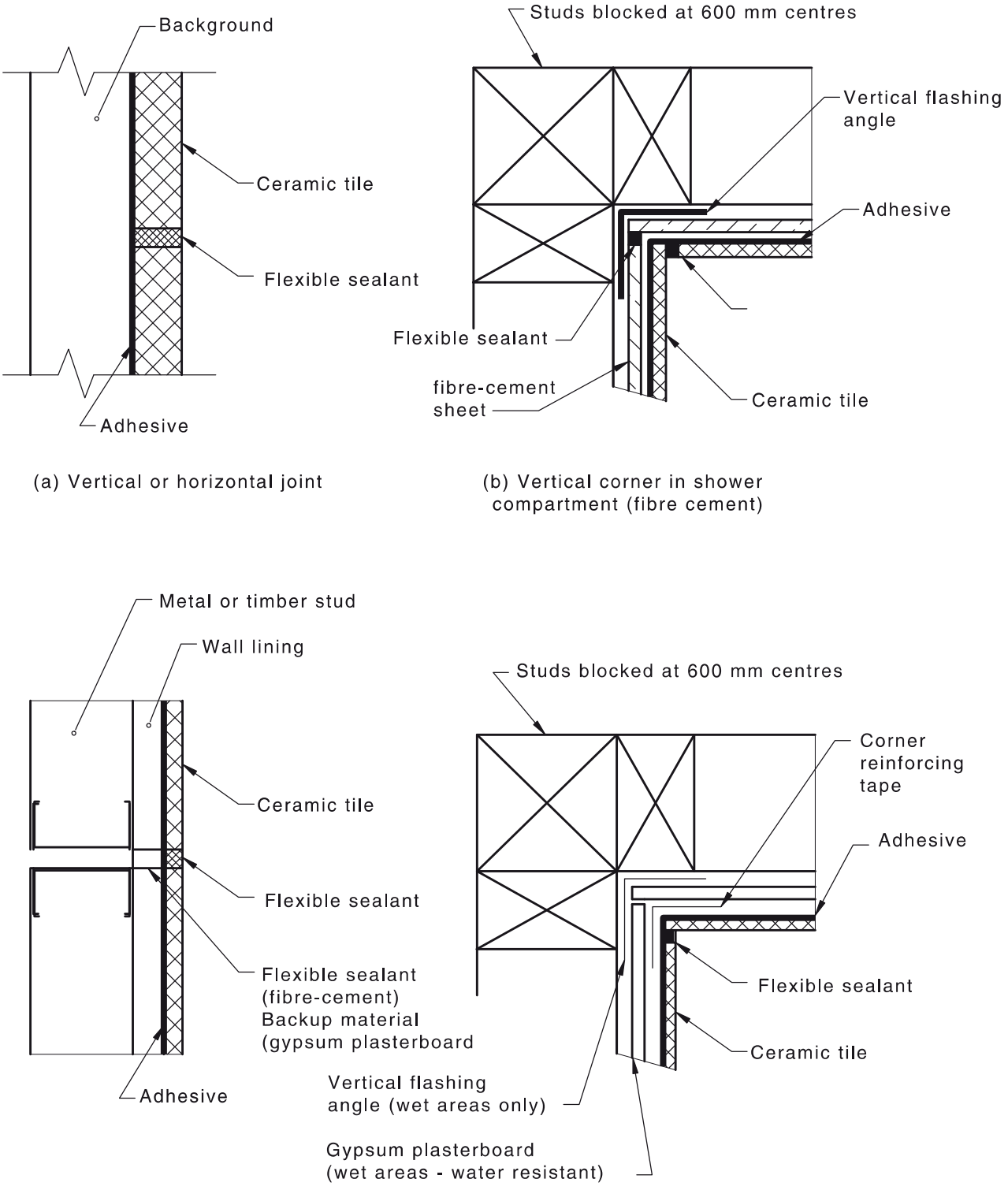
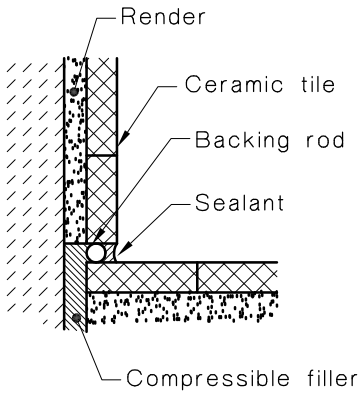


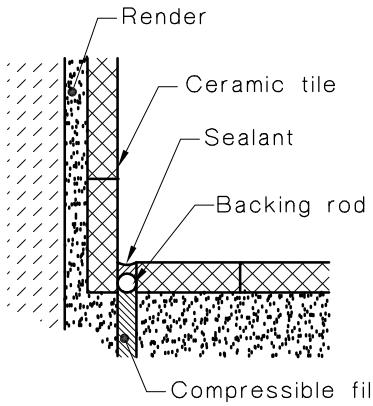
FIGURE 5.2 TYPICAL MOVEMENT JOINT SYSTEM FOR WALLS

5.4.5.4 *Floor/wall joints*

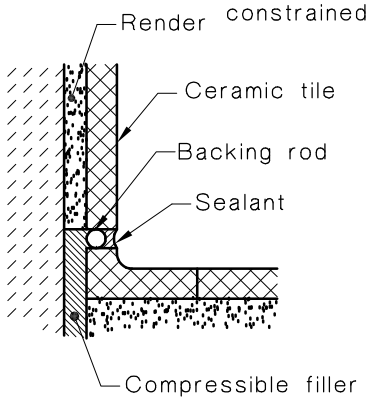
Alternative treatments for floor/wall joints are shown in Figure 5.3.



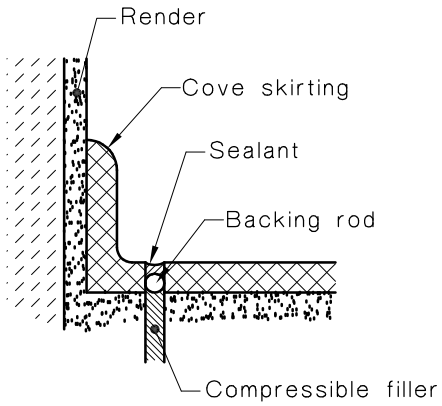
(a) Wall joint—in rooms with floor area <10m^2



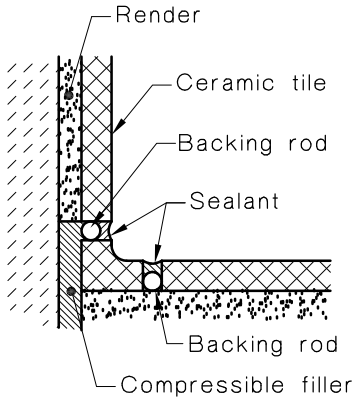
(b) Floor joint—if wall tiling is not constrained from vertical movement



(c) Wall joint (horizontal cove)—in rooms with floor areas <10m^2 and wall tiling is constrained from vertical movement



(d) Floor joint—large floor with vertical cove skirting



(e) Wall and floor joint—large floor area, wall tiles to ceiling

NOTES:

1 This Figure shows the recommended location of movement joint elements in tiling systems. It is not a construction detail.

2 Details shown indicate render over brickwork wall and screed over concrete floor system. The same movement joint details apply to different wall tiling systems. The compressible filler or the backing rod may not be required where the tiles are directly adhered to the floor.

FIGURE 5.3 FLOOR/WALL JOINTS

5.4.5.5 *Sealants*

Before any sealing work is started, the condition of the substrate should be checked to ensure it complies with the specification. Particular attention should be paid to joints, especially structural movement joints, which may be tapered over their length or depth, or too narrow or too wide. Where this is the case, work should not proceed.

The width/depth ratios of the sealant should be in accordance with the sealant manufacturer's recommendations.

Typical width/depth ratios are as follows:

(a) Elastic sealants ..... 2:1.

(b) Elasto-plastic sealants ..... 2:1 to 1:1.

(c) Plasto-elastic sealants ..... 1:1 to 1:2.

(d) Plastic sealants ..... 1:1 to 1:3.

The width and spacing of the movement joints specified above and in Clause 5.4.5 are based on the use of sealants with an MAF of 20. Variations may occur if sealants with different properties are used (see BS 6213).

Notwithstanding these ratios, care should be taken in narrow joints to ensure that the depth of the sealant is adequate, that is, the depth for porous substrates should be a minimum of 10 mm and for non-porous substrates a minimum of 6 mm.

5.4.5.6 *Backup materials*

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

5.4.5.7 *Preformed strips*

Preformed strips should be inserted between the tiles as they are laid. They should be filled to the combined depth of the tiles and bed and keyed into the bed by the shape of the strip section.

5.4.6 Tile finish and joints

The recommendations for tile finish and joints are as follows:

(a) When measured with a straightedge, the finished surface of the tiling should be flat and true to within a tolerance of ±4 mm in 2 m from the required plane. The lippage between two adjacent tiles should not exceed 2 mm. In the case of tiles where the surface has been ground flat, for example polished tiles, the lippage should not exceed 1.5 mm, and for joint widths of 3.0 mm or less the lippage should not exceed 1.0 mm.

NOTE: Lippage is inherent in all installation methods and may also be unavoidable due to the tile tolerances. Lippage may also be unavoidable where tiles larger than 150 × 150 mm are graded to a waste outlet, unless transverse cuts are incorporated.

Any adjustment of tiles should be made before the initial set of the bedding material takes place.

(b) In readiness for grouting, any surplus bedding material remaining on the surface of the tiles or in the joint spaces should be removed before it hardens. Care should be taken to avoid disturbance of the tiles during the setting of the bedding.

(c) Joint widths should be consistent throughout the installation unless otherwise specified. The recommended joint widths are as follows:

(i) *Floors*:

(A) Dust-pressed tiles ..... 3 mm.

(B) Extruded tiles ..... 6 mm.

(ii) *Walls*:

(A) Dust-pressed tiles ..... 1.5 mm.

(B) Extruded tiles ..... 6 mm.

Wider joints may be required to accommodate larger tiles, dimensional irregularities in the tiles, to maintain modular discipline, or to provide a decorative effect. Where larger format tiles are laid using narrower grout joints, movement joints should be placed at closer centres.

Joint widths are normally measured at the tile face.

When spacer lug and universal edge tiles are used, the tiles automatically provide suitable spacing, approximately 1 mm to 2 mm for walls and 3 mm to 6 mm for floors.

(d) Joint alignment should be consistent throughout the installation unless otherwise specified. The final alignment should be within a tolerance of ±4 mm in 2 m from the specified joint alignment. Provision should, however, be made for variation in the type, size and quality of the tile.

(e) When tiles without spacer lugs are used, the correct spacing should be obtained by using spacing inserts of suitable thickness between the tiles as fixing proceeds. Tiles without spacer lugs should never be fixed with butt joints, as an adequate width of joint is necessary for the relief of any local stress.

Spacing inserts should be removed in conjunction with the preparation for grouting.

NOTE: This is particularly important in large areas of tiling, in high-rise structures and in wide-span post-tensioned concrete floor systems. Rigid spacing inserts left in place may negate the contribution of grouted joints to the relief of irreversible differential movements.

5.4.7 Bonding

In some installations small hollow-sounding areas may be found. Although they do indicate incomplete bond they are not necessarily indicative of imminent failure; however, cases where more than 20% of the tile sounds hollow when tapped (‘drummy’) would have to be considered suspect over the long term. Needless to say this ratio would need to be varied depending on—

(a) whether the tile is fixed to the floor or wall; and

(b) the anticipated form and amount of traffic.

5.4.8 Grouting

Grouting should be in accordance with Clause 5.7.

5.5 INSTALLATION OF CERAMIC TILES WITH CEMENT MORTAR

5.5.1 General

The bond strength of mortar is likely to be less than that of adhesives and it is important that the selection, storage, mixing and application of the materials are properly controlled so that the best results are achieved. Advice on the selection and storage of suitable cement and sand is given in Section 2. Mixing and application are dealt with in Clauses 5.5.4 to 5.5.6.

NOTE: In some instances it may be difficult to obtain a satisfactory bond when fixing low porosity tiles (less than 6% water absorption, see AS 4662) with mortar.

5.5.2 Backgrounds

Concrete floors should be swept clean immediately prior to applying the slurry/bond coat, which should not be allowed to dry out prior to the application of the mortar bed. Where a scratch coat or levelling coat has been applied, it should have cured for at least 24 h before the mortar bed is applied.

The concrete surface should be completely free of standing water.

Backgrounds suitable to receive internal ceramic wall tiling fixed by sand/cement bedding are those that are rigid, provide adequate key and suitable suction, and whose movements subsequent to tiling will be sufficiently low so as not to affect the applied finish.

Except where the render and lay method is to be used, cement-rendered surfaces should have been applied at least seven days before tiling is commenced.

5.5.3 Preparation of tile

In most instances tiles with water absorption greater than 10% (AS 4662, Types A III and B III) should be completely immersed in clean fresh water in clean containers for a period appropriate to the method of fixing to be used.

NOTES:

1 Where the background suction is low, this period could be as short as 5 min.

2 Dip-fixing or dry-fixing may sometimes be appropriate.

The tile packaging material should not be allowed to contaminate the water. After soaking, the tiles should be removed from the water and stacked tightly together on a clean surface to drain, with the end tiles turned glaze outwards. They should be fixed as soon as the surface water has gone. Tiles that exhibit drying along the edges should be re-soaked and drained before setting. Free moisture should not remain on the backs of tiles when they are being set.

5.5.4 Mortar mixes

The bedding mortar should comply with AS 2701 and should not be richer than 3:1 nor leaner than 5:1 sand/cement by volume.

NOTE: Within these limits the choice of the precise proportions is governed by the need to produce a mortar of the required properties with the minimum water content. The latter aspect is vital in minimizing the drying shrinkage of the mortar and thus any tendency towards adhesion failure. The properties of a sand will depend upon its source and will influence, in particular, the quantity of water to be added to give the mortar the desired consistency. Consequently the sand should be selected with care to obtain optimum performance from the mortar. Once the proportions are established, every effort should be made to minimize random variations.

The mixing of mortars by a suitable machine is to be preferred, but where this is not possible, it should be carried out on a clean non-absorbent surface, using clean tools. Whichever method of mixing is used, the materials should be thoroughly blended before water is added. Mixing should be continued until the batch has a uniform consistency.

Great care should be taken in the use of admixtures such as plasticizers, waterproofers and fungicides and cements containing such materials.

5.5.5 Fixing to floors

5.5.5.1 *Bedding in sand/cement mortar bed*

The sand/cement bedding method for fixing floor tiles is as follows:

(a) Before placing the mortar bed either—

  (i) spread a very thin continuous coating of pure Portland cement paste on the concrete surface; or

  (ii) dust a thin layer of dry Portland cement on the concrete and wet it.

(b) Broom this pure Portland cement slurry or the wetted Portland cement dust to completely coat the concrete surface with a thin and uniform coating.

(c) Thoroughly mix the bedding mix with only sufficient water added to make a crumbly consistency that retains its shape when squeezed in the hand.

(d) Apply the mortar bed immediately over the pure cement coating while it is still wet and firmly tamp and screed it.

(e) Spread the semi-dry mix roughly to a thickness slightly greater than that required for the actual bed. Thoroughly compact the mix and draw off the surface to the required level. Lay only sufficient bedding mix for one man to deal with satisfactorily in one operation.

(f) Pour a cement-based slurry with sufficient water to make it slightly fluid over the bedding and spread with a trowel until it is about 2 mm thick. Alternatively, dust a thin layer of Portland cement on to the bedding and set the tile while it is still tacky. In either case the working time will vary according to the prevailing conditions but is usually between 10 and 15 min. Do not spread more slurry or Portland cement than can be covered within this period.

(g) Place the tiles in position and firmly beat into the bedding. Adjustment of tile joints should be carried out at this time.

NOTE: Where large dense (<3% water absorption) tiles are used, apply a bond coat incorporating a bonding agent to the back of each tile prior to fixing as set out above. Additional perimeter/movement joints are also recommended.

The nominal thickness of bedding with this system is about 25 mm. If the bedding thickness is greater than 40 mm to 50 mm, a scratch coat should be used.

5.5.5.2 *Bedding in mortar over a separating layer*

When mortar beds are to be laid over a separating layer the procedure is as follows:

(a) Sweep the substructure clean.

(b) Place the separating layer over the smooth substructure, and lap at least 100 mm at joints.

(c) Where wire reinforcing is specified, place it over the membrane and support it so that it is approximately at the centre of the mortar bed thickness. Lap the reinforcing at least one full mesh and do not butt it against vertical surfaces.

5.5.5.3 *Bedding in mortar over an in situ flexible underlay*

When mortar beds are to be placed over an in situ flexible underlay the procedure is as follows:

(a) Sweep the substructure clean.

(b) Install the underlay in accordance with the manufacturer's recommendations.

(c) Where reinforcement is required in the mortar, install it in accordance with Clause 5.5.5.2.

5.5.5.4 *Bedding in mortar over structural particleboard flooring*

Where tiles are to be bedded in mortar over structural particleboard flooring the procedure is as follows:

(a) Prime the surface of the particleboard with a two-part epoxy sealant.

(b) After drying, apply a second coat and allow it to become tacky.

(c) Apply the mortar bed.

Further advice may be obtained from the appropriate adhesive and particleboard manufacturers.

5.5.6 Fixing to walls

5.5.6.1 *General*

Whilst the bedding of wall tiles in mortar has largely been superseded by the use of proprietary adhesives, there are occasions when it may be adopted.

5.5.6.2 *Buttering method*

The buttering method of fixing wall tiles is as follows:

(a) Evenly butter the tiles with the bedding mix and tap 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.

(b) Fill deep keys or ribs in the backs of tiles with the bedding mix when buttering.

The resultant thickness of the bedding behind the tiles should generally be 15 mm and in no circumstances should it be more than 25 mm. The depth of mortar in keys or ribs will be additional to these thicknesses.

In some instances where tiles are dense, a bond coat may be required.

This method is not suitable for mosaic tiles.

5.5.6.3 *Render and lay method*

The render and lay method of fixing paper-faced mosaic sheets is as follows:

(a) Render the wall to a true surface to take full tiles where possible (e.g., in reveals).

(b) Pre-grout the back of the sheet with a suitable grouting/bonding mixture, leaving approximately 1 mm thickness on the back of the sheet.

(c) Hang the mosaic sheet in position and firmly press back at the top edges, continuing the pressure downwards until the sheets are firmly bedded.

(d) After a few sheets have been so positioned, beat this area back to ensure good adhesion and a true flat surface.

(e) Use a straightedge to ensure that the surface of the mosaic is flat and true as defined in Clause 5.4.6. Make any adjustment of the mosaic within 10 min of fixing.

(f) Grout between sheets (see Clause 5.7) and wet and remove the paper facing.

(g) Clean the mosaic tiles and adjust the grouting where necessary.

(h) Clean the face of the mosaic tiles, using a damp cloth, before any cement smears and surplus mortar begin to harden on the surface or in the joint spaces, taking care to avoid disturbance of the mosaic tiles during the setting of the bedding.

5.6 INSTALLATION OF CERAMIC TILES WITH ADHESIVE

5.6.1 General

There are three major groups of adhesives used for the fixing of ceramic tiles, as follows:

(a) Cement-based adhesive.

(b) water-resistant organic adhesive.

(c) Other adhesives, e.g. epoxies, silicones.

Each of these groups of adhesives may be fixed using either the thin-bed method or the thick-bed method, depending on the specific properties of the particular adhesive. Contact coverage for each of these groups of adhesives should be as detailed in Clause 5.6.4.

It is essential that the manufacturer's instructions be followed.

5.6.2 Thin-bed fixing

The application should be carried out in such a manner as to ensure that the final bed thickness does not exceed 3 mm and a minimum number of voids occurs behind the tiles.

NOTE: Water may accumulate in voids and this may give rise to damage to the installation in frosty conditions. In thin-bed adhesives applied in thicknesses greater than 3 mm, excessive stresses may develop, possibly resulting in cracking of the tiles or adhesion failure. In this instance, consideration should be given to the use of thick-bed adhesives or mortar fixing.

Mosaic tiles should be applied using the method described in Item (a) or (b) below but with a minimum bed thickness to give satisfactory coverage. Each sheet should be beaten back to ensure good adhesion and a true flat surface.

The buttering method in Item (c) is not suitable for mosaic work.

Suitable methods for thin-bed fixing are as follows:

(a) *Notched trowel method* For internal applications where dry conditions will prevail after tiling is completed, the notched trowel method should be used. This method is as follows:

(i) Spread the adhesive on the surface to achieve the best possible mechanical bond. 'Rib' the adhesive with a notched trowel of an appropriate size to obtain a uniform thickness. Flat-backed tiles measuring 150 mm × 150 mm should be fixed into ribs of adhesive spread by at least a 6 mm width × 6 mm depth × 6 mm spacing notched trowel. For other tile sizes the notched trowel dimensions are recommended as follows:

(A) 200 mm × 200 mm—8 mm notched trowel.

(B) 250 mm × 250 mm—10 mm notched trowel.

(C) 300 mm × 300 mm—12 mm notched trowel.

(D) 400 mm × 400 mm and above—12 mm notched trowel + buttering of the tile.

These ribs shall be horizontal for walls.

NOTE: When the trowel is held at an appropriate angle and its notched side is drawn over the adhesive, it will give a series of parallel ribs. The dry tiles should be pressed into and moved at least the width of a rib perpendicular to the adhesive ribs. This should achieve both the minimum required coverage and bed thickness. This operation has to be carried out correctly as adequate ribs are essential to ensure an evenly distributed area of contact between tile and adhesive. The open time may vary from that specified by the manufacturer, depending on site conditions. Exceptional conditions of low humidity, high temperature, radiant heat and temperature can reduce open times to as little as a few minutes. In these circumstances tiling may be inadvisable.

Do not apply tiles to 'skinned over' adhesive.

(ii) Press the tile and beat it into place to obtain an adequate coverage by adhesive on the back of each tile.

NOTE: In some areas (e.g., shower compartments or areas where access is difficult), tiles may have to be butter fixed [see Item (c)] to achieve satisfactory adhesion.

(iii) Occasionally remove a tile as fixing proceeds to check that adequate contact is being maintained with the adhesive (see Clause 5.6.4).

(b) *The floating method* The floating method is as follows:

(i) Spread the adhesive evenly over the background.

(ii) Apply the tiles as detailed in Item (a) (notched trowel method) with a twisting or sliding action and tap back firmly into the floated bedding.

(iii) Take care to ensure that the bed thickness is in accordance with the adhesive manufacturer's recommendations.

(c) *Buttering method* Buttering of individual tiles is a slower method of tiling than that described in Items (a) and (b) (notched trowel and floating methods) but it may be necessary for occasional awkward tiling positions, e.g., around window openings.

In this method, the adhesive is not spread on the wall, it is 'buttered' evenly over the whole of the back of each tile with a trowel. The bed thickness should be slightly greater than the final thickness required so that, when tiles are pressed and tapped back firmly into position, the correct bed thickness is achieved. This should not be greater than the maximum recommended by the adhesive manufacturer.

In some instances the adhesive manufacturer will not recommend butter fixing; however, buttering the adhesive with a suitable notched trowel will generally be acceptable, provided adequate coverage is obtained.

Spot-fixing' where the tiles are fixed with four or five dabs of adhesive is not recommended and should be avoided at all times.

Care should be taken to ensure that, as far as possible, no voids are left behind the tiles.

(d) *The combined method* In the combined method the adhesive is spread over the background as in the floating method [Item (b)] and buttered on the back of the tile as in the notched head trowel method [Item (c)].

5.6.3 Thick-bed

In the case of surfaces that are not sufficiently flat and true to permit thin-bed fixing, or where there are deep keys or ribs in the back of the tile, some certain cement-based materials are available which may be used as thick-bed adhesives, and some irregularity in the background may be accommodated in this way. In practice, the amount of irregularity that can be taken up will be limited by several factors. Thus, for each thick-bed adhesive the manufacturer will stipulate the maximum thickness at which it should be used, and the final bed thickness should not be greater than this thickness. A limit to the thickness of adhesive used may also be imposed by the nature of the background, the tile and the circumstances of use. For example, a thick bed of adhesive will tend to dry out slowly on a dense or impervious surface, and the bed thickness may have to be limited to prevent possible slumping as tiles are being fixed.

Usually thick-bed adhesives are used at an average bed thickness of about 6 mm, and in most cases the adhesive may be applied to the surface as a floated bed. With some thick-bed adhesives, notching with a trowel may then be acceptable in a similar manner to that described in Clause 5.6.2(a). With other types of thick-bed adhesive, however, a notched trowel should not be used except perhaps to provide light ribbing only to the surface of the adhesive to facilitate subsequent application of tiles. The adhesive manufacturer's instructions should be observed in every instance.

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

Alternatively, for slightly thicker beds, the buttering method or the combined method may be found more convenient (see Clause 5.6.2(d)). The buttering method is not suitable for mosaic work. Again the manufacturer's recommendations should be observed. Whichever method of application is adopted, dry tiles should be used and these should be pressed firmly into position to ensure good contact between tile and bed.

Deep keys or ribs in the backs of tiles should normally be filled with the adhesive immediately before the tiles are fixed.

5.6.4 Adhesive coverage and distribution

5.6.4.1 *General*

The ability of an adhesive-based tiling system to meet performance requirements is affected by various factors, one of which is the contact coverage and distribution of the adhesive.

5.6.4.2 *Coverage*

Adhesive should be applied to the substrate and then spread using a notched trowel of an appropriate size and shape. Optimum coverage requires pressing of tiles into the adhesive bed and moving them perpendicular to the direction of the adhesive notches.

The contact coverage of the adhesive should be maximized. Minimum contact coverage should be:

Internal residential walls	65%
Residential floors	80%
Commercial and industrial walls	80%
Commercial and industrial floors	90%
Wet areas	90%
Swimming pools	90%
External walls	90%
Exterior floors, decks and roofs	90%

NOTE: While increased contact coverage will assist in resisting differential movement, and coverages lower than those recommended might facilitate tiling system failures, a failure to achieve the recommended coverage should not automatically be seen as the primary cause of differential movement failures.

5.6.4.3 *Distribution*

The coverage should be sufficiently distributed to give full support to the tile with particular attention to this support under all corners and edges of the tile.

Expressing contact coverage as a percentage alone presents some problems. For example, 80% coverage on a floor tile is not generally acceptable if a significant portion of the tile (e.g., one edge) is left without any adhesive.

A1

5.6.4.4 *Depth*

In conjunction with the amount of contact coverage, the depth of adhesive is also seen as critical, as this is an important point for stresses to be absorbed within the installation. It is essential that the manufacturer's instructions be followed.

5.6.4.5 *Good tiling practice*

The following procedure should be carried out:

(a) Use appropriately sized notched trowels for spreading adhesive. Triangular (saw-toothed) trowels tend to wear down faster and may not give adequate depth of bed.

(b) Where possible, spread adhesive so as to leave horizontal ribs on walls and unidirectional ribs on floors. (See also Clause 5.6.2(a)(i).)

(c) Occasionally remove a tile to check that adequate coverage is being obtained.

(d) Butter the adhesive onto the back of the tile when tiling in positions with difficult access.

(e) Use the trowel with the largest notches suitable for the situation, as this tends to give a greater depth of bed.

(f) Ensure adequate pressure and movement is applied to tiles when fixing (this affects both coverage and bed thickness).

(g) Allow for the effects of any embossing on the tile back (e.g., honeycomb, chocolate block, ribs, lugs, etc.) when selecting the size of notched trowel. Some tiles with deep keys may require the application of adhesive to the tile back as well as the background.

(h) Cross-shaped spacers inserted in joints before pressing tiles onto the adhesive layer may obstruct or reduce the shearing motion necessary to maximize contact area.

These guidelines cannot address every installation circumstance. The substrate, type and size of tile, climatic conditions, interior or exterior use, and adhesive manufacturer's recommendations are all factors the installer should consider under all circumstances.

Some aspects of tiling design which ultimately influence selection of tiling materials and methods are outside the scope of this Standard. Factors such as movement characteristics of structures, induced vibration and intended service conditions of flooring, may not be readily evident to installers. These matters should be addressed comprehensively during design and specification.

5.6.5 Cement-based adhesives

5.6.5.1 *Background*

Cement-based adhesives are suitable for use on mature cement-rendered surfaces, concrete, and brickwork. They are not recommended for use on plaster, wood, metal, or painted surfaces. Where tiling is to be carried out on fibre-cement sheeting, the adhesive manufacturer's recommendations should be followed.

Ideally, the background should be dry and the surface should not generally be dampened before the adhesive is applied. Dry backings should only be dampened if necessary to achieve the required working properties and the cure.

5.6.5.2 *Preparation of tiles*

Unless otherwise specified, tiles are normally fixed dry.

5.6.5.3 *Mixing cement-based adhesive*

Cement-based adhesives may be either pre-packaged proprietary mixes to which water is added, or on-site mixed (e.g., cement/latex). In all cases the manufacturer's recommendations should be followed.

Additional water, adhesive, or other ingredients should not be added after the original mixing, but the mixed material may be reworked to restore its original consistency before use.

Adhesive consistency should be such that, when applied with the recommended notched trowel to the backing, the ridges formed in the adhesive do not flow or slump.

The open-time and working time of the mix will be specified by the manufacturer. These time limits should be strictly observed.

5.6.5.4 *Fixing to floors—Thin-bed and thick-bed*

The installation of floor tiles using cement-based adhesive should be carried out as follows:

(a) Spread the adhesive evenly over an area no greater than can be covered with tiles while the adhesive remains plastic. Comb the adhesive with a notched trowel as recommended by the adhesive manufacturer (see Clause 5.6.2).

(b) Press the tile firmly into freshly notched adhesive within the adhesive manufacturer's recommended open time and beat in to obtain an optimum contact with the adhesive bed. Adjust tiles as necessary before the initial set takes place.

NOTE: Obtaining adequate contact with rib-backed tile often requires trowelling a layer of adhesive on the back of each tile prior to placing on the adhesive bed.

(c) Do not apply to 'skinned-over' adhesive.

(d) Adjust tiles to a true and even surface.

(e) Wipe off excess adhesive from joints and surface.

(f) Insert temporary filler in movement joints.

(g) Grout according to Clause 5.7.

5.6.5.5 *Fixing to walls and ceilings*

The installation of tiles for walls and ceilings includes base, reveals, wall breaks, and accessories, where required.

Thin-bed fixing (see Clause 5.6.2) is recommended in preference to thick-bed fixing (see Clause 5.6.3), which would normally only be used if the background is uneven, or if the tiles have deep ribs or keys.

NOTE: Ceilings include beam soffits and deep window reveals.

5.6.6 Water-resistant organic adhesives

5.6.6.1 *General*

Organic-based adhesives fall into two main categories, most being water-based but some solvent-based.

Organic adhesives are suitable for use on a wide range of backgrounds, particularly sheet materials on timber or metal stud construction where a degree of flexibility is required.

The method to be adopted for fixing tiles using these adhesives will vary with the type of background, the nature of the adhesive and the anticipated conditions to which the installation will be subjected in service. The methods described in Clause 5.6.2 are those usually adopted with this group of adhesives, but there are several products available and some variations in fixing procedures exist. Therefore, it is important to follow the precise recommendations of the adhesive manufacturer concerning, for example, the type of trowel, the mixing procedure, the working time after spreading and the suitability of the background. The procedure is as follows:

(a) Where organic-based adhesives are used in wet areas with water-resistant gypsum plasterboard, follow the gypsum plasterboard manufacturer's recommendations concerning the application of the adhesive.

(b) Use solvent-based adhesives only in adequately ventilated areas.

(c) Comply with the manufacturer's recommendations concerning the safe handling of the product.

(d) Do not expose flammable adhesives near naked lights, fires or electrical equipment.

(e) Always replace the lid on containers immediately after use.

5.6.6.2 *Backgrounds*

Organic-based adhesives are available for use on mature cement-rendered surfaces, concrete, brickwork, plaster surfaces, various sheets and boards, metal surfaces, painted surfaces, existing tile and glazed brick surfaces and some timber; however, solvent-based adhesives are not suitable for use on painted surfaces because of possible interaction between their solvent and the paint. The following specific recommendations should be followed:

(a) Apply the adhesive to a dry background, i.e., do not dampen the background.

(b) Apply primer/sealer to all surfaces where recommended by the adhesive manufacturer.

5.6.6.3 *Preparation of the tiles*

Unless otherwise specified, tiles should be fixed dry.

5.6.6.4 *Mixing of the adhesive*

Some organic adhesives are supplied ready for use, others require mixing of two or more components.

Unless otherwise recommended by the adhesive manufacturer, a minimum of 12 h should be allowed for the setting of tiles before grouting.

5.6.7 Other adhesives

There are adhesives available that cannot be included in Clauses 5.6.5 and 5.6.6 (e.g., three-part-mix epoxies and silicones). In addition, the development of new adhesives is continuing and some that do not fall into any of the categories mentioned may ultimately be marketed.

When specifying one of these products, the specifier and the user should satisfy themselves that it is suitable for the intended conditions of use and, in general, it should have comparable working and adhesion characteristics to the cement-based and organic-based adhesives. The manufacturer's recommendations should be followed in every case.

5.7 GROUTING

5.7.1 General

Grouting of the joints may be carried out at any time to suit the convenience of the work but should preferably be left for at least 12 h after fixing of tiles, unless otherwise specified. Sufficient time should elapse to ensure adequate setting, and to preclude disturbance of the finish during the grouting operation. It is not advisable to delay the grouting unduly as the open joints may collect general building dust and deleterious material.

Where proprietary coloured grouts or cement grouts containing coloured oxides are used, a sample tile or small inconspicuous area should be tested to determine if staining will occur. The application of a grout release or penetrating sealer may facilitate the use of such grout without staining the tile. This may be particularly relevant when using porous or polished tiles.

Where a sand/cement grout is required a suitable mix is 1 part Portland cement to 2–4 parts fine sand mixed to a paste consistency with the minimum of water (too wet a mix may result in the joint-filling cracking on drying out). If a proprietary grouting material is specified, it should be mixed and applied strictly in accordance with the manufacturer's recommendations. For optimum strength and resistance to wear and cleaning agents, the grouting mix should be fresh and with a higher proportion of cement (within the specified range). It should, however, be pointed out that higher strength grout mixes may not take up induced stresses as well as a lower strength mix.

The procedure is as follows:

(a) Remove strings, ropes or pegs before grouting. Spacing inserts should be removed in conjunction with the preparation for grouting.

NOTE: Spacers may impair the performance of the system if left in place.

(b) Before grouting, dampen the joints between the tiles and leave no sign of freestanding water.

(c) Apply the grouting mix to as large an area as can be worked before hardening commences. Apply the grout with a grouting trowel or other suitable tool, and work back and forth over the area until all the joints are completely filled. Use a rubber-faced trowel when grouting glazed tile with cement-based grouts.

(d) Take care when jointing glazed tiles to avoid damage to the surface. In the case of tiles faced with soft glazes that may be scratched easily, it is advisable to protect the glaze adjacent to the joints with masking tape.

(e) Finish grout to the depth of the cushion on cushion-edge tiles. All joints of square-edge tiles should be flush with the surface of the tiles. Tool the top surface of the grout to provide a contoured depression no deeper than 1 mm for up to a 6 mm wide joint, and 2 mm for a 6 to 10 mm wide joint.

NOTE: The selection of the materials and methods to be adopted in filling and finishing the joints will depend on the joint widths and the functional requirements, for example, in heavily trafficked areas the joint should be as near flush as possible.

(f) Fill all gaps so that adhesive does not show through grouted joints. Remove surplus grout from the tiles with the aid of a damp, not wet, cloth and tool the joints with a piece of wood or other material of suitable size and shape. When a proprietary grouting material is used, observe the manufacturer's recommendations for cleaning. Do not use sawdust for removing surplus grout from floors. The finished grout should be uniform in colour, smooth and without voids, pinholes or low spots.

(g) After the grouting has dried, polish the tile surface, using a clean dry cloth.

5.7.2 Mosaic tiles

The procedure for mosaic tiles is as follows:

(a) When the sheets have been firmly beaten in, any facing paper removed and the work is sufficiently firm, rub grout over the surface to fill any voids remaining in the joints, then give the work a preliminary cleaning.

(b) After the grout has hardened sufficiently, wash the surface of the work with water and clean.

(c) Clean off any grout residue that resists removal by water using a proprietary cement remover applied in accordance with the manufacturer's recommendations.

(d) Finish with a final washing with water.

NOTES:

1 The grouting mix normally consists of neat Portland cement or tinted cement, either of which may be combined with up to 50% lime.

2 The colours of grouting and bedding materials range from dark to almost white and the designer should appreciate that these, when seen through translucent and transparent mosaics, will affect the shade of the finished work.

3 Many mosaics have tapering edges, causing the material to be quite thin near the face; in the case of those glass and porcelain mosaic tiles that are otherwise opaque, these edges sometimes are translucent and the colour of a dark grouting can, by being diffused through time, create a slight misty effect at each side of the grouted joint.

5.7.3 Curing

All cement-based tile installations, including Portland cement grouts, should be damp cured for 48 h minimum, unless otherwise specified.

5.8 CLEANING TILES

Upon completion of setting and grouting, the tiles should be thoroughly sponged and washed. Glazed tiles should be finally polished with clean, dry cloths.

APPENDIX A

NON-PROPRIETARY SCREEDS

A1 METHODS OF SCREED CONSTRUCTION

Screeds laid in large areas may lift as they dry and shrink and subsequently crack when loaded if the bond to the base is insufficient. They should be constructed in one of the following ways:

(a) A screed bonded to a prepared concrete base. If a damp-proof membrane is required it should be placed below the base slab.

(b) An unbonded or floating screed thick enough to provide sufficient rigidity and reduce the likelihood of lifting.

A2 CEMENT AND SAND OR FINE CONCRETE SCREEDS

A2.1 General

As an alternative to direct bedding on a base concrete, a cement and sand or fine concrete screed may be applied to a hardened base as a levelling layer on which to lay the tiles.

A2.2 Bonding

The adequacy of the bond of the screed to the base should be considered in relation to the floor tiling to be applied and its subsequent use.

Where maximum bond between the screed and the base is required, the method for preparation of the base given in Clause 4.3.3 should be followed. A base with only a tamped surface is unsuitable and a screed laid over such a base should be considered as unbonded.

Screeds that should be considered as unbonded include the following:

(a) Where the base has been contaminated (e.g., with oil).

(b) Where the base contains admixtures to reduce permeability.

(c) Where the base has a separating layer between it and the screed.

A2.3 Thickness

The thickness of the screeds should be as follows:

(a) *Bonded screed* When laid on and bonded to a set and hardened base prepared as in Clause 4.3.3, the minimum thickness of the screed at any isolated point should be 15 mm.

In some circumstances the thickness of the screed may have to be greater than 40 mm but it should be noted that above this thickness there will be an increasing risk of loss of adhesion with the base. Either reinforcement or a scratch coat is recommended when the thickness exceeds 50 mm.

(b) *Unbonded screed* When laid on a separating layer or a base that incorporates an admixture that reduces permeability or has been contaminated (e.g. with oil), or a base that for any reason cannot be prepared for bond as in Clause 4.3.3, the screed thickness at any point should be greater than 40 mm.

It is emphasized that a high risk of the screed lifting exists with unbonded screeds, which may lead to steps at joints due to differential movement. These steps may be eliminated by the incorporation in the screed of mesh reinforcement, which also passes through the screed joints.

Where possible, falls in the floor should be formed in the base concrete so that an applied screed is of uniform thickness.

A2.4 Framed construction

Reinforced screeds (see Clause 2.13) should always be used over framed construction.

A2.5 Pipes and trunking

The laying of conduits or pipes within the thickness of a screed should be avoided if possible, as cracks may occur over them. To minimize the effects of cracking where it is essential that conduits and pipes be incorporated, a minimum of 40 mm thickness of screed, containing reinforcement in accordance with Clause 2.13, should be placed over the conduit or pipe. The reinforcement should be placed centrally in the depth of the screed over the conduit or pipe and extend for 250 mm on each side.

Ducts or trunking more than 75 mm wide are not recommended.

NOTE: The significant increase in depth of a bonded screed required to accommodate pipes and trunking within its thickness may lead to increased risk of hollowness.

A3 BAY SIZES

Screeds should be laid in as large an area as possible in one operation, consistent with achieving the appropriate surface finish and the levels required, to minimize the number of joints.

NOTE: These areas may be divided into strips 3 m to 4 m wide for convenience of laying, but consideration should be given to the need for movement joints and their location in the finished floor.

A4 USE OF BONDING AGENTS

Proprietary bonding agents may be used as an alternative to cement slurry. If neat cement slurry is used it is essential that the recommendations for preparing the base given in Clause 5.5.5.1 be followed. Proprietary bonding agents should be used in accordance with the manufacturer's recommendations.

A5 SOUNDNESS OF BONDED AND UNBONDED SCREEDS

To withstand the imposed loads and traffic in service, the specifier, when considering the thickness of the screed, should take into account the thickness of the tile and the method of laying. For any traffic conditions, tiles laid with thin-bed adhesives will tend to require a greater thickness of screed than those laid by other methods.

A6 TOLERANCES ON LEVEL AND SURFACE FINISH OF SCREEDS AND CONCRETE BASES

A6.1 General

Flatness or surface regularity is a measure of the deviations from a plane over a large area of the floor, as well as over small local areas. Some variations in surface level can be allowed without detriment to the satisfactory application of the floor tiling, and the permissible limits associated with these variations will depend on many factors.

A6.2 Surface finish

The tolerances of surface finish should take into account the method used to fix the tiles. Methods based on fixing tiles with substantial thicknesses of mortar will allow some adjustment of the surface regularity, whereas tiles laid with thin-bed adhesives will allow minimal correction.

Subfloor smoothing and levelling compounds may be used to correct irregularities in the screed prior to fixing ceramic tiles with adhesives. The manufacturer's recommendations for their use and application should be observed. The materials used should adhere well to the base (even when applied down to a feather edge), be of adequate strength to support anticipated loads and be compatible with the ceramic tile adhesive. Generally these products should only be used in light to moderate traffic conditions.

A6.3 Departure from datum

The maximum departure of the level of the screed or the base slab from datum should be specified, taking into account the area of the floor and its use. For large areas, in the absence of specific recommendations, ±15 mm from datum for large areas is considered adequate for normal purposes.

Greater accuracy to datum may be needed in small rooms, along the line of partition walls, in the vicinity of door openings and where specialized equipment is to be installed directly on the floor. It should be noted that thin tile beds must not be used to adjust the level of the final surface.

A7 SUSCEPTIBILITY TO CRACKING OF SCREEDS

The cracking of screeds is mainly caused by restraint or drying shrinkage. Lifting due to differential drying through the thickness can lead to cracking under load.

Where screeds are placed in very hot weather or without cover from the sun, the subsequent contractions on cooling will increase the risk of cracking. This risk can be reduced by laying screeds under an overhead covering, although care should be taken to avoid any funnelling effect that could produce rapid drying.

If the screed is not adequately bonded to the base slab, lifting can occur, which may subsequently lead to the screed cracking under load. Joints in the base that may open should be carried through the screed, otherwise reflected cracking may form at these positions.

Consideration should be given to the following factors, which also influence cracking:

(a) *Water content* Increasing the water content of a mix will increase the drying shrinkage of screeds, thus increasing the risk of cracking. The quantity of water used should be kept to the minimum necessary to ensure thorough compaction. Some admixtures will reduce the water content (see Paragraph A9).

(b) *Reinforcement* The provision of reinforcement will not prevent, but will control, shrinkage cracking. Where used in screeds, it will limit the width of cracks and so provide some advantage. Reinforcement will not prevent lifting of screeds but where it passes through joints it will prevent steps.

(c) *Curing* Shrinkage occurs as concrete dries. Screeds should, therefore, be kept continuously damp for at least 7 days after laying, until they have attained sufficient strength to resist the stresses due to further shrinkage, which may continue for several months.

(d) *Drying* Screeds should be allowed to dry out as slowly as practicable after curing to reduce the risk of curling (see Paragraph A8).

(e) *Aggregates* Some aggregates have higher than average shrinkage properties and can cause a greater risk of cracking.

A8 ELIMINATING CONSTRUCTION MOISTURE

Although ceramic tiles are unaffected by constructional water, concrete bases and screeds will shrink as they dry out and may produce sufficient forces to break the adhesion between the tiles and bed. It is therefore essential that a proportion of the drying shrinkage of the concrete base or screed be allowed to take place before fixing tiles.

Structural concrete should be subjected to continuous air-drying after the end of curing for at least 6 weeks before either a screed or a tile bed is applied to it. Sand/cement and fine concrete screeds should be cured for at least 7 days and be subjected to continuous air-drying after curing for at least 2 weeks before the bed and tiling are applied. Longer periods may be required in poor drying conditions or where the floor is to be heated. It should also be noted that some cementitious adhesives are suitable for use on screeds that were laid as little as 12 h previously; however, many waterproofing membranes require low residual moisture content in the screed prior to their application. Refer to the manufacturers' instructions.

Where the bed is laid over a separating layer, allowing some shrinkage to take place before tiling is less important, as movements in the base or screed are not transmitted to the tile bed or tiles.

A9 ADMIXTURES

Where admixtures are used, they should comply with AS 1478. The following are examples:

(a) *Air entraining* Admixtures that entrain a small amount of fine air bubbles may help to reduce 'bleeding' of free water and improve the finished surface of the concrete. An excessive amount of entrained air can reduce the strength and abrasion resistance of the concrete to unacceptable levels.

(b) *Water-reducing* Water-reducing admixtures may be used to improve workability and reduce the water content otherwise required in the mix. They may also entrain a small quantity of air.

(c) *Superplasticizing* Superplasticizing admixtures greatly increase workability at normal water content for a short period to produce 'flowing concrete', which needs little or no compaction. Alternatively they may be used as water-reducing admixtures.

(d) *Accelerating* Accelerating admixtures may be used to accelerate the rate of setting and hardening of concrete in cold water. Admixtures that contain calcium chloride should not be used in, or in materials adjacent to, reinforced concrete or concrete or screed containing embedded metal.

(e) *Retarding* Retarding admixtures decrease the initial rate of reaction between cement and water and thereby retard the setting of the concrete.

(f) *Waterproofing* Waterproofing admixtures should be used with caution. Some contain water-repelling ingredients, which may impair the adhesion of either the screed to the base, or the tiling to the screed.

These integral waterproofing admixtures should not be considered as an alternative to the membranes otherwise specified.

APPENDIX B

SAND/CEMENT RENDERING

B1 GENERAL

It is essential that the rendering be suited to the background to which it is applied and to the bedding materials appropriate to the tiling.

B2 BACKGROUND PREPARATION

B2.1 General

It is important to ensure that, before applying rendering, the background has completely dried out. This is particularly important where the background consists of materials such as lightweight concrete, calcium silicate bricks, concrete bricks and concrete blocks, which can have an appreciable drying shrinkage related to their composition and degree of saturation.

Any laitance on the surface and any areas contaminated by oil, grease or other substances that destroy the natural key for rendering should be cleaned or removed.

It is essential that the surface to be rendered provide a good key, a good bond being dependent upon a mechanical key or suction. Hacking may be necessary but is not effective unless the surface is removed to a depth of about 3 mm. This may be done by hand or mechanically (e.g., by bush-hammering or shot-blasting) as appropriate. Alternatively, keying may be produced by the application of a ‘dash coating’; this may be a mix of cement and sand, or a proprietary composition, sprayed over the surface in the form of closely spaced globules.

Retarders painted on the formwork enable a good key to be formed on the surface of concrete. Considerable care is required to ensure that all traces of retarder, unset cement and loose particles are removed and that the aggregate is exposed uniformly; this can be done by wire brushing and thorough washing using clean water to which a suitable detergent has been added, followed by washing with clean water. Retarders and detergents containing coloured dyes are recommended so that their removal can be seen to be complete when no traces of the dyes remain.

Indented keys in concrete may be provided by using rubber or composition formers fixed to the formwork.

Several different chemical types of bonding agent are available. Before deciding on a proprietary bonding treatment, the advice of the manufacturer of any particular bonding medium should be obtained as to its suitability, its method of application and the necessary physical and mechanical properties of the surface to receive it. The agent employed should be one that does not re-emulsify after application. These bonding agents are usually employed in one of four ways, as follows:

(a) As a coating preceding the application of a sand/cement rendering.

(b) With an admixture (e.g., cement), and applied as a slurry bonding coat preceding the application of a sand/cement rendering.

(c) As an admixture to the rendering mix, partially or completely replacing the water.

(d) By combining (a) or (b) with (c) in one rendering operation.

The surface of brickwork or other solid background that is disintegrating or is so weak that it is unlikely to support rendering should be covered with firmly fixed metal lathing or wire netting.

B2.2 Dense, strong and smooth materials

Treatment of this type of material should be as follows:

(a) *High-density clay brickwork and clay blocks* Where the joints of brickwork have not been raked back during construction, this should be done to a depth of 13 mm if the joints are soft enough. If the mortar is too hard for raking back or if the bricks or blocks are very hard and smooth, other methods of forming a key should be used. Walls constructed of keyed bricks need no raking back.

(b) *Dense concrete either precast or in situ* Grease and mould oil should be removed. Ridges and fins left on concrete by shuttering imperfections should be removed before cleaning down. Where a surface retarder has been employed on the shuttering, any loose material on the surface should be removed with a wire brush and the surface washed with water to expose the aggregate.

If the concrete surface is not sufficiently keyed to give proper adhesion, it should be hacked or other methods of forming a key should be used. The joints in new and old concrete block-walling should be treated as described for brickwork.

(c) *Hard natural stone* Dense or smooth stone may need to be treated to form a key.

B2.3 Moderately strong and porous materials

Treatment of this type of material should be as follows:

(a) *Clay bricks and blocks* Treatment should be as described in Paragraph B2.2(a).

(b) *Medium strength natural aggregate concrete* Treatment should be as described in Paragraph B2.2(b).

(c) *Soft natural stone* This may need to be treated to form a key (see Paragraph B2.2(c)).

(d) *Calcium silicate bricks and concrete bricks and blocks* In addition to general cleaning treatment, joints should be raked back as already described in Paragraph B2.2(a). With some types of extremely smooth calcium silicate bricks, metal lathing or wire netting may be required to obtain a good key.

B2.4 Moderately weak and porous materials

Treatment of this type of material should be as follows:

(a) *Concrete blocks and concrete-based lightweight aggregate and autoclaved aerated concrete* Apart from ensuring that the surface is free from any substance likely to destroy the natural key for bedding or rendering, no special treatment is necessary. Some unusually smooth blocks may, however, require treatment as described for brickwork in Paragraph B2.2(a).

Any rendering for external tiling should be applied using anchored reinforcement and the recommendations for preparatory work made in Paragraph B2.2(a).

(b) *Autoclaved aerated concrete* Apart from general preparatory treatment, special treatment is seldom necessary as this material usually has moderate suction and good key. Some dampening may be required to control suction but this should be carefully controlled. A minimum amount of water is used to achieve this objective.

B2.5 No-fines concrete

This usually requires no preparation other than as described in Paragraph B2.1.

B2.6 Lathing and netting

Suitable gauges of metal lathing or wire netting should be used and fixed at intervals such that the applied rendering is rigid. Lathing and netting made in other materials (e.g., plastics or impregnated fibre), should be selected for their ability to bond to the applied rendering and, when suitably fixed, to ensure its rigidity and to support its weight and that of the tiling and bedding.

B2.7 Other backgrounds

Other backgrounds should be inspected and a decision taken as to whether sand/cement rendering is compatible with them and whether they have sufficient integral strength to support both rendering and the subsequently applied tiled finish.

B3 APPLICATION OF RENDER

B3.1 General

Care should be taken to ensure that dampened surfaces, where necessary to control suction, do not dry out before the rendering is applied. No unabsorbed water should remain on the surface. The rendering should be protected to prevent rapid drying out for at least the first three days after application and should be completed at least one week and preferably two weeks, depending on weather, humidity and site conditions, before the fixing of the tiling begins.

The rendering should be true, free of hollow-sounding areas and firmly bonded to the background.

B3.2 Rendering using anchored reinforcement

Wire mesh firmly secured to the background can be incorporated within the rendering to ensure that, in the event of adhesion failure between the rendering and the background, the rendering and the applied tiling remain intact and fully supported. This system is recommended for work above first floor and in any situation where differential movement may be expected or the background material is considered too weak or friable to support rendering or tiling without such treatment (e.g., concrete and concrete blocks containing lightweight aggregate).

Galvanized welded-fabric reinforcing mesh consisting of 50 mm × 50 mm squares, having wires not less than 2.5 mm in diameter, with any cut ends painted with a suitable anti-corrosion coating, should be fixed to the background. It is essential that the fixings to the structural wall be made to a depth of 25 mm or more depending on the strength of the background, passing through any dubbing or first coat of rendering, as described in this Paragraph.

The reinforcement should be applied with the horizontal wires outwards and should be fixed by means of 25 mm austenitic stainless steel anchors, or by drilling holes in which plastics anchors are inserted, to receive stainless steel countersunk-head wood screws (at least 38 mm × 10 gauge). The length of the plastics anchors should be 50 mm, although 40 mm is satisfactory in dense strong background materials. The fixings should be set at approximately 450 mm centres in both directions and staggered, located so that the horizontal wires rest on the screws, thus providing direct support for the mesh. The vertical wires of the mesh should be spaced 3 mm from the background by stainless steel washers placed as the screws are inserted.

The mesh should be secured to the screws by austenitic stainless steel binding wire of softened quality and 1.22 mm diameter, twisted tightly and with the ends turned inwards. Alternatively, the mesh may be clamped by placing stainless steel washers on the outer face under the heads of the screws. Other forms of metal mesh and lathing may call for different methods of fixing.

A slurry coat of neat cement should be brushed on the background and the mesh; whilst this is still wet, the rendering should be applied, working around and through the wires and ensuring that the rendering is fully bonded to the background and that the mesh is covered by a thickness of about 7 mm. Spatterdash may be used instead of slurry and should be a mix of 2:1 sand/cement by volume, thrown by mechanical means or by a dashing scoop over the background to an average thickness of about 3 mm, then allowed to cure by drying slowly before the rendering is applied.

Where, in order to bring the background to the desired plane, it is necessary to apply dubbing or a first coat of rendering in thicknesses in excess of 20 mm, a slurry coat or spatterdash should be applied. This should be followed by the dubbing or rendering in single coats each 8 mm to 13 mm in thickness, scratched and then cured for 7 to 10 days before the reinforcing mesh is fixed. It is not advisable to exceed a total thickness of 25 mm of dubbing or rendering before the mesh is fixed and further rendering is applied.

B3.3 Relationship between component materials

The relationship between the background, rendering, adhesive or mortar bed and the tiles is very important in respect of two properties of the components: their strength and drying shrinkage movements. Attention should be given to the variation in strength and drying shrinkage movement of the common backgrounds.

B4 RENDERING MIXES

B4.1 General

To improve the workability of rendering, a small proportion of plasticizer may be incorporated in the mix. Proprietary plasticizers complying with AS 1478 are recommended for this purpose in preference to lime, since the latter may impair the adhesion of the rendering. The use of any such admixture should be carefully controlled. Proprietary masonry cement and sand may be used as an alternative. These mixes, providing strength equivalent to that of the sand/cement mixes, described below, should be proportioned and used in accordance with the recommendations of the manufacturers of any proprietary materials used.

Mixes of proprietary masonry cements and sand are generally indicated in circumstances where the conventional sand/cement rendering may be inappropriate if it develops a strength higher than that of the background, as may be the case with moderately weak and porous backgrounds.

For dense, strong and smooth or moderately strong and porous backgrounds, the rendering should consist of sand and Portland cement in proportions not richer than 3:1 by volume when based on dry sand. Sand is usually delivered and used in the damp state, and if no allowance is made for this, the mix, particularly if volume batched, may be richer than is desirable. Therefore, based on damp sand, the mix should not be richer than approximately 4:1 by volume (5:1 by weight).

It is important that the recommended proportion of cement is not exceeded, as strong mixes increase the drying shrinkage forces set up in the cladding and thus encourage defects. Too lean a mix should be avoided, otherwise the rendering may be too weak to support the cladding and its bedding.

When integral waterproofing materials are incorporated in a mix, they should be used strictly in accordance with the manufacturer's recommendations. Rendering containing such materials inhibits the adhesion of sand/cement bedding mortars; to correct this, a suction coat of normal sand/cement rendering should be applied to the waterproofed coat within 24 h. It is not generally necessary to apply a suction coat when cement-based adhesives are to be used for bedding the cladding.

B4.2 Dense, strong and smooth or moderately strong and porous backgrounds

On backgrounds such as high density clay bricks or blocks, dense concrete (either precast or in situ) and stone, the rendering should consist of sand and Portland cement in proportions not richer than 3:1 by volume when based on dry sand (damp sand 4:1, see Paragraph B4.1). It is important that the rendering be not more strongly gauged with cement, as strong mixes increase the drying shrinkage forces set up in the tiling and thus encourage defects. Too lean a mix should be avoided, otherwise the rendering may be too weak to support the tile bedding mortar.

B4.3 Moderately weak and porous backgrounds

On backgrounds such as certain types of lightweight aggregate concrete, autoclaved aerated concrete, and bricks of relatively low strength, the conventional sand/cement rendering may be inappropriate if it develops a strength greater than that of the background. Mixes of sand and proprietary masonry cements are generally indicated in such circumstances, the materials being proportioned and used according to the cement manufacturer's recommendations.

B4.4 Mixed backgrounds

Where tiling is continuous across backgrounds of varying types, their differential movements may induce cracking. This risk may be avoided by incorporating a movement joint in such positions or be minimized by fixing metal lathing or wire netting across the junction so that it is incorporated in the rendering.

B4.5 Backgrounds subject to dampness

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

If the soluble salts in the background are sulfates, there is the additional possibility that these may react with the cement of any sand/cement rendering to form the mineral 'ettringite'. The formation of this mineral is accompanied by expansion, and this again may lead to stresses great enough to cause adhesion failure.

Sulfate-resisting cements resist this particular form of chemical attack but have no greater resistance than any other cement to the physical action of deposited salts referred to earlier.

In the context of tiling, the permanent exclusion of water from the background will usually be found more effective than the use of sulfate-resisting cements, since it will minimize the possibility not only of sulfate attack but also of salt deposition.

B5 THICKNESS AND TRUENESS OF RENDERING

Rendering up to a maximum thickness of 13 mm may usually be applied as a single coat. If a greater thickness is required, the first coat should be combed or scratched before it hardens, to provide a key for a following coat. The comb usually consists of a wooden handle in which metal teeth are embedded about 20 mm apart and is used to create wavy horizontal furrows about 5 mm deep. The first coat should be allowed to harden and dry out to permit shrinkage to take place before the following coat is applied. The succeeding coat should not be richer than the preceding one and should be of lesser thickness.

The final coat should be lightly combed if the cladding is to be bedded in sand/cement mortar but if adhesives are to be used combing will not usually be necessary and the surface should be left with wood float finish.

Attempts to apply over-thick rendering may result in unduly high shrinkage stresses and consequent cracking and loss of adhesion. It is not good practice to apply rendering having a total thickness in excess of 20 mm without reinforcement.

Where tiling is to be bedded in thin-bed adhesives, the trueness of the surface of the rendering should be such that, when checked with a 2 m straightedge, any gap behind the straightedge does not exceed 4 mm. Where the gap exceeds 4 mm, local correction will be necessary or, alternatively, a thick-bed adhesive may be specified. This also applies to surfaces not rendered accurately to a specified plane. Where sand/cement mortar bedding or thick-bed adhesives are adopted, greater variations, e.g. up to 8 mm in 2 m, can be tolerated.

APPENDIX C

CLEANING AND MAINTENANCE

C1 GENERAL

There are generally three stages of tile cleaning. The installation cleaning should incorporate removal of excess adhesives and grouts resulting only in a light haze remaining on the finished surfaces (see Clause 5.8). There is usually a need for post installation cleaning that will remove any building soiling including plaster, paint, etc. Routine maintenance will provide a cleaning regime that should ensure the cleanliness and safety of the floor while maintaining the integrity of the tiling system.

Understanding the nature and requirements for a particular floor are key to its performance and service life. This will vary according to the type of tile and any treatment applied to protect or enhance the tile, e.g., pre-sealing, waxes, grout release agents and physical protection layers. An understanding of the surface characteristics of highly slip-resistant tiles will often dictate which cleaning methods should be used.

Damage can occur to flooring if incorrect chemicals or methods are used.

Personnel responsible for post installation cleaning and maintenance should be given specific recommendations for cleaning and full information concerning any particular possible risks of misuse.

C2 ROUTINE MAINTENANCE

It is generally accepted that all things require maintenance and ceramic floor finishes are no different. Recent worldwide developments have altered the nature of ceramic floors. Maintenance of these surfaces is fairly easy to achieve where appropriate processes are used. Daily sweeping and washing to remove soiling remains the most basic method.

Daily sweeping or vacuuming is very important to remove loose soil, sand, mud or other forms of debris that collects on a floor. Loose soil provides an abrasive load that can damage glazed surfaces, leaving a hazy or soiled appearance in high traffic areas. These areas soon start looking different to areas unaffected by abrasion, detracting from the bright polished finish favoured by people. In addition to the worn appearance, the cleaning of this area will become more difficult as the surface alters.

Most loose soil and sand can be collected by creating soil traps at the entrance prior to walking onto the flooring. An entry mat should allow sufficient positive contact of both feet prior to entry to remove most of the soil. If animal entry points are used, the same precautions should be taken as a great deal of loose soil will be deposited by the family pet.

Washing the flooring should remove visible soiling where the correct amount of cleaning agent is used. Residual streaks, detergent marks and films can result from use of excessive cleaning agent, detracting from the gloss. Adequate rinsing of the floor or using a no rinse detergent will correct the issue.

Effective cleaning usually can be achieved by normal washing or scrubbing with warm water and a pH neutral sulphate-free cleaning agent. Greasy deposits can be removed with a detergent incorporating an organic solvent or a highly-alkaline detergent (pH >9), but these should be used for only occasional cleaning. Overuse of acidic cleaning agents may result in grout attack and cause hazing of glazed tiles.

The occasional use of abrasive cleaning agents can be beneficial but should be restricted to unglazed floor finishes. Abrasive cleaning methods should generally be avoided as they can contribute to excessive wear. Appropriate cleaning agents are available including proprietary abrasive cleaning agents that will not wear or scratch. Appropriate abrasive methods can be used to remove stubborn stains on polished and profiled glazed tiles. It should 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 of some tiles, and may result in gradual loss of thickness in the wear layer.

When a tile has a profiled surface, the process may differ as soil and cleaning agents tend to build up on the surface. When such profiled surfaces require cleaning, adequate dwell time and agitation is required to dislodge the soiling prior to complete removal. Agitation can be achieved using appropriate cleaning pads or brushes. Such methods will dislodge most forms of soiling including build-up of past cleaning agents and soil that collects in recesses. Steam and high pressure cleaning methods may occasionally be appropriate in some installations.

It is important to ensure that the cleaning agent is completely removed by a final rinsing with clean water.

Household soaps are not recommended as they tend to leave a slippery scum, particularly in hard-water areas.

Apart from normal usage or obvious misuse, surface contamination can arise from the following:

(a) Efflorescence.

(b) Residual cement film.

(c) Surface sealing materials.

(d) The reaction of cleaning agents with hard water.

(e) Unsuitable cleaning agents.

(f) Overuse of high alkaline detergents.

(g) Flexible additives left on surface areas.

(h) Coloured oxides deposited through grouting.

(i) Moss, algae, leaves stains, bark stains, wood stains, rust marks, pot plant marks and leaching.

C2.2 Efflorescence

Efflorescence usually appears as a white powder on the surface of the tile or joints. It is caused by liquid water carrying soluble salts from below the tile to the surface. When the water evaporates it leaves a powdery residue. If the installation is new, the residue can usually be removed by sweeping or vacuuming the powder away. If soluble salts are cleaned using water or acidic cleaning solutions, some of the salt will dissolve, be reabsorbed and may reappear as efflorescence. Should the problem be persistent seek professional advice regarding continual moisture problems.

Some deposits may react with carbon dioxide forming insoluble compounds that adhere tenaciously to the tile and adjoining surfaces.

Leaching can be mistaken for efflorescence as a white deposit can develop. Leaching can occur when water enters a tiling system dissolving soluble salts in the bedding or where water contains high mineral contents from other sources. Water access and egress is usually gained through faults or cracks, either in the grout or from differential movement cracks in the tiling system. These soluble deposits leave conspicuous drainage marks and are extremely difficult to remove. Prior to removal, the source of water flow must be located to stop water intrusion. Once the source has been repaired, the leaching can be cleaned often using an appropriate strength of an acidic based cleaning agent.

C2.3 Residual cement film

After a flooring system has been installed, the tiling professional may have left a light cement film on the surface. This film is generally insoluble in water. This can be removed by treatment with appropriate proprietary acid cleaners. The floor should be wetted to saturate the grout, and free water removed before the application of the cleaning agent. It is important that this treatment be followed immediately by the use of a proprietary neutralizing agent or a slightly alkaline solution, followed by a thorough rinsing with clean water.

C2.4 Other residual films

Other films that can be found on the surface of finished tiling include residues from tile protective waxes, epoxy grouting and polymer-modified grouts and adhesives. This film is generally insoluble in water. This problem is best addressed by thorough cleaning immediately after tile installation. These films can be removed by treatment with appropriate proprietary products. Alternatively, specialist guidance should be sought.

C2.5 Surface sealing materials

Generally two types of sealers are used. They are topical surface coatings and penetrating sealers. The purpose of the sealer and the characteristics of the tile should be considered prior to sealants being used to ascertain the performance requirements.

Some sealers have volatile components that may restrict their application.

Surface coatings seal the surface pores and generally reduce the roughness of the finish, thereby making the tile easier to clean. Sometimes surface coatings are applied to enhance the appearance of the tile. Surface coatings may alter the slip resistance. Abrasive foot traffic will remove the coating over time necessitating ongoing maintenance in the norm of a reapplication. Surface sealers require their own form of cleaning and maintenance and advice should be taken regarding upkeep.

Penetrating sealers are primarily used to reduce the adhesion of contaminants and restrict the entry of staining materials on the surface and grout joints of a tile. Penetrating sealers do not generally alter the appearance of the tiles or affect their slip resistance. The selection of the type of penetrating sealer will usually involve its ability to repel oils or water-based contaminants, or both. Penetrating sealers are generally used with more porous tiles; however, they are often beneficial in protecting polished porcelain type tiles from staining. The selection of the sealer will be dictated by the tile characteristics and level of the performance required. Due to the complexity of the selection of the penetrating sealer, it is advised that professional assistance be sought.

APPENDIX D

FALLS IN FLOOR FINISHES

D1 GENERAL

The primary consideration for falls in floor finishes is to ensure water does not remain on the finished floor in a manner that can adversely affect the health or amenity of the occupants or deteriorate building elements.

Falls in floor finishes should ensure water exits the area at the floor waste or doorway if that is the designed exit point (e.g. laundry door to exterior). Water should not pond on the floor, with the exception of residual water remaining due to surface tension.

D2 FACTORS AFFECTING FALLS

The ratio of fall achieved in a floor may vary depending upon the—

(a) finished height requirements at doorways;

(b) height of fixtures or fittings;

(c) dimensions of the tiles used, adequate falls become more difficult to achieve as the size of the tiles used increase;

(d) area of the floor to be drained; and

(e) requirements of persons with disabilities.

D3 FALL RATIOS

The recommended ratio of fall within a shower area is between 1:60 and 1:80.

The recommended ratio of fall in other wet areas is between 1:80 and 1:100.

In some circumstances the fall in the floor finishes in the same area may vary.

Where falls steeper than 1:100 are not achievable, the effectiveness of the floor drainage should be confirmed to ensure it meets the primary consideration set down in Paragraph D1 above.

D4 DIAGONAL CUTTING OF TILES

Tiles may require diagonal cutting in the area around the waste to achieve the required falls, sufficient drainage and to ensure lipping is minimized and within the guidelines of Clause 5.4.6(a).

APPENDIX E

WET CONDITIONS (CONTINUOUSLY IMMERSED)

E1 WET CONDITIONS (CONTINUOUSLY IMMERSED)

E1.1 General

It is important that the nature of any liquid involved is known before the specification for the installation is determined. Liquids include potable water, saltwater, water treated with additives. Some liquids may be aggressive.

Mosaic tiles usually come on sheets that have mesh or netting holding them in position on the back, or with paper or film holding them in position on the face. For swimming pools, and other installations where frequent or constant immersion is expected, front-mounted mosaics are preferred. This is because the adhesive holding back mounted mosaics can sometimes seriously interfere with the ability of the tile adhesive to bond to the back of the tile. It is strongly advised that the suitability of mesh-backed tiles for constantly wet applications be established prior to the commencement of tile installation.

It should also be noted that the joint size of front-mounted mosaics remains constant on curved surfaces, whereas, back-mounted mosaics either narrow or widen their joints when fixed to internal or external curved surfaces respectively.

The primary objective is that the basic structure behind the tiling should be watertight. Additionally, screed or rendering, bedding material and grouts should withstand continuous contact with the immersion liquid without deterioration.

Tiles used for pool surrounds should also be resistant to salt attack if the pool contains saline solution.

Cementitious grouting compositions are usually porous, and although integral waterproofers can be incorporated it should be recognized that they will not make the joints impervious.

The most common installations subject to continuous immersion are those in various kinds of pools, baths, tanks and reservoirs. In these situations there are many different service requirements and it is important that consideration be given to such related factors as the background structure, its subsequent treatment, the choice of tiled finish and its application, intervals between operations, the nature of the liquid concerned, temperatures and potential movement.

For external swimming pools, the usual precautions against inclement weather and extremes of temperature during and after the tiling operation should be taken, and notice taken of possible climatic/thermal effects.

Ideally, the sulfate concentration (expressed as SO_3) of water in swimming pools should not exceed 300 p.p.m. Where greater concentrations of sulfates cannot be avoided, consideration should be given to the use of impermeable adhesives, grouting materials, renders and screeds that are not affected by sulphates. High levels of sulfate either present in the water supply or added via pool maintenance chemicals (especially flocculants) would otherwise react with and erode materials containing Portland cement.

E2 INTERNAL SWIMMING POOLS OF CONCRETE CONSTRUCTION (EXCLUDING SALTWATER POOLS)

E2.1 General

The structure shell of indoor swimming pools containing mains (potable) water should be designed and constructed of reinforced or prestressed concrete or gunite (pneumatically applied cement:sand mortar or concrete). The design, specification, and construction should be in accordance with AS 3735. If possible, there should be no structural movement joints.

The following recommendations apply in addition to those given in Paragraph E1:

(a) Any cracks in the concrete should be effectively repaired prior to the application of any screed or rendering or other coatings to the floor and walls.

(b) The mortar or concrete should be batched by mass and should consist of cement and fine and coarse aggregate complying with AS 1379.

(c) The free water:cement ratio for concrete and mortar used for the structural shell should not exceed 0.5.

The surface of the concrete/gunite of the pool shell that is to receive rendering or screed, tiling or mosaic, should be prepared in such a way that maximum bond is obtained. Methods for the preparatory work for walls and floors are described in Clauses 4.3 and 4.5, respectively. Before rendering, screeding or tiling is carried out, the shell of the pool should be tested and tested for watertightness.

The advice of the manufacturer should be obtained for all ceramic materials and components in swimming pools, including overflow channels, pool ladders, steps, etc. Where externals pools may be subject to freezing conditions, it is imperative that frost-resistant materials are used.

Adhesives should comply with the requirements for Types C2S1 or R1 of AS 4992.1. and should be suitable for continuous immersion.

Some concrete swimming pools have been constructed so precisely that direct fixing, even with thin-bed adhesives, has been feasible. However, these are exceptional, and, of necessity, the costs of obtaining such precision casting may be high. In most cases, therefore, the wall should be rendered and a screed provided on the floor to ensure a true and even surface.

The minimum time intervals that should be allowed to elapse between the successive stages are given in Table E1.

Construction stages are as follows:

(a) Between curing the pool shell and rendering or screeding: 6 weeks.

(b) Between completion of rendering or screeding and the commencement of tile fixing: 3 weeks.

(c) Between completion of tile fixing and the commencement of grouting: 3 days.

(d) Between completion of the grouting, movement joints and the filling of the pool: 3 weeks.

These time intervals should only be reduced if an adequate design solution is provided. A longer period may be necessary in wet weather.

For tiling of fibreglass pools refer to adhesive manufacturers for guidance.

TABLE E1

MINIMUM TIME INTERVALS BETWEEN SUCCESSIVE STAGES IN TILING

Mosaic (mesh-backed)	Mosaic (paper-faced)	Ceramic tile	Membrane* (liquid applied)	Gunite (sprayed concrete)	Stages			
					1† week	2 weeks	3 days	4 weeks
✓					6	0	1	1
	✓				6	0	N/A	1
		✓			6	1	1	1
		✓	✓		6	1*	1	1
		✓		✓	6‡	1	1	1
✓				✓	6‡	0	1	1
	✓			✓	6‡	0	N/A	1
✓			✓		6*	0	1	1
	✓		✓		6*	0	N/A	1

LEGEND:

* Moisture meter reading of <15% required before membrane applied.

† Assumes concrete effective thickness of approximately 150 mm (Table 4.2) at 23°C temperature 50% RH. The drying time required may increase with increased thickness, increased RH and decreased temperature.

‡ Cement polymer scratch coat (1:1:1) before rendering.

NOTES:

1 Where there is turbulent agitation of the water, the grout will require superior erosion resistance.

2 For mineral content water, a membrane may be required.

3 Based on continuous air-drying.

E2.2 Pool surrounds

To minimize ponding, pool surrounds should be constructed with adequate gradients and should drain to appropriately sited outlets or channels. Nominally level floors do not drain satisfactorily and pool surrounds should have a gradient, but it should not be steeper than 1 in 35.

People are not always able to accommodate small changes in gradient on wet floors. The slip potential of pool surrounds is affected by contaminated water (chemicals), contamination of the floor by body fats, contaminated feet (contaminated water and body fats) and the gradient. Tiles of appropriate surface roughness should be used. Guidance may be found in HB 197.

E2.3 Walls (rendering)

The walls of the pool shell should be rendered in accordance with Appendix B.

If curing compounds and release agents are used, these need to be removed in accordance with the manufacturer's instructions prior to the application of any screed.

Except in the case of mosaics the rendering should be completed at least 7 days before tiling begins and the prepared surface should be dry to receive the tiles. When a bonding agent is used to achieve improved adhesion of the rendering to its background, the agent should be of a water-resistant type.

Bonding agents based on polyvinyl acetate (PVA) do not have good water resistance and should not be specified for swimming pools.

E2.4 Floors (screeds)

The normal method of laying floor screeds in swimming pools is by separate construction, i.e., the screed is laid after the concrete of the pool shell has hardened (see Paragraph E2.1). It is essential that the screed be well bonded to the surface of the concrete. If curing compounds and release agents are used, these need to be removed in accordance with the manufacturer's instructions prior to the application of any screed. Immediately before laying the screed, the surface of the concrete should be cleaned and brushed with a slurry coat. Proprietary products should be used in accordance with the manufacturer's instructions. The accuracy of the concrete base should allow a screed thickness of 25 mm to 40 mm to be maintained over the whole area; where necessary, the concrete should be dressed to achieve this accuracy.

The mix proportions of cement and sand for the screed should be between 1:3 and 1:4.5, by mass. The water:cement ratio should be kept as low as possible, compatible with sufficient workability to ensure full compaction.

Careful curing of the screed is of great importance, especially in warm dry conditions. Curing should start immediately the screed is compacted and finished. To ensure this, each completed area should be—

(e) covered without delay using polyethylene sheets well lapped and weighted down around the edges to prevent wind blowing underneath; or

(f) continuous wet curing for the first 6 h.

The screed should be left with a wood float finish.

For further information on the laying of floor screeds refer to Appendix A.

E2.5 Waterproofing with liquid applied membranes

Where waterproofing is required, a suitable liquid membrane may be applied to the pool shell, or the screed and render, in accordance with the manufacturer's instructions. Where required by the manufacturer, it is essential that proper attention be given to detailing the installation of bond breakers at all 'square' joints at any wall/wall or wall/floor interfaces.

E2.6 Fixing tiles to the pool shell (floor and walls)

The tiles should be solidly bedded so that voids behind them are eliminated as far as possible. Thin-bed adhesives are not suitable for the fixing of tiles with backs incorporating deep keys or frogs; for these, thick-bed adhesives should be used.

E2.7 Fixing floor tiles to the pool surround and adjacent areas

The tiles should be solidly bedded so that voids are eliminated beneath them as far as possible. Special problems may arise where the floor areas have to be waterproofed to prevent penetration of water to underlying corridors, electrical equipment and other services. In these circumstances, safeguards necessary to prevent water penetration should be incorporated in the design of the structure and drainage system; it should not be assumed that the degree of protection against water penetration given by the tiling will be adequate.

E2.8 Penetrations

Where pipes, rails or anchoring penetrate a waterproof membrane they will need to be appropriately detailed.

Where tiling has been installed and it is subsequently necessary to penetrate a waterproof membrane, the membrane should be reinstated so that the waterproofing is not compromised.

E2.9 Grouting in swimming pools

Proprietary grouts should be specified, selected for their suitability to meet the service conditions anticipated and should be used in accordance with the grout manufacturer's instructions.

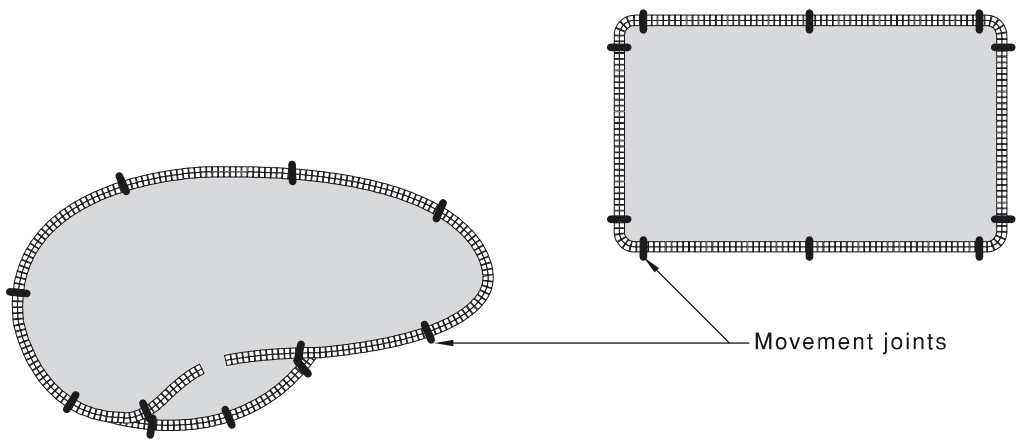
Reaction resin grouts (RG1) or cementitious grouts (CG2WA), in accordance with AS 4992.3 will be necessary to ensure long-term durability: where the pool water is soft, i.e., with low levels of calcium (temporary hardness), where acidic cleaning agents are used and especially for heavily used free-form pools with simulated beaches, wave machines and similar machines that cause rapid water movement (see Paragraph E2.11).

E2.10 Movement joints

Most pools do not have movement joints in the structural concrete shell. Older pools may have movement joints, which may be sources of water leakage and should be carried through to the face of the tiling. Refer to Clause 5.4.5 for further information on movement joints. Movement joints should be incorporated in the pool lining around the perimeter at the junction of the bottom and sides, at vertical corners and at any change of plane in the bottom. Movement joints are considered adequate in these positions where the normal joints between tiles are at least 5 mm wide, but if they are narrower it is advisable to insert additional movement joints down the pool sides and across the bottom in a continuous loop at 6 m intervals or less to suit design considerations.

Movement joints should be inserted to coincide with the structural junction of the pool shell and the surround slab and where pool surround tiling abuts walls, drainage channels and other features. Intermediate movement joints should be inserted at intervals of 6 m or less, except for mosaics where they are not required.

For coping, movement joints are recommended at intervals of 3 m, with a maximum of 4.5 min (see Figure E1).



NOTE: Movement joint locations are indicative only. The number and actual locations vary depending on the properties of the pavers, the type of concrete/substrate, climatic conditions and the pool dimensions

FIGURE E1 TYPICAL LOCATIONS OF MOVEMENT JOINTS FOR COPING TILES

Movement joints can be filled completely with a suitable sealant. Alternatively, the joints can be part-filled with a compressible filler such as polyethylene foam strip and completed with the sealing compound. It is important to prepare the joints correctly, and whichever sealant is chosen it is advisable to consult the manufacturer concerning choice and method of application.

Special consideration should be given to selection of an appropriate sealant and, should not only accommodate the movement in the tiling and constant immersion, but also resist the chemical attack due to chlorine and other additives used in the water and in cleaning agents. The joints are also vulnerable to physical damage. In general the flexibilized epoxide sealants sealants are preferred. Silicone sealants require dry conditions at the time of application and careful preparation and priming of the joints, otherwise they are susceptible to adhesion loss and the sealant can easily be removed.

Flexible epoxide sealants are less critical on joint preparation and are less susceptible to damage. Some can be applied to wet joints and some can even be used under water. Some are only suitable for remedial work after installation has achieved a stable condition. Polysulfide sealants may be used but are subject to degradation by chlorine and other additives and may require periodic replacement.

E2.11 Pool water conditions

The durability of the grouting will depend on the nature of the pool water supply and the chemicals used in the treatment of the water and the cleaning of the tiling. Cementitious grouts (CG1) should only be used where the pool water has adequate calcium hardness and alkalinity so that balanced water conditions can be consistently maintained at the recommended pH level.

Most pool chemicals should be dissolved and added to pool water as a solution. With the exception of some proprietary materials in tablet form, no chemical should be left undissolved on top of the pool floor tiling since the localized concentrated solution may be sufficiently aggressive to erode cementitious grouts and even erode the tile glaze.

The use of sulfate containing chemicals, e.g., sodium bisulfate (dry acid), should be discouraged due to the need to keep sulfate levels as low as practicable and to prevent sulfate attack on cement grouts, tile beds, screeds, rendering and concrete.

E2.12 Filling and emptying

Pools should not be filled for at least 3 weeks after completion of the grouting and movement joints, this interval being important to the success of the installation (see Paragragh E2.1). Pools should be filled and emptied slowly in order to minimize the stresses due to loading and thermal changes. The maximum rate of filling or emptying pools should be controlled so that the water level rises or falls about 750 mm every 24 h.

NOTE: It is not advisable to leave a tiled swimming pool empty for prolonged periods.

E2.13 Heating

The pool water should be heated at a rate of 0.25°C/h.

E3 SALTWATER POOLS, RANKS AND RESERVOIRS OF CONCRETE CONSTRUCTION

E3.1 General

The term saltwater is intended to include all types of saline water such as medicinal spa water, used in swimming and hydrotherapy pools and sea water, rather than low concentrations of salt added for chlorination purposes.

Sea water and saline waters are particularly aggressive to ferrous metals and therefore special care should be exercised to ensure that all ferrous metals are adequately protected.

The structural shell of saltwater pools, tanks and reservoirs should be designed and constructed of reinforced or prestressed concrete or gunite (pneumatically applied cement:sand mortar or concrete). The design, specification and construction should be in accordance with AS 3735.

For requirements of concrete in contact with seawater, reference should be made to Section 4 of AS 3735.

The recommendations in Paragraphs E2.1 and E2.10 regarding sealing of cracks and joints in the pool shell should be followed.

For pools containing water with a higher concentration of dissolved salts than in sea water, specialist advice should be obtained on the type of cement and mix proportions for all concrete and mortar. A full chemical analysis of the pool water should therefore be obtained, and this could be used as a basis for the decision on what special precautions, if any, are needed.

E3.2 Screed, rendering, bedding and jointing

Sulfate-resisting Portland cement complying with AS 3972 should be used for the rendering and screed and the tiles should be fixed with a sulfate-resisting adhesive (e.g. epoxy resin). Advice from the manufacturer of the adhesive should be sought, and the enquirer should make known to the manufacturer full details of the chemical analysis of the pool water.

It should be noted that walkways around the edges of the pools are particularly vulnerable, due to the fact that they are subjected to alternate wetting and drying. This creates a build-up of salts in the grout and bed materials, unless they are impermeable to water.

Tiles should be solidly bedded as detailed in Paragraph E2.6. The jointing procedures in Paragraghs E2.9 and E2.10 should be followed.

E4 CONCRETE TANKS AND SERVICE RESERVOIRS

Tiling should be carried out as described for concrete swimming pools, but reference should be made to AS 3735.

AMENDMENT CONTROL SHEET

AS 3958.1—2007

Amendment No. 1 (2010)

CORRECTION

SUMMARY: This Amendment applies to Clause 5.6.4.3.

Published on 12 March 2010.

NOTES

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