



Code of practice for



Wall and floor tiling



Part 1. Code of practice for internal ceramic
wall tiling and mosaics in normal conditions

(formerly CP 212 : Part 1)



Carrelages et dallages

Partie 1. Code de bonne pratique relatif aux carreaux et mosaïques
céramiques pour revêtement des murs intérieurs dans les conditions normales

Wand- und Bodenfliesen

Teil 1. Leitfaden für keramische Fliesen und Mosaik für

Innenwände unter normalen Bedingungen

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Foreword

This Part of the code of practice BS 5385 has been prepared by a reconstituted Code Drafting Committee to take account of the developments in adhesives that are recommended in preference to cement/sand mortar in most situations which have led to the use of tiles and mosaics on a much wider variety of backgrounds. The text has been extended beyond that of the 1963 edition to offer more precise and detailed recommendations on backgrounds and their treatment and on application and jointing procedures. A section on the application of mosaics has been introduced (section five) which draws attention to the procedures that differ from those appertaining to tiling.

Throughout the code, references to tiles and tiling are intended to apply equally to mosaics and mosaics work except where any differing provisions in section five relate.

This code of practice represents a standard of good practice and therefore takes the form of recommendations. Compliance with it does not confer immunity from relevant statutory and legal requirements.

Part 1 covers internal ceramic wall tiling and mosaics to be 'installed in normal conditions (for the purposes of this code 'normal conditions' imply normal environmental temperature and humidity).

It is not to be inferred from this that all recommendations made in this Part of the code are unsuitable for more extreme conditions.

This standard will be issued in five Parts, the other Parts are as follows:

Part 2. Code of practice for external ceramic wall tiling and mosaics.

Part 3.* Code of practice for laying ceramic floor tiles and mosaics.

Part 4. Code of practice for ceramic tiling and mosaics in specific conditions.

Part 5.* Code of practice for laying terrazzo tile and slab, stone and composition block floors.*

NOTE. This British Standard is a revision of CP 212 : Part 1, which will be withdrawn upon publication of this standard.

* In preparation.





British Standard Code of practice for

Wall and floor tiling



Part 1. Code of practice for internal ceramic wall tiling and mosaics in normal conditions

Section one. General

1. Scope

This Part of the code concerns internal ceramic wall tiling and mosaics in normal conditions. It deals with the types and classes of backgrounds and their suitability to receive a bedded finish using the following fixing methods, which also are described in the relevant sections:

- (a) bedding in cement-based adhesives on an intermediate substrate or as a direct bedding method;
- (b) bedding in organic-based adhesives on an intermediate substrate or as a direct bedding method;
- (c) bedding in other adhesives on an intermediate substrate or as a direct bedding method;
- (d) bedding in cement/sand mortar on rendering or as a direct bedding method.

NOTE. The word 'weight' has been used in its colloquial sense in this standard, instead of the formally correct word 'mass'.

2. References

The titles of the standards publications referred to in this standard are listed on the inside back cover.

3. Definitions

For the purposes of this code the following definitions apply.

3.1 adhesive. Bedding material other than cement/sand bedding mortar.

3.2 backgrounds. This term is used in three senses:

- (a) those that without treatment are suitable to receive the bedded finish by a direct bedding method;
- (b) those already treated to receive the bedded finish;
- (c) those requiring some form of surface treatment in readiness for the bedded finish.

3.3 bedded finish. The tile or mosaic finish including its bedding.

3.4 bedding. A layer of specified material that bonds the tiles or mosaics to a background.

3.5 direct bedding/direct fixing. The application of a bedded finish to a background without an intermediate substrate.

3.6 grouting/grout. The operation of, or the materials used in, filling the joint cavities between tiles or mosaics.

3.7 intermediate substrate. A layer, e.g. rendering or plaster, applied to a background to provide a surface suitable to receive the bedded finish.

3.8 joint. A space between the edges of adjacent tiles or mosaics.

3.9 movement joint. A joint, usually wider than a normal joint between tiles or mosaics, designed to accommodate movement in the installation.

3.10 pre-grouting. The operation of, or the materials used in, filling the joint cavities between mosaics on the reverse sides of the sheets before the sheets are placed in position.

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

3.12 thick bed. Bedding exceeding 3 mm in thickness.

3.13 thin bed. Bedding not exceeding 3 mm in thickness.

4. Exchange of information and time schedules

4.1 The working drawings and specifications should be prepared in sufficient detail to afford proper guidance in the preparation of estimates and the execution of the work. If bills of quantities form part of the contract, they should be prepared in accordance with the 'Standard method of measurement of building works' or the 'Code for the measurement of building works in small dwellings' as appropriate*. As soon as possible after acceptance of contract, there should be an exchange of information between those responsible for the execution of the backgrounds, the application of tiling and mosaics systems, and other trades whose work will affect or be affected by the tiling or mosaics. Any special conditions to which the installation may be subjected in service (e.g. drastic cleaning operations) should be made known and allowed for in the specification or discussed prior to the preparation of estimates.

4.2 Unless the terms of the subcontract state otherwise and are known to the tiling contractor at the time of quotation, the main contractor should be responsible for the provision of the following at such times and in such a manner as to avoid the tiling contractor incurring lost time in the proper execution of his work:

- (a) adequate dry storage (lock-up);
- (b) water supply adjacent to working areas;
- (c) adequate artificial lighting if required;
- (d) suitable scaffolding and staging, which should be in accordance with the requirements of the Building and Construction Regulations made under the Factories Act;
- (e) unloading and hoisting facilities;
- (f) electric power supply adjacent to working areas;
- (g) protection of work during and after fixing.

*Both publications can be obtained from the Royal Institution of Chartered Surveyors, 12 Great George Street, London SW1P 3AD (telephone 01-839 5600).

4.3 In preparing a time schedule for the work involved in a building, each operation should be considered in relation to the others, giving due consideration to the most economical use of general plant and scaffolding by all trades and also ensuring that they do not interfere unduly with each other's work. The whole of the work should be carried out in accordance with the requirements of the Building and Construction Regulations made under the Factories Act.

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

4.5 The time schedule should allot times for the construction and preparation of the backgrounds to allow sufficient intervals for drying out and initial shrinkage to take place. It should also allow for all cutting of holes and chases in the walls to receive the bedded finish and in adjacent walls before any intermediate substrate is applied.

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

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

Section two. Materials and storage

5. Tiles and mosaics

This code applies to glazed and unglazed ceramic tiles, other than those requiring cramping or other mechanical fixing devices, and to mosaics of various kinds. Their compatibility with the materials recommended for fixing and their suitability for application to the various backgrounds and environments described in this code will depend on such factors as their composition, weight and accuracy of shape. Glazed ceramic tiles of the types included in BS 1281 should comply with the recommendations of this standard.

There are several different types of mosaics available in a variety of shapes and sizes, including glazed and unglazed ceramic mosaics, glass mosaics and marble mosaics. To facilitate ease of handling, mosaics are assembled on sheets, the separate pieces of mosaics 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.

With sheets backed with nylon strip, nylon fabric net or similar, the backing will be embedded in the bedding mortar or adhesive used for fixing. Therefore the glue used to bond the strips or net should be of a type that will not deteriorate in service and should be compatible with the bedding material. The glue should be confined to the strips or net and should not spread on to the backs of the individual pieces, otherwise it will adversely affect adhesion between the mosaics and the material used to fix them.

As there is at present no British Standard for mosaics, it is recommended that before selecting a particular system advice should be obtained from the relevant sources as to the appropriate fixing method and suitability of a particular type of mosaic for a particular environment.

Clean, dry, frostfree storage should be provided on site and adequate precautions taken to avoid excessive handling and possibility of damage.

6. Cements

The cements referred to in this code should be used in accordance with the manufacturer's instructions and should comply with the requirements of the relevant standards where applicable as follows:

Portland cement (ordinary and rapid-hardening)	BS 12
Portland-blastfurnace cement	BS 146
Masonry cement	—
Sulphate-resisting Portland cement	BS 4027

Cements packed in the customary multiwall paper sacks remain usable for considerable periods if supported out of contact with the floor in a dry cool store. If large quantities are involved, deliveries should be kept separate and used in succession. In rare instances a delivery may be still warm from the manufacturing process, and such material should preferably be allowed to cool before use.

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

7. Sand

7.1 General. The nature of the sand used has a great effect on the properties of mortars in the fresh and hardened states.

If mortars are to be satisfactory for rendering and tile fixing, they have to be workable and retain water against any tendency to absorption by surfaces to which they may be applied. On the other hand the long-term suitability of a mortar depends largely on its drying shrinkage, and this is to a great extent governed by the type of sand and consequently by the amount of water that has to be added in order to confer the required properties on the fresh mix.

Evenly graded sands tend to yield mixes that, if proportioned appropriately (see clause 17 and 21.4.3), possess the ideal properties.

Sands containing an abnormal proportion of fine grains may cause the mix to require an excessive water addition. Those sands containing an undue amount of absorbent matter, such as chalk, clay or loam, may have a similar effect.

All sand should be protected from the weather so that its moisture content does not fluctuate widely through repeated wetting and drying. Sand 'bulks' according to its moisture content, so that changes in the latter can affect the consistency of volume batching and hence the mix proportions, water content and consequent drying shrinkage.

Sand that is at a temperature at or below the freezing point of water may impair the setting of the cement in the mix, particularly if its use leads to the applied material's freezing before it hardens. In winter, therefore, precautions should be taken to exclude such sand from use.

Apart from considerations of grading, sands should be inert and not contain significant quantities of foreign matter able to affect materially the adhesion of renderings, beddings or tiles.



Documents

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7.2 For cement/sand renderings. In the absence of experience concerning the suitability of a given sand, sands should comply with the requirements of BS 882 or BS 1199, although those having gradings falling within zone 1 (table 2) of BS 882 : Part 1 : 1965 or Part 2 : 1973 are likely to have poor water retention and to be too harsh for normal use. Those having gradings within zone 2 or 3 are more likely to yield mixes having acceptable consistencies and drying shrinkages.

7.3 For cement/sand tile-fixing mortars. Sands falling within the classification of BS 1199 contain greater proportions of finer particles than the BS 882 sands referred to in 7.2 and thus tend to be better suited to the relatively thin layers of mortar applied when fixing tiles and mosaics, although sands complying with the requirements of BS 882 (zones 2 and 3) are suitable in bedding mixes for deep keyed or frogged tiles.

8. Plaster

Plaster backgrounds to receive ceramic tiles are usually based on gypsum building plasters and should be provided in accordance with the recommendations of CP 211.

Gypsum plasters should comply with the requirements of BS 1191 : Part 1 or Part 2.

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

9. Cement-based adhesives

These are usually proprietary compositions specifically manufactured for tile fixing. They are usually in dry powder form containing cement as the basic ingredient and generally require mixing on site with water only. Pending the issue of a British Standard, they should comply with the basic requirements given in appendix A.

10. Organic-based adhesives

These are usually proprietary organic adhesives of diverse composition, specifically manufactured for tile fixing. Pending the issue of a British Standard, they should comply with the basic requirements given in appendix A.

11. Water

Water should be fresh and clean. All containers used for storing or carrying water or for soaking tiles should be clean. Sea water is not suitable. Attention is drawn to BS 3148.

12. Rules (battens)

Rules (battens) should be true and equal to the combined thickness of the tile and fixing bed. They should be cleaned after use.

13. Materials suitable for movement joints

Pending the issue of British Standards, materials for movement joints should be composed of non-rigid materials applied either in the form of a compound or as a prefabricated strip; they should combine the properties of resilience and/or plasticity within the maximum temperature ranges likely to be encountered. Table 1 provides a guide to most of the sealants in general use and a summary of their properties.

14. Grouting materials

See 22.2, 22.3 and 22.4.

Section three. Design considerations

15. Backgrounds

15.1 General. The nature of the background is a prime consideration in deciding the choice of any intermediate substrate or other preparatory treatment necessary before tiling. Properties of the background that may influence the choice are indicated here and are also summarized in table 2.

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

Porosity and suction affect both the adhesion and the cohesion of plaster and therefore influence the selection of the type of mix to be used and particularly the proportion of sand in gypsum undercoat mixes.

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

15.1.3 Trueness of construction. This is important because of its effect on the thickness and number of coats of cement/sand mortar rendering or plaster (if any), the choice of fixing method and the final appearance of the tiling.

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

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

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

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

15.2 Types and classes of backgrounds. Backgrounds may conveniently be placed into one of the following classes (see also table 2).

15.2.1 Dense, strong and smooth materials. Such materials (which include high density clay bricks or blocks, dense concrete either pre-cast or in situ, stone, glazed bricks and glazed tiles) have low porosity, little suction and smooth surfaces that offer no mechanical key. Where an intermediate substrate is necessary there may be difficulties in securing satisfactory bond to the background, so that some artificial means of ensuring good bond is often necessary. Drying shrinkage of dense clay bricks or blocks is negligible. In dense concrete it may vary from low to high according to mix, quality, etc., but is usually no more than moderate.

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15.2.2 Moderately strong and porous materials. Most bricks and blocks other than the very dense types considered under 15.2.1 or lightweight products considered under 15.2.3 fall into this class together with some medium strength natural aggregate concretes, structural lightweight concrete and soft stone. Materials in this class have relatively high suction and generally provide a good mechanical key and good adhesion for an intermediate substrate if required. Drying shrinkage of concrete is variable and should be taken into consideration.

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

15.2.3 Moderately weak and porous materials. Blocks containing lightweight aggregate, autoclaved aerated concrete and some bricks of relatively low strength need more care in the selection of an intermediate substrate than backgrounds classed in 15.2.2. It is particularly important that the substrate should be not stronger than the background as otherwise shrinkage is liable to lead to shearing of the surface of the background. Lightweight concrete can have a large drying shrinkage movement which may be related to such factors as composition and/or degree of saturation.

15.2.4 No-fines concrete. This forms a class by itself. It has many relatively large voids and affords an effective mechanical key for an intermediate substrate. Drying shrinkage and suction vary from low to moderate according to the aggregate used.

15.2.5 Sheets and boards. Such materials include plaster-board, asbestos cement sheet and asbestos board, fibreboard, plywood and wood chipboard. They are mainly used with framed or battened construction which should be so designed as to provide a rigid surface.

If the sheets or boards are of a type likely to warp or deteriorate due to moisture absorption, they should be waterproofed.

15.2.6 Metal lathing. As a background this is mainly used with framed construction and offers a good key for cement/sand rendering and plaster provided that it is fully restrained (see 16.2.6). For type of material and application, see CP 211 and BS 5262.

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

16. Treatment of backgrounds

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

- (a) keying of the surface or the application of a bonding agent to improve the adhesion potential;
- (b) applying an intermediate substrate to provide the necessary measure of suction or accuracy;
- (c) taking down backgrounds of sheets or boards if they are not sufficiently rigid or accurate, then re-installing or replacing them.

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

Backgrounds not built accurately to a specified plane or having surfaces that are uneven may have deviations from a true flat surface that are too great to be capable of accommodation within the recommended thickness of a tile bedding material. If such backgrounds are of bricks, blocks, stone or concrete, it is recommended that an intermediate substrate should be applied to provide a true surface to receive the tiled finish.

When backgrounds are sheets and boards, painted surfaces, tiles or glazed bricks, the tiled finish usually will be applied directly to the background by means of a suitable thin-bed adhesive. Backgrounds having irregularities exceeding the limit defined in 16.4.1 may have to be corrected by re-instatement in the case of sheets and boards or by the application of an intermediate substrate if the background is capable of sustaining such a substrate.

The reliability of a system employing bedding of thicknesses greater than those recommended in section four, to accommodate inaccuracies in a background surface, is doubtful especially if the bedding thickness is not consistent throughout the installation, giving rise to variable stresses and the resultant possibility of failures, e.g. adhesion or cracking.

Separately from the aforementioned need to correct major irregularities, it may be necessary for the background to be treated with an intermediate substrate. The benefits to be derived from the use of thin-bed adhesives for the application of tiles are realized only when the adhesives can be spread to a recommended consistent thickness; thus the accurate surface that can be produced by an intermediate substrate makes an important contribution to the tiling system as a whole.

Cement/sand rendering provides a much stronger base for tiling than does plaster and wherever possible it should be specified, although the tiles can be fixed satisfactorily to sound plaster surfaces providing the recommendations in this code are observed. Reference to section four and table 2 will show that preference is given to the use of adhesives for the application of tiles to most surfaces, but there are some tiles that are not entirely suited to thin-bed application and usually are bedded in a thick-bed adhesive or in cement/sand mortar, which generally are not compatible with plaster or most sheets and boards as bases to receive them.

16.2 Treatment of backgrounds to receive cement/sand rendering

16.2.1 General. It is important to ensure that, before applying rendering, the background has dried out especially 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 (see also table 2).

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 should provide a good key, a good bond being dependent upon a mechanical key and/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 'spatterdash' 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 shuttering 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 with which a suitable detergent has been incorporated, followed by a final washing down with clean water. Retarders and detergents containing coloured dyes are recommended so that their removal can be seen to be complete when no traces of the dyes remain.

Indented keys in concrete may be provided by using rubber or composition formers fixed to the shuttering.

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 physical and mechanical properties necessary in the surface to receive it. The agent employed should be one that does not re-emulsify after application. These bonding agents usually are employed in one of four ways:

- (a) as a coating preceding the application of a cement/sand rendering;
- (b) with an admixture, e.g. cement, and applied as a slurry bonding coat preceding the application of a cement/sand rendering;
- (c) as an admixture to the rendering mix, partially or completely replacing the gauging water;
- (d) by combining (a) or (b) with (c) in one rendering operation.

Backgrounds on which bonding agents may be used are included in table 2.

The surface of brickwork or other solid backgrounds 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 (see 16.2.6 and BS 5262).

16.2.2 Dense, strong and smooth materials

16.2.2.1 High density clay brickwork and clay blocks. Where the joints of brickwork have not been raked back during construction, this should be done to a depth of 13 mm if the joints are soft enough. If the mortar is too hard for raking back or if the bricks or blocks are very hard and smooth, other methods of forming a key should be used (see 16.2.1 and 16.2.6). Walls constructed of keyed bricks need no raking back.

16.2.2.2 Dense concrete either pre-cast 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 (see 16.2.1 and 16.2.6). The joints in new and old concrete blockwalling should be treated as described for brickwork.

16.2.2.3 Hard natural stone. Dense or smooth stone may need to be treated to form a key (see 16.2.1 and 16.2.6).

16.2.3 Moderately strong and porous materials

16.2.3.1 Clay bricks and blocks. Treatment should be as described in 16.2.2.1.

16.2.3.2 Medium strength natural aggregate concrete. Treatment should be as described in 16.2.2.2.

16.2.3.3 Soft natural stone. This may need to be treated to form a key (see 16.2.1 and 16.2.6).

16.2.3.4 Calcium silicate bricks and concrete bricks and blocks. In addition to general cleaning treatment, joints should be raked back as already described in 16.2.2.1. With some types of extremely smooth calcium silicate bricks, metal lathing or wire netting may be used to obtain a good key.

16.2.4 Moderately weak and porous materials

16.2.4.1 Blocks and concrete containing lightweight aggregates. These usually require no preparation other than as indicated in 16.2.1. Some unusually smooth blocks may, however, require treatment as described for brickwork in 16.2.2.1.

16.2.4.2 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. The minimum amount of water has to be used to achieve this objective.

16.2.5 No-fines concrete. This usually requires no preparation other than as described in 16.2.1.

16.2.6 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 with the applied rendering and, when suitably fixed, to ensure its rigidity and to support its weight and that of the tiling and bedding.

16.2.7 Other backgrounds. These should be inspected and a decision taken as to whether cement/sand rendering is compatible with them and whether they have sufficient integral strength to support both rendering and the subsequently applied tiled finish.

16.3 Treatment of backgrounds to receive a plaster finish
The preparatory treatment necessary for the application of plastering systems to the backgrounds classified in 15.2 is similar to the treatment to receive cement/sand rendering defined in 16.2, and also table 1 and clause 303 of CP 211 : 1966.

16.4 Treatment of backgrounds to receive tiles by direct bedding

16.4.1 General. Tiles may be bedded directly to a background using thin-bed or thick-bed adhesives or cement/sand mortar as bedding materials. Methods of application and suitability of backgrounds to accept these methods are described in section four and table 2.

Where the tiles are to be bedded in thin-bed adhesives, the trueness of the background surface should be such that when checked with a 2 mm straightedge, any gap under the straightedge does not exceed 3 mm. Where the gap exceeds 3 mm, local correction of the background or, alternatively, the use of a thick-bed adhesive may be necessary; this also applies to backgrounds not built accurately to a specified plane, e.g. not upright. Irregularities up to 6 mm can be overcome by using thick-bed adhesives.

When cement/sand tile bedding mortar is to be applied directly to a background, the surface should be treated as described for cement/sand rendering in **16.2**.

16.4.2 Sheets and boards. These include the materials listed in **15.2.5**. A very important consideration with this type of background is that the sheets or boards have to be adequately braced to provide a rigid surface, free from any springiness and surface undulations, that will undergo no subsequent distortion during and after completion of the tiling. Wherever possible the boards should be screwed, not nailed, to the supporting framework.

In general, where the sheet or board has a smooth and a rough side, the latter should be used for tiling. The surface to receive the tiles should be clean and free from dust and other forms of contamination.

It is also sound practice to seal all exposed edges of boards, and the back where possible, with a suitable sealer to prevent distortion by atmospheric changes; this applies particularly to wooden surfaces such as chipboard.

Gypsum plasterboard is generally suitable as a background for tiling, but the following precautionary factors should be observed.

- (a) The adhesion between the paper liner and the plaster core should be adequate. Experience shows that this is adequate when the recommendations laid down in this code are followed (see (b) to (e) and **21.2**).
- (b) The boards should not become damp either during storage or after installation.
- (c) Different lining papers are used on either face of the central core of plaster and only the side intended for the direct application of a decorative finish should be used as a base for tiling.
- (d) Where gypsum plasterboard is used as a base for plaster, the plaster finish coat should be applied in accordance with the board manufacturer's instructions. When tiles are then applied, the recommendations given in clause **18** and **21.2** should be strictly observed.
- (e) The weight of tiling should be kept to the minimum by the use of thin tiles, i.e. preferably 4 mm but no greater than 6.5 mm thick.

16.4.3 Painted surfaces. It is very important to make a detailed examination of a painted surface before deciding if it is suitable to receive tiles. The permanent success of the installation is dependent upon good adhesion between the paint and the surface to which it has been applied and between any substrate and the basic structure. When the adhesion of the coating is in doubt, it should be stripped. For information on stripping paint and distemper, reference should be made to CP 231.

Backgrounds decorated with hard gloss paint, e.g. fair-faced brickwork and plasterwork, are often sufficiently plumb and smooth for tiles to be fixed directly to them using a suitable adhesive. Where the paintwork is sound and shows no sign of flaking, and provided that the surface is sufficiently flat and true to permit thin-bed fixing, the only preparation required is a thorough cleaning down to remove any surface grease, grime, condensation, etc.

When it is necessary and appropriate to render decorated backgrounds, e.g. painted brickwork or concrete, the paint should be removed and an adequate key provided or the rendering should be supported on reinforcement mechanically fixed to the background. The general principles described in clause **18** apply to plaster used as a base for decoration and subsequent tiling.

16.4.4 Existing glazed tile and glazed brick surfaces.

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

Where loose tiling occupies complete walls, it may be convenient to apply the new tiling directly to the original bedding.

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

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

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

16.4.5 Other backgrounds. By using a suitable type of adhesive, tiles may be fixed to most types of surface (those most likely to occur in practice are discussed in clauses **15**, **16**, **17** and **18**). Occasionally other backgrounds are encountered, e.g. metals, that pose special problems. In such cases full information should be given of the application and service conditions to a manufacturer of adhesives, whose advice should be sought.

17. Cement/sand rendering

17.1 General. It is essential that the rendering be suited to the background to which it is applied and to the bedding material appropriate to the tiling. Recommendations for achieving the best relationship between the component materials in respect of their strength and shrinkage movement factors are included in table 2.

The rendering should be true, free of hollow-sounding areas and firmly bonded to the background. It should be protected if necessary to prevent rapid drying out for at least the first 3 days after application and should be completed at least 1 week and preferably 2 weeks (depending on weather, humidity and site conditions) before the fixing of the tiling begins.

Care is necessary to ensure that surfaces subsequently wetted down to control suction do not dry before the rendering is applied. The rendering should keep pace with the wetting or the surfaces should be re-wetted as necessary.

17.2 Mix for rendering to various backgrounds. 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 has been drawn in **15.2** to the variation in strength and drying shrinkage movement of the common backgrounds.

To improve the workability of rendering and thus to aid application and finishing, a small proportion of plasticizer may be incorporated in the mix. Proprietary plasticizers complying with the requirements of BS 4887 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 equivalent strength to the cement/sand mixes described in 17.2.1 to 17.2.4, should be in accordance with the instructions of the manufacturers of any proprietary materials employed.

Weight batching should be adopted whenever possible as this will help to ensure uniformity of mix proportions and thus the uniformity of the quality of the material.

17.2.1 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 Portland cement and sand in proportions not richer than 1 : 3 by volume (1 : 3.4 by weight) 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 1 : 4 by volume (1 : 4.5 by weight). 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.

17.2.2 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 cement/sand 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 (see table 2).

17.2.3 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.

17.2.4 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 sulphates, there is the additional possibility that these may react with the cement of any cement/sand rendering to form the mineral 'ettringite'. The formation of this mineral is accompanied by expansion, and this again may lead to stresses great enough to cause adhesion failure.

Sulphate-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 sulphate-resisting cements, since it will minimize the possibility not only of sulphate attack but also of salt deposition.

17.3 Thickness and trueness of rendering. It is not good practice to apply rendering having a total thickness in excess of 25 mm as this may result in unduly high shrinkage stresses and consequent cracking.

Rendering up to 13 mm in thickness may usually be applied as a single coat. If a greater thickness is required, the first coat should be 'combed' 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 tiling is to be bedded in cement/sand mortar; but if adhesives are to be used, combing will not usually be necessary and the surface should be left with a wood float finish.

Where the 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 under the straightedge does not exceed 3 mm. Where the gap exceeds 3 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, e.g. not upright. Where cement/sand mortar bedding or thick-bed adhesives are used, greater variations can be tolerated up to 6 mm.

18. Plastering

18.1 General. Plasterwork should be carried out in accordance with the recommendations given in CP 211. If a proprietary plaster is to be used, the recommendations of the manufacturer should also be followed.

The plasterwork should be firmly bonded to its background and be sufficiently strong to support the specified tiling. The weight of tiling should be kept to the minimum, especially on lightweight plaster, by the use of thin tiles, i.e. preferably 4 mm but no greater than 6.5 mm thick. Before tiling work is undertaken, the plasterwork should be sounded for evidence of complete adhesion to its background; this is particularly important where it has been applied to lightweight concrete walls. The surface should be examined for potential weakness and also, especially in the case of old plasterwork, for decaying and loose areas behind the surface. Defective areas should be cut out and made good and sufficient time allowed for any new plaster involved in the remedial work to dry out thoroughly before tiling is applied.

It is essential that there should be a good bond between the plaster backing coat and the plaster finish coat. Tiles should be fixed only to the finish coat and should not be fixed directly to the backing coat. New plasterwork should have been completed at least 4 weeks and should be dry throughout before tiling commences.

Excessive trowelling of the plaster to improve its appearance should be discouraged, since this practice may result in a dusty surface that is unsatisfactory for tiling.

Priming may be required prior to tiling especially on light-weight plaster surfaces. If so, a bonding coat of a suitable primer that is compatible with the adhesive should be applied in accordance with the manufacturer's instructions. Plaster cannot be regarded as a satisfactory base for tiling in wet areas, e.g. shower compartments.

18.2 Plastering systems for various backgrounds. Plastering systems appropriate to various backgrounds are given in table 3 of CP 211 : 1966. This table should be read in conjunction with tables 2a and 2b of the same code, in which the characteristics of and mixes for plaster final coats and undercoats are detailed.

The number of coats of plaster that are necessary to enable a flat, true and uniform surface to be obtained depend on the unevenness in level and the suction of the background. An indication of the range of coats normally employed on different backgrounds is given in table 3 of CP 211 : 1966.

18.3 Trueness of the plaster surface. Since thin-bed adhesives should always be specified for fixing tiles to plaster, the trueness of the surface should be such that, when checked with a 2 m straightedge, any gap under the straightedge does not exceed 3 mm. Where the gap exceeds 3 mm, local correction of the background will be necessary; this also applies to backgrounds not built accurately to a specified plane, e.g. not upright.

19. Movement joints

19.1 General. Experience indicates that stresses may be set up in the tiling system as a result of movements due to such factors as drying shrinkage and moisture movements in the background and thermal and moisture changes in the tiling. These stresses can sometimes be sufficient to promote loss of adhesion and bulging or cracking of the tiling. When there are reasons to suggest that these conditions may arise, consideration should be given at the design stage to the provision of movement joints. These movement joints, which should not be confused with structural movement joints, should extend completely through the tile and bed and should be a minimum of 6 mm wide; but where substantial movement may be anticipated in any part of the installation, the movement joint should extend through the depth of any plaster or mortar rendering.

The composition and location of movement joints involve considerations of construction materials, drying times, bedding systems, anticipated temperature conditions, superficial areas concerned and the setting out of the tiles.

19.2 Disposition and forming. In detailing the disposition of movement joints the designer will normally consider the following locations in relation to their effect on the setting out of the tiling:

- (a) over existing movement joints;
- (b) where tiling abuts other materials;
- (c) at junctions between different materials, when tiling is continuous across varying types of background;
- (d) in large tiled areas at internal vertical corners and at 3 m to 4.5 m centres horizontally and vertically.

Materials for movement joints should be non-rigid and should be as recommended in clause 13 (see also 19.3, 19.4 and 19.5).

Where joints in tiling occur over movement joints in the background wall, they should coincide and be continuous

with these joints and should be of a suitable width to permit the sealant to accommodate the expected movement. All joints should be rectangular in section, with firm, straight, smooth edges free from cavities and irregularities. In forming such joints it is useful to insert a fillet to ensure smooth, clean faces to the joint, removed only when the tiles are sufficiently firm. Care should be taken to avoid grout and other materials becoming trapped in the joint, which prevent the proper application of the back-up and sealant.

19.3 Sealants. Choice of sealant will depend upon many factors, but the sealant should be capable of accommodating the anticipated amount of movement without loss of adhesion to the sides of the joint. It should also withstand the normal service conditions affecting the installation as a whole regarding such factors as water resistance, resistance to damage from cleaning processes, etc. The sealant manufacturer's advice should be taken into account. A summary of the more important properties of recommended sealants is given in table 1.

Sealants should not be applied until the joint spaces are thoroughly clean and dry. Preferably joints awaiting sealing should be protected from the ingress of foreign matter by being covered, e.g. by an adhesive tape; but when moisture or solvents are present in the bedding or the background, the joints should be left exposed until all moisture has dried out and any solvents have dissipated. Joint spaces left open and uncovered may collect deleterious matter and should be thoroughly cleaned immediately before the sealant is applied.

If the sealing of the movement joints is to be carried out by a specialist, the tiling contractor should be made aware of any requirements in the sealant application instructions that affect his operations.

19.4 Back-up and filler materials. From an economic and a functional standpoint and where the joint depth allows, it is usually advisable to partially fill the joints with a cheap filler material before topping up to the final level with the more expensive sealant. References in foregoing paragraphs to the formation and preparation of joint spaces to receive sealants apply equally when back-up and filler materials are to be used.

The back-up or filler material in the lower part of the joint cavity should be compatible with the sealant being used and in general should be compressible, should support the sealant and should not exude bituminous or oily products. In particular its compressibility should be such that, when the joint closes, the sealant is not forced out. Suitable materials include cellular rubber and plastics, such as cellular polyethylene, some fibreboards, caulking cotton and untarred oakum.

With the more elastic sealants it is essential that they do not stick to the back-up or filler, as the ability of the sealant to accommodate movement will be reduced by any restriction of its underface. Where this risk is present, an additional barrier such as polyethylene film should be applied between the filler and the sealant.

19.5 Pre-formed strips. Pre-formed strips may be used in stress-relieving or compression joints where a watertight seal is not critical. Materials such as cork, cork/rubber compounds, rubber/bitumen strips, PVC and synthetic rubber strips are available.

Section four. Application of tiles: methods and materials

20. General

20.1 Bedding methods. Suitable bedding methods are

- (a) bedding in cement-based adhesives (see 21.1),
- (b) bedding in organic-based adhesives (see 21.2),
- (c) bedding in other adhesives (see 21.3),
- (d) bedding in cement/sand mortar (see 21.4).

The backgrounds to which each system is suited are listed in the appropriate subclause in 21.1 to 21.4 and summarized in table 2. For the installation of tiles complying with the requirements of BS 1281 and other types with similar shallow key backs, methods (a), (b) and (c) are considered most suitable. Thin-bed adhesives are not suitable for the fixing of tiles with backs incorporating deep keys or frogs; for these, thick-bed adhesives or cement/sand mortar should be used subject to being compatible with the background.

20.2 Workmanship. The application of wall tiling demands efficient supervision and the employment of skilled operatives.

20.3 Compatibility of backgrounds and bedding systems.

In the context of section four the term 'backgrounds' should be understood to mean the surfaces intended to receive the bedding directly. These may be the surfaces of structural walls or the surfaces of applied materials such as rendering, plastering, sheets, boards and existing tiles.

The treatment of base surfaces to produce backgrounds conditioned to receive tiling is detailed in section three. In 21.1.1, 21.2.1 and 21.4.1 additional information is given that may be specific to a bedding method; in particular the degree of surface unevenness in the background is stated as the acceptable maximum for each bedding method. When specifying the treatment of base surfaces in accordance with section three, it should be laid down that these maxima are not exceeded.

Preparatory work in the formation of backgrounds that fails to meet the recommendations in this code will entitle the tiling contractor to insist that the necessary corrections are made before tiling is commenced. Should such corrective work be called for, sufficient time should be allowed for the surface to reach a condition suitable to the bedding method contemplated.

20.4 Setting out. It is important to the appearance of the finished wall tiling that unsightly cut tiles are avoided and that joints are even in width. Allowance should be made for an adequate width of joint (see 21.1.6). The general principle to be observed is that the necessity for cut courses, both vertical and horizontal, should be determined in advance and the work set out so that any such courses are as large as possible and are arranged in the least prominent of alternative locations.

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

Where wall surfaces are interrupted by features, e.g. windows, access panels or sanitary fittings, the tile fixer may need guidance from the 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 should be set out so that horizontal joints are aligned.
- (b) The upper and/or lower extremities of a wall may not be level, requiring a course or courses to be cut with a raking edge. Wherever possible the horizontal joints should be positioned so that the whole of the rake can be taken up within the height of the tile in the cut course.
- (c) If it is thought desirable to align a joint with a feature, this may initiate the need for, and frequently dictate the location of, cut courses.

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

In modular tiling the joint centres of glazed wall tiles and ceramic floor tiles made (inclusive of the joint clearance) to the basic 100 mm module and multiples thereof can be aligned exactly. Care should be taken in irregularly shaped spaces and it may be considered simpler to tile the floor first so that the wall tile joints can be arranged to correspond where special features or angles occur. Alignment is not usually possible when the tiles are non-modular and the minimum recommended joints are specified.

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

20.5 Movement joints. These can be incorporated in tiling when any of the bedding systems are employed. They are fully described in clause 19.

20.6 Preparation of tiles. Whilst some bedding methods call for the tiles to be dry, in others they are required to be soaked prior to fixing. Neglect of the instructions in this respect is almost certain to lead to adhesion failures.

20.7 Mixing of bedding materials. When a proprietary adhesive is used for bedding tiles, strict attention should be paid to the maker's instructions. General guidance is given in clause 21.

It is not practicable to give similarly precise instructions concerning cement/sand mortars for bedding. The properties of a sand will depend upon its source and will influence in particular the quantity of water that has to be added to the mortar batch in order to give it a desired consistency. Thus the sand has to be selected with care to obtain optimum performance from the cement/sand mortar.

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

20.8 Tolerances for finished tile surfaces. The surface should be true such that, when checked with a 2 m straight-edge, any gap under the straightedge does not exceed 3 mm. Where thin-bed adhesives are used, this degree of accuracy can be achieved only when the background surface is equally true.

20.9 Lighting. Whenever possible the lighting at the time of applying the bedded finish should not be appreciably different from the ultimate permanent lighting. It should be recognized that within the tolerance laid down for the overall plane, there can be minute differences of plane