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British Standard

Wall and floor tiling

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

Carrelages et dallages

Partie 4. Code de bonne pratique relatif aux carreaux en céramique
et en mosaïque dans des conditions particulières

Wand- und Bodenfliesen

Teil 4. Leitfaden für das Verlegen von Keramikfliesen und -mosaik
unter besonderen Bedingungen

Foreword

This Part of BS 5385 has been prepared under the direction of the Elements and Components (of Diverse Materials) for Buildings Standards Committee. It is the fourth in a series dealing with the installation of wall and floor tiling and mosaics, the others being:

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

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

When published BS 5385 : Parts 3 and 5 will supersede CP 202 which is the current code of practice for general floor tiling.

Consideration is given to the need for properties in the tiling installation either to meet specific functional or environmental requirements or to assist in counteracting potentially detrimental effects on the installation and/or the structure.

Although the recommendations for the installation of tiling and mosaics in CP 202 and BS 5385 : Parts 1 and 2 are substantially relevant to these conditions they have been augmented in this code to provide greater assistance to the specifier in appreciating the factors involved and to offer more detailed guidance in the selection of the most suitable materials and methods. Where appropriate, cross-reference is made to the other standards to avoid repetition.

Throughout the code, references to tiles and tiling are intended to apply also to mosaics. However, mosaics may be unsuitable in certain situations and attention is drawn to these where appropriate.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

* In preparation.

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Section one. General

1 Scope

This Part of BS 5385 gives recommendations for the installation of ceramic wall and floor tiling and mosaics in situations where there are specific functional or environmental requirements and/or conditions that are potentially detrimental to the installation or the background or both. Recommendations are made for the choice of materials, application practices and, where appropriate,

for the design of backgrounds and structural bases.

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

2 Definitions

For the purposes of this Part of BS 5385 the definitions given in BS 5385 : Parts 1 and 2 and CP 202 apply.

Section two. Installation: methods and materials

3 General

The conditions covered in this code, imposing requirements on tiling that warrant precautions additional to those normally taken, fall into two groups:

- (a) conditions to be resisted: chemical attack, movement, radioactivity, thermal effects, traffic, loads, wet and damp conditions;
- (b) conditions to be achieved: anti-static conditions, sound insulation, thermal insulation, sterile conditions.

For situations where several conditions are associated, the specification should be directed towards achieving the most important function required of the system. In some cases a compromise solution may be found for meeting conflicting requirements, but this should not be considered if its adoption is likely to place the durability of the installation at risk.

Specifications should be framed to meet the most exacting conditions that may be imposed on the installation, even though these may not be sustained and may occur only infrequently.

Should an installation be subjected to a later change of use introducing conditions different from those foreseen originally, a careful check of the installation should be made to assess its degree of suitability.

Bedding methods for wall and floor tiling are given in appendices A and B respectively and recommendations regarding suitability of these methods in specific conditions are given in tables 1 and 2 respectively.

Guidance on the types of wall and floor tiles for specific conditions is given in tables 3 and 4 respectively.

Some adhesives and jointing materials give off odours during curing that may adversely affect foodstuffs and other materials and/or cause discomfort to occupants. It is important in the case of proprietary products that the manufacturer's instructions are closely followed.

Table 1. Suitability of bedding methods for wall tiling in specific conditions

Specific conditions	Bedding methods (see appendix A)			Clause reference
	Cement-based adhesives	Organic-based adhesives	Cement:sand mortar	
<i>Chemical attack</i>				
Mildly corrosive conditions	S	S	S	4.3.1 4.3.2
Highly corrosive conditions	U	C	U	4.4
<i>Radioactivity</i>	S	S	S	7.2
<i>Sound insulation</i>	U	S	U	8.1.1
<i>Thermal insulation</i>	S	S	S	8.2.1 8.2.2
<i>Sterile conditions</i>	S	S	S	9.2
<i>Thermal effects</i> (climatic and environmental)	S	S	S	10
<i>Impact</i>	S	C	S	11.3
<i>Wet and damp conditions</i>				
Installations continuously immersed or subject to frequent contact with water	S	C	S	12.2 13
Installations subject to infrequent contact with water	S	S	S	12.3 12.4

NOTE. Key

S Suitable

U Unsuitable

C Refer to manufacturer to confirm suitability.

Table 2. Suitability of bedding methods for floor tiling in specific conditions

Specific conditions	Bedding methods (see appendix B)						Clause reference
	Cement: sand mortar	Cement: sand semi-dry mix	Cement: sand mortar over separating layer	Cement-based adhesives	Organic-based adhesives	Chemically-resistant mortar	
<i>Chemical attack</i>							
Mildly corrosive conditions	S	S	S	S	S	S	4.3.1 4.3.2 4.4
Highly corrosive conditions	U	U	U	U	U	S	B.5
<i>Electrostatic conditions</i>	S	S	S	S	C	S	5
<i>Radioactivity</i>	S	S	S	S	S	S	7.2
<i>Sound insulation</i>							
By systems 8.1.2(a) and (b)	U	U	U	S	S	U	8.1.2
On thick screed over a sound-absorbent layer	S	S	S	S	S	S	8.1.2
<i>Thermal insulation</i>	S	S	S	S	S	S	8.2.3
<i>Sterile conditions</i>	S	S	S	S	S	S	9.2
<i>Thermal effects</i> (climatic and environmental)	S	S	S	S	S	S	10
<i>Traffic and load conditions</i>							
Light to moderate loads and impact	S	S	S	S	S	S	11
Heavy loads and impact	S	S	U	S	C	S	11
Extremely high dynamic and static loading	S	S	U	S	C	S	11
<i>Wet and damp conditions</i>							
Installations continuously immersed or subject to frequent contact with water	S	S	U	S	C	S	12.2 13
Installations subject to infrequent contact with water	S	S	S	S	S	S	12.3 12.4
NOTE. Key S Suitable U Unsuitable C Refer to manufacturer to confirm suitability							

Table 3. Suitability of tiles for wall tiling in specific conditions

Specific conditions	Product group as classified in table 2 of BS 6431 : Part 1 : 1983*				Clause reference
	AI	Alla	BI	BIII	
<i>Chemical attack</i>					
Mildly corrosive conditions	S	S	S	S	4.3.1
Highly corrosive conditions	S	S	S	C	4.3.3.1 4.3.3.3
<i>Radioactivity</i>	C	U	C	U	7
<i>Sound insulation</i>	S	S	S	S	8.1.1
<i>Thermal insulation</i>	S	S	S	S	8.2.1 8.2.2
<i>Sterile conditions</i>	S	C	S	S	9.1
<i>Thermal effects</i> (climatic and environmental)	S	C	S	C	10
<i>Impact</i>	S	C	S	C	11.3.1 11.3.3
<i>Wet and damp conditions</i>					
Installations continuously immersed or subject to frequent contact with water	C	C	C	C	12.2 13
Installations subject to infrequent contact with water	S	S	S	S	12.3 12.4

* For product groups not shown in the table, refer to the tile manufacturer to determine their suitability.

NOTE, Key
 S Suitable.
 U Unsuitable.
 C Refer to manufacturer to confirm suitability.

4 Chemical attack

4.1 General

Chemical attack in the context of this section is that which occurs when certain materials in tile installations are affected by chemical reaction, e.g. when cement-based bedding and joint filling materials are attacked in acidic conditions. Although ceramic products are resistant to attack in most acidic and alkaline situations they are not recommended for use where they would be in contact with fluoride chemicals, especially hydrofluoric acid. It is advisable to consult the manufacturers of tiles and jointing and bedding materials as to the suitability of their products to withstand attack from the chemicals envisaged (see also 4.3). It is important to note that certain cleaning agents, particularly those containing acids, can also attack cement-based bedding and joint filling materials. Both wall and floor tile installations may be affected in this way but floors are more at risk than walls.

The effect of chemical reaction on ceramic tiles is to corrode the surface but with suitable tiles this will be at such a slow rate that it will not significantly affect the life of the installation. Discoloration of tiles may occur from chemical reaction with strong alkalis. If penetration of corrosive chemicals occurs beyond the tiled layer of an installation, chemical reaction may cause rapid deterioration or removal of the base or structural wall. For this reason the tiles and grouting material chosen for chemical resistant installations should be of low permeability.

The design of physical features may have to be considered as a further means of reducing the risk of chemical attack. This applies especially where corrosive substances may remain in contact with the tiles for long periods.

4.2 Design considerations

4.2.1 Tanking. Floor installations should preferably be tanked, i.e. a chemically-resistant and impervious layer

Table 4. Suitability of tiles for floor tiling in specific conditions

Specific conditions	Product group as classified in table 2 of BS 6431 : Part 1 : 1983*				Clause reference
	AI	AIa	BI	BII	
<i>Chemical attack</i>					
Mildly corrosive conditions	S	S	S	S	4.3.1 4.3.3
Highly corrosive conditions	S	S	S	C	4.3.3.2 B.5
<i>Electrostatic conditions</i>	C	U	C	U	5
<i>Radioactivity</i>	C	U	C	U	7.2
<i>Sound insulation</i>	S	S	S	S	8.1.2
<i>Thermal insulation</i>	S	S	S	S	8.2.3
<i>Sterile conditions</i>	S	C	S	S	9.1
<i>Thermal effects</i> (climatic and environmental)	S	C	S	C	10
<i>Traffic and load conditions</i>					
Light to moderate loads and impact	S	S	S	C	11
Heavy loads and impact	S	S	S	U	11
Extremely high dynamic and static loading	S	S	S	U	11
<i>Wet and damp conditions</i>					
Installations continuously immersed or subject to frequent contact with water	C	C	C	C	12.2 13
Installations subject to infrequent contact with water	S	S	S	S	12.3 12.4
* For product groups not shown in the table, refer to the tile manufacturer to determine their suitability.					
NOTE. Key					
S Suitable					
U Unsuitable					
C Refer to manufacturer to confirm suitability.					

should be incorporated between the base and the floor finish, carried up the sides to an appropriate height. Should any corrosive liquid succeed in penetrating the tiling, serious structural damage would be averted by effective tanking. It should not be assumed that the protection against liquid penetration given by the tiling will be adequate.

4.2.2 Falls. Adequate falls should be provided in floors. Gradients between 1:80 and 1:40 are recommended, the precise fall being varied to cope with conditions in different areas. The choice of gradient will depend on the character of the surface and the amount of spillage anticipated. Smooth surfaces call for less slope than rougher types, while large spillages need to be taken away more readily than smaller amounts. Falls of 1:80 should be the minimum;

gradients steeper than 1:40 may be inconvenient and may be dangerous.

The direction of falls should be planned with traffic flow in mind, so that traffic will move across, rather than up and down, the slope.

4.2.3 Drainage. The position of drainage channels and gullies should be considered to ensure rapid removal of corrosive liquids and also their relationship to the direction of wheeled traffic, e.g. trolleys and trucks, likely to be encountered in service.

4.2.4 Movement joints. The design and disposition of movement joints should follow the principles stated in CP 202 and BS 5385 : Part 1, but where possible, joints should be placed away from areas where corrosive liquids may collect and remain for long periods.

4.3 Materials

4.3.1 General. To ensure that suitable materials having adequate chemical resistance are selected, it is important that the potential service conditions are defined precisely. It is necessary to know the type of corrosive chemical involved, its concentration and also its temperature at the time it makes contact with the tiling; the attack of acids, for instance, is more marked at high temperatures. Specifiers are advised to draw upon the experience of specialists to determine the most suitable combination of materials in respect of performance, cost and appearance. There may be occasions when the attack will be more severe than that originally envisaged, perhaps by accident; therefore, it is advisable to cater for this possibility at the outset by choosing a system that will provide a greater degree of resistance than would normally have been required. Should the installation be subjected to a change of use involving corrosive substances other than those for which provision was made, a careful assessment of the system will be necessary to check that it offers adequate resistance in the new conditions.

4.3.2 Bedding and joint filling. Chemically-resistant materials chosen to resist the particular corrosive environment should be used for joint fillings; in addition, it is expedient to bed the tiles in suitably resistant materials where corrosion is likely to be severe.

The chemical resistance to various liquids of the more commonly used materials for bedding and for filling normal joints and sealants for use in movement joints is given in table 5. The flexibility of bedding, jointing and sealant materials is given in table 6.

Proprietary materials should be selected and used strictly in accordance with the manufacturer's recommendations.

4.3.3 Tiles

4.3.3.1 General. In choosing the type of tile, not only chemical resistance but also other functional requirements should be considered such as resistance to impact and abrasion, ease of cleaning, slip resistance, appearance, etc. Manufacturers should be asked to confirm that their products have properties suited to particular situations.

Ceramic mosaics including glass have properties similar to those of other ceramic products but cannot be recommended because chemically-resistant bedding and grouting do not lend themselves to the methods of mosaic application and cannot be inserted successfully into the narrow joints which are a feature of commercially-produced mosaic in sheet form.

4.3.3.2 Floor tiles. Ceramic floor tiles and pavers have a high resistance to chemical attack but density, strength and thickness also are important. Density and strength are necessary to provide resistance to impact and heavy traffic and to withstand thermal movement associated with steam cleaning or hot liquids coming into contact with the floor surface. The thickness is important where there is a need to provide sufficient depth of filling material in the joints to prevent corrosive liquids reaching the bedding and base.

Concentrated acids, e.g. sulphuric, acetic and lactic, and concentrated alkalis, e.g. potassium and sodium hydroxide, attack ceramic floor products extremely slowly. In general, organic chemicals have no effect, the only exceptions being some containing fluorine; it is advisable not to use ceramic products where contact with certain fluoride chemicals, especially hydrofluoric acid, is unavoidable.

4.3.3.3 Wall tiles. Many glazed wall tiles have porous bodies but some have dense bodies with low water absorption. Porous tiles in conjunction with chemically-resistant joint filling perform satisfactorily in contact with liquids that are only slightly aggressive, but in severe conditions the denser types should be specified in combination with chemically-resistant bedding and joint filling.

Glazes may be attacked more readily than tile bodies and colouring stains in glazes may be affected; on the latter point, the selection of tiles should be supported by advice from manufacturers.

4.4 Bedding methods

Methods of applying tiles are described in appendices A and B. These methods relate to the bedding materials described in the appendices but in order to meet various corrosive conditions, selection will have to be made from a range of special bedding products that may call for application procedures different from those described. It is important that the precise recommendations of manufacturers of proprietary materials are followed concerning, for example, the mixing procedure, the working time after spreading, the suitability of the background and the type of trowel.

Special care should be taken in the sealing of junctions where floor tiling abuts walls, fixed machines, drainage channels, etc. to ensure that penetration of corrosive liquids cannot occur at these positions.

For mildly corrosive situations any of the methods given in B.1 to B.4.4 may be used provided the grouting is appropriate for the chemical(s) to be resisted. For situations where the corrosive substance is highly aggressive, the recommendations in B.5 should be followed.

5 Electrostatic conditions

5.1 General

Anti-static precautions are necessary in interior situations where flammable or potentially explosive materials are in use, e.g. anaesthetics in operating theatres, flammable liquids, gases and fine powders in industrial processes.

In order to prevent build-up of electrostatic charges in such cases, and to ensure safe discharge of static electricity from persons and equipment, floors in such areas should be conductive. However, the electrical resistance of the anti-static floor should not be too low or the risk of electric shock associated with equipment connected with mains electricity may be seriously increased. Therefore, it is recommended that all new floors in areas where anti-static

Table 5. Resistance of bedding, jointing and sealant materials to various liquids

Resistance to	Bedding and jointing materials										Sealants				
	Portland cement mortar	High-alumina cement mortar	Silicate cement	Sulphur cement	Rubber latex cement	Phenol formaldehyde resin	Cashew nut resin	Furane resin	Epoxide resin	Polyester resin	Bitumen compounds	Polysulphide rubber	Silicone rubber	Polyurethane	Epoxide/polysulphide
<i>Acids</i>															
Oxidizing (concentrated)	P	P	G	F	P	P	F	P	F	F	P	P	P	P	F
Oxidizing (dilute)	P	F	G	G	G	F	G	P/F	G	G	F	P	G	P	F
Other (concentrated)	P	P	G	G	P	G	G	G	F/G	F	F	P	P	F	G
Other (dilute)	P	F	G	G	G	G	G	G	G	G	G	F	G	F	G
<i>Fatty acids</i>	P	F	G	F	P/G*	G	P	G	F/G	G	P	F	G	G	G
<i>Alkalis</i>															
Concentrated	G	P	P	P	F	P	P	G	F/G	P	P	P/G	F/G	P	G
Dilute	G	P	P	G	G	F	G	G	G	P	F	F/G	G	P	G
<i>Sulphates</i>	P†	G	G	G	F/G*	G	G	G	G	G	G	G	G	P	F
<i>Solvents</i>															
Chlorinated	G	G	G	P	P/F*	G	P	G	F	P	P	P	P/F	G	G
Other	G	G	G	P	P/F*	P/G	P	G	G	P	P	F/G	P/F	F	G
<i>Oils and greases</i>															
Animal/vegetable	P	F	G	P	P/G*	G	P	G	G	G	P	F	G	G	G
Mineral	G	G	G	G	P/G*	G	P	G	G	G	P	G	G	G	G
<i>Milk</i>	P	F	P	F	G	G	G	G	G	G	P	F/G	G	G	G
<i>Water</i>	G	G	P	G	G	G	G	G	G	G	G	G	G	G	G
<i>Chlorinated water</i>	G	G	P	G	G	G	G	G	G	G	G	P/F	G	G	G
<i>Sea water</i>	G	G	P	G	G	G	G	G	G	G	G	G	G	G	G
<i>Sugar solutions</i>	P	F	G	G	F/G*	G	G	G	G	G	G	F/G	G	G	G
<i>Common salt</i>	G	G	P	G	G	G	G	G	G	G	G	G	G	G	G

* *Rubber-latex cement*. The higher resistance is obtained with certain synthetic rubbers.

† *Portland cement mortar*. Resistance to sulphate attack is 'good' where a sulphate-resisting Portland cement complying with BS 4027 is used.

NOTE 1. Key

P Poor

P/F Poor/fair

F Fair

F/G Fair/good

P/G Poor/good

G Good

NOTE 2. This table should be regarded as a general guide to the properties of the materials listed. Precise details of corrosive conditions should be submitted to specialists.