

Screeds, bases and in-situ floorings —

Part 2: Concrete wearing surfaces — Code of practice

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- Association of Concrete Industrial Flooring Contractors
- Association of Lightweight Aggregate Manufacturers
- Construction Confederation
- Contract Flooring Association
- Department of the Environment, Transport and the Regions
- European Resin Manufacturers' Association
- Federation of Plastering and Drywall Contractors
- Federation of Resin Flooring Formulators and Applicators (FeRFA)
- Mastic Asphalt Council
- Mortar Producers Association
- National Federation of Terrazzo-Marble and Mosaic Specialists
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Foreword

This part of BS 8204 has been prepared by Subcommittee B/544/6 as a revision of BS 8204-2:1987, which is withdrawn.

The main changes from the 1987 version are as follows.

- a) The term “wearing screed” is used to replace “high strength concrete topping” or “granolithic topping” to take account of developments in European standardization.
- b) References to specifications for materials have been updated. Pulverized-fuel ash and ground granulated blastfurnace slag are now required to conform to BS 3892-1 and BS 6699 respectively. British Standards for cements now include a number of standard strength classes. In the case of BS 12, Portland cement of class 42.5N is equivalent to ordinary Portland cement and Portland cement of class 42.5R or 52.5N is equivalent to rapid hardening Portland cement.
- c) Coarse aggregates conforming to BS 882 for use in wearing surfaces should have a high resistance to crushing, as specified by their 10 % fines value or their aggregate impact value. This additional requirement should be passed on to the concrete supplier.
- d) The detailing of ground supported slabs is extended to include recommendations to reduce cracking.
- e) For controlling and measuring surface regularity where high precision is required, reference is now made to a report of the Concrete Society on industrial ground floors.
- f) An accelerated test for abrasion resistance is described in annex B. This test has been used satisfactorily on concrete floors for more than 10 years and has been found to give a reliable indication of performance.
- g) The recommendations on slip resistance are now compatible with those in Part 3 of this standard and the pendulum tester is described in annex C.
- h) The maximum width of strips that can be laid for direct finished ground supported slabs is increased to about 6 m now that precise floor regularity can be achieved with improved techniques.

The other parts of BS 8204 are the following:

- *Part 1:1999, Concrete bases and cement sand levelling screeds to receive floorings — Code of practice;*
- *Part 3:1993, Code of practice for polymer modified cementitious wearing surfaces;*
- *Part 4:1993, Code of practice for terrazzo wearing surfaces;*
- *Part 5:1994, Code of practice for mastic asphalt underlays and wearing surfaces.*

An additional part 6 of BS 8204 dealing with synthetic resin wearing surfaces is to be prepared.

As a code of practice, this British Standard takes the form of guidance and recommendations. It should not be quoted as if it were a specification and particular care should be taken to ensure that claims of compliance are not misleading.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

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

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 33 and a back cover.

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1 Scope

This part of BS 8204 gives recommendations in respect of materials, design, work on site, inspection and testing for in-situ concrete direct finished base slabs, with concrete as the wearing surface, and wearing screeds (formerly known as high strength concrete toppings and granolithic toppings). It applies to both ground supported floors and suspended floors.

BS 8204 does not provide guidance on the structural design of ground supported or suspended floors. Information on this aspect is given in references [1] and [2] and in BS 8110-1. The recommendations in this code relate to those other aspects of the design of concrete floors that affect the performance of their wearing surfaces.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of this British Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. For undated references, the latest edition of the publication referred to applies.

BS 12:1996, *Specification for Portland cement*.

BS 146:1996, *Specification for Portland blastfurnace cement*.

BS 410:1986, *Specification for test sieves*.

BS 812-120:1989, *Testing aggregates — Part 120: Method for testing and classifying drying shrinkage of aggregates in concrete*.

BS 871:1981, *Specification for abrasive papers and cloths*.

BS 882:1992, *Specification for aggregates from natural sources for concrete*.

BS 903-A8:1990, *Physical testing of rubber — Part A8: Method for determination of rebound resilience*.

BS 903-A26:1995, *Physical testing of rubber — Part A26: Method for determination of hardness (hardness between 10 IRHD and 100 IRHD)*.

BS 915:1972, *Specification for high alumina cement*.

BS 1014:1975, *Specification for pigments for Portland cement and Portland cement products*.

BS 1047:1983, *Specification for air-cooled blastfurnace slag aggregate for use in construction*.

BS 1370:1979, *Specification for low heat Portland cement*.

BS 3148:1980, *Methods of test for water for making concrete (including notes on the suitability of the water)*.

BS 3797:1990, *Specification for lightweight aggregates for masonry units and structural concrete*.

BS 3892-1:1993, *Pulverized-fuel ash — Part 1: Specification for pulverized-fuel ash for use with Portland cement*.

BS 4027:1996, *Specification for sulfate-resisting Portland cement*.

BS 4483:1985, *Specification for steel fabric for the reinforcement of concrete*.

BS 4659:1989, *Specification for tool and die steels*.

BS 5075-1:1982, *Concrete admixtures — Part 1: Specification for accelerating admixtures, retarding admixtures and water reducing admixtures*.

BS 5075-2:1982, *Concrete admixtures — Part 2: Specification for air-entraining admixtures*.

BS 5075-3:1985, *Concrete admixtures — Part 3: Specification for superplasticizing admixtures*.

BS 5328-1:1997, *Concrete — Part 1: Guide to specifying concrete*.

BS 5328-2:1997, *Concrete — Part 2: Methods for specifying concrete mixes*.

BS 5328-3:1990, *Concrete — Part 3: Specification for the procedures to be used in producing and transporting concrete*.

BS 5395-1:1977, *Stairs, ladders and walkways — Part 1: Code of practice for the design of straight stairs*.

BS 6100-1, *Glossary of building and civil engineering terms — Part 1: General and miscellaneous*.

BS 6100-6, *Glossary of building and civil engineering terms — Part 6: Concrete and plaster*.

BS 6588:1996, *Specification for Portland pulverized-fuel ash cements*.

BS 6699:1992, *Specification for ground granulated blastfurnace slag for use with Portland cement*.

BS 7583:1996, *Specification for Portland limestone cement*.

BS 8102:1990, *Code of practice for protection of structures against water from the ground*.

BS 8110-1:1985, *Structural use of concrete — Part 1: Code of practice for design and construction*.

CP 102:1973, *Code of practice for protection of buildings against water from the ground*.

3 Definitions

For the purposes of this part of BS 8204 the terms and definitions given in BS 6100-1 and BS 6100-6 and the following apply.

3.1

base

building element that provides the support for a screed and any other building element

3.2

flooring

uppermost fixed layer of a floor that is designed to provide a wearing surface

NOTE Layers in a concrete ground floor and a suspended concrete floor are illustrated in Figures 1 and 2 respectively.

3.3

direct finished base slab

base that is suitably finished to provide a wearing surface or to receive directly the flooring to be applied without the need for a levelling screed

3.4

screed material

mixture comprising cement, aggregates, water and, in some cases, admixtures and/or additives

3.5

screed

layer of material laid in situ, directly onto a base, bonded or unbonded, or onto an intermediate layer or insulation layer, for one or more of the following purposes:

- to obtain a defined level;
- to carry the final flooring;
- to provide a wearing surface

3.6

wearing screed (formerly known as high strength concrete topping or granolithic topping)

screed that serves as a flooring

3.7

levelling screed

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

3.8

overslab

concrete layer (usually 100 mm or more thick) constructed on and commonly debonded from a hardened concrete base slab to provide a wearing surface or to receive flooring

3.9

departure from datum

deviation in height of the surface of a flooring layer from a fixed datum plane

3.10

surface regularity (flatness)

deviation in height of the surface of a flooring layer over short distances in a local area

3.11

addition

finely divided inorganic material used in concrete in order to improve certain properties or to achieve special properties

NOTE There are two types of addition:

- nearly inert (Type 1);
- pozzolanic or latent hydraulic (Type 2).

3.12

dry shake finish

mixture of cement and fine hard aggregate, and sometimes admixture and pigment, applied dry as a thin layer and trowelled into the fresh concrete

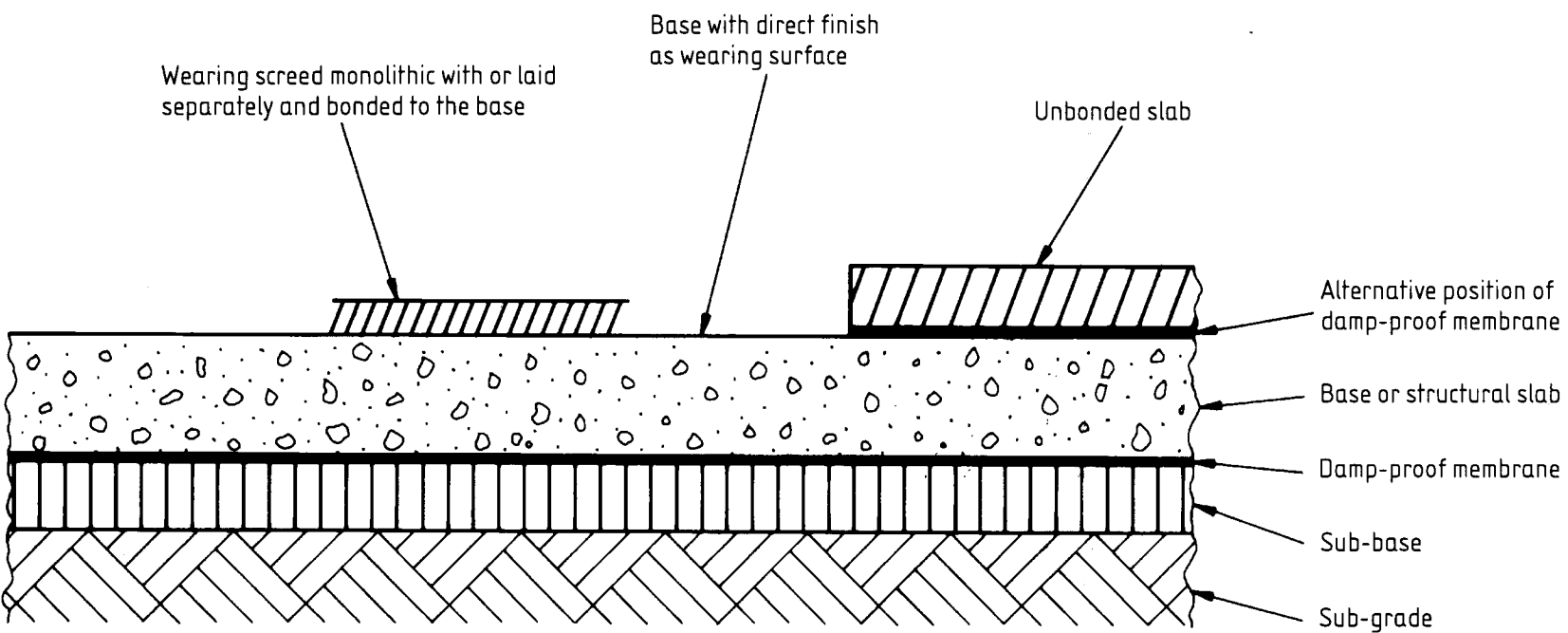


Figure 1 — Illustration of layers in a ground-supported concrete floor

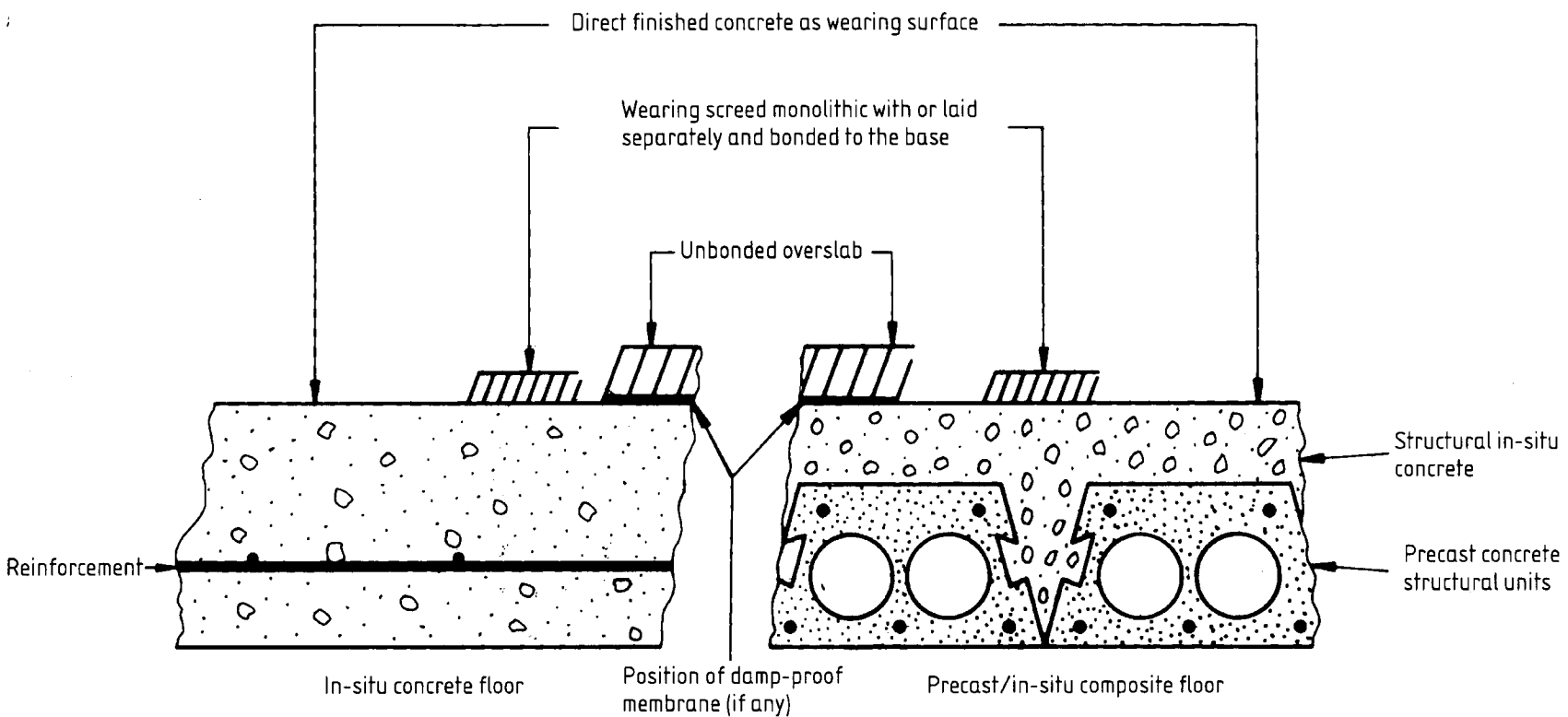


Figure 2 — Illustration of layers in a suspended concrete floor

4 Exchange of information and time schedule

4.1 General

Consultations and exchange of information between all parties concerned with the building operations should be arranged at an early date. This will enable each party to have full knowledge of the particulars of the work so that they can co-operate in producing the conditions required to complete a satisfactory job.

4.2 Exchange of information

The designer should provide in good time all relevant information to those responsible for laying the concrete wearing surface and to others whose work may be affected, including whichever of the following are applicable:

- a) description, situation and address of site and means of access;
- b) those conditions of contract that may practically affect this particular work;
- c) degree of weather protection afforded by the structure;
- d) location and areas of floors to be covered;
- e) age and nature of the base and any preparatory treatment required;
- f) finished floor level and maximum permissible departure from datum;
- g) class of surface regularity;
- h) class of abrasion resistance;
- i) slip resistance;
- j) type of damp-proofing and insulation;
- k) type and thickness of wearing screed;
- l) any work consequent upon services passing through the flooring;
- m) treatment of joints;
- n) treatment of skirtings;
- o) treatment of junctions with adjacent floors and floorings;
- p) type of surface finish;
- q) any surface sealing or chemical surface hardening required;
- r) any requirements related to underfloor heating;
- s) minimum time interval between stages of work and the application of heat in the building;
- t) date for the completion of preliminary work;
- u) dates for the start and completion of various sections of the floor;
- v) details of any compliance testing required;
- w) any other requirements for materials, design or work on site.

4.3 Time schedule

In considering the time schedule, in addition to the usual intervals between commencement and completion of work by the various trades involved, allowances should be made for the following:

- a) completion of the building envelope to allow construction of a floor or wearing screed protected from rain, wind and sun;
- b) delays due to frost and cold weather;
- c) laying underfloor services; this should preferably be completed before the base is formed as there is a risk of subsequent cracking if services are embodied in the flooring;
- d) curing and drying of the base concrete before the flooring is laid, where appropriate;
- e) curing of the flooring;
- f) period of protection of the completed floor from damage by other trades, including restriction of access;
- g) the increased risk of restrained drying shrinkage cracking in ground-supported floor slabs if the floors are loaded soon after completion.

5 Materials

5.1 Cement

The cement should be one of the following:

- a) Portland cement conforming to BS 12;
- b) low heat Portland cement conforming to BS 1370;
- c) sulfate resisting Portland cement conforming to BS 4027;
- d) Portland blastfurnace cements conforming to BS 146;
- e) Portland pulverized-fuel ash cement conforming to BS 6588;
- f) combinations produced in the concrete mixer from Portland cement conforming to BS 12 and ground granulated blastfurnace slag conforming to BS 6699, where the proportions and properties conform to BS 146:1996, except **6.3** of that standard;
- g) combinations produced in the concrete mixer from Portland cement conforming to BS 12 and pulverized-fuel ash conforming to BS 3892-1, where the proportions and properties conform to BS 6588:1996, except **6.3** of that standard;
- h) Portland limestone cement conforming to BS 7583;

NOTE There is little experience of the use of this cement and there are no data available on the abrasion resistance of concrete made with it.

CAUTION When Portland cement is mixed with water, or even becomes damp, alkalis are released that can be harmful to the skin. The effect depends on the length of contact, any abrasion, the individual and the part of the body involved. Suitable protective clothing should be worn. If eyes are affected, they should be washed out without delay and medical advice sought.

i) calcium aluminate (high alumina) cement conforming to BS 915;

CAUTION Calcium aluminate cement should be used with care. Guidance on the correct use of calcium aluminate cement should be sought from the manufacturers and current specialized publications. It should not be used in concrete for structural purposes.

j) proprietary cements, designed to provide rapid drying and hardening, for which there is no current British Standard. Reference should be made to the manufacturers for guidance on their use.

There is little experience of the use of Portland cements conforming to BS 146 and BS 6588 and to the combinations described in f) and g) in thin wearing screeds. Adequate curing is most important when using them [see 7.5.2d)].

Portland cements and combinations of strength class 42.5 have a compressive strength equivalent to that of ordinary Portland cement conforming to BS 12:1996. Limited experience is available with the use of other types and grades of cement for concrete wearing surfaces. For example, a cement of strength class 32.5 would probably require an increase in cement content of about 10 %.

5.2 Additions

Pulverized-fuel ash should conform to BS 3892-1 and ground granulated blastfurnace slag should conform to BS 6699. There are no British Standards for other additions and their suitability should be ascertained from experience of their use in similar mixes.

5.3 Aggregates

5.3.1 General

Aggregates and sand should be selected that do not contain any deleterious material in sufficient quantity to affect adversely the surface finish. For example, lignite, coal and iron pyrites can cause “pop-outs”. Some aggregates exhibit higher than average drying shrinkage and should not be used as they can give rise to a greater risk of cracking (see BRE Digest 357 [3] and BS 812-120).

All-in aggregates should not be used in bases or wearing screeds.

All the requirements of 5.3 should be passed to the aggregate, concrete and screed materials suppliers.

5.3.2 Aggregates for direct finished concrete surfaces

The aggregate should be one of the following:

- a) aggregate conforming to BS 882, with mechanical properties conforming to the requirement in Table 2 of that standard for heavy duty concrete floor finishes;
- b) aggregate conforming to BS 1047 and BS 3797 and other types for which there is no British Standard, provided they are suitable having regard to strength, density, shrinkage, durability and abrasion resistance of the concrete.

5.3.3 Sand for direct finished concrete wearing surfaces

Sand should be a natural sand, resulting from the disintegration of rock, conforming to the grading limits of C or M in BS 882:1992, Table 4. Sands produced from crushed rock are not recommended unless their grading is in accordance with that specified in BS 882.

The coarser limits of grading C sand may produce a harsher mix that may be difficult to finish with a “closed” surface. The finer limits of grading M sand may increase the water requirement and subsequent shrinkage as well as reducing the final strength of a wearing surface.

Limestone sands may increase the risk that the floor surface could become polished under traffic and give a poor slip resistance.

5.3.4 Aggregates for wearing screeds

Aggregates for wearing screeds conforming to BS 882, with mechanical properties conforming to the requirement in Table 2 of that standard for heavy duty concrete floor finishes.

5.3.5 Sand for wearing screeds

Sand for wearing screeds should conform to BS 882 except for the grading and fines limits, which should conform to Table 1 of this standard. These grading limits are tighter than those for gradings C and M of BS 882:1992, Table 4. Conformity to BS 882 will ensure that the sand will be clean, washed and free from clay and other minerals that would adversely affect either the workability of the screed material during application or the performance of the set and hardened wearing screed.

Other sands may be used provided there are satisfactory data on the properties of similar wearing screeds made with them, e.g. bonded or unbonded.

Limestone sands may increase the risk that the floor surface could become polished under traffic and give a poor slip resistance.

Table 1 — Grading limits of sand for wearing surfaces

Sieve size (BS 410)	Proportion by dry mass passing nominal mesh size %
10.00 mm	100
5.00 mm	90 to 100
2.36 mm	65 to 97
1.18 mm	40 to 90
600 µm	24 to 75
300 µm	8 to 40
150 µm	0 to 10
75 µm	0 to 3

5.4 Pigments

Pigments should conform to BS 1014.

5.5 Admixtures

Generally admixtures should conform to the British Standards listed in Table 2. Other admixtures may be used provided there are satisfactory data on the properties of the wearing screed or concrete made with them.

Table 2 — Admixtures

Type	Standard
Accelerating	BS 5075-1
Retarding	BS 5075-1
Water-reducing	BS 5075-1
Air entraining	BS 5075-2
Superplasticizing	BS 5075-3

Admixtures should not impair the durability of the wearing screed or the concrete wearing surface, nor combine with the constituents to form harmful components, nor increase the risk of corrosion of any embedded metal.

If two or more admixtures are to be used together in the same wearing screed or concrete mix, data should be obtained to assess their interaction and ensure their compatibility (see 7.6 for use of admixtures).

5.6 Dry shake/sprinkle finish and special aggregates

There are no British Standards for these materials. Dry shake materials should not contain any unsound particles that could adversely affect the surface finish. For example, impurities in some slags can cause “pop-out”. Recommendations on the use of proprietary materials are given in 7.7.

5.7 Surface treatments

There are no British Standards for surface treatments. Recommendations on the use of proprietary materials are given in 7.8.

5.8 Ready mixed concrete

Ready mixed concrete for base slabs and wearing screeds should conform to BS 5328-2.

5.9 Water

Water should be clean and free from materials deleterious to concrete and wearing screeds in their fresh and hardened states (see BS 3148:1980, appendix A). In general, drinking water is suitable for this use.

6 Design considerations: performance requirements**6.1 Tolerances on level and surface regularity****6.1.1 Departure from datum**

The maximum permissible departure of the level of the wearing surface from a specified or an agreed datum plane should be specified, taking into account the area of the floor and its use. For large areas for normal purposes a departure of ± 15 mm from datum will be found to be satisfactory. Greater accuracy to datum could be required 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. The datum plane for the majority of floors will be horizontal but, on occasions, sloping. In the latter case, departure from datum should be measured from the sloping plane.

The difficulty in controlling the construction of concrete floor surfaces to specified level to datum tolerances should be taken into account where the base is a suspended concrete floor or concrete on metal decking, as these can deflect excessively.

6.1.2 Surface regularity

The class of surface regularity (see 3.10) required for a floor surface will depend upon the use of the floor. Insistence on a higher standard than necessary will result in higher costs and this should be borne in mind in selecting a surface regularity. The straightedge method given in annex A is generally satisfactory for very many floor uses. Where the flooring is to be used for specific applications, e.g. for some large area warehouse or industrial floors, that require a higher degree of level accuracy and a greater precision over the rate of change of surface slope, the method of achieving flatness, its related system of testing and limits for deviation from flatness given in [1] should be specified. The method described in [1] can also be used to advantage for obtaining a comprehensive and rapid assessment of surface regularity for large areas.

Table 3 — Classification of surface regularity for finished wearing surfaces

Class	Maximum permissible departure from a 3 m straightedge resting in contact with the floor (see annex A) mm	Application
Special	n.a. ^a	Specific use for higher degree of accuracy of level
SR1	3	High standard: for commercial and industrial buildings
SR2	5	Normal standard: for commercial and industrial buildings
SR3	10	Utility standard: for other floors, where surface regularity is less critical

^aAlternative methods of assessment are described in Concrete Society Technical Report No. 34 [1].

The suitability of a floor in service in terms of surface regularity is governed by its radius of curvature and changes in height over short distances. It is recognized that the straightedge basis for specifying floor surface regularity does not take into account the “waviness” or rate of change in elevation of a floor over any specified length. The straightedge method is therefore only suitable for floors finished by conventional techniques that will produce a smoothly undulating surface rather than an irregular “washboard” effect.

Where the straightedge basis for specification is used it may be advisable for the various interested parties in a contract to agree the sampling rate for testing the floor to check conformity, and the procedures to adopt if conformity is not achieved, *before* the floor is constructed. Such agreement should include the number of positions where the straightedge will be placed to check conformity.

The method of specifying and checking flatness described in [1] is related to the taking of levels along lines on a floor at 300 mm and 3 000 mm centres, using proprietary electronic measuring devices or precise surveying levels and comparing the differences in measured levels.

The difference in height across joints in the flooring should be less than 2 mm in the case of classes SR2 and SR3 of Table 3. Where category SR1 is specified, there should be no abrupt changes in level across joints. Light grinding can remove small differences in height across joints and the resulting change in appearance, which is usually local, is often acceptable.

Testing to check surface regularity and level conformity (see 12.2.2) should be made within 24 h of the first bay or area of flooring being laid to establish early that the method of laying can meet the specification requirement. Surface regularity and level testing should not be left to be checked until all the flooring is completed.

The specification of high strength wearing screeds does not imply that a high level of accuracy will be achieved.

6.1.3 Change in surface regularity and levels with time

All the following factors should be taken into account in the design and specification (see [4]).

- a) After a concrete floor has been constructed, the concrete is liable to undergo changes in moisture content and temperature that can affect its level and surface regularity over a period of time.
- b) Over the period that the concrete is developing strength, during the first seven days or so after laying, differential thermal contraction between the top and bottom surface of the slab can cause it to curl at the joints.
- c) Differential drying shrinkage of the slab between its top and bottom surface over the first year can also cause curling, particularly around joints.
- d) Deflection of suspended slabs under load with time can cause changes in level and surface regularity.
- e) Settlement of ground-supported slabs due to compression of the sub-grade under load with time can produce changes in level and surface regularity.

Where required, a survey to assess the floor should normally be made within about a month of completion (see also 12.2.2). Beyond this time, the level and surface regularity could change.

6.2 Resistance to abrasion

A classification for abrasion resistance of concrete floor surfaces is given in Table 4, which gives the maximum depth of wear allowed in any test for each of the classes. A test to measure the abrasion resistance of a floor surface is described in annex B.