BRITISH STANDARD

BS 8204-1:2003

Screeds, bases and in situ floorings —

Part 1: Concrete bases and cement sand levelling screeds to receive floorings — Code of practice

ICS 91.060.30

Admixtures should not impair the durability of the base or levelling screed, 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 levelling screed or concrete, data should be obtained to assess their interaction and ensure their compatibility (see **6.11.2** for use of admixtures).

5.5 Ready-mixed concrete for bases

Concrete should be specified in accordance with BS 8500-1.

5.6 Ready-mixed levelling screeds

Ready-to-use screeding materials should conform to the performance requirements of BS EN 13813.

The preferred method to meet the requirements of established suitability of constituents, as required in BS EN 13813, is for materials to meet the requirements of **5.1**, **5.2**, **5.3**, **5.4**, **5.7** and **5.8** of this standard, otherwise, the manufacturer should demonstrate the established suitability of the screed constituents.

NOTE 1 Optionally, the ready-to-use screed material may be heavily retarded by the use of an appropriate admixture to give an extended working period, generally 8 h. After this time, commencement of the set takes place in the normal manner.

NOTE 2 One tonne of screed material will cover an area of approximately 9 m^2 when laid at a thickness of 50 mm. It is essential that the screed material is used before the working life specified by the manufacturer expires. On no account should the screed be remixed in a mechanical mixer. Screeds have to be protected from traffic and damage after laying. Adequate curing and protection from the weather is essential and the surface should not be trafficked for at least 5 days after laying.

5.7 Reinforcement

Reinforcement for levelling screeds should be steel fabric of type D49 or A98 conforming to BS 4483:1998, Table 1. Alternatively, a 50 mm square, 16 gauge welded wire mesh flat sheet should be used.

NOTE Heavier reinforcement might be required by the designer for use in levelling screeds intended for structural purposes.

5.8 Water

Water should be clean and free from materials deleterious to concrete and levelling screeds in their fresh and hardened states. In general, drinking water is suitable for this use.

NOTE In cases of doubt the water should conform to BS EN 1008.

6 Design considerations

6.1 Sub-base

A sub-base should be provided to give uniform support to ground-supported base slabs and the flooring applied to them. The sub-base should consist of inert well-graded granular material of maximum size 80 mm, fully compacted and lightly blinded sand or inert, crushed, fine material to form a flat surface to within a tolerance of $^{\ 0}_{-25}$ mm. Alternatively, lean concrete with a cement content in the range 100 kg/m^3 to 150 kg/m^3 should be used: these are equivalent to nominal proportions in the range 1:20 to 1:15.

NOTE Guidance on suitable sub-base materials and compaction of sub-base is given in the Highways Agency's Specification for Highway Works [8] under the heading "Cement bound materials".

6.2 Base and screed construction

NOTE See A.2 for the use of lightweight aggregates.

The floor should be constructed in one of the following ways (see Figure 1 and Figure 2):

a) a structural slab direct finished to receive the applied flooring;

b) a levelling screed bonded to a prepared concrete slab;

c) an unbonded levelling screed or overslab or floating levelling screed thick enough to provide sufficient rigidity and reduce the likelihood of curling (see **6.4.3**).

Levelling screeds laid in large areas can curl as they dry and shrink, and can crack later when loaded if the bond to the base is insufficient. The use of unbonded and floating levelling screeds might not be acceptable for some floorings, which would be affected by excessive curling or movement at joints.

Of the three methods of construction described above, method a), which avoids the use of a levelling screed, is the only one that guarantees that hollowness, curling and cracking of screeds is avoided.

Where a damp-proof membrane is required see **6.10**.

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by Technical Committee B/507, Paving units, kerbs, screeds and in situ floorings, to Subcommittee B/507/6, Screeds and in situ floorings, upon which the following bodies were represented:

Association of Concrete Industrial Flooring Contractors
Association of Lightweight Aggregate Manufacturers
British Cement Association
Concrete Society
Contract Flooring Association
Federation of Plastering and Drywall Contractors
Federation of Resin Flooring Formulators and Applicators
Mastic Asphalt Council
Mortar Producers Association Limited
National Federation of Terrazzo-Marble and Mosaic Specialists
National Specialist Contractors Council
Quarry Products Association
Society of Chemical Industry
Co-opted members

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Contents

1 Scope

This part of BS 8204 gives recommendations for constituent materials, design, work on site, inspection and testing of concrete bases that are to receive in situ wearing screeds of the following types:

a) concrete (see BS 8204-2);

b) polymer modified cement (see BS 8204-3);

c) terrazzo (see BS 8204-4);

d) mastic asphalt (see BS 8204-5);

e) synthetic resin (see BS 8204-6);

f) magnesium oxychloride;

g) pumpable self-smoothing screeds (see BS 8204-7);

and for bases and levelling screeds that are to receive flexible floor coverings such as:

h) textiles;

i) linoleum;

j) polyvinyl chloride;

k) rubber;

l) cork;

and rigid floorings such as:

m) wood block and strip;

n) laminate floor coverings;

o) ceramic tiles;

p) natural stone.

It applies to ground-supported and suspended concrete floor bases.

This part of BS 8204 includes the use of concrete and levelling screeds made with lightweight aggregates conforming to BS EN 13055-1. Where the recommendations differ from those for normal weight aggregates, these are given in Annex A.

Recommended methods for the assessment of levels and surface regularity and for the determination of in situ crushing resistance (soundness) are given in Annex C, Annex D and Annex E.

This part of BS 8204 is not intended to provide guidance on the structural design or related construction of concrete ground-supported floors or suspended slabs. Information on these aspects is given in BS 8110-1 and reference [4]. The specification of concrete for base slabs is given in BS 8500-2. The recommendations in this code of practice relate to those other aspects of design and construction of concrete slabs that affect the performance of the overlying levelling or wearing screed.

See Part 3 for polymer modified cementitious levelling screeds.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS 146:2002, *Specification for blastfurnace cements with strength properties outside the scope of BS EN 197-1.*

BS 915-2, *Specification for high alumina cement — Part 2: Metric units.*

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

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

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

BS 4483:1998, *Steel fabric for the reinforcement of concrete.*

BS 4551-2:1998, *Methods of testing mortars, screeds and plasters — Part 2: Chemical analysis and aggregate grading.*

BS 4887-1, *Mortar admixtures — Part 1: Specification for air-entraining (plasticizing) admixtures.*

BS 4887-2, *Mortar admixtures — Part 2: Specification for set retarding admixtures.*

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

BS 7979, *Specification for limestone fines for use with Portland cement.*

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

BS 8110-1:1997, *Structural use of concrete — Part 1: Code of practice for design and construction.*

BS 8500-1, *Concrete — Complementary British Standard to BS EN 206-1 — Part 1: Method of specifying and guidance for the specifier.*

BS 8500-2:2002, *Concrete — Complementary British Standard to BS EN 206-1 — Part 2: Specification for constituent materials and concrete.*

BS EN 197-1:2000, *Cement — Part 1: Composition, specifications and conformity criteria for common cements.*

BS EN 206-1:2000, *Concrete — Part 1: Specification, performance, production and conformity.*

BS EN 934-2, *Admixtures for concrete, mortar and grout — Part 2: Concrete admixtures — Definitions, requirements, conformity, marking and labelling.*

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

BS EN 12620, *Aggregates for concrete.*

BS EN 13055-1, *Lightweight aggregates — Part 1: Lightweight aggregates for concrete, mortar and grout.*

BS EN 13139, *Aggregates for mortar.*

BS EN 13318, *Screed material and floor screeds — Definitions.*

BS EN 13813, *Screed material and floor screeds — Screed material — Properties and requirements.*

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

3 Terms and definitions

For the purposes of this part of BS 8204, the terms and definitions given in BS 6100-1, BS 6100-6 and BS EN 13318 and the following apply.

3.1
base
building element that provides the support for a screed and floor finishes

3.2
flooring
uppermost fixed layer of a floor that is designed to provide a wearing surface

NOTE Layers in a ground-supported concrete floor and a suspended concrete floor are illustrated in Figure 1 and Figure 2 respectively.

3.3
direct finished base slab
concrete flooring element 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
levelling screed
screed suitably finished to obtain a defined level and to receive the final flooring

3.7
wearing screed
screed that serves as a flooring

NOTE This term was formerly known as high strength concrete topping or granolithic topping.

3.8
bonded screed
screed that is bonded to the base

3.9
unbonded screed
screed laid either onto a separating layer or onto a base not prepared to achieve bonding

3.10
floating screed
screed laid on an acoustic and/or thermal insulating layer and completely separated from other building elements, such as walls and pipes

3.11
fine concrete screed
screed consisting of concrete in which the maximum aggregate size is 10 mm

3.12
cement sand screed
screed consisting of screed material containing sand up to a 4 mm maximum aggregate size

3.13
smoothing compound
material applied to a base or screed to provide a smooth, even surface suitable for the installation of a floor covering

3.14
departure from datum
deviation in height of the surface of a flooring layer from a fixed datum plane

3.15
surface regularity
deviation in height of the surface of a flooring layer over short distances in a local area

NOTE Surface regularity is also known as flatness.

3.16
in situ crushing resistance (ISCR)
resistance of levelling screeds to the crushing effect of imposed loads and traffic in service

NOTE ISCR was formerly known as soundness.

3.17

no-fines concrete basecoat (of a lightweight aggregate screed)
layer forming the lower section of the screed, which can be either bonded to the concrete base or separated by an intermediate layer

3.18

cement sand topping (of a lightweight aggregate screed)
bonded surface layer of the screed, commonly cement sand of thickness approximately 15 mm, which provides a smoother finish suitable for the flooring

3.19

combinations
restricted range of Portland cements and additions which, having been combined in the mixer, count fully towards the cement content and water/cement ratio in concrete

NOTE A procedure for establishing the suitability of combinations is specified in Annex A of BS 8500-2:2002.

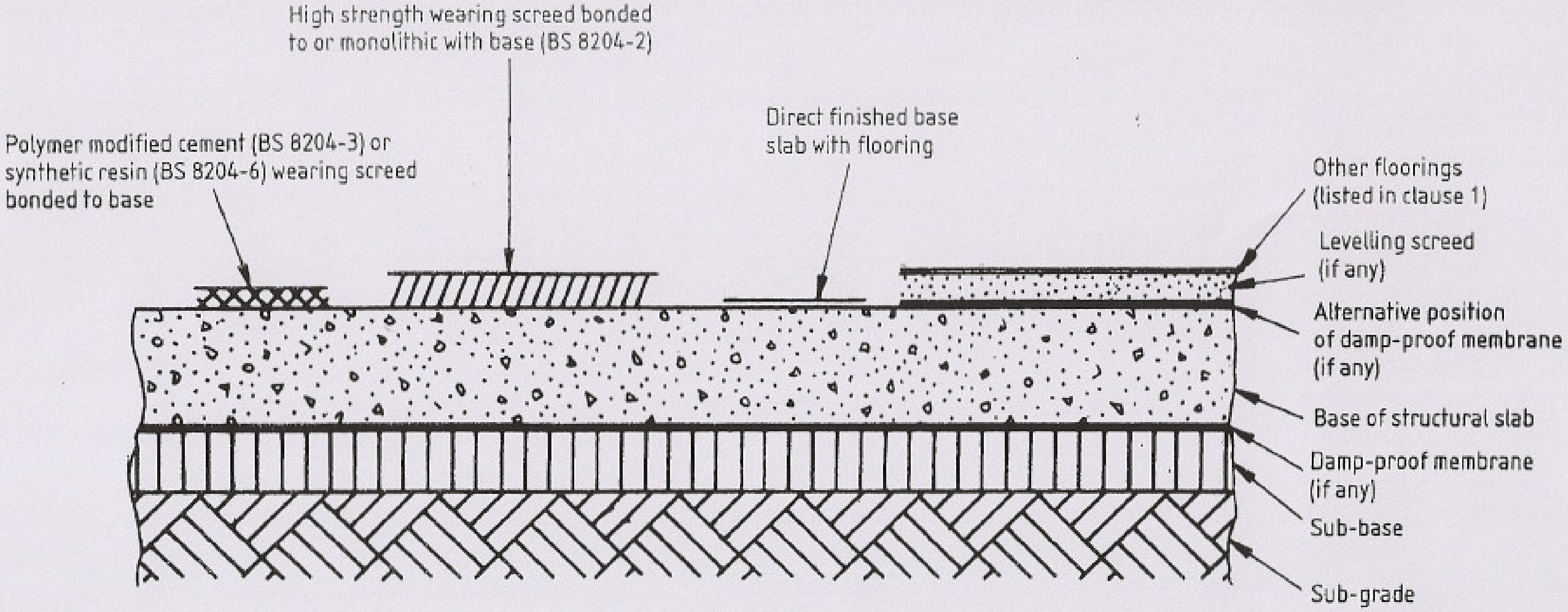


Figure 1 — Illustration of layers in a ground-supported concrete floor

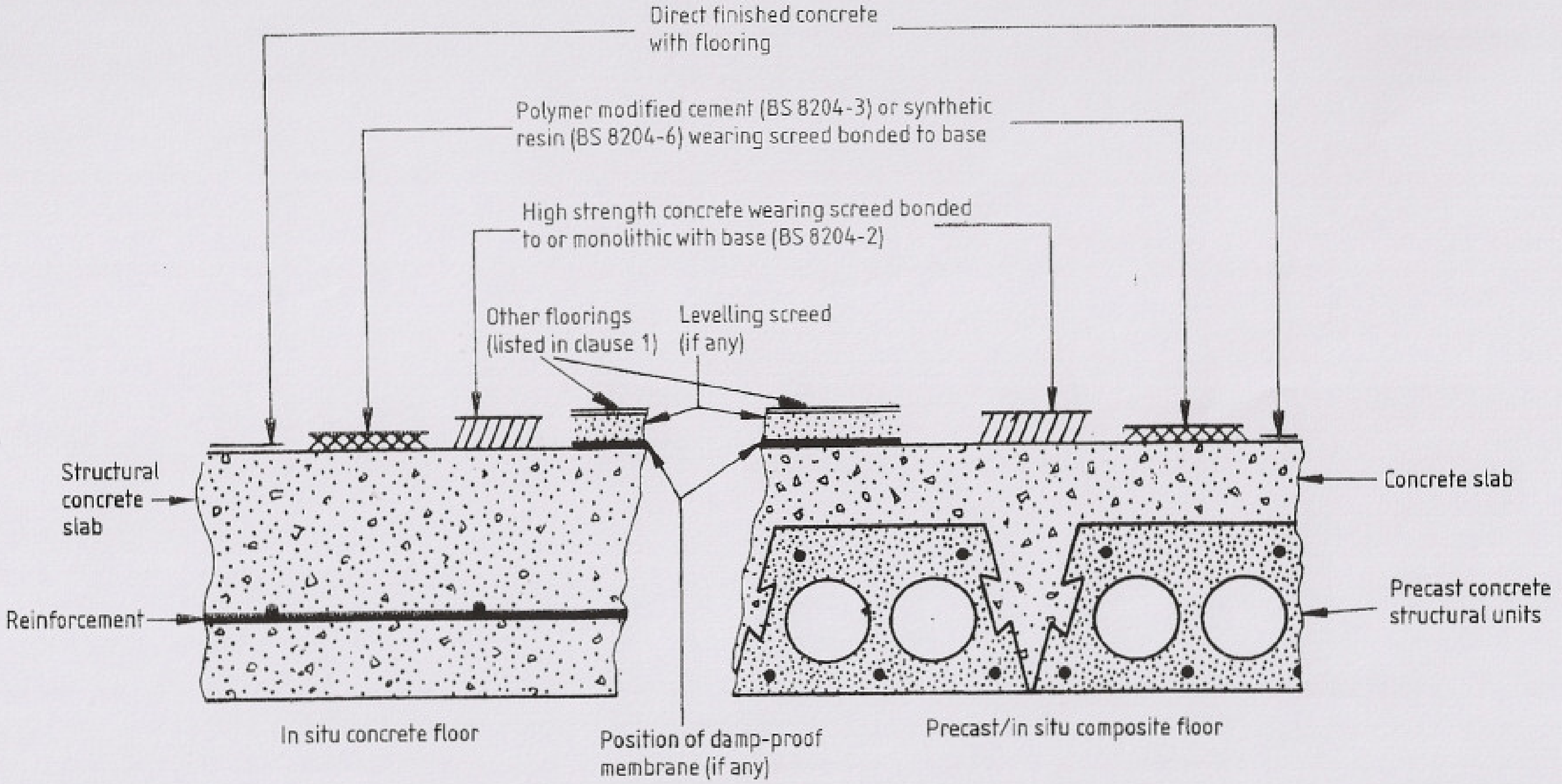


Figure 2 — Illustration of layers in a suspended concrete floor

4 Exchange of information and time schedule

4.1 General

It is essential that consultations and exchange of information between all parties concerned with the building operations are arranged at an early date. This will enable each party to have full knowledge of the particulars of the work so that they can cooperate in producing the conditions required to complete a satisfactory job.

4.2 Exchange of information

It is essential that the designer provides in good time all relevant information to those responsible for laying the concrete base and/or cement sand levelling screed and to others whose work might 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 might 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) type of flooring to be laid;

g) specifications for the base and screed;

h) class of concrete for proposed base;

i) number of layers;

j) thickness of floor and flooring;

k) finished floor level and maximum permissible departure from datum;

l) class of surface regularity (see Table 5) of base or levelling screed;

m) type of damp-proofing and insulation;

n) type and thickness of levelling screed;

o) category of in situ crushing resistance (soundness) required;

p) any work consequent upon services passing through the floor;

q) treatment of joints;

r) treatment of skirtings;

s) treatment of junctions with adjacent floor and floorings;

t) type of surface finish of base or levelling screed;

u) any requirement for a smoothing compound;

v) any special requirements related to underfloor heating;

w) minimum time intervals between stages of work and the application of heat in the building;

x) date for the completion of preliminary work;

y) dates for the start and completion of various sections of the floor;

z) details of any compliance testing required;

aa) 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 levelling screed protected from rain, wind and sun;

b) delays due to frost and cold weather;

c) laying underfloor services; this should 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 and/or levelling screed before the flooring is laid, where appropriate (see **7.10**);

e) period of protection of the base or screed from damage by other trades, including the period of restriction of access, until the flooring is laid;

f) the risk of restrained drying shrinkage cracking in ground-supported floor slabs increasing if the floors are loaded soon after completion.

5 Materials

5.1 Cement

5.1.1 *General*

Cements and combinations, of strength class 42,5 N, have a compressive strength equivalent to that of ordinary Portland cement conforming to BS 12:1989. Lower strength classes of cement and combinations used either in concrete bases or in cementitious levelling screeds might need an increase in cement or combination content to obtain similar properties and performance. For example, a cement of strength class 32,5 N would probably require an increase in cement content of about 10 %. An additional period of curing might also be necessary (see Annex F).

Concretes made with the cements and combinations listed in **5.1.2** have different characteristics, e.g. strength development, susceptibility to poor curing, and therefore the choice of cement or combination type should depend upon the particular placing conditions.

There is limited experience of the use of some types of cement and combinations in cementitious levelling screeds, see **5.1.4**.

CAUTION. Calcium aluminate (high alumina) 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 (see **7.2**).

WARNING 1. 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.

WARNING 2. Cement mortar and concrete might until set cause both irritant and allergic contact dermatitis.

— Irritant contact dermatitis is due to a combination of the wetness, alkalinity and abrasiveness of the constituent material.

— Allergic contact dermatitis is caused mainly by the sensitivity of an individual's skin to hexavalent chromium salts.

5.1.2 *Cement for concrete bases*

The cement or combination for concrete bases should be one of the following:

a) Portland cement CEM I conforming to BS EN 197-1;

b) low heat Portland cement conforming to BS 1370;

c) sulfate-resisting Portland cement conforming to BS 4027;

d) Portland-slag cement CEM II/A-S or CEM II/B-S conforming to BS EN 197-1;

e) blastfurnace cement CEM III/A or CEM III/B conforming to BS EN 197-1;

f) blastfurnace cement BIII/A or BIII/B conforming to BS 146;

g) Portland-fly ash cement CEM II/A-V or CEM II/B-V conforming to BS EN 197-1;

h) Portland-limestone cement CEM II/A-L or CEM II/A-LL conforming to BS EN 197-1;

i) calcium aluminate cement (high alumina cement) conforming to BS 915-2;

j) combinations produced in the concrete mixer from Portland cement CEM I conforming to BS EN 197-1 and ground granulated blastfurnace slag conforming to BS 6699, where the proportions and properties conform to CEM II/A-S, CEM II/B-S, CEM III/A or CEM III/B of BS EN 197-1:2000 except Clause 9 of that standard;

k) combinations produced in the concrete mixer from Portland cement CEM I conforming to BS EN 197-1 and ground granulated blastfurnace slag conforming to BS 6699, where the proportions and properties conform to BIII/A or BIII/B of BS 146:2002, except Clause 10 of that standard;

l) combinations produced in the concrete mixer from Portland cement CEM I conforming to BS EN 197-1 and pulverized-fuel ash conforming to BS 3892-1, where the proportions and properties conform to CEM II/A-V or CEM II/B-V of BS EN 197-1:2000, except Clause 9 of that standard; or

m) combinations produced in the concrete mixer from Portland cement CEM I conforming to BS EN 197-1 and limestone fines conforming to BS 7979, where the proportions and properties conform to CEM II/A-L or CEM II/A-LL of BS EN 197-1:2000, except Clause 9 of that standard.

With Portland-limestone cement [see items h) and m)] and limestone fines, reference should be made to BRE Special Digest 1 [2] for low temperature situations.

5.1.3 *Cement for cementitious levelling screeds*

The cement or combination for cementitious levelling screeds should be one of the following:

a) Portland cement CEM I conforming to BS EN 197-1;

b) sulfate-resisting Portland cement conforming to BS 4027;

c) Portland-slag cement CEM II/A-S or CEM II/B-S conforming to BS EN 197-1;

d) calcium aluminate cement (high alumina cement) conforming to BS 915-2;

e) proprietary cements, designed to provide rapid drying and hardening properties, for which no British Standard exists. Reference should be made to the manufacturers for guidance on their use;

f) combinations produced in the concrete mixer from Portland cement CEM I conforming to BS EN 197-1 and ground granulated blastfurnace slag conforming to BS 6699, where the proportions and properties conform to CEM II/A-S or CEM II/B-S of BS EN 197-1:2000, except Clause 9 of that standard.

5.1.4 *Other cements for cementitious levelling screeds*

There is limited experience of the use of the following cements and, where appropriate, the equivalent combinations in screed material for cementitious levelling screeds. Reference should be made to the manufacturers for guidance on their use.

a) Air-entrained/enhanced Portland cement CEM I 32,5 R conforming to BS EN 197-1.

b) Portland-fly ash cement CEM II/A-V or CEM II/B-V conforming to BS EN 197-1.

c) Portland-limestone cement CEM II/A-L or CEM II/A-LL conforming to BS EN 197-1.

d) Combinations produced in the concrete mixer from Portland cement CEM I conforming to BS EN 197-1 and pulverized-fuel ash conforming to BS 3892-1, where the proportions and properties conform to CEM II/A-V or CEM II/B-V of BS EN 197-1:2000, except Clause 9 of that standard.

e) Combinations produced in the concrete mixer from Portland cement CEM I conforming to BS EN 197-1 and limestone fines conforming to BS 7979, where the proportions and properties conform to CEM II/A-L or CEM II/A-LL of BS EN 197-1:2000, except Clause 9 of that standard.

With Portland-limestone cement [see items c) and e)] and limestone fines, reference should be made to the BRE Special Digest 1 [2] for low temperature situations.

5.2 Additions

Pulverized-fuel ash should conform to BS 3892-1, ground granulated slag should conform to BS 6699 and limestone fines should conform to BS 7979. There are no British Standards for other additions and their suitability should be ascertained from experience of their use in similar products.

5.3 Aggregates

NOTE See A.1 for the use of lightweight aggregates.

5.3.1 *General*

The gradings of coarse aggregates in BS EN 12620 and sands in BS EN 13139 are based on different principles to BS 882. Guidance on the specification of sands conforming to BS EN 13139 is given in Annex B. BS EN 12620 specifies grades in terms of the consistency of the coarse aggregate with the supplier declaring the typical grading for the aggregate and working to tolerances given in BS EN 12620. The sieve sizes used to describe aggregate sizes in BS EN 12620 and BS EN 13139 are expressed in reverse order to BS 882, i.e. the lower sieve size is given before the upper sieve size. For example the equivalent BS EN 12620 aggregate to a BS 882 10 mm single sized aggregate is 4/10. BS EN 12620 and other standards use the designation fine aggregate for material with an upper size smaller than or equal to 4 mm.

Aggregates should not contain any deleterious material in sufficient quantity to affect adversely the surface of a directly finished base or levelling screed. For example, lignite, coal and iron pyrites in the aggregate 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 EN 1367-4).

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

5.3.2 *Aggregates for concrete bases*

Aggregates for concrete bases should conform to BS EN 12620.

5.3.3 *Aggregates for fine concrete levelling screeds*

Aggregates for fine concrete levelling screeds should be composed of 4/10 material conforming to BS EN 12620 and of sand in accordance with **5.3.4**. See Annex B.

5.3.4 *Sand for cement sand levelling screeds*

Sand for cement sand levelling screeds should conform to BS EN 13139.

The preferred grading would be a 0/4 sand with a fines category 1 within the range MP, and ideally have a grading between 20 % to 66 % passing the 0.5 sieve. For further discussion see Annex B.

Where the screed is to be placed by pumping, a further restriction on the proportion passing a 0.250 mm sieve should be used (see **7.6**).

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

5.4 Admixtures

Admixtures should conform to the British Standards listed in Table 1.

Table 1 — British Standards for admixtures

Type of admixture	British Standard
	Mortar admixtures for screeds
Air-entraining	BS 4887-1
Set-retarding	BS 4887-2
	Concrete admixtures
Accelerating	BS EN 934-2
Retarding	BS EN 934-2
Water-reducing	BS EN 934-2
Air-entraining	BS EN 934-2
Superplasticizing	BS EN 934-2

Admixtures should not impair the durability of the base or levelling screed, 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 levelling screed or concrete, data should be obtained to assess their interaction and ensure their compatibility (see **6.11.2** for use of admixtures).

5.5 Ready-mixed concrete for bases

Concrete should be specified in accordance with BS 8500-1.

5.6 Ready-mixed levelling screeds

Ready-to-use screeding materials should conform to the performance requirements of BS EN 13813.

The preferred method to meet the requirements of established suitability of constituents, as required in BS EN 13813, is for materials to meet the requirements of **5.1**, **5.2**, **5.3**, **5.4**, **5.7** and **5.8** of this standard, otherwise, the manufacturer should demonstrate the established suitability of the screed constituents.

NOTE 1 Optionally, the ready-to-use screed material may be heavily retarded by the use of an appropriate admixture to give an extended working period, generally 8 h. After this time, commencement of the set takes place in the normal manner.

NOTE 2 One tonne of screed material will cover an area of approximately 9 m² when laid at a thickness of 50 mm. It is essential that the screed material is used before the working life specified by the manufacturer expires. On no account should the screed be remixed in a mechanical mixer. Screeds have to be protected from traffic and damage after laying. Adequate curing and protection from the weather is essential and the surface should not be trafficked for at least 5 days after laying.

5.7 Reinforcement

Reinforcement for levelling screeds should be steel fabric of type D49 or A98 conforming to BS 4483:1998, Table 1. Alternatively, a 50 mm square, 16 gauge welded wire mesh flat sheet should be used.

NOTE Heavier reinforcement might be required by the designer for use in levelling screeds intended for structural purposes.

5.8 Water

Water should be clean and free from materials deleterious to concrete and levelling screeds in their fresh and hardened states. In general, drinking water is suitable for this use.

NOTE In cases of doubt the water should conform to BS EN 1008.

6 Design considerations

6.1 Sub-base

A sub-base should be provided to give uniform support to ground-supported base slabs and the flooring applied to them. The sub-base should consist of inert well-graded granular material of maximum size 80 mm, fully compacted and lightly blinded sand or inert, crushed, fine material to form a flat surface to within a tolerance of $^{\ 0}_{-25}$ mm. Alternatively, lean concrete with a cement content in the range 100 kg/m^3 to 150 kg/m^3 should be used: these are equivalent to nominal proportions in the range 1:20 to 1:15.

NOTE Guidance on suitable sub-base materials and compaction of sub-base is given in the Highways Agency's Specification for Highway Works [8] under the heading "Cement bound materials".

6.2 Base and screed construction

NOTE See A.2 for the use of lightweight aggregates.

The floor should be constructed in one of the following ways (see Figure 1 and Figure 2):

a) a structural slab direct finished to receive the applied flooring;

b) a levelling screed bonded to a prepared concrete slab;

c) an unbonded levelling screed or overslab or floating levelling screed thick enough to provide sufficient rigidity and reduce the likelihood of curling (see **6.4.3**).

Levelling screeds laid in large areas can curl as they dry and shrink, and can crack later when loaded if the bond to the base is insufficient. The use of unbonded and floating levelling screeds might not be acceptable for some floorings, which would be affected by excessive curling or movement at joints.

Of the three methods of construction described above, method a), which avoids the use of a levelling screed, is the only one that guarantees that hollowness, curling and cracking of screeds is avoided.

Where a damp-proof membrane is required see **6.10**.

6.3 Base slabs

6.3.1 *Concrete strengths*

The compressive strength class of concrete for base slabs to receive flooring directly should be not less than that shown in Table 2.

Higher strengths can be required for structural purposes or to resist damaging from early trafficking during the construction period. Concrete for direct finished base slabs should be in accordance with BS 8110-1.

Concrete for bases in contact with aggressive soils, e.g. those containing sulfates, should be in accordance with BS 8500-1.

NOTE Guidance on the classification of ground conditions and recommendations for the composition of concretes suitable to resist attack in a range of ground conditions are given in BRE Special Digest 1 [2].

Table 2 — Concrete strength for base slabs

Slab application	Minimum cement content kg/m³	Compressive strength class
Slab to receive direct application of flooring, or cement sand levelling screed	275	C25/30
Slab to receive high strength bonded or monolithic wearing screed	300	C28/35
NOTE 1 BS 8500-2 lists standardized prescribed concrete and designated concrete that may be chosen to conform to these values.		
NOTE 2 British Standard specifications for cement contain standard strength classes. Where cement of a class less than 42,5 is used, care should be taken to ensure that the cement content selected has the potential to produce a concrete of an equivalent grade. For example, a cement of strength class 32,5 N would probably require an increase in cement content of about 10 %.		

6.3.2 *Direct finished base slabs*

NOTE See A.3 for the use of lightweight aggregates.

A concrete base slab to receive flooring directly should be of appropriate strength and should be provided with the appropriate finish for the flooring, e.g. by the process of floating, trowelling or grinding.

Where heavy traffic is anticipated from following trades before flooring is laid, protection should be provided, or a higher grade of concrete than that specified in **6.3.1** and shown in Table 2, should be used.

6.3.3 *Thickness*

The thickness of the base slab should be determined by the loading conditions and, for any ground-supported slab, by the load-carrying capacity of the ground. The minimum thickness of any slab on the ground should be 100 mm.

6.4 Cement sand and fine concrete levelling screeds

6.4.1 *General*

A cement sand or fine concrete levelling screed can be applied to a prepared concrete slab as a levelling layer, as an alternative to direct finishing of the base slab, provided that the levelling screed has the required load bearing capacity.

The appropriate category of in situ crushing resistance for the levelling screed (see Table 3 and Table 4) should be selected and specified according to the floor covering thickness and floor usage. A levelling screed should not be used on its own as a wearing surface.

NOTE The mix proportion or compressive strength of levelling screeds to meet the ISCR requirements should be determined as in 7.5.

The surface of the levelling screed should be finished according to the type of wearing surface or flooring that is to be laid. For mastic asphalt, wood block and strip, and some textile floor coverings, a wood float finish should be used, while thin sheet and tile floor coverings usually require a smoother, steel trowelled surface. If a designer specifies the use of a thin sheet or tile floor, then the use of a smoothing compound should be specified in certain circumstances (see **7.9**).

6.4.2 *Bonding*

NOTE See A.4 for the use of lightweight aggregates.

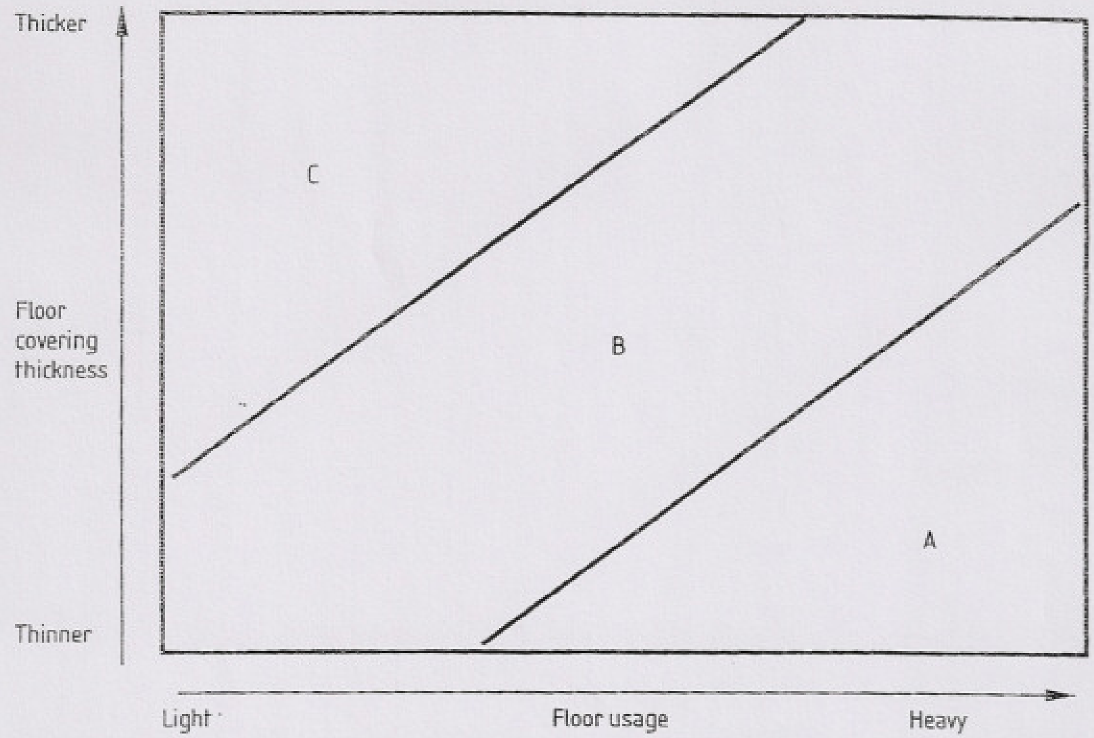
The adequacy of the bond of the levelling screed to the base should be considered in relation to the flooring to be applied.

To achieve the maximum possible bond between the levelling screed and the base, the method for preparation and cement slurry bonding of the base given in **7.4.2** and **7.4.3** should be followed. A base with a tamped surface is not suitable without further preparation and a levelling screed laid over such a base should be considered as unbonded. Slurry bonding, incorporating a bonding agent (see **7.4.3**), of vertical daywork joints of the set or hardened levelling screed may be used to achieve a bond to the fresh screed material being applied in an adjacent strip or bay. This helps to reduce curling that can occur at an unrestrained vertical butt joint as described in **6.5.3**.

Proprietary bonding agents may be used mixed with cement to form a grout or applied direct to the base as an alternative to cement grout. Bonding agents that are based on epoxy resin, which also act as damp-proofing membranes, are available. If bonding agents are used, it is essential that the recommendations for cleaning and roughening the base and bonding treatment given in **7.4.2** and **7.4.3** are still followed.

Levelling screeds laid over concrete bases that have been contaminated (e.g. with oil), or contain waterproofing admixtures, or have a damp-proof membrane between the levelling screed and the base, should be considered as unbonded, except where the damp-proof membrane is an epoxy resin, which can also function as a bonding agent. Where an insulating quilt or board is between the levelling screed and the base, the screed should be considered as floating.

Table 3 — Choice of in situ crushing resistance category for levelling screeds (see 6.7.2)



Floor usage category	Description
Heavy	Areas expected to take very heavy foot traffic and/or heavy trolleys, or where any breakdown of the screed would be unacceptable: for example, hospital operating theatres, X-ray rooms, main hospital corridors and rooms where radioactive material is handled.
Medium	Areas expected to take heavy foot traffic and/or medium weight trolleys: for example, public areas, corridors, main lift and lobby areas, canteens and restaurants, public rooms in residential accommodation, classrooms, hospital wards and offices.
Light	Other areas subjected to foot traffic and light trolleys: for example, light office use, consulting rooms and domestic housing.
Floor covering thickness	**Typical examples**
Thick	20 mm to 25 mm timber block flooring, 16 mm ceramic tiles, 20 mm natural stone or 28 mm terrazzo tiles.
Medium	Adhesive bedded 9 mm ceramic tiles.
Thin	Thermoplastic sheet/tiles (see BS 8203).
NOTE For categories A, B and C see Table 4.	

Table 4 — Acceptance limits for in situ crushing resistance test (after dropping the weight four times)

Category	Maximum depth of indentation mm	
	Bonded and unbonded screeds (see Annex D)	**Floating screed** (see Annex E)
A	3	3
B	4	4
C	5	2.5 (using 2 kg weight only)

NOTE 1 Up to 5 % of indentations may exceed those in this table by up to 1 mm.

NOTE 2 Tests carried out on an area of levelling screed that has been laid with a rough texture or has been roughened by wear can result in some extra compaction of the surface layer on the first impact, possibly giving rise to an increase in indentation of up to 1 mm.

NOTE 3 The method of test for ISCR measures the strength and integrity of a levelling screed in depth. It does not measure the surface strength of a screed. Very occasionally screeds can be encountered that pass the test but, because they have a weak or dusty surface, they are unsuitable to receive flooring.

6.4.3 *Thickness*

NOTE See **A.5** for the use of lightweight aggregates.

Refer to **6.8** for deviations in level and surface regularity of the base slab because these can affect the thickness of the screeds to be laid. See BS 5606 for expected deviations in base levels and calculations to provide guarantees on minimum screed thickness. The thickness of the levelling screeds should be as follows.

a) *Bonded screed.* When laid on and bonded to a set and hardened base prepared as described in **7.4.2**, the minimum thickness of the levelling screed at any point should be 25 mm.

To accommodate possible deviations in the finished levels of the surfaces of bases, the specified design thickness of the screed should normally be 40 mm to ensure this minimum screed thickness of 25 mm. In some circumstances, the design thickness of the levelling screed will have to be increased above 40 mm, but it should be noted that above this thickness there is an increasing risk of loss of adhesion to the base.

If the degree of preparation described in **7.4.2** cannot be achieved, then the levelling screed should be considered as unbonded.

b) *Unbonded screed.* When laid on a damp-proof membrane, except one formed by an epoxy resin that can function as a bonding agent, a separating layer or a base that incorporates a waterproofing admixture or has been contaminated (e.g. with oil), or a base that for any reason cannot be prepared for bond as in **7.4.2**, the screed thickness at any point should be not less than 50 mm. Owing to deviation in the base level, the specified design thickness might have to be 70 mm or greater.

c) *Floating screed.* When laid on a compressible layer such as a sound insulating quilt, the thickness of the screed at any point should be not less than 75 mm, except for domestic and similar applications where light loading is to be expected, for which a thickness not less than 65 mm should be used. Owing to deviation of the base levels, the specified design thicknesses might have to be 100 mm and 90 mm respectively, or greater, to maintain minimum thickness.

The minimum thicknesses at any point of levelling screeds laid on thermal insulation boards, which offer firmer support for compaction of the screed, should be at least 65 mm, depending on the traffic and loading to be expected. The levelling screed should preferably be of fine concrete. The insulation board should be chosen to bear the imposed loads and should be sufficiently rigid to enable the screed to be properly compacted.

If bases undulate in level, support for rigid or semi-rigid insulation boards beneath screeds will be on the high points with wide unsupported voids underneath. These bases should therefore be levelled first, with cement and sand slurry or screed material, or in severe cases even screeded, to ensure good board contact.

It is emphasized that a high risk of the screed curling exists with unbonded and floating levelling screeds, which can lead to steps at joints due to differential movement. These steps may be minimized by the incorporation in the levelling screed of steel fabric reinforcement, which should also pass through the screed joints (see **6.9.1** and **7.8**).

Where the risk of curling of an unbonded or floating levelling screed cannot be accepted, a concrete overslab 100 mm thick or more should be used. This should be designed as a new floor.

Where possible, any falls required in the floor should be formed in the base concrete so that an applied levelling screed is of uniform thickness.

6.4.4 *Reinforcement*

If reinforcement is required for structural purposes or for minimizing the width of cracks (see **6.9.1**), then fabric reinforcement of the appropriate grade should be specified (see **5.6**). In floating screeds, wire netting conforming to BS EN 10223-2 and similar materials are often specified for use in floor systems. Such netting is placed over the insulation to protect it during construction. It does not contribute to the structural performance or crack resistance of the screed. The size of fabric reinforcement should be chosen with regard to its overall thickness and the need to accommodate up to three layers at overlaps in about the middle third of the screed (see **6.9.1** and **7.8**).

6.4.5 *Location of services*

NOTE 1 See A.6 for the use of lightweight aggregates.

The laying of pipes or conduits within the thickness of a levelling screed should be avoided because cracking can occur over them and can lead to problems with subsequently applied floorings (see BS 6700 for specific recommendations on water pipes). If this is unavoidable, the pipes and conduits should be securely anchored in position and screed material well compacted around and over them to a minimum thickness of 25 mm above the pipes.

Reinforcement can help to reduce the width of cracks and prevents lipping; it should be placed across the conduits and pipes within the 25 mm cover thickness and extend at least 150 mm on either side.

Where trunking or ducts are to be incorporated in the levelling screed the designer should ensure that their finished level corresponds with that of the levelling screed.

Where trunking or ducts are below finished screed level, the space above the trunking or duct should be filled with a strong resilient material, e.g. a polymer modified cementitious screed, able to withstand the loads to be imposed.

NOTE 2 Attention is drawn to the need to comply with various statutory requirements.

6.4.6 *Heated levelling screeds*

NOTE 1 See A.7 for the use of lightweight aggregates.

Heated levelling screeds are generally laid in conjunction with proprietary underfloor heating systems as floating screeds over thermal insulation. The heating pipes or cables should be secured in position; their installation details should be provided by the manufacturer of the heating system.

Cement sand levelling screeds should be laid at the thicknesses recommended in **6.4.3**c) unless otherwise specified by the manufacturer of the proprietary system.

In all cases, once levelling screeds are cured and dried they should be heated very slowly to their operating temperatures and maintained at the operating temperature for several days before cooling down to room temperature, but not below 15 °C, before installing the flooring.

NOTE 2 The usual operating surface temperature of a heated levelling screed is about 27 °C; however, some locations operate at higher temperatures, e.g. 35 °C.

6.4.7 *Cement sand levelling screeds on stairs*

Levelling screeds to concrete stairs should always be bonded after preparation as recommended in **7.4.2** and **7.4.3**. The minimum thickness of screed laid on stair treads should be 20 mm and the maximum 40 mm. The thickness of screed rendered onto risers should be between 12 mm and 15 mm.

6.5 Bay sizes and position of joints

NOTE See A.8 for the use of lightweight aggregates.

6.5.1 *Ground-supported base slabs*

Directly finished ground-supported base slabs should be laid in strips of such width that the appropriate surface regularity given in Table 5 can be achieved. For higher standards of surface regularity, the maximum width of strip should be limited to about 6 m. With increasing width of strip it is more difficult to achieve the required surface regularity.

Where contraction joints are used to avoid shrinkage cracking in strips of unreinforced concrete bases, they should be not more than 6 m apart. For strips of reinforced base slabs, joint spacing may be greater depending upon the weight of reinforcement used (see [4] and [5]).

An alternative to strip construction is the large area pour technique, in which the ground-supported concrete base may be laid in areas of about 1 000 m^2 or more. During concrete laying surface levels are obtained from a level plane established by a laser. The benefit of using this method where flooring is to be applied directly to the concrete base is that the formed joints between strips, often a source of problems with levelness, are eliminated. Joints may be formed by sawing the base surface at about 6 m to 8 m centres both ways to reduce the incidence of shrinkage cracks (see [4]). Surface regularity classes SR2 and SR3 of Table 5 can be achieved by a skilled specialist contractor with the large area pour technique. For the highest surface regularity of a base, strip construction should be used (see also [4]).

6.5.2 *Suspended slabs*

The bay sizes and any consequent joints in the construction of suspended slabs should be specified because they depend on several factors, e.g. the significance of any cracking, the position and magnitude of restraints, the percentage and orientation of reinforcement and the likely thermal and moisture movements.

6.5.3 *Levelling screeds*

It is important to consider the relationship between the base, the levelling screed and the flooring, and the potential for relative movement at cracks or joints, which can adversely affect the performance of the flooring. Where there are structural movement joints in the base slab, these should be continued at the same position and width through the levelling screed to the surface of the finished flooring. The detail at the flooring surface depends upon the joint width, the type of floor finish, the service conditions and the expected amount of movement and may comprise proprietary movement joints or sealant joints.

Where construction joints in the base slab have opened, or can open, they could reflect through an overlaid bonded levelling screed. Similarly, at positions of rigid supports in base constructions, which are subject to deflection (e.g. supports to precast planks), there is a risk of reflective cracking through an overlaid levelling screed. In both these cases, if the floor finish is to be bonded and rigid, a joint capable of accommodating the expected movement should be formed through the levelling screed and floor finish.

Within the constraints of the joints required for accommodating base slab movements, described in the two preceding paragraphs, the levelling screeds should be laid in as large an area as possible in one operation to minimize the number of joints, consistent with achieving the appropriate surface regularity given in Table 5 and the levels required. These areas may be laid as strips 3 m to 4 m wide for convenience of application, with special attention to bonding and compaction along the edges.

Table 5 — Classification of surface regularity of direct finished base slab or levelling screed

Class	Maximum permissible departure from the underside of a 2 m straightedge resting in contact with the floor (see Annex C) mm
SR1	3
SR2	5
SR3	10

Levelling screeds laid in large areas tend to crack randomly as they dry and shrink. These shrinkage cracks are more easily dealt with than the more pronounced curling, which can occur at vertical butt joints if levelling screeds are laid in small bays. They do not generally affect the performance of bonded flexible floor finishes or rigid types of floor finishes, which are laid on a separate bed over an isolating membrane. However, shrinkage cracks in the levelling screed can continue to move and can reflect through bonded rigid floor finishes such as ceramic and stone tiles, terrazzo and synthetic resins. To minimize this risk, the levelling screed should be divided into bays with stress relief joints to ensure that any movements in the screed coincide with acceptable positions of joints in the floor finish. Such stress relief joints should generally be spaced along the length of the strip at about 5 m to 6 m intervals, although in rigid tiled floors the spacing may be dictated by the need to have intermediate joints between the positions required for stress relief in the floor finish, which may be up to 10 m apart (see BS 5385). For in situ floor finishes such as resins, account should be taken of the effect of such jointing on appearance. The detailing of these joints in the floor finish depends on the type of finish and the service conditions and may include proprietary movement joint sections or sealant joints.

Stress relief joints in the levelling screed should be formed either by cutting through with a trowel during laying or by saw cutting after hardening. The latter method allows the intermediate tile joints to be set out prior to saw cutting, making coordination of joint positions simpler. The joints in the levelling screed should be straight, vertical and at least to mid-depth. Saw cutting should not be delayed too long as there is a risk of random cracking occurring before cutting. The optimum "window" for saw cutting depends on a number of factors but should not generally extend beyond 3 weeks to 4 weeks.

Where the levelling screed is reinforced, the reinforcing steel fabric should generally be discontinuous at stress relief joints to provide maximum reduction of the risk of random cracking elsewhere. This should be weighed against the risk of differential curling, which would be increased by discontinuing the steel fabric [see **6.4.4** and **6.9.1**c)].

Heated levelling screeds to receive most types of rigid floorings and some types of resilient floorings should be divided by movement joints to provide screed bays of up to 40 m^2 with a maximum bay length of 8 m. The position of these joints should be designed to coincide with the joints in the flooring. Any random cracks in the screed that might open and close with thermal cycling are to be avoided with rigid floorings and some form of screed reinforcement can be found to be necessary to minimize such cracks.

6.6 Joint construction

6.6.1 *Base slabs*

Formed longitudinal joints between ground-supported base slab strips and any formed transverse joints, e.g. daywork joints, should be plain vertical butt joints incorporating load transfer devices, e.g. tie or dowel bars, which prevent differential curling of adjacent slabs and the formation of steps.

6.6.2 *Levelling screeds*

Formed daywork joints between strips of levelling screeds should be vertical butt joints.

6.7 In situ crushing resistance (soundness)

NOTE See A.9 for the use of lightweight aggregates.

6.7.1 *General*

The designer should specify the screed in terms of the category of in situ crushing resistance (ISCR), not by the screed material proportions, and should select from Table 3 and Table 4 the ISCR required for the levelling screed to withstand the imposed loads and traffic in service.

The screed material proportions to meet the specified ISCR should be chosen by the contractor (see **7.5**).

In making the selection account should be taken of the type and thickness of the flooring to be applied and the loading to which it is likely to be subjected. In general, cement and sand screeds are not suitable if heavy powered trucks or heavy equipment fitted with small hard castors are to be used. For these types of use, the base should be concrete or a sand concrete screed compressive strength class C 25/30. Higher strengths might be required in some situations.

Care should be taken if proposing to use a floating screed in a situation which will be subject to heavy loads, to ensure that the installation will have sufficient load carrying capacity to perform without deformation.

The ISCR should be assessed by means of the BRE Screed Tester (see [1] and [10]). (See **8.6**, Annex D and Annex E).

Acceptance limits for the categories of ISCR are given in Table 4.

6.7.2 ***In situ crushing resistance requirements for levelling screeds to receive flexible floor coverings and rigid floorings***

Table 3 gives guidance on types and examples of use for levelling screeds of different categories when using various types of floor coverings.

When selecting a category of screed, the type and thickness of the flooring to be applied should be taken into account irrespective of the properties of the flooring, category A should be specified for very heavy load and traffic conditions.

Cement sand levelling screeds do not usually provide suitable bases to receive synthetic resin flooring or polymer modified cementitious wearing screeds. Cement sand levelling screeds should never be used as a base to receive high strength concrete wearing screeds.

6.8 Tolerances on level and surface regularity of base slabs and levelling screeds

6.8.1 *General*

The designer should consider:

a) the finished floor surface;

b) the screed/direct finished slab surface;

c) the base slab to receive a screed;

when specifying departure from datum and surface regularity, taking into account the types and thicknesses of the flooring and the levelling screed. For a floating screed, the thickness, and the variation in thickness, of the insulating layer should be taken into account.

Some variations in surface regularity may be allowed without detriment to the satisfactory application of the flooring: the permissible limits associated with surface regularity and departure from datum depend on many factors. In general, the thinner the applied flooring the higher the class of surface regularity required.

6.8.2 *Departure from datum*

The maximum permissible departure of the level of the direct finished slab or levelling screed from a specified or agreed datum plane should be specified taking into account the area of the floor and its end use. For large areas for normal purposes a departure of up to 15 mm from datum is generally considered to be satisfactory. Greater accuracy to datum can be necessary 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.

6.8.3 *Surface regularity*

The class of local surface regularity of a directly finished base or levelling screed, if used, should be selected from those given in Table 5 according to the use of the floor. In making this selection, account should be taken of the type and thickness of the wearing screed or flooring to be applied and the standard of surface regularity required of the finished floor. The highest standard (SR1) should be used where a thin flooring is to be applied and where the minimum irregularity is required of the finished floor, e.g. for a television studio. Conversely, the lowest standard (SR3) may be selected where a thicker type of wearing surface is applied and where the regularity of the finished floor is not a significant factor.

NOTE Insistence on higher standards of surface regularity than are necessary will result in higher costs.

In service, the suitability of a floor in terms of surface regularity is governed by its radius of curvature and changes in height over short distances. Specialist test equipment is now available with which to assess these factors and new specifications may be used to control them (see [4]). Although this new test equipment is more complex to use than the straightedge, it is less laborious on large floor areas.

The designer should specify the maximum permitted abrupt change in level across joints in direct finished slabs and levelling screeds, taking into account the type and thickness of the flooring to be applied. For some types of floorings, a maximum of 2 mm would be acceptable, taking into account the surface preparation necessary to receive the flooring. For other types of flooring, especially thin floorings, it would be appropriate not to have any changes in level across joints.

6.8.4 *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) The majority of differential drying shrinkage of the slab between its top and bottom surface takes place over the first year and can 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 **8.3**). It should however be recognized that after this time the level and surface regularity could still change.

6.8.5 *Finished surface of base slabs*

When a levelling screed is to be used, the designer should consider both the surface regularity and departure from datum of the finished surface of the base slab, not only in relation to the type and thickness of levelling screed intended to be specified, but also the surface regularity and departure from datum of the finished surface of the screed.

The limits within which it is permissible to apply that type of levelling screed (e.g. bonded, unbonded or floating) should be considered. A nominal screed thickness close to the minimum value (or indeed maximum value) for that type of screed should not be specified unless the base slab can be laid to sufficiently close limits without prejudicing the requirements for level and surface regularity of the surface of the finished screed. It might not be possible to accommodate the levels of base slabs that are outside the specified tolerance limits using levelling screeds at the thicknesses recommended in this standard.

6.9 Liability to cracking of direct finished base slabs and levelling screeds

6.9.1 *Factors influencing cracking*

The cracking of concrete base slabs and levelling screeds is mainly caused by restraint to early thermal contraction and drying shrinkage. Restraint can be reduced by including a slip membrane under the slab. Curling due to differential drying through the thickness can lead to cracking under load, especially in the case of levelling screeds. Cracking and curling are further influenced by the following factors.

a) *Water content*. Increasing the water content of a screed material increases the drying shrinkage of concrete slabs and levelling screeds, increasing the risk of cracking. The quantity of water used should be kept to a minimum but sufficient to ensure thorough compaction. Water reducing and superplasticizing admixtures enable the water content to be reduced while maintaining the required level of consistence (see **6.11.2**).

b) *Aggregates*. Some aggregates have higher than average drying shrinkage properties and should be avoided owing to a greater risk of cracking [3].

c) *Reinforcement*. The provision of reinforcement does not prevent, but can control, shrinkage cracking. It is seldom used in bonded screeds, but if used in unbonded or floating screeds it limits the width of cracks and so provides some advantage. Reinforcement does not prevent curling but where it passes through joints it will minimize steps. Where reinforcement is used, it should be placed in about the middle third of the levelling screed, and if required may extend across bay joints. To ensure adequate compaction and bond around the steel fabric, the use of a slightly wetter screed material may be considered (see 7.8).

d) *Curing.* Concrete slabs and levelling screeds should be kept moist continuously for at least 7 days, starting as soon as possible after laying (see **7.10**), to enable them to develop sufficient tensile strength to resist the stresses caused by restraint to shrinkage that occurs as concrete dries. Shrinkage can continue for several months.

e) *Drying.* Slabs and levelling screeds should be allowed to dry out as slowly as practicable after curing to reduce the risk of curling. Accelerated drying by forced ventilation or heating should not be used as this can result in incomplete hydration of the cement and cracking and curling of the screed.

The possibility of damage to the floor finish over joints or cracks, such as rippling of thin sheet and tile flooring, can be caused by a reversal of curling due to the redistribution of moisture within the thickness of the screed once it is covered. This risk can be reduced by covering the dry screed with impermeable sheeting for about 7 days before laying the flooring.

f) *Hot weather.* Where floors are placed in very hot weather or without cover from the sun the subsequent contraction on cooling increases the risk of cracking. The risk can be reduced by constructing these elements under an overhead covering, although care should be taken to avoid any wind funnelling effect, which could induce rapid drying.

6.9.2 *Ground-supported base slabs*

As the manner in which a base slab is designed affects the potential for cracking, ground-supported base slabs should be designed as one of the following.

a) A fully jointed slab in which most of the contraction movement takes place at the joints. The reinforcement required is determined by the spacing of unrestrained joints.

b) A continuously reinforced slab without joints and containing sufficient reinforcement to distribute the contraction strain in the form of a large number of very fine cracks, which in themselves are not likely to detract from the performance of the applied flooring.

c) A post-tensioned slab incorporating bonded or unbonded tendons, which are stressed to provide a low level of compressive stress within the concrete, allowing all construction joints to remain tightly closed in the long term even after drying shrinkage movement is complete.

For further information see [4] and [5].

The possible effect on the concrete of deleterious material in the ground or ground water should be considered. Consideration should be given to protection by means of a damp-proof membrane or the use of an appropriate compressive strength class of concrete. (See BS 8500-1.)

6.9.3 *Suspended base slabs*

Suspended slabs may be of in situ or precast concrete or composite construction and may be designed as reinforced or pre-stressed members. The designer of a structural suspended floor should be consulted to establish the possible degree and position of any likely cracking and degree of deflection of the span where these are likely to affect the performance of the applied flooring.

When suspended slabs are constructed on the ground, e.g. heavily loaded slabs on piles in poor ground, the slab tends to behave like the slabs described in **6.9.2**. High proportions of top reinforcement can be used to control adequately cracking due to drying shrinkage. A risk of some cracking cannot be avoided.

6.9.4 *Levelling screeds*

If the levelling screed is not adequately bonded to the base slab, curling can occur, which can subsequently lead to the screed cracking under load. Joints in the base that could open should be carried through the levelling screed, otherwise reflected cracking can form at these positions.

6.10 Damp-proofing ground-supported floors

Concrete bases and levelling screeds in contact with the ground without a damp-proof membrane should not be expected to keep ground moisture back either in liquid or vapour form. Ground moisture can pass through until it either disperses by free evaporation from the surface of the flooring or reaches a less permeable material under which it tends to accumulate.

The degree of protection required depends on the type of flooring. Some floorings and/or the adhesives used to fix them are adversely affected by water from below. Others can transfer moisture to the air without deterioration. Another group forms effective damp-proof membranes. The design data for damp-proofing new concrete floors in contact with the ground, including the degree of protection required by different floorings, is given in CP 102. For basement floors in contact with the ground, BS 8102 should be consulted. In addition to the damp-proofing materials listed in CP 102, proprietary epoxy resins are available, which act as both damp-proof membranes and bonding agents. Levelling screeds laid over these resins in accordance with the manufacturer's recommendations may be considered as bonded. The effect of joint opening or cracking, which can rupture the damp-proof membrane, should be considered. Where existing bases and levelling screeds do not incorporate adequate damp-proofing systems, mastic asphalt or proprietary surface applied membranes should be considered.

There is no generally applicable requirement in the Building Regulations for England and Wales [6] to provide a damp-proof membrane below all ground-supported floors. Approved Document C4 Section 3 indicates which floors need a damp-proof membrane. The requirements of the Building Standards (Scotland) Regulations [7] for preventing moisture from the ground damaging the inner surface of any part of a building are deemed to be satisfied if a damp-proof membrane is provided. Plastic sheeting laid under the slab to reduce frictional restraint might not provide adequate damp-proofing. Constructions to meet the Building Regulations for Northern Ireland are described in Technical Booklet C [12].

Integral waterproofing admixtures incorporated in concrete bases or levelling screeds do not provide adequate damp protection for moisture sensitive floorings and retard the drying process. They can also impair adhesion of the screed or floorings.

6.11 Eliminating construction moisture

6.11.1 *General*

Before moisture sensitive floorings and floor coverings are laid it is essential to ensure both that the floor is constructed to prevent moisture reaching them from the ground and that sufficient of the water used in the construction is eliminated.

Usually the flooring or floor covering is fixed directly to the concrete base slab or onto a levelling screed laid above it. In either case the amount of water used in the screed material or concrete is more than that required for hydration of the cement used because extra water is normally required to give an adequate level of consistence to the screed material or concrete. After the curing period (see **7.10**), it is essential that the excess water be allowed to evaporate. The time taken for this to happen should be taken into account at the planning stage. Estimated drying times are necessarily only very approximate as drying is influenced by ambient conditions, concrete quality, thickness and surface finish. Of these factors, thickness and finish are the most important.

With cement sand levelling screeds, one day should be allowed for each millimetre of thickness for the first 50 mm, followed by an increasing time for each millimetre above this thickness. It is therefore reasonable to expect a levelling screed 50 mm thick, drying under good conditions, to be sufficiently dry in about 2 months.

Concrete, being less permeable, takes longer to dry. In practice it has been found that even under good drying conditions concrete bases 150 mm thick often take more than a year to dry from one face only. Moderate and heavy use of power-float and power-trowel finishing methods further delay drying. Suspended concrete slabs cast on permanent metal decking or other impermeable materials have similar drying times to those laid over damp-proof membranes. The use of curing membranes significantly extends the drying out period. For slabs that can dry from both sides, about half the thickness can be considered to dry downwards.

Where levelling screeds are laid directly onto concrete bases without a damp-proof membrane between them, account should be taken of the time needed to dry the total thickness of base and screed. Where moisture sensitive floorings or floor coverings are to be laid, schedules should be arranged to permit extended drying times for concrete bases. If this cannot be done, then it is crucial at the design stage to specify the use of a sandwich damp-proof membrane between the base concrete and the levelling screed.

Accelerated drying of concrete bases and levelling screeds by forced ventilation or heating should not be used. This can result in incomplete hydration of the cement and cracking and curling of the screed.

Proprietary systems based either on admixtures for normal concrete bases and screeds or special cements are available to produce early drying concrete and levelling screeds.

The moisture contents of levelling screeds onto which particular floorings are to be laid and methods for measuring moisture content are given in BS 5325, BS 8201, BS 8203 and BS 8425.

6.11.2 *Use of admixtures*

Admixtures should be thoroughly dispersed throughout the concrete by efficient mixing to avoid inconsistency of effect and resulting problems of concrete finishing. The possibility of secondary or indirect effects due to admixtures should be considered. The following admixtures may be used.

a) *Water reducing*. These may be used to increase consistence and reduce the water content otherwise required in the concrete base or screed material. Some types can also entrain a small quantity of air and cause retardation of concrete setting and thus delay finishing.

b) *Superplasticizing*. These greatly increase consistence at normal water contents for a limited period to produce flowing concrete, which needs little or no compaction. Alternatively they may be used as high range water reducing admixtures.

c) *Air-entraining*. These entrain a small quantity of fine air bubbles that help to reduce bleeding of free water. An excessive amount of entrained air should be avoided as this can reduce the strength and can lead to problems with finishing.

d) *Accelerating*. These may be used to accelerate the rate of setting and hardening of concrete in cold weather. Admixtures containing chloride, which can cause corrosion of metals, should not be used in reinforced concrete, concrete or wearing screeds containing embedded metal, or in materials adjacent to any of these.

e) *Waterproofing*. Waterproofing admixtures should be used with caution. Some contain water repellents, which can impair the adhesion of a wearing screed to the base.

Integral waterproofing admixtures should not be considered as alternatives to damp-proof membranes recommended in CP 102.

f) *Retarding*. These decrease the initial rate of reaction between cement and water and thereby delay the setting of the concrete.

7 Work on site

7.1 Protection against the weather

7.1.1 *Cold weather*

Concreting in cold weather should be carried out in accordance with BS 8110-1:1997, **6.2.4** for concrete supplied in conformity to BS EN 206-1:2000, **5.2.8**. If mixing and laying are to proceed during cold weather, measures should be taken to ensure that stored aggregates and cement are maintained at temperatures above freezing. The surface temperature of the laid concrete or screed (not the air temperature) should be maintained above 5 °C during construction and for 4 days to 5 days after laying. In this way the concrete will normally have achieved sufficient strength to resist damage by frost.

Freshly placed and finished bases and levelling screeds exposed to the weather should be covered with tarpaulins or sheeting, carefully lapped and supported clear of the surface on a temporary framework in such a manner that the wind cannot blow underneath.

The time and amount of protection may be reduced by employing any of the following:

a) an increased cement content (for base slabs only);

b) cement with early strength development;

c) admixtures to reduce the water/cement ratio;

d) admixtures to accelerate setting and hardening;

e) heated materials in concrete (for base slabs only);

f) thermal blankets.

NOTE For further information on these points, which cannot be quantified briefly, see [9]. Unless heated enclosures and/or heated materials are used it can be preferable to delay operations until the weather is warmer.

7.1.2 *Hot or drying weather*

Concreting in hot weather should be carried out in accordance with BS 8110-1:1997, **6.2.5** for concrete conforming to BS EN 206-1:2000, **5.2.8**. In hot or drying weather care should be taken that the concrete or screed materials do not stiffen or dry out to an extent that prevents thorough compaction. After compaction and finishing, the surface should not be allowed to dry out quickly. This can be achieved by protection with plastics sheeting or other suitable means. In addition, where concrete or screed is laid in the open, its surface should be protected from the effects of the sun to reduce the risk of thermal cracking on subsequent cooling.

7.1.3 *Wet weather*

If protection is not provided by the structure, the freshly placed concrete or screed material should be covered to prevent damage to the surface by rain.

7.2 Use of calcium aluminate cement (high alumina cement)

Calcium aluminate cement should not be mixed on site with any other kind of cement.

Levelling screeds made with calcium aluminate cement concrete may be used on hardened Portland cement concrete bases.

The total water/cement ratio of calcium aluminate cement concrete should not exceed 0.40 by mass and the cement content should not be less than 400 kg m^{-3}. It is most important that this concrete should be effectively cured during the first 24 h so that its very rapid rate of hardening can proceed normally without deleterious effects on the strength and durability [see **5.1.2**i) and **5.1.3**d)].

7.3 Installation of the base

7.3.1 *Levels to be achieved*

The sub-base and the concrete base should be fully compacted and laid to the tolerances given in **6.1** and **6.8** respectively.

7.3.2 *Concrete*

The concrete should be produced not only for strength, but also to give a cohesive product, without excessive bleeding, so that it can be placed and finished within the specified time. Concrete slabs containing admixtures that entrain air might exhibit surface delamination and blisters where power trowelled. Late and excessive bleeding can also contribute to this effect. To minimize the occurrence of such defects, high air contents and excessive quantities of sand should be avoided. The surface should not be closed by power floating too soon as this might otherwise entrap water from late bleeding. Base concrete with high water content that leads to bleeding should be avoided because this would particularly delay the placing of a monolithic levelling screed.

7.3.3 *Laying the base concrete*

A ground-supported concrete base slab or a suspended concrete slab at ground level should be laid on the prepared sub-base, and slip membrane or damp-proof membrane if any, using a concrete strength class as specified (see **6.3**). In the case of a suspended upper floor base slab, the concrete should be placed on temporary formwork or a permanent supporting layer, e.g. of precast concrete or steel. The formwork or supporting layer should be set in such a manner and at such a level that when the concrete base is compacted, levelled and finished, its specified design thickness and the position of the surface relative to datum can be achieved. Joints in a base slab to facilitate construction should be in accordance with **6.6.1**.

7.3.4 *Compacting the base*

The base concrete should be fully compacted by suitable methods, in such a way that an excess of laitance is not brought to the surface. The use of superplasticisers can ease the concrete placing and compaction effort. Self compacting concrete (SCC) requires no compacting effort.

7.3.5 *Levelling the base*

The surface of the base concrete should be brought to a level within the specified tolerances (see **6.8**), using rigidly fixed forms, permanently built-in concrete rails or temporary levelling rails. Forms and rails should be fixed so that they are not displaced during the compaction of the concrete. For large area pours, the use of a laser level and staff can avoid the use of temporary levelling rails.

Where close tolerances on level are required, forms should have a square edged metal top surface, which is within accurate limits of line. The top should be set to a level to achieve the specified surface regularity of the concrete (see **6.8**). To enable good quality formed joints to be produced, side forms should be clean and undamaged to allow accurate striking off.

7.3.6 *Finishing the base*

After the concrete has been fully compacted, has stiffened sufficiently, and any bleed water has evaporated (normally after 1 h to 6 h), it should be levelled initially and floated smooth by hand or machine.

Where a directly finished base is required, the surface should be further trowelled at least twice at intervals during the next 3 h to 6 h, to produce a uniform and hard surface. The surface finish for the base is determined by the requirements of the applied flooring.

7.3.7 *Curing*

Immediately after the surface has been finished by trowelling and when it has hardened sufficiently to prevent damage, the concrete should be cured continuously for at least 7 days (longer in cold weather) in one of the following ways.

a) A resin, spray-on curing membrane should be applied at the manufacturer's recommended rate to ensure complete coverage of the surface.

Liquid curing membranes should not be used on slabs to which materials are subsequently to be bonded unless the membrane is first effectively removed, e.g. by grinding or shot-blasting.

b) Waterproof sheeting should be kept in close contact with the surface of the concrete for the full curing period. The sheeting should overlap the sides and ends of the slab and be securely held in position. Adjacent sheets should overlap by at least 150 mm.

The incorporation of an admixture can alter the rate of setting of the concrete. Care should be taken to ensure that the curing method selected commences as soon as possible to provide conditions that minimize evaporation. This is particularly important when using concretes with low water/cement ratio content. The recommendations given in Annex F should also be considered.

As a concrete floor dries, it shrinks slightly. The danger of consequent cracking is greatly reduced by ensuring that the concrete dries out slowly. The building should not be heated for 6 weeks to 8 weeks after the floor has been finished, even in winter, and then the temperature should be increased slowly.

7.4 Preparation of the base to receive screeds

7.4.1 *General*

The bond between the levelling screed and the concrete base depends to a great extent upon the conditions of the surface of the base at the time of laying the screed. Where the screed is laid on a set and hardened base, complete bond cannot be ensured.

7.4.2 *Roughening of the base*

In the case of in situ slabs, or precast units, where a high degree of bond is required, the laitance on the base should be entirely removed by suitable mechanized equipment to expose cleanly the coarse aggregate. All loose debris and dirt should be removed, preferably by vacuuming.

With precast units, for bonded but non-structural levelling screeds, the surface of the units should be left rough during production and should be thoroughly washed and cleaned, e.g. by wire brushing, to remove all adhering dirt. Where the levelling screed is designed to act compositely with the units and additional preparation of the units is required, the use of contained shot-blasting equipment will be found to be more suitable than mechanical scabbling if there is a risk that the latter might damage the units.

To prevent later contamination or accumulation of dirt, these operations should be delayed until shortly before the levelling screed is laid.

7.4.3 *Bonding treatment*

The base concrete should be kept wet for several hours before the levelling screed is to be laid, e.g. overnight, any excess water being removed before grouting. Within a period of 30 min before the screed is to be laid (less in hot weather), a thin layer of neat cement grout or slurry of creamy consistency should be brushed into the surface of the base concrete. It is essential that the levelling screed is compacted onto the base while the grout is still wet. A proprietary bonding agent may be used or a proprietary bonding admixture may be added to the grout or slurry in accordance with the manufacturer's instructions. In these cases the appropriate procedure of **7.4.2** should still be carried out. Proprietary bonding agents should be used in accordance with the manufacturer's instructions, which usually require the screed to be placed while the bonding agent is still tacky. Polyvinyl acetate (PVA) bonding agents are unsuitable for bonding screeds.

Wetting of the base can be unnecessary in the case of some proprietary bonding agents, e.g. epoxy resin.

7.4.4 *Unbonded levelling screeds*

Where an unbonded levelling screed is to be constructed either on a new floor or on an old one being renovated, the base should be sufficiently clean and smooth to receive any separating material specified. Before the screed is laid the reasons for any cracking or hollowness of the existing base should be sought and appropriate remedial treatment carried out. Cracks and loose or hollow portions should be cut out and made good.

7.4.5 *Floating levelling screeds*

A base of in situ or precast concrete should be smooth and level enough to carry rigid or semi-rigid insulation boards and so avoid boards sitting on high spots creating wide voids. Any such depression should be filled (before laying the boards) with cement grout or screed material.

7.5 Installation of the screed

NOTE See A.10 for the use of lightweight aggregates.

7.5.1 *Screed material proportions*

All screed material proportions are based on the use of the following materials.

a) *Portland cement of strength class 42,5 N.* If cements of other types and/or classes are used (see **5.1.1**), then constituent material proportions might need to be adjusted in order to achieve screeds of similar strength characteristics to those recommended. Definitive guidance on their use in cement sand screeds is not available at the time of publication.

b) *Dry aggregates.* Due allowance should be made for the moisture content of any damp materials used.

Where the thickness of the levelling screed is 50 mm or greater, consideration should be given to the use of fine concrete to minimize water demand and hence drying shrinkage. However, there is a risk of a lower standard of fine closed finish when using 4/10 aggregate in the screed.

7.5.2 *Bonded and unbonded levelling screeds*

For both bonded and unbonded levelling screeds, the contractor should determine and use appropriate constituent material proportions and methods of working in order to fulfil the necessary requirements of 6.7 for in situ crushing resistance. A screed with nominal constituent material proportions by weight of cement to sand of 1:4 with a lower limit 1:3 and an upper limit of 1:4.5 would normally be expected to meet the criteria for in situ crushing resistance. Similarly, a screed of compressive strength class C20 or C25 would normally be expected to meet the criteria for in situ crushing resistance.

7.5.3 *Floating levelling screeds*

The required in situ crushing resistance should normally be met by using the ranges of constituent material proportions for cement and sand in **7.5.2** and for fine concrete in **7.5.4**. To assist their compaction, the fresh screed material may be made slightly wetter than that for bonded and unbonded levelling screeds, but in so doing the risk of cracking and curling will be increased.

7.5.4 *Fine concrete levelling screeds*

Where a fine concrete is used, the required in situ crushing resistance should normally be met by using the range of constituent material proportions by weight of cement to total aggregate between 1:4 and 1:5. The proportions of sand and 4/10 mm aggregate may be varied to allow the easiest compaction and the achievement of the specified finish. For example, where finishing to a fine closed texture is required, proportions by weight of approximately 1:3.5:1 (cement: sand: aggregate) can be acceptable. In order to minimize water demand and where such finishing is not so important (e.g. where thicker in situ floorings are to be applied), constituent material proportions by weight of 1:2:2 (cement: sand: aggregate) can be suitable.

7.5.5 *Batching*

Where possible, materials should be batched by weight. This can be unpracticable on some sites and in these circumstances the materials should be volume batched. The cement should be batched by the whole bag and the sand by means of a suitable container of known volume. Due allowance should be made for the bulking of damp sand.

7.5.6 *Water content*

The quantity of water used in both cement sand and fine concrete screeds should be kept to the minimum consistent with the need to compact the screed material fully.

7.5.7 *Method of mixing*

NOTE See A.11 for the use of lightweight aggregates.

The materials should be thoroughly and efficiently mixed by means of forced action mechanical mixers, e.g. trough and pan paddle mixers and paddle mixers attached to screed pumps. The amount of water added should be the minimum necessary to give sufficient level of consistence for laying and thorough compaction.

To ensure uniform dispersion of admixtures, the measured dosage should be added to the water before mixing or at the same time as the water is added to the mix. When certain admixtures, e.g. superplasticizers, are added after mixing the concrete or levelling screed, the materials should be remixed thoroughly to ensure uniformity.

Free-fall drum mixers produce inconsistent mixing of low moisture content material and their use is not recommended for such materials.

A common problem is the use of too dry, badly mixed cement and sand screed materials that cannot be properly compacted, with the result that the levelling screed can have a dense crust with the underlying screed very weak and friable. The result of this has been for point loads to cause a crushing failure within the screed.

7.6 Pumping the screed material

NOTE See A.12 for the use of lightweight aggregates.

The pumping system should deliver the material to the working area in a condition suitable for laying. Experience has shown that most efficient pumping is achieved when well-graded sand with not less than 15 % passing a 0.250 mm sieve is used. It is often difficult to pump satisfactorily screed material richer than 1:4 by mass at water contents suitable for levelling screeds.

7.7 Using ready-to-use screed material

Ready-to-use screed material should be laid without any further mixing or the addition of extra water. When the specified retardation time has been exceeded, no attempt to retemper the screed material using extra water should be permitted.

7.8 Laying the levelling screed

NOTE See A.13 for the use of lightweight aggregates.

Narrow strips of screed material, laid and compacted to finished level, should be used to establish the level of the screed. Immediately after laying the strips, the infilling screed material should be placed and compacted. Where the edge of a strip forms a daywork joint it should be formed or cut to produce a vertical joint. Alternatively, screed battens, carefully levelled and trued, should be fixed at the correct height for the required thickness of screed. Battens should be removed before laying the adjacent bay of screed. At daywork joints all bedding screed beneath the battens should be cut away to form a vertical joint.

The screed material should be spread on the prepared base with adequate surcharge, thoroughly compacted, either by heavy tamping or by mechanical means, and levelled with a screed board.

In order to facilitate the compaction of thicker cement sand levelling screeds, i.e. over 50 mm thickness, the screed may be laid in two layers. Both layers should be of approximately equal thickness and the same constituent material proportions and water content. To ensure satisfactory adhesion, the surface of the compacted lower layer should be lightly roughened by raking before adding the second layer. Where reinforcement is used it should be placed in about the middle third of the thickness of the screed. This can only be achieved if the thickness of the reinforcement is correctly chosen in relation to the thickness of the screed so that the total thickness of the steel fabric at the overlaps can fit into the middle third of the screed depth. This can be achieved by laying the screed to about half its thickness, compacting it, lightly roughening the surface with a rake, laying the reinforcement on the compacted layer and then immediately placing and compacting the upper layer.

Where a levelling screed is laid on a compressible insulation layer, extra attention should be given to ensure adequate compaction, e.g. by the use of a slightly wetter mixed screed material.

7.9 Finishing the levelling screed

The levelling screed should be finished to suit the type of flooring (see **6.4.1**). The finished surface should be free from excessive dusting and friability.

Although the aim is to achieve both the necessary flatness and surface texture, this might not be possible for some thin sheet and tile floor coverings with a screed containing sand. Likewise, fine concrete screed containing aggregate of up to 10 mm maximum size and of low moisture content does not produce an acceptable surface texture for these types of floor coverings. In such cases, the levelling screed should be finished by applying a smoothing compound ("underlayment" in BS 8203) to the hardened screed as part of the floor covering system just before laying the floor covering. A smoothing compound should not be used on a weak or friable levelling screed.

7.10 Curing the levelling screed

The levelling screed should be prevented from drying for at least 7 days after laying by covering with a suitable impervious membrane, preferably waterproof sheeting. This curing period is required to enable the surface of the screed to hydrate and harden sufficiently prior to drying. Once the period for curing the surface has elapsed, the sheeting should be removed to enable the levelling screed to dry normally.

Where a curing compound is used, contained shot blasting or a similar technique can be required to remove it. If curing compounds are used and left in place beyond the 7 day curing period, they will result in extended drying times and can impair the adhesion of any subsequently applied material. For this reason, BS 8203 recommends the removal of curing membranes within the 7 day curing period. Some curing materials should be used with caution, both because they are designed to penetrate the surface and seal the capillaries in the screed, and also because they cannot be removed.

7.11 Protection of the surface

Levelling screeds and directly finished bases covered by this part of BS 8204 are not designed as wearing surfaces, therefore their surfaces should be given adequate protection against damage or wear during subsequent building operations and until the flooring is laid.

8 Inspection and testing of bases and levelling screeds

8.1 Inspection

Before screeding work is commenced, the base should be checked for level to ensure that the specified thicknesses of screed can be applied over the whole area. This is essential for precast concrete units as some planks can have appreciable camber.

The work should be inspected during progress and after completion, attention being paid to the following points:

a) materials;

b) preparation of the base, where the levelling screed is to be bonded;

c) batching and mixing;

d) proper compaction;

e) correct finishing;

f) levels and surface regularity;

g) correct curing.

8.2 Inspection and testing of the completed work

After completion of the work, those of the following tests detailed in accordance with **4.2**y) should be carried out:

a) levels and surface regularity of levelling screeds and direct finished concrete bases;

b) adhesion of bonded screeds to the base;

c) curling and lipping of unbonded and floating screeds;

d) in situ crushing resistance of screeds;

e) assessment of cracks.

8.3 Levels and surface regularity

When the base or levelling screed is tested by the methods given in Annex C, the departure from datum should be within the limits specified by the designer and the surface regularity should be within the limit given in Table 5 for the appropriate class chosen by the designer (see **6.8**).

8.4 Adhesion of bonded levelling screeds to the base

The adhesion of the levelling screed to the base should be examined by tapping the surface with a rod or a hammer: a hollow sound indicating lack of adhesion.

Tests to check the adhesion of a levelling screed to its base should be made as late as possible in a construction programme, when the maximum effect of drying shrinkage has taken place. Tests undertaken in less than 4 weeks could be unreliable. Account should be taken of the time necessary for any required replacement section of levelling screed to be laid within the construction programme.

Good preparation of the base is essential and, together with good workmanship, will minimize loss of adhesion; however, it cannot be guaranteed that adhesion will always be complete. It would be unrealistic to expect levelling screeds thicker than 40 mm always to be completely adhered even to a correctly prepared base.

If any hollowness is found it is usually confined to the edges and corners of bays and on either side of any cracks that have developed in the levelling screed. Hollowness, indicating lack of adhesion, does not necessarily mean that the screed is unsatisfactory, unless it is accompanied by visible or measurable lifting of the edges of bays or at cracks, to the extent that the lifted areas of screed could break under anticipated loads. The type of flooring to be applied subsequently and the end use of the floor should also be taken into consideration.

Areas of levelling screed that are considered to be unsatisfactory should be treated by one of the following methods.

a) Making good the affected areas by filling or injecting the hollow areas with a low-viscosity synthetic resin to stabilize and improve the bond between the levelling screed and the base.

b) Isolating the affected areas by sawing, making vertical cuts into adjacent sound screed, and taking care to minimize the effect of the cutting-out operation on the adhesion of the sound screed. The unsatisfactory areas of screed should then be removed and replaced by new material.

8.5 Curling and lipping of unbonded and floating levelling screeds

Unbonded and floating screeds should only be considered unsatisfactory if they have lifted by a visible or measurable amount at joints and cracks to the extent that there is a risk of fracture under superimposed loads. When tapped with a rod or hammer, unbonded and floating screeds sound hollow.

8.6 In situ crushing resistance (ISCR) of bonded and unbonded levelling screeds

When the levelling screed is tested by the method given in Annex D, the indentation produced after dropping the weight four times should not exceed that given in Table 4 for the specified category (see **6.7**). However, up to 5 % of indentations exceeding those in Table 4 by not more than 1 mm are acceptable. These are in addition to any allowance for roughness referred to in Note 2 of Table 4.

The screed should pass the ISCR test 14 days after it has been laid. In cold weather, low curing temperatures can require this period to be extended. Conformity can be proved at an earlier age provided that the requirements of Table 4 can be met.

8.7 In situ crushing resistance of floating levelling screeds

The ISCR of this type of screed should be assessed by the method given in Annex E.

NOTE When the floating screed contains pipes or heating elements, tests should be carried out at least 75 mm from their known position to avoid possible damage to them.

The levelling screed should meet the acceptance limits for the category chosen. If the levelling screed does not meet the appropriate acceptance limits for the category chosen, the screed should not necessarily be rejected. Alternative methods, such as analysing the material for cement content and taking cores for strength determination, can be used to ascertain whether the screed is sound and fit for purpose.

8.8 Assessment of cracks

Cracks should be assessed in relation to the area involved and the flooring to be applied (see also **6.5.2** and **8.4**) and likely future movement.

Fine cracks are not normally detrimental to any applied flooring and do not need filling: wider cracks can need filling or other remedial work.

8.9 Determination of constituent material proportions of a failed or suspect levelling screed

When it is necessary to determine the constituent material proportions of a hardened levelling screed this should be done by the method given in BS 4551-2.

Attention is drawn to the warnings given in BS 4551-2 that, where samples of the cement and aggregate used are not available, the analysis of the screed can lead to inaccurate assessment of the constituent material proportions and the use of assumed data can give results that could be at variance with the true constituent material proportions.

NOTE For guidance, traditional volume proportions of cement:sand of 1:3, 1:4 and 1:5, would have percentage cement by mass of original dry material of 20.5-25.0, 16.0-20.0 and 13.0-15.5 respectively.

Annex A (normative)
Recommendations for the use of lightweight aggregates in concrete bases and levelling screeds

NOTE This annex gives recommendations for the use of lightweight aggregate concrete bases and levelling screeds where they differ from those for the use of normal weight aggregates.

A.1 Aggregates (see 5.3)

Aggregates for lightweight concrete bases should be a combination of coarse aggregate conforming to BS EN 13055-1 and sand conforming to BS EN 12620 or BS EN 13055-1.

Aggregates for lightweight concrete no-fines basecoats should conform to BS EN 13055-1 and be composed of single sized aggregate in accordance with Table 1 of that standard.

Sand for the cement sand topping should conform to **5.3.4**.

A.2 Base and levelling screed construction (see 6.2)

A lightweight aggregate no-fines levelling screed consists of two layers bonded together, a basecoat and a topping. The basecoat is of no-fines lightweight concrete, which can be bonded to a prepared concrete base slab as in **6.2**b), or unbonded or floating as in **6.2**c).

The no-fines concrete results in an open textured surface; a cement sand topping is generally applied within 24 h of laying the basecoat to provide a surface suitable for the types of flooring.

A.3 Direct finished base slabs (see 6.3.2)

A smooth finish can be obtained, after the initial set has resulted in a stiffer concrete, by either hand or power floating. With normal techniques of vibration and levelling a "pimpling" effect can appear due to the prominence of the coarse aggregate particles. The rounded shape of the coarse aggregate and its lower density in relation to the other constituents can lead to problems in obtaining an acceptable finish to the concrete: using sand conforming to BS EN 12620 can assist in achieving a smooth finish.

A.4 Bonding (see 6.4.2)

It is usual with lightweight aggregate levelling screeds for the no-fines basecoat to be topped with a cement sand topping in accordance with **7.5.1** and **7.5.2**.

Adequate bond can be achieved if the topping is applied within 18 h to 24 h of laying the basecoat. If a delay occurs, a neat cement grout should be applied to the basecoat as described in **7.4.3** before laying the topping.

A.5 Thickness (see 6.4.3)

The thickness of the cement sand topping on the basecoat should be between 15 mm and 20 mm. The overall thicknesses of the levelling screeds should be as follows.

a) *Bonded screed*. When laid on and bonded to a set and hardened base prepared as described in 7.4.2, the minimum thickness of the levelling screed at any point should be 40 mm (25 mm basecoat and 15 mm topping). The treatment of the base described in **7.4.3** is not required when the lightweight aggregate screed is more than 65 mm thick.

b) *Unbonded screed*. The minimum thickness of the levelling screed at any point should be 65 mm (50 mm basecoat and 15 mm topping).

c) *Floating screed*. The minimum thickness depends on the type of lightweight aggregate and the compressibility of the insulation material. Guidance on the thickness should be sought from the supplier of the aggregate.

A.6 Location of services (see 6.4.5)

When pipes and conduits are laid within the thickness of the basecoat they should be firmly anchored in position and the material well compacted around and over them to a minimum thickness of 50 mm above the pipes. Where, for example, services cross one another and/or 50 mm cover cannot be achieved, a cement sand haunching should be well compacted around and over them to a minimum depth of 25 mm.

A.7 Heated levelling screeds (see 6.4.6)

Underfloor heating systems should not be installed in or below lightweight aggregate basecoats. A system incorporated in the topping should be covered by at least 25 mm of material.

A.8 Bay sizes (see 6.5)

There is generally no need to lay a basecoat in bays as no-fines concrete has a low drying shrinkage. Where large areas of topping are laid in one operation the recommendations in 6.5.3 apply.

A.9 In situ crushing resistance (see 6.7)

No-fines lightweight aggregate concrete levelling screeds are generally used where category B or C in situ crushing resistance is required. In order to achieve category A, particular attention should be given to the thickness of the cement sand topping and possibly to the incorporation of a polymer admixture. A trial area could be laid to verify the proposed construction.

A.10 Screed proportions, batching and mixing (see 7.5)

For all lightweight aggregate screeds the proportions should be based on advice from the lightweight aggregate manufacturer. Most applications using no-fines concrete as the basecoat are adequately met by constituent material proportions of cement to lightweight aggregate within the range 1:6 to 1:10 by volume.

The cement sand topping should be proportioned as detailed in 7.5.2.

If lightweight aggregates are batched by mass, due allowance should be made for any moisture contained within the aggregate.

A.11 Method of mixing (see 7.5.7)

A forced action mechanical mixer should be used for best results, although acceptable mixing by other machine or by hand can be achieved.

The initial absorption of the aggregate should be met by adding water while mixing until all the particles of aggregate have a sheen. Cement should then be added and thoroughly mixed in. Water should then be added in small amounts until each particle of aggregate is covered with a shiny grey cement grout.

It is important to ensure that the water content is carefully controlled. If there is not enough water the particles of aggregate have a dull grey fluffy appearance resulting in little or no bond. If there is excess water the colour of the aggregate can show through the shiny grey film due to an inadequate coating of cement grout, which drains to the base of the levelling screed when laid and leaves the upper part of the basecoat deficient in cement.

A.12 Pumping the screed material (see 7.6)

When standard pneumatic placers are used to transport no-fines concrete over long horizontal runs, humps should be provided in the discharge line. This is to form plugs of screed material, which maintain pressure in the system. Otherwise the air can pass over the screed material without forcing it along the discharge line.

A.13 Laying the levelling screed (see 7.8)

After the no-fines basecoat material has been spread out it should be compacted by hand tamping to the required level or fall to 15 mm to 20 mm below the finished level. Mechanical means should not be used to compact no-fines concrete. The basecoat should then be covered with suitable impermeable sheeting to prevent drying out.

The cement sand topping should be laid after the basecoat has hardened sufficiently to support foot traffic directly or on boards. This is usually between 18 h and 24 h after laying the basecoat. If a delay occurs before laying the topping, a neat cement grout or a proprietary bonding agent should be applied to the set and hardened basecoat as described in 7.4.3.

Annex B (informative)
Guidance for specifying sands for cement sand levelling screeds: comparison of the grading and fines content of aggregates in BS EN 13139 with established UK practice

Compared to the sands specified in BS 882, a BS EN 13139 0/4 fine aggregate with fines category 1 has fewer coarser particles. Table B.1 compares BS EN 13139 designations with sands in current use in the UK. The use of gradings from BS 1199 had already been discarded in the UK in favour of the gradings for C and M of BS 882 shown in Table B.2. However, in practice the coarse end of grade C is too coarse for a levelling screed to be laid "semi-dry". Mixes tend to have poor workability, particularly if the sand has irregular shaped particles. The limits on the percentage passing the 0.5 mm sieve in BS EN 13139 are narrower when compared with the UK limits specified in BS 882. However, in the UK, the limits for Type M sand specified in BS 882 have allowed too much fine material.

NOTE BS 882 and BS 1199 will be withdrawn on 31 May 2004.

Taking account of these issues it is recommended that the nearest grading for UK levelling screeds in a BS EN 13139 is a 0/4 fine aggregate with fines category 1 with the range *MP*, which should ideally have a grading between 20 % to 66 % passing a 0.5 mm sieve.

For fine concrete levelling screeds over 50 mm thick, a typical mix with a ratio of 1:3:1 of CEM I 42,5 cement: BS 882 C or M sand: 10 mm single size BS 882 coarse aggregate, is often used in the UK. There can be some use for a BS EN 13139 0/8 aggregate to achieve this type of mix. For the 0/8 designation, the amount of material greater than 1.4*D* is limited to 0 % to 2 %. Specifiers and users of the 0/8 designation for levelling screeds are recommended to consider the grading they require for this type of mix in terms of limiting the percentage passing two additional sieve sizes, 2.0 mm and 0.5 mm, to no more than 25 %.

BS 8204-1:2002 recommends that the sand used for levelling screeds falls within the new grading limits given in BS 8204-1:2002, **5.3.4** and Table 1. The use of gradings C or M of BS 882 are not recommended in BS 8204-1:2002.

The effect of this change in recommendations, compared to that previously recommended, i.e. grading M of BS 882, is given in Table B.2. In practice, it can be seen that the same recommendation is relevant for the nearest BS EN 13139 designation which is a 0/4 fine aggregate of fines category 1 with the range *MP*, having a grading between 20 % and 66 % passing 0.5 mm sieve.

Table B.2 gives a comparison of BS EN 13139 with established UK grading and fines content limits for sands used in levelling screeds.

Guidance on the description and grading of sands that produce suitable screed products is shown in Table B.1.

Table B.1 — Sand descriptions and recommended European designations

Screed type	British Standard equivalent	Recommended designation in BS EN 13139
Levelling screed[a]	BS 882, finer range of Type *C* or coarser range of Type *M*	0/4 (*CP* or *MP*), category 1 fines
Levelling screed >50 mm[b]	1:3:1 parts of CEM I 42,5 cement: fine aggregate (C or M): 10 mm *SS*	0/8 (*CP* or *MP*), category 1 fines
BS 8204:2002 levelling screed[c]	BS 8204-1:2002, Table 1	0/4 (*CP* or *MP*), category 1 fines

NOTE Aggregates for levelling screeds have performed satisfactorily when the percentage passing the 0.5 mm sieve is of the order indicated below for the levelling screed types [a], [b] and [c] identified in this table:

[a] (20–80) %;

[b] ≥25 %;

[c] (20–86) %.

BS EN 13139 only provides the three following classifications for the percentage passing the 0.5 mm sieve:

CP (5–45) %;

MP (30–70) %;

FP (55–100) %.

Accordingly, users and specifiers need to assess the suitability of the sand from the declared typical grading and tolerances of the sand.

Table B.2 — Comparison of the grading and fines content limits of aggregates in BS EN 13139 with established UK practice (% passing by mass)

Sieve aperture mm		Levelling screeds				
		BS EN 13139 designation		BS 882		BS 8204-1:2002
European	UK	0/8	0/4	C	M	—
16.00		100	—	—	—	—
10.00	10.0	98 to 100	—	100	100	100
8.00		90 to 99 (±5)	100	{96 to 100}	{96 to 100}	{96 to 100}
5.6	5.6	—	95 to 100	—	—	—
	5.0	—	—	89 to 100	89 to 100	90 to 100
4.00		—	85 to 99 (±5)	80 to 100}	{82 to 100}	{82 to 99}
	2.36	—	—	60 to 100	65 to 100	65 to 97
	1.18	—	—	30 to 90	45 to 100	40 to 90
1.00		(±10)	(±20)	—	—	—
	0.6	—	—	15 to 54	25 to 80	24 to 75
0.5		5 to 45 (*CP*)	5 to 45 (*CP*)	{12 to 50}	20 to 71}	{20 to 66}
		30 to 70 (*MP*)	30 to 70 (*MP*)	{12 to 50}	{20 to 71}	{20 to 66}
	0.3	—	—	5 to 40	5 to 48	8 to 40
0.25		—	(±20)	—	—	—
	0.15	—	—	0 to 15	0 to 15	0 to 10
	0.075	—	—	0 to 4	0 to 4	0 to 3
0.063		0 to 3 category 1 (±2)	0 to 3 category 1 (±3)	{0 to 3}	{0 to 3}	0 to 2}

NOTE 1 *FP*, *MP*, *CP* come from the permitted percentage passing the 0.5 mm sieve as defined in BS EN 13139:2002, Annex A (informative): *F* = fine grading, *M* = medium grading, *C* = coarse grading, *P* = % passing 0.5 mm sieve.

NOTE 2 { } = Interpolation of equivalent grading limits from UK specifications.

NOTE 3 ( ) = Required BS EN 13139 tolerances on producer's declared typical gradings.

Annex C (normative)
Methods for the assessment of levels and surface regularity

C.1 The following methods should be used to assess deviations of levels and surface regularity.

C.2 Where the straight-edge basis for specification is used it is advisable for the various interested parties in a contract to agree the sampling rate for testing the concrete base or cement sand levelling screed to check conformity, and the procedures to adopt if conformity is not achieved, before the concrete base or cement sand levelling screed is constructed. Such agreement should include the number of positions where the straight edge will be placed to check conformity.

C.3 Check deviation of levels from datum using standard surveying methods.

C.4 Check surface regularity by using a straightedge 2 m long laid in contact with the floor surface and resting under its own weight. Measure the deviations of the floor surface from the underside of the straightedge, between the points which are in contact with the floor surface, by means of a slip gauge or other suitable accurate measuring device. A suitable form of slip gauge is shown in Figure C.1.

NOTE The number of measurements required to check levels and surface regularity should be agreed between the parties concerned bearing in mind the standard required and the likely time and costs involved.

Dimensions in millimetres

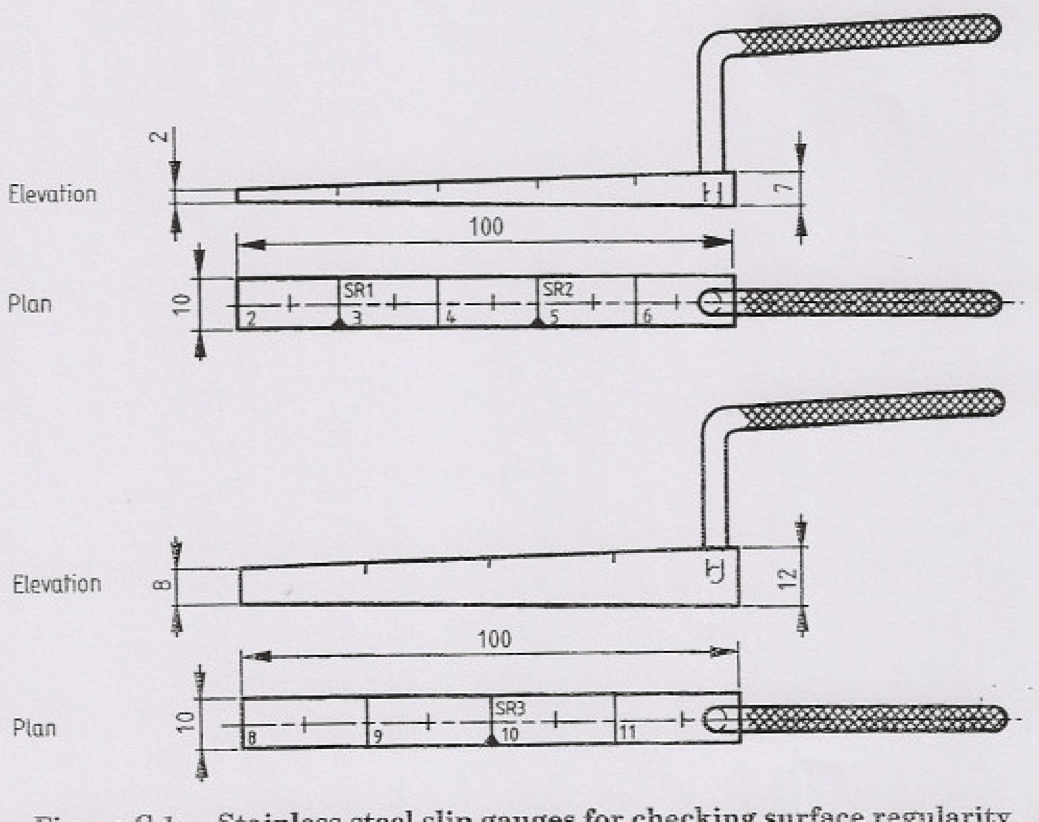


Figure C.1 — Stainless steel slip gauges for checking surface regularity

Annex D (normative)
Method for the determination of in situ crushing resistance of bonded and unbonded levelling screeds

NOTE For floating screeds see Annex E.

D.1 Principle

The screed is subjected to repeat impact blows by dropping a weight vertically down a guide onto a hardened steel anvil in contact with the screed surface. The depth of the indentation from the resulting impact after four blows is measured.

D.2 Apparatus

D.2.1 *BRE screed tester*, of the form shown in Figure D.1. It consists essentially of a cylindrical guide rod along which an annular weight of mass (4.00 ± 0.01) kg travels vertically through a distance of (1 000.0 ± 0.5) mm after its release by pressing a lever. At the end of its travel the weight strikes the case-hardened anvil, which has its cylindrical face of (25.23 ± 0.05) mm diameter in contact with the screed and thereby transmits the required impact to the screed.

D.2.2 *Depth measuring device*, for measuring the depth of the indentation in the screed surface, capable of reading depths from 0 mm to 10 mm to an accuracy of ±0.1 mm.

D.3 Sampling

The method of sampling will vary depending upon the size and shape of the floor area and the nature of any base, such as positions of joints.

Carry out not less than three tests in areas less than 20 m^2 and on each 20 m^2 to 25 m^2 of screed laid in larger areas. Test corridors at 3 m to 5 m intervals. Select the positions at which tests are made at random, but include areas vulnerable to traffic damage such as doorways. Avoid testing within 300 mm of joints and cracks as the test can cause further cracking. When test indentations in excess of those given in Table 4 are measured, carry out additional tests to ascertain the area of non-conformity.

NOTE For detailed guidance on the sampling and testing of screeds for in situ crushing resistance using the screed tester and interpretation of test results see [10] and [1].

D.4 Procedure

Select a reasonably flat, smooth area of screed and ensure that it is free from all loose dirt and grit. Locate the anvil of the screed tester at the test position in contact with the screed. With the guide rod held vertically, deliver four successive blows of the test weight to the anvil at the same position on the screed, dropping each time freely from the trigger point. After the fourth blow, measure the depth of the final indentation in the screed with the depth measuring device.

NOTE When carrying out this procedure on a slope (which should not exceed 1 in 12) the guide rod should be held vertically. The average indentation should be recorded.

D.5 Expression of results

Record the measured indentations on a plan of the floor area and compare with the relevant limit shown in Table 4.

Annex E (normative)
Determination of in situ crushing resistance of floating levelling screeds

E.1 Principle

The screed is subjected to repeat impact blows by dropping a weight vertically down a guide on to a hardened steel anvil in contact with the screed surface. The depth of the indentation from the resulting impact after four blows is measured.

E.2 Apparatus

E.2.1 *BRE screed tester*, of the form shown in **Figure D.1**. It consists essentially of a cylindrical guide rod along which an annular weight falls vertically through a distance of (1 000.0 ± 0.5) mm after its release by pressing a lever. At the end of its travel the weight strikes the collar of a hardened anvil, which has its cylindrical face of (25.23 ± 0.05) mm diameter in contact with the screed and thereby transmits the required impact to the screed.

For categories A and B screeds the mass of the weight is (4.00 ± 0.01) kg.

For category C screeds the mass of the weight is (2.00 ± 0.01) kg.

E.2.2 *Depth measuring device*, for measuring the depth of the indentation in the screed surface, capable of reading depths from 0 mm to an accuracy of ±0.1 mm.

E.3 Sampling

The method of sampling will vary depending upon the size and shape of the floor area and the layout of any base.

Carry out not less than three tests in areas less than 20 m^2 and three tests on each 20 m^2 to 25 m^2 of screed laid in larger areas. Test corridors at 3 m to 5 m intervals. Select the positions at which tests are made at random but avoid carrying out tests within 300 mm of bay joints and cracks as the test can cause further cracking. When test indentations in excess of those given in Table 4 are measured, carry out additional tests to ascertain the area of non-conformity.

E.4 Procedure

E.4.1 Select a reasonably flat, smooth area of screed that is free from all loose dirt and grit. Locate the anvil of the screed tester at the test position in contact with the screed. For floating screeds designed as categories A or B use a 4 kg weight; for category C use a 2 kg weight. With the guide rod held vertically, deliver four successive blows to the anvil at the same position on the screed, allowing the weight to drop freely from the trigger point. After the fourth blow, measure the depth of the final indentation in the screed with the depth measuring device.

NOTE When carrying out this procedure on a slope (which should not exceed 1 in 12) the guide rod should be held vertically. The average indentation should be recorded.

E.4.2 If a fracture occurs during the test, record it as the test result (see **E.5.1**). A fracture leads to a truncated cone of material, which can be knocked out from the underside of the screed. A fracture of the screed can be determined by the change in note produced when the weight hits the anvil. Normally a ring will be heard. This changes to a dull thud when a fracture occurs. It is usually accompanied by a sudden increase in the depth of the indentation.

Dimensions in millimetres

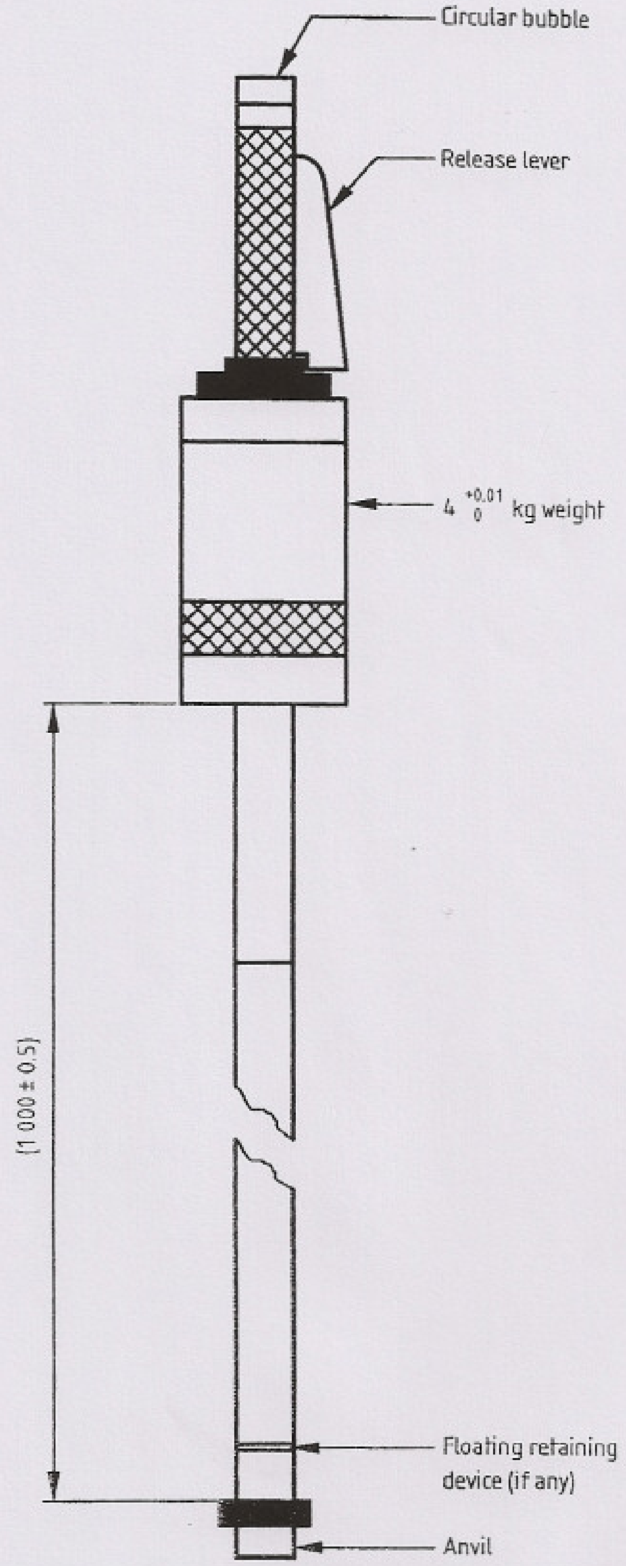


Figure D.1 — BRE screed tester

E.5 Results

E.5.1 *Expression of results*

Record on a plan of the floor the depth of the measured indentations, together with any fractures and the number of the drop on which they occurred.

E.5.2 *Interpretation of results*

Compare the results with the relevant limit shown in Table 4. Any portion of the screed where the depth of indentation does not exceed the relevant acceptance limit should be considered satisfactory.

If a truncated cone fracture was recorded during the first three drops the screed is to be considered unsatisfactory. If the fracture occurs on the fourth drop and the indentation is within the appropriate limit given in Table 4 then the screed is satisfactory.

Any portion of the screed where the depth of indentation is greater than the relevant limit should not necessarily be rejected. Such screeds should be assessed by other means to ascertain whether they are fit for purpose. This can require the removal of samples for the determination of cement content, strength, thickness, etc.

The BRE screed test can be unsuitable for assessing floating screeds thinner than the recommended 75 mm for categories A and B and 65 mm for category C. However, if a floating screed is laid thinner than that recommended and it passes the test then it can be considered satisfactory.

NOTE Floating screeds which fail this test can be more severely damaged during the test than the equivalent bonded or unbonded screeds. The test can crack floating screeds that are thinner than those recommended in this standard.

Annex F (normative)
Curing recommendations for different cement types

Traditionally, cementitious levelling and wearing screeds were produced from ordinary Portland cement of a single strength class (now called CEM I 42,5 N, 42,5 R or 52,5 N). In recent years a greater variety of cement and combinations have become available in a number of strength classes. The decision to use a cement other than CEM I 42,5 N, 42,5 R or 52,5 N can be made for a number of reasons:

a) to achieve special properties in the concrete base, directly finished base slab or screed;

b) to achieve cost savings;

c) to use materials with a lower environmental impact;

d) availability.

In order to obtain a concrete base, directly finished base slab or screed that will be satisfactory in service, the placing of the concrete or screed material should be followed by curing in a suitable environment during the early stages of strength development. Curing is the process of preventing the loss of moisture from the hardening concrete or screed while maintaining a satisfactory temperature regime. Concrete and screeds made from cements or combinations that develop strength more slowly will require curing for a longer period to ensure that the concrete or screed develops the desired properties. This is especially important during cold weather.

Cements and combinations that develop strength at a reduced rate compared to CEM I 42,5 N and therefore require an extended period of curing include:

a) Portland-slag cements;

b) Portland-fly ash cements;

c) Portland-limestone cements;

d) cements and combinations of strength class 32,5 N.

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

BS 5325, *Installation of textile floor coverings — Code of practice.*

BS 5385 (all parts), *Wall and floor tiling.*

BS 5606, *Guide to accuracy in building.*

BS 6700, *Specification for design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilages.*

BS 8201, *Code of practice for flooring of timber, timber products and wood based panel products.*

BS 8203, *Code of practice for installation of resilient floor coverings.*

BS 8204 (all parts), *Screeds, bases and in situ floorings.*

BS 8425, *Code of practice for installation of laminate floor coverings.*

BS EN 1008, *Mixing water for concrete — Specification for sampling, testing and assessing the suitability of water, including water recovered from processes in the concrete industry, as mixing water for concrete.*

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2) Obtainable from the Concrete Society, Century House, Telford Avenue, Crowthorne, Berks RG45 6YS.
3) Obtainable from the British Cement Association, Century House, Telford Avenue, Crowthorne, Berks RG45 6YS.
4) Obtainable from The Stationery Office.