

Concrete for industrial floors

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INTRODUCTION

This publication gives guidance on the specification of concrete for industrial floors. Where appropriate reference is made to BS EN 206–1, specialist publications and BS 8204–2, *Screeds, bases and in-situ floorings. Part 2: Concrete wearing surfaces - Code of practice* (see paragraph below). The detail of what to specify and certain rules of application are not given in BS EN 206–1 but in a complementary British Standard, BS 8500. To help practitioners, a derived document, *Standards for fresh concrete*, has been produced that contains the text of both standards woven together plus guidance on use.

A European Standard, BS EN 13318–2, *Screed materials and floor screeds. Part 2: Screed materials - Properties and requirements* is currently under preparation. The sections of BS 8204–2 that deal with materials, specification and testing will be superseded by this European Standard. As a consequence, it is likely that abrasion resistance categories and composition limitations for concrete will change.

SPECIFICATION

Concrete for floors is normally specified as designed concrete with special mix limitations. However, designated, prescribed or specially designed proprietary concrete may also be specified.

Designed and designated concretes have a performance requirement for strength.

The use of prescribed concrete for flooring applications is not usual and consequently this publication covers only designed and designated concretes.

For a designed concrete, specify that the concrete shall be produced in accordance with the relevant clauses of BS EN 206–1/BS 8500 and also specify the following:

- compressive strength class;
- exposure class or limiting values for concrete composition related to durability and abrasion

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British Cement Association
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Building Research Establishment
Cement Admixtures Association
Cementitious Slag Makers Association
Concrete Industry Alliance
Concrete Society
Glanville Consultants
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Ove Arup & Partners
Quarry Products Association
Ready-mixed Concrete Bureau
RMC Readymix Ltd
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United Kingdom Quality Ash Association

A full list of the publications in this series is given on the back page.

resistance. Note. In some cases it may not be necessary to specify a maximum w/c ratio;

- nominal upper aggregate size;
- requirements for aggregates including physical and mechanical characteristics;
- type and quantity of fibres, if required;
- chloride content class;
- consistence class;
- permitted cement types;
- permitted admixtures.

It may be necessary to specify additional requirements where specifying concrete for floors. (See *Standards for fresh concrete* or 6.2.3 of BS EN 206–1: 2000.)

The requirements in the specification for concrete to be used in floors are normally determined by the service conditions (abrasion resistance, surface finish and flatness), method of construction and any requirements related to the method of finishing. Consult the reference documents :

- BS 8204– 2, *In-situ floorings. Part 2: Code of practice for concrete wearing surfaces.* The reader should also refer to the comment in the introduction to this publication regarding the pending European Standard.
- The Concrete Society Technical Report No. 34 *Concrete industrial ground floors - A guide to their design and construction.*
- The Concrete Society's *Good concrete guide 1, Guidance on specification, mix design and production of concrete for industrial floors.*

EXPOSURE CLASSIFICATION

BS EN 206–1 defines a set of exposure classes related to different forms of deterioration. However, this classification does not include classes of abrasion resistance and consequently for floor construction consult specialist documents and Table 4 of BS 8204–2: 1999.

Table 1 gives classes of abrasion resistance for industrial floors based upon service conditions and application in accordance with BS 8204–2. However, these categories may change when this standard is replaced by the European Standard.

In addition to abrasion, other exposure conditions may also apply. Select all relevant exposures from BS 8500.

The end use and trafficking levels will generally influence requirements for durability. These restrictions are likely to be more onerous than those specified for resisting other exposure conditions. As a result, abrasion resistance or structural performance to resist the design loading may control the specification of the concrete for flooring.

COMPRESSIVE STRENGTH CLASS

A concrete strength of C40 was frequently specified for direct finish floors to category AR3 abrasion resistance, but its equivalent is not cited in Table 7 of BS EN 206–1: 2000. The intermediate class, C32/40, may be specified or the slightly lower strength class C30/37, subject to it satisfying structural design requirements in conjunction with composition restrictions to achieve resistance to surface abrasion.

LIMITING VALUES FOR CONCRETE COMPOSITION

Firstly select from Table 2 the appropriate requirements for the flooring application. Then check the limiting values of concrete composition given in BS 8500 for any other applicable exposure class. Select and specify the most onerous values.

There are some additional requirements for specifying concrete for floors. For example, it may be necessary to specify (or at least approve) limits on the sand content as a proportion of the total aggregate in the mix and to specify the overall grading of the aggregate. Additionally some types of aggregate are unsuitable for directly finished concrete. For further guidance on specification refer to Concrete Society publications CSTR 34 and *Good concrete guide 1*.

NOMINAL UPPER AGGREGATE SIZE

For in-situ floor slabs the preferred upper aggregate size has generally been 20 mm. Flooring contractors have found 40 mm upper aggregate size concrete more difficult to compact and level whilst the use of 10 mm aggregate will result in a cost penalty due to the higher cement content necessary to meet the maximum water/cement ratio and strength specification.

Table 1: Classification of abrasion resistance for directly finished wearing surfaces

Class	Service Conditions	Typical applications
Special / DF	Severe abrasion and impact from steel or hard plastic-wheeled traffic or scoring by dragged metal objects	Very heavy duty engineering workshops and very intensively used warehouses, etc.
AR1 / DF	Very high abrasion; steel or hard plastic-wheeled traffic and impact	Heavy duty industrial workshops, intensively used warehouses, etc.
AR2 / DF	High abrasion; steel or hard plastic-wheeled traffic	Medium duty industrial and commercial
AR3 / DF	Moderate abrasion; rubber tyred traffic	Light duty industrial and commercial.

Table 2: Concrete requirements for directly finished wearing surfaces based on BS 8204–2

Class	Concrete strength class (designated concrete)	Minimum cement content ^{1), 2)} , kg/m ³
Special / DF	Specially designed proprietary concrete	Refer to BS 8204–2
AR1 / DF	Specially designed proprietary concrete	Refer to BS 8204–2
AR2 / DF	C40/50, (RC 50)	400
AR3 / DF	C30/37 or C32/40, (RC 40)	325
NOTES		
1) BS 8204–2 has no recommendations for maximum w/c ratio. This is limited indirectly by the strength class requirement.		
2) See BS 8204–2 for recommendations with respect to constituent materials		

In order to specify suitable aggregates, certain other factors may also require specification. These are 10% fines value, flakiness index, drying shrinkage value and impurities. Guidance is given in the *Good concrete guide 1* and Annex A of BS 8500–1: 2000.

SPECIFYING FIBRES

Both steel and polypropylene fibres are frequently specified for ground-supported floor slabs. Further information on steel fibres is given in the Concrete Society/ACIFC publication *Steel fibre reinforced concrete industrial ground floors – an introductory guide*. Polypropylene fibres are used mainly to reduce bleeding and minimise plastic cracking.

Steel fibres should be specified as follows:

- type – hooked end wire, split sheet etc.;
- length – in millimetres;
- aspect ratio – length / diameter;
- addition rate – kilograms per cubic metre.

Polypropylene fibres should be specified as follows:

- type – e.g. mono-filament or fibrillated;
- length – in millimetres;
- addition rate – kilograms per cubic metre.

CHLORIDE CONTENT CLASS

As steel mesh and steel fibres are frequently specified and many plain concrete floors will be constructed using dowel bars to transfer loads across joints, the majority of concrete specifications should contain the requirement for a chloride class of Cl 0,40.

CONSISTENCE CLASS

Specify a consistence class or target value appropriate for the intended method of placement and construction. Guidance on suitable classes for different floor construction and placing methods is given in *Good concrete guide 1*.

PERMITTED CEMENT TYPES

In most circumstances, the specification should permit all the cements and combinations listed in Table 3.

Generally the cements and combinations shown in Table 3 have been used successfully for floor construction. Specific guidance is given in *Good concrete guide 1*.

PERMITTED ADMIXTURES

Specify that admixtures should conform to BS EN 934–2, *Admixtures for concrete, mortar and grout. Part 2: Concrete admixtures - definitions and requirements* but note the following. Where the producer selects admixtures to modify the properties of concrete, for example to increase workability or reduce the free water cement ratio, care is required to ensure the required effect is achieved without any detrimental side effects.

Table 3: Recommended cements and combinations for normal flooring applications

Cement/combination type	Notation
Portland cement	CEM I
Portland-slag cement	CEM II/A-S CEM II/B-S P/L
Portland-silica fume cement	CEM II/A-D
Portland-fly ash cement	CEM II/A-V CEM II/B-V P/LPFA P/PFA ¹⁾
Blastfurnace cement	CEM III/A ²⁾ P/B ²⁾
NOTES 1) With a maximum of 35% pfa for direct finish floors. 2) With a maximum of 50% ggbs for direct finish floors.	

Where floors are to be power trowelled, it is essential that the admixture dose is accurately measured and that the admixture is uniformly mixed in the concrete. Uniform dispersion is difficult with site addition of admixtures to the concrete in a truckmixer. If these precautions are not

taken, variation in setting may occur. For further guidance see *Good concrete guide 1* and seek specialist advice from the admixture suppliers.

EXCHANGE OF INFORMATION

The current methods of floor construction may necessitate additional requirements for concrete specification and supply. A discussion between the user and producer will help to ensure that the concrete supplied has the optimum performance characteristics within the limits of the specification, and it will minimise any misunderstandings.

Before placing large volumes of flooring concrete, information should be requested about the concrete to be supplied, the sources of materials, back-up facilities and the status of quality assurance of the constituent materials and the concrete supplying plant.

By prior agreement, information can be supplied during the period of delivery on changes to the sources of supply of constituent materials and changes to the status of quality assurance. This may be critical where large area floors are under construction as any change to constituent sources may materially affect the properties of the concrete. However, the producer is not permitted to make any changes to the mix proportions that override any specification requirement, e.g. a maximum water/cement ratio.

CONFORMITY

The factory production control system in European product standards requires the producer to demonstrate conformity. This philosophy is in BS EN 206–1 and it is a fundamental difference from previous UK standards for concrete. The reader should refer to the section on conformity in another publication in this series, *Concrete for normal uses*.

FURTHER READING

The other publications from this series will be helpful. Visit www.cementindustry.co.uk and click ‘information’/‘library’/‘BCA publications’ to check availability and for free download.

Standards for fresh concrete – a composite of BS EN 206-1 and BS 8500

Specifying concrete to BS EN 206–1/BS 8500:

Concrete for normal uses
Concrete resistant to chemical attack
Guide to the selection of concrete quality and cover for reinforcement for normal concrete structures
Examples of the specification of designated concrete
Examples of the specification of designed concrete
Guidance on additional requirements for designed concrete
Lightweight concrete
Visual concrete
Coloured concrete
Concrete for industrial floors

Specifying constituent materials for concrete to BS EN 206-1/BS 8500:

Cements
Additions
Admixtures

European replacements for British Standards: Concrete and its constituent materials

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