BRITISH STANDARD

BS EN
1766:2000

Products and systems for the protection and repair of concrete structures — Test methods — Reference concretes for testing

The European Standard EN 1766:2000 has the status of a British Standard

ICS 91.100.30

National foreword

This British Standard is the official English language version of EN 1766:2000.

The UK participation in its preparation was entrusted by Technical Committee B/517, Concrete, to Subcommittee B/517/8, Repair and protection of concrete, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this subcommittee can be obtained on request to its secretary.

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Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 12, an inside back cover and a back cover.

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English version

Products and systems for the protection and repair of concrete structures – Test methods – Reference concretes for testing

Produits et systèmes pour la protection et la réparation des structures en béton – Méthodes d'essais – Bétons de référence pour essais

Produkte und Systme für den Schutz und die Instandsetzung von Betontragwerken – Prüfverfahren – Referenzbetone für Prüfungen

This European Standard was approved by CEN on 30 July 1999.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Central Secretariat: rue de Stassart, 36 B-1050 Brussels

Ref. No. EN 1766:2000 E

Contents

Foreword

This European Standard has been prepared by Technical Committee CEN/TC 104, Concrete (performance, production, placing and compliance criteria), the Secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by July 2000, and conflicting national standards shall be withdrawn at the latest by December 2002.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

This European Standard describes a method for making consistent reference concrete test specimens with a reproducible surface texture. Specifications for the products and systems for the repair and the protection of concrete structures will be subject of separate standards.

For the time being, five types of reference concrete are needed. With further experience of test methods, it is anticipated that they can be modified and that the number of reference concretes will be reduced.

1 Scope

This European Standard specifies the composition, characteristics and preparation procedure for reference concrete substrates which are to be used in the test methods to measure performance requirements of products and systems for the repair and protection of concrete structures.

The provisions of this standard are applicable to concrete with a maximum aggregate size of 16 mm or 20 mm or with a maximum aggregate size of 8 mm or 10 mm.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

ENV 197-1, *Cement - Composition, specifications and conformity criteria - Part 1: Common cements.*

prEN 206, *Concrete - Performance, production and conformity.*

EN 933-2, *Tests for geometrical properties of aggregates – Part 2: Determination of particle size distribution – Test sieves, nominal size of apertures.*

EN 934-2, *Admixtures for concrete, mortar and grout – Part 2: Concrete admixtures - Definitions, specifications and requirements.*

prEN 1008, *Mixing water for concrete – Specification for sampling, testing and assessing the suitability of water, including wash water from recycling in installations in the concrete industry, as mixing water for concrete.*

EN 1542, *Products and systems for the protection and repair of concrete structures - Test methods – Pull-off test.*

prEN 12390, *Testing concrete - Determination of compressive strength – Specification for compression testing machines.*

3 Principle

Reference concrete test specimens with reproducible surface texture and appropriate strength are cast to enable the physical properties of repair materials to be evaluated.

The required surface roughness is obtained by grit blasting the surface of the hardened concrete.

4 Equipment

4.1 Concrete mixer (forced action pan mixer)

4.2 Moulds

Moulds for producing concrete specimens, of non-absorbent, rigid material, not attacked by cement paste, of a size 300 mm x 300 mm x 100 mm or other sizes specified in individual test method standards, corresponding to the property to be tested, shall be used.

4.3 High frequency vibrating table

Or vibration rod suitable for compaction of the concrete in the moulds.

4.4 Grit-blasting equipment

It shall comply with the following:

4.4.1 Air pressure approximately 0,5 MPa.

4.4.2 Nozzle diameter 8 mm to 12 mm.

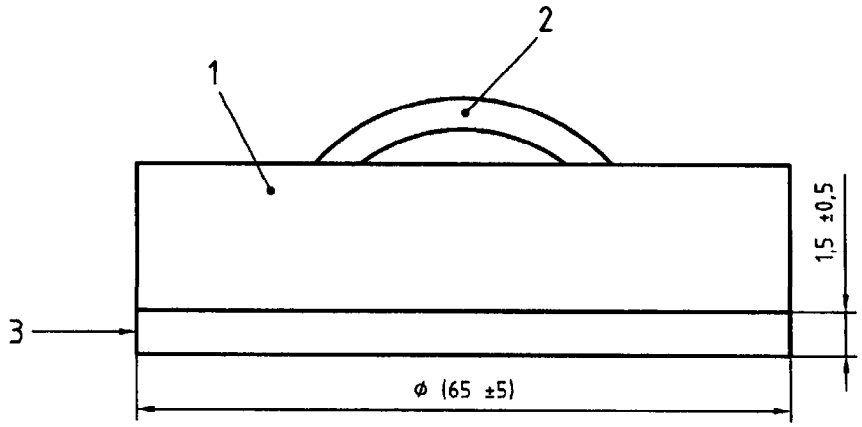
4.4.3 The spread angle of the nozzle shall be sufficient to prevent the jet from cutting deeply into the concrete surface. This shall be demonstrated by preliminary test.

NOTE As an alternative, high pressure water-blasting equipment, capable of operating with or without the addition of grit, can be used subject to preliminary tests to confirm that the required surface texture can be achieved.

4.5 Surface roughness measuring equipment

4.5.1 Measuring cylinder, of (25 ± 1) ml total capacity and 20 mm maximum internal diameter.

4.5.2 Disc, comprising a flat wooden disc (65 ± 5) mm in diameter with a hard rubber disc of the same diameter (1,5 ± 0,5) mm thick stuck to one face, the reverse face being provided with a handle (see Figure 1).



Legend

1 Wooden disk
2 Handle
3 Rubber disk

Figure 1 — Disk for surface roughness measurement

5 Materials

5.1 Aggregates

Aggregates shall be natural and silica-based with low water absorption (less than 2 % by mass). The aggregate grading, measured according to EN 933-2, shall conform to the maximum sizes listed below and have an appropriate size distribution in order to obtain the mechanical properties specified for each type, i.e. tensile strength, tensile bond strength and compressive strength. For instance, typical aggregate gradings for this purpose are given in Annex A (informative).

5.2 Mixing water

Water according to prEN 1008 shall be used.

5.3 Cement

Portland type CEM I 42,5 R according to ENV 197-1 shall be used.

5.4 Admixtures

Admixtures according to EN 934-2 shall be used.

5.5 Grit for surface preparation by blasting

Commercial grit for grit-blasting of concrete shall be used, with grain size within the range of 0,25 mm to 1,0 mm. The grit shall not contain ferrous components such as chilled cast iron slag which are prone to rusting.

5.6 Silica sand for measuring roughness

Silica sand with a grain size of 0,05 mm to 0,1 mm, dried to a constant weight, shall be used.

6 Reference concrete mixes

6.1 General

This standard specifies five types of reference concrete, defined by the maximum size of the aggregate and mix proportions. The reference concrete is chosen according to the type of product or system for the protection and repair of concrete structures and to the related test methods standards.

NOTE 1 The water taken into account hereafter in the water/cement ratio is the added water plus the water already contained in the admixtures and the additions.

NOTE 2 Workability should be appropriate to achieve adequate placing of concrete with freedom from bleeding or segregation. Any special requirements for surface finish of placed specimens for particular test methods using reference concrete samples will be stated in those test methods.

Admixtures conforming to EN 934-2 are permitted to give a workable concrete mix to meet the requirements of Table 1, or to confer adequate freeze-thaw resistance by entrainment of air.

NOTE 3 The application of a suitable plasticizer or superplasticizer conforming to EN 934-2 is likely to be required to achieve optimum compaction, as described in 6.4.

6.2 Reference concrete with 16 mm or 20 mm aggregate (see Table 1)

6.2.1 Compositions and properties

6.2.1.1 Type C (0,40)

The mix shall contain 410 kg/m³ cement and have a water/cement ratio of 0,40. Mixes shall have a 28 day mean compressive strength measured according to prEN 12390 of (60 ± 5) N/mm² for cubes and (50 ± 5) N/mm² for cylinders.

6.2.1.2 Type C (0,45)

The mix shall contain 360 kg/m³ cement and have a water/cement ratio of 0,45. Mixes shall have a 28 day mean compressive strength measured according to prEN 12390 of (50 ± 5) N/mm² for cubes and (40 ± 5) N/mm² for cylinders and, when applicable, a tensile strength measured according to EN 1542 of not less than 2,5 N/mm².

6.2.1.3 Type C (0,70)

The mix shall contain 260 kg/m³ cement and a water/cement ratio of 0,70 ± 0,05. Mixes shall have a 28 day mean compressive strength measured according to prEN 12390 of (30 ± 5) N/mm² for cubes and (25 ± 5) N/mm² for cylinders and, when applicable, a tensile strength measured according to EN 1542 of not less than 1,5 N/mm².

6.3 Reference concrete with 8 mm or 10 mm aggregate (see Table 1)

6.3.1 Compositions and properties

6.3.1.1 Type MC (0,40)

The mix shall contain 455 kg/m³ cement and have a water/cement ratio of 0,40.

The reference concrete shall have an average surface tensile strength determined by the pull-off test according to EN 1542 with a minimum value of 3,0 N/mm², but not for any individual result. The pull-off test shall be carried out on the prepared concrete surface immediately before applying the material to be tested, using at least one substrate specimen from each batch of concrete. At least one in every 15 specimens shall be tested.

NOTE The requirements are usually met by a concrete with a compressive strength which satisfies class C 60 for cubes and C 50 for cylinders (C50/60), as specified in prEN 206.

6.3.1.2 Type MC (0,45)

The mix shall contain 395 kg/m³ cement and have a water/cement ration of 0,45.

The reference concrete shall have an average surface tensile strength determined by the pull-off test, according to EN 1542 with a minimum value of 2,5 N/mm², but not for any individual result. The pull-off test shall be carried out on the prepared concrete surface immediately before applying the material to be tested, using at least one substrate specimen from each batch of concrete. At least one in every 15 specimens shall be tested.

NOTE The requirements are usually met by a concrete with a compressive strength which satisfies class C 50 for cubes and C 40 for cylinders (C 40/50), as specified in prEN 206.

Table 1 — Specifications for composition and properties

Concrete type	C(0,40)		C(0,45)		C(0,70)		MC(0,40)		MC(0,45)	
Maximum aggregate size, in mm	20	16	20	16	20	16	10	8	10	8
Water/cement ratio	0,40		0,45		0,70 [a]		0,40		0,45	
Cement content, in kg/m³	410	425	360	375	260	275	455	470	395	410
28 day mean compressive strength[b], in N/mm²										
Cubes	60 ± 5		50 ± 5		30 ± 5					
Cylinder	50 ± 5		40 ± 5		25 ± 5		c		d	
Minimum surface tensile strength[e], in N/mm²							3,0		2,5	

[a] For concrete type C (0,70), the W/C ratio may be allowed to vary by ± 0,05 in order to achieve the required strength.

[b] The compressive strength is measured according to prEN 12390.

[c] The requirements are usually met if the compressive strength of the concrete corresponds to the class C60 for cubes and C50 for cylinders (C 50/60), according to prEN 206.

[d] The requirements are usually met if the compressive strength of the concrete corresponds to the class C50 for cubes and C40 for cylinders (C 50/40), according to prEN 206.

[e] The surface tensile strength is measured according to EN 1542.

6.4 Specimen preparation

The preparation of a reproducible reference concrete shall be done as follows:

— prepare a concrete batch the volume of which shall be of 50 % to 90 % of the mixer capacity;

— pour all dry aggregates into the container of the mixer, add half of the batch water and mix for 2 min;

— carry on the mixing and add the cement and the other half of the batch water containing possible admixtures during the next minute.

The total mixing time shall not be more than 5 min.

The mixed concrete shall be firmly compacted into the moulds using a chosen method to achieve uniform compaction, without segregation or excessive laitance. Any concrete above the upper edge of the mould should be removed using a steel float and the surface levelled flush with the sides of the mould.

6.5 Concrete curing and storage

The concrete specimens shall be cured in the moulds for 24 h after casting at (20 ± 2) °C, either under polyethylene sheeting or at not less than 95 % relative humidity, then demoulded and cured for a further 27 days under water at (20 ± 2) °C.

After the curing period, the specimens shall be either taken for test or stored under normal laboratory conditions of (21 ± 2) °C and (60 ± 10) % relative humidity, until ready for testing.

As required by the manufacturer of the repair product to be assessed, the preparation of the surface of the reference concrete shall be brought to a uniform condition, defined as follows:

a) wet: Immerse for 48 h at (21 ± 2) °C, then remove all surface water by standing upright for 30 min before using tests;

b) dry: Condition for seven days at (21 ± 2) °C and at (60 ± 10) % relative humidity.

7 Surface preparation and roughness index determination

7.1 Surface preparation

The bottom face of the concrete specimens cured and stored according to 6.5 for at least 28 days shall be prepared by grit-blasting using a device as in 4.4 and the grit as in 5.5. The surface roughness shall be defined for the product properties to be tested.

Grit blasting shall be carried out with the specimen horizontal. The grit-blasting nozzle shall be held directly over the specimen surface at a distance of about 0,5 m, and slightly moved to achieve a uniform abrasion of the surface until the required roughness is obtained.

NOTE This is obtained when the tips of the largest aggregates are exposed by a significant amount.

7.2 Measurement of the Roughness index

The roughness shall be measured by the sand patch method. Ensure the surface is clean and dry. Fill the cylinder with 25 ml of the sand and, taking care not to compact the sand by any vibration, strike off the sand level with the top of the cylinder. Pour the sand into a heap on the prepared concrete surface and, keeping the face of the disc flat (see 4.5.2), carefully work the disc in a rotary motion so that the sand is spread into a circular patch, ensuring that all cavities are filled. The procedure is complete when no further distribution of sand outward is achieved. Measure the diameter of the sand patch to the nearest 1 mm at three equally spaced positions around the circumference and calculate the mean diameter, d, to the nearest millimetre. Calculate the roughness index, in millimetres, from the equation:

$$\text{Roughness index} = \frac{31800}{d^2}$$

NOTE Alternatively the volume of measuring cylinder and sand used can be altered, from 25 ml to 5 ml, to suit the area of concrete surface being measured, in which case the roughness index is calculated as follows:

$$\text{Roughness index} = \frac{V}{d^2} \times 1272$$

where

d is the mean diameter of sand patch, in millimetres, expressed to nearest 1 mm;

V is the volume of sand used, in millilitres.

The correspondence between the roughness index and volume of sand used is given in Table 2.

Table 2 — Correspondence between the roughness index and the volume of sand used

V, in ml	Coefficient *C* (*V* x 1272)	Roughness index $\left(\frac{C}{d^2}, \text{in mm}\right)$
5	6 360	$\frac{6\,360}{d^2}$
10	12 720	$\frac{12\,720}{d^2}$
15	19 080	$\frac{19\,080}{d^2}$
20	25 440	$\frac{25\,440}{d^2}$
25	31 800	$\frac{31800}{d^2}$

8 Report

The following information shall be recorded for the reference concrete specimens made from one batch:

a) mix composition (including type of admixtures and additions, if any);

b) date and time of production;

c) origin and particle size distribution of the aggregates;

d) curing and storage conditions (period and surface state);

e) compressive strength (average and minimum value);

f) pull-off strength when required;

g) roughness index;

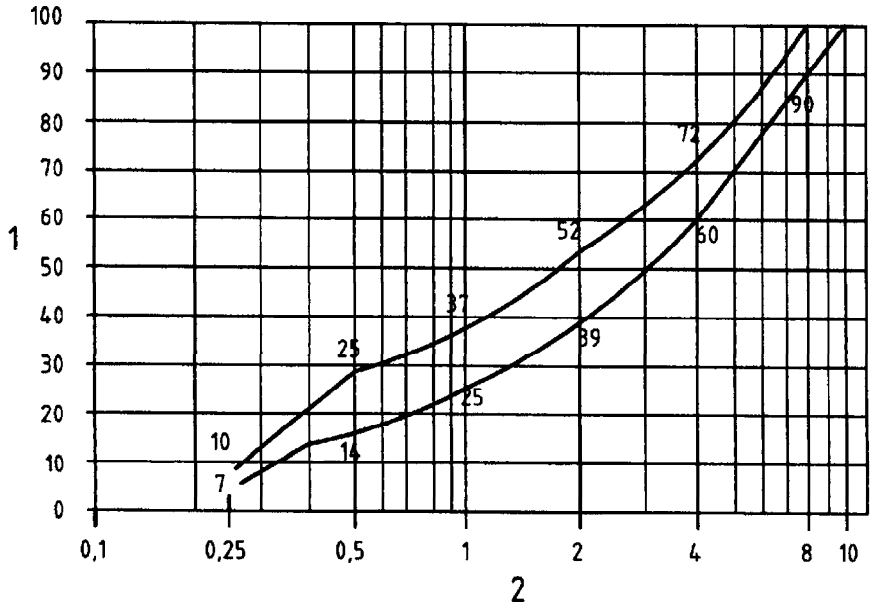
h) reference to this European Standard;

i) any deviation from this standard.

Annex A
(informative)

Grading curves

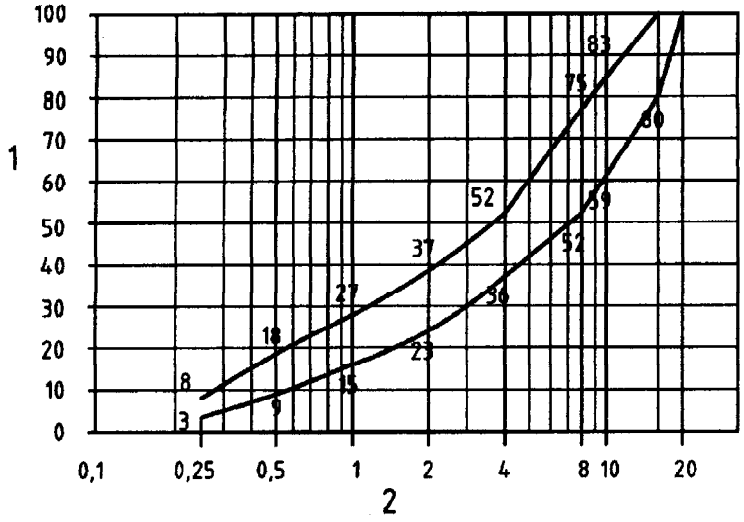
These grading curves are used:



Key

1 Percentage by mass
2 Grading (mm)

Figure A.1 — Aggregate grading for reference concrete (minimum/maximum lines for aggregate 8 mm / 10 mm)



Key

1 Percentage by mass

2 Grading (mm)

Figure A.2 — Aggregate grading for reference concrete (minimum/maximum lines for aggregate 16 mm / 20 mm)

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