

Concrete —

Performance, production, placing and compliance criteria

Cooperating organizations

The European Committee for Standardization (CEN), under whose supervision this European Prestandard was prepared, comprises the national standards organizations of the following countries:

Austria	Oesterreichisches Normungsinstitut
Belgium	Institut beige de normalisation
Denmark	Dansk Standardiseringsraad
Finland	Suomen Standardisoimisiito, r.y.
France	Association française de normalisation
Germany	Deutsches Institut für Normung e.V.
Greece	Hellenic Organization for Standardization
Iceland	Technological Institute of Iceland
Ireland	National Standards Authority of Ireland
Italy	Ente Nazionale Italiano di Unificazione
Luxembourg	Inspection du Travail et des Mines
Netherlands	Nederlands Normalisatie-instituut
Norway	Norges Standardiseringsforbund
Portugal	Instituto Português da Qualidade
Spain	Asociación Española de Normalización y Certificación
Sweden	Standardiseringskommissionen i Sverige
Switzerland	Association suisse de normalisation
United Kingdom	British Standards Institution

This Draft for Development, having been prepared under the direction of the Technical Sector Board for Building and Civil Engineering (B/-), was published under the authority of the Standards Board and comes into effect on 15 August 1992

© BSI 07-1999

The following BSI reference relates to the work on this Draft for Development:
Committee reference B/517

ISBN 0 580 20943 1

Amendments issued since publication

Amd. No.	Date	Comments

Contents

	Page
Cooperating organizations	Inside front cover
National foreword	ii
Brief history	2
Text of ENV 206	5
National annex NA (informative) Provisions from British Standards to complement ENV 206	32
National annex NB (informative) Committees responsible	Inside back cover

National foreword

This publication is the English language version of ENV 206 *Concrete — Performance, production, placing and compliance criteria*, published by the European Committee for Standardization (CEN). It includes a national annex that gives provisions from British Standards to complement ENV 206.

ENV 206 has been prepared as part of a package of standards, harmonized within the member countries of CEN, that deals with design and construction in concrete. The package also includes Eurocode 2 Part 1 (ENV 1992-1-1) for the design of concrete structures, and specifications for the constituents of concrete. The intention is that the complete European package will ultimately replace national packages of standards so that products can be traded freely and contracts for construction works will be open to tender on the basis of common design rules. Until all the standards in the European package are available, those that have been developed first have to rely on existing national standards to render them usable. In this publication reference is made in several clauses to “the national standards or regulations valid in the place of use of the concrete”. National annex NA gives in each case the British Standard that should be used. The national annex is not permitted to modify any of the requirements of the European Prestandard.

ENV 206 has the status of a prestandard also because some of its technical requirements are only agreed provisionally. A programme of work will be carried out to refine these requirements during its three year period of validity so that it can be transformed into a European Standard. Users of this publication should be aware of potential problems in its contractual use associated particularly with the division of responsibility between the purchaser and the supplier and the obligatory requirements for third party certification of product conformity which, in some cases, may not be available in the UK. A separate publication, *Guide to the use of ENV 206 in the U.K.*, gives guidance on the application of its requirements in relation to current practice.

Where the European prestandard ENV 1992-1-1 is the basis of design, this publication is the obligatory reference document for concrete as a material but the cautions above applying to its general use should be taken into account. Where British Standard codes of practice, e.g. BS 8110, are the basis of design, BS 5328 should continue to be used when specifying concrete.

Where, for the specific purpose of gaining experience, individual clauses from this publication are included in specifications, users will have to include the references given in National annex NA wherever national rules or regulations are indicated. When incorporating such clauses, users should consider whether the contractual responsibilities are identified clearly or whether additional wording is needed.

This publication is not to be regarded as a British Standard

It is being issued in the Draft for Development series of publications and is of a provisional nature because it is considered that further experience is required in its application before it is converted into a British Standard. It should be applied on this provisional basis, so that information and experience of its practical application may be obtained for reporting to the CEN committee responsible for converting the prestandard into a European Standard.

A review of the prestandard will be carried out two years after its publication.

Submission of comments from users of this publication is requested.

According to the replies received, the responsible BSI committee will judge whether to support the conversion into a European Standard or what other action should be taken.

Comments should be sent in writing to BSI, 2 Park Street, London W1A 2BS, for the attention of Mr A.R. Mears, quoting the document reference, the relevant clause and, where possible, a proposed revision, within 2 years of the issue of this document.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, the ENV title page, pages 2 to 34, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

UDC 666.971/98:691.32:693.5:620.1:658.562

Descriptors: Concrete, composition, property, classification, characteristics, durability, specifications, delivery, production, implementation, quality control, conformity tests

English version

Concrete — Performance, production, placing and compliance criteria

Béton — Performances, production, mise en œuvre et critères de conformité

Beton — Eigenschaften, Herstellung, Verarbeitung und Gütenachweis

This European Prestandard (ENV) was approved by CEN on 1989-09-19 as a prospective standard for provisional application. The period of validity of the ENV is limited initially to three years. After two years the members of CEN will be requested to submit their comments, particularly on the question whether the ENV can be converted into a European Standard (EN).

CEN members are required to announce the existence of this ENV in the same way as for an EN and to make the ENV available promptly at national level in an appropriate form. It is permissible to keep conflicting national standards in force (in parallel to the ENV) until the final decision about the possible conversion of the ENV into an EN is reached.

CEN members are the national standards bodies of Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

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

© CEN 1990 Copyright reserved to all CEN members

Brief history

This European Prestandard was prepared by Technical Committees CEN/TC 94 “*Ready mixed concrete — Production and delivery*” and CEN/TC 104 “*Concrete — Performance, production, placing and compliance criteria*” with Belgium, Denmark, France, Germany, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Sweden and United Kingdom as participating members and DIN assuming the Secretariat.

This prestandard was elaborated on the basis of the Draft European Standards prEN 199 *Ready mixed concrete — Production and delivery* and prEN 206 *Concrete — Performance, production, placing and compliance criteria*. The work on prEN 199 commenced in 1979 and was brought to a temporary end in 1981.

CEN/TC 94 agreed that prEN 199 was only concerned with specifications for production, delivery and quality control specific to ready-mixed concrete. As for those aspects which pertain to the building material concrete, it was assumed that these would be dealt with in another European Standard which was under discussion in CEN/TC 104. The work in CEN/TC 104 commenced in 1981 on the document prEN 206 which was finalized in 1984 and sent for preliminary voting in 1985.

At the preliminary voting on prEN 199 and prEN 206 neither draft gained the required majority for implementation as European Standards for technical reasons as well as for reasons concerning the immediate implementation of the documents as national standards in accordance with CEN rules. After careful consideration of the comments received, both Committees CEN/TC 94 and CEN/TC 104 decided at a joint meeting in 1986 to merge the drafts prEN 199 and prEN 206 into a single document and to give this future document the status of a European Prestandard (see “Status of the document”) to meet the objections of several CEN members concerning its immediate implementation. The document submitted as ENV 206 is the result of discussions at four joint meetings of the Committee CEN/TC 94 and CEN/TC 104, was prepared at several meetings of a Joint Working Group which have taken place since 1986, and is based on the papers prEN 199 and prEN 206 as well as on the comments received during preliminary voting, and especially at the last joint meeting of CEN/TC 94 and CEN/TC 104 in Milan in June 1988.

In accordance with CEN/CENELEC Common Rules, the following countries are bound to implement this European Prestandard: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

Status of the document

In the opinion of the Committees CEN/TC 94 and CEN/TC 104 the present document has the status of a European Prestandard (ENV). According to the common rules of CEN/CENELEC this means that the document has no obligatory character for the CEN members and does not have to be automatically implemented in their national standards.

One of the main objectives of this European Prestandard is to state provisions for the material concrete harmonizing and completing those contained in Eurocode 2 for the design and execution of concrete structures. Thus in Eurocode 2 and Eurocode 4 reference is made to ENV 206 concerning concrete technology. In those cases where the Eurocodes are used for structural design, the European Prestandard ENV 206 becomes automatically obligatory.

In the document provisions are expressed by the terms “shall” and “should”. In cases where “shall” is used it means that the provisions are obligatory requirements. In cases where “should” is used it means that the provisions are to be followed in normal applications and if there are variations from the provisions they have to be justified; but the variations have to follow the provisions expressed by “shall” in any case.

Further procedure

According to the common rules of CEN/CENELEC, three years after the document has been adopted and published as a European Prestandard, it has to be examined in order to check its technical content and the possible alteration of its status into that of a European Standard (EN).

Another reason to choose the status of a European Prestandard was a certain number of technical questions remaining unclarified. In some cases a uniform European regulation could not yet be achieved and reference had to be made to national regulations. In other cases the reference documents were not available in their final form (for instance the European Standard specifications for cement, EN 197, and some other test standards). Possible modifications of these documents could also have an influence of ENV 206.

Agreement on other questions can only be considered to be preliminary and corresponding experience has still to be gained in the European field, as concerning for instance

- the requirements for durability;
- the provisions for quality control (e.g. statistical principles, conformity criteria, number of samples);
- extension of Table 8 to higher strength classes;
- strength classes for light-weight concrete;
- consideration of additions in the determination of the w/c ratio and the cement content;
- requirements for qualification of the personnel;
- differing provisions for the production of precast elements;
- examination of all reference ISO standards;
- identification of division of responsibility between purchaser and supplier;
- reconsideration of accuracy of weighing equipment;
- reconsideration of curing requirements.

The Technical Committees decided to continue to work on these items immediately after the publication of the European Prestandard ENV 206, i.e. within the three year period of validity mentioned above.

Contents

	Page
Brief history	2
1 General	5
1.1 Object	5
1.2 Field of application	5
2 References	5
2.1 General	5
2.2 Normative references	5
2.3 Optional references	6
2.4 Other references	6
3 Definitions	6
4 Constituent materials	8
4.1 Cements	8
4.2 Aggregates	8
4.3 Mixing water	8
4.4 Admixtures	8
4.5 Additions	8
5 Basic requirements for concrete composition	8
5.1 General	8
5.2 Structure of concrete	8
5.3 Types of cement, cement content and water/cement ratio	8
5.4 Particle size of aggregates	9
5.5 Chloride content of concrete	9
5.6 Consistence during casting	9
5.7 Resistance to alkali-silica reactions	9
5.8 Admixtures	9
5.9 Additions	9
5.10 Concrete temperature	10
6 Requirements for durability	10
6.1 General	10
6.2 Resistance to environmental actions	10
7 Concrete properties and methods of verification	10
7.1 General	10
7.2 Fresh concrete	10
7.3 Hardened concrete	13
8 Specification of concrete	14
8.1 General	14
8.2 Data for specifying designed mixes	14
8.3 Data for specifying prescribed mixes	15
9 Production of concrete	15
9.1 Personnel, equipment and installations	15
9.2 Batching of constituent materials	16

	Page		Page
9.3 Mixing of concrete	16	Table 20 — Strength classes of concrete related to w/c ratio	30
10 Transport, placing and curing of fresh concrete	17	Table NA.1 — UK national strength grades	33
10.1 Personnel	17		
10.2 Transport	17		
10.3 Delivery	17		
10.4 Consistence at delivery	18		
10.5 Placing and compacting	18		
10.6 Curing and protection	18		
10.7 Heat treatment	19		
10.8 Removal of formwork	19		
11 Quality control procedures	20		
11.1 General	20		
11.2 Production control	20		
11.3 Conformity control	27		
Annex A Modifications to reference documents	31		
Table 1 — Maximum chloride content of concrete	9		
Table 2 — Exposure classes related to environmental conditions	11		
Table 3 — Durability requirements related to environmental exposure	12		
Table 4 — Slump classes	13		
Table 5 — Vebe classes	13		
Table 6 — Compaction classes	13		
Table 7 — Flow classes	13		
Table 8 — Strength classes of concrete	14		
Table 9 — Classification of light-weight concrete	14		
Table 10 — Accuracy of measuring equipment	16		
Table 11 — Accuracies for batching of constituent materials	16		
Table 12 — Minimum curing times in days for exposure classes 2 and 5a	19		
Table 13 — Strength development of concrete	19		
Table 14 — Materials control	22		
Table 15 — Equipment control	23		
Table 16 — Control of production procedure and of concrete properties	24		
Table 17 — Concrete control by contractor when using ready mixed concrete	26		
Table 18 — Number of samples for conformity control	29		
Table 19	29		

1 General

1.1 Object

This European Prestandard gives technical requirements for the constituent materials of concrete, the concrete composition, the properties of fresh and hardened concrete and their verification, also for the production of concrete, its transport, delivery, placing and curing and the quality control procedures.

Another purpose of this prestandard is to give the information on concrete as a material which is necessary for use with the relevant Eurocodes.

1.2 Field of application

The provisions of this prestandard are applicable to concrete mixed on site, ready mixed concrete or concrete produced in a factory. The prestandard is applicable to cast in situ or prefabricated structures and structural components for buildings and civil engineering structures where plain, reinforced or prestressed concrete is used. The prestandard is not applicable to certain precast concrete products such as masonry blocks, paving, pipes, nor for grout, etc.

Additional, or sometimes even different, requirements may be necessary

- for complex structures such as special viaducts, large dams, pressure vessels for nuclear power stations, offshore structures, and for roads;
- for using new constituent materials, special technologies (e.g. manufacturing processes) or innovating technologies in the building process.

In all cases the measures chosen shall be suitable and shall not conflict with the requirements for safety and durability of the structure.

This prestandard applies only to concrete having a closed structure made with normal-weight aggregate, so made and compacted as to retain no appreciable amount of entrapped air other than entrained air in accordance with 6.2.2.

The provisions of this prestandard may, in principle, also be applied to heavy-weight concrete (see 3.8) with natural aggregates and to light-weight concrete (see 3.7) with artificial or natural aggregates as appropriate. In these cases, however, special considerations may be necessary in addition.

Besides the provisions of this prestandard other rules may be used for simple structures of less importance if they are covered by national regulations.

2 References

2.1 General

The term “normative” means that the requirements of the standards or parts of them, to which reference is made in the relevant clauses of ENV 206, are to be used exclusively.

Exceptionally, during the lifetime of ENV 206, nationally adopted test methods may be used, provided it is affirmed by the national standards body that the results achieved according to the national standards are equivalent to those achieved by relevant international standards.

The term “optional” in 2.3 means that other equivalent standards or rules may be agreed upon.

2.2 Normative references

EN 196-7, *Methods of testing cement — Part 7: Methods of taking and preparing samples of cement*.

EN 197-1, *Cement; Composition, specifications and conformity criteria — Part 1: Definitions and composition*¹⁾.

EN 197-2, *Cement; Composition, specifications and conformity criteria — Part 2: Specifications*¹⁾.

EN 197-3, *Cement; Composition, specifications and conformity criteria — Part 3: Conformity criteria*¹⁾.

ISO 1920:1976, *Concrete tests — Dimensions, tolerances and applicability of test specimens*²⁾.

ISO 2736-1:1986, *Concrete tests — Making of test specimens — Part 1: Sampling of fresh concrete*.

ISO 2736-2:1986, *Concrete tests — Making of test specimens — Part 2: Making and curing of test specimens for strength tests*²⁾.

ISO 4012:1978, *Concrete — Determination of compressive strength of test specimens*²⁾.

ISO 4013:1978, *Concrete — Determination of flexural strength of test specimens*²⁾.

ISO 4103:1979, *Concrete — Classification of consistency*.

ISO 4108:1980, *Concrete — Determination of tensile splitting strength of test specimens*.

ISO 4848:1980, *Concrete — Determination of air content of freshly mixed concrete — Pressure method*.

ISO 7031, *Concrete, hardened — Determination of the depth of penetration of water under pressure*²⁾¹⁾.

ISO 9690, *Production and control of concrete. Classification of chemically aggressive environmental conditions affecting concrete*³⁾¹⁾.

¹⁾ At present at the draft stage.

²⁾ As amended in Annex A.

³⁾ Reference applies to the draft proposal ISO/DP 9690:1987 and shall be rediscussed during the lifetime of ENV 206.

2.3 Optional references

ISO 4109:1980, *Fresh concrete — Determination of the consistency — Slump test*.

ISO 4110:1979, *Fresh concrete — Determination of the consistency — Vebe test*.

ISO 4111:1979, *Fresh concrete — Determination of the consistency — Degree of compactibility (Compaction index)*.

ISO 6275:1982, *Concrete, hardened — Determination of density*.

ISO 6276:1982, *Concrete, compacted fresh — Determination of density*.

ISO 6782:1982, *Aggregates for concrete — Determination of bulk density*.

ISO 6783:1982, *Coarse aggregates for concrete — Determination of particle density and water absorption — Hydrostatic balance method*.

ISO 7033:1987, *Particle density and water absorption of fine and coarse aggregates for concrete (Pycnometer method)*.

ISO 7034, *Cores of hardened concrete — Taking, examination and testing in compression*⁴⁾.

ISO 8045, *Concrete, hardened — Determination of rebound number using the rebound hammer*⁴⁾.

ISO 8046, *Concrete, hardened — Determination of pull-out strength*⁴⁾.

ISO 8047, *Concrete, hardened — Determination of ultrasonic pulse velocity*⁴⁾.

ISO 9812, *Fresh concrete — Determination of consistency — Flow test*⁴⁾.

RILEM CPC7, *Direct tension (Final recommendation, 1975)*.

EN 45011, *General criteria for certification bodies operating product certification*.

EN 45014, *General criteria for declaration of conformity*.

2.4 Other references

Eurocode 2, *Common unified rules for concrete structures*⁴⁾;

Eurocode 4, *Common unified rules for composite steel and concrete structures*⁴⁾;

3 Definitions

3.1 concrete

material formed by mixing cement, coarse and fine aggregate and water and produced by the hardening of the cement paste (cement and water); besides these basic components, it may also contain admixtures and/or additions

NOTE If the maximum particle size of the aggregate is 4 mm or less, the resulting material is termed mortar, not concrete.

3.2

fresh concrete

concrete still in the plastic state and capable of being compacted by normal methods

3.3

hardened concrete

concrete which has hardened and developed a certain strength

3.4

site mixed concrete

concrete batched and mixed on or near the construction site by the user

3.5

ready mixed concrete

concrete batched in a plant outside the construction site or on the construction site, mixed in a stationary mixer or a truck mixer and delivered by the producer to the user in the fresh condition ready for use either on the construction site or into a vehicle of the user

3.6

normal-weight concrete

concrete having an oven-dry (105 °C) density greater than 2 000 kg/m³ but not exceeding 2 800 kg/m³

3.7

light-weight concrete

concrete having an oven-dry density of not more than 2 000 kg/m³. It is entirely or partly produced by the use of aggregate that has a porous structure (light-weight aggregate; see definition 3.18)

3.8

heavy-weight concrete

concrete having an oven-dry density greater than 2 800 kg/m³

3.9

truck mixer

concrete mixing unit generally mounted on a self-propelled chassis capable of producing and delivering a homogeneously mixed concrete. A truck mixer may be used as a truck agitator

3.10

truck agitator

equipment mounted on a self-propelled chassis and capable of maintaining mixed concrete in a thoroughly mixed and homogeneous mass during transit

⁴⁾ At present at the draft stage.

3.11**non-agitating equipment**

dump truck, transport hoppers or other equipment used for transporting concrete without agitating

3.12**batch**

quantity of concrete mixed in one cycle of operations of a batch mixer, or the quantity of concrete conveyed ready-mixed in a vehicle, or the quantity discharged during 1 min from a continuous mixer

3.13**delivery**

the process of handing over the concrete to the user normally by discharging from the ready mixed concrete truck

3.14**admixture**

product which is added in small quantities by mass of the cement before or during mixing or during an additional mixing operation, causing the required modifications to the normal properties

3.15**addition**

finely divided inorganic material that may be added to concrete in order to improve certain properties or to achieve special properties. There are two types of additions

- nearly inert additions (type I); and
- pozzolanic or latent hydraulic additions (type II).

3.16**aggregate**

material consisting of uncrushed and/or crushed natural and/or artificial mineral substances with particle sizes and shapes suitable for the production of concrete

3.17**normal-weight aggregate**

aggregate with a particle density between $2\,000\text{ kg/m}^3$ and $3\,000\text{ kg/m}^3$, when determined according to ISO 6783 or ISO 7033

3.18**light-weight aggregate**

aggregate consisting of grains with a porous structure and with a particle density of less than $2\,000\text{ kg/m}^3$, when determined according to ISO 6783 or ISO 7033

3.19**heavy-weight aggregate**

aggregate having a particle density appreciably greater than $3\,000\text{ kg/m}^3$, when determined according to ISO 6783 or ISO 7033

3.20**cement (hydraulic binder)**

finely ground inorganic material which when mixed with water, forms a paste which sets and hardens by means of hydration reactions and processes and which, after hardening, retains its strength and stability even under water

3.21**effective water content**

mixing water plus water already present on the surface of the aggregates and in the admixtures and additions (and possibly water from added ice or steam heating)

3.22**water/cement ratio**

ratio of effective water content to cement content in the concrete

3.23**designed mix**

mix for which the user is responsible for specifying the required performance and additional characteristics and the producer is responsible for providing a mix which complies with the required performance and additional characteristics

3.24**prescribed mix**

mix for which the user specifies the composition of the mix and materials to be used. The producer is responsible for providing the specified mix but is not responsible for the performance of the concrete

3.25**initial test**

test or tests to check, before the concrete is used, how it shall be composed in order to meet all the performance requirements in the fresh and hardened stage, account being taken of the constituent materials to be used and the particular conditions on site

3.26**entrained air**

microscopic air bubbles intentionally incorporated in concrete during mixing, usually by use of a surface active agent; typically between $10\text{ }\mu\text{m}$ and $100\text{ }\mu\text{m}$ diameter and spherical or nearly so

3.27**entrapped air**

air voids in concrete which are not purposely entrained and which are significantly larger and less useful than those of entrained air, 1 mm or larger in size