

Concrete —

Part 1: Specification, performance, production and conformity

The European Standard EN 206-1:2000, with the incorporation of amendments A1:2004 and A2:2005, has the status of a British Standard

ICS 91.100.30

National foreword

This British Standard is the official English language version of EN 206-1:2000, including amendments A1:2004 and A2:2005. It supersedes DD ENV 206:1992 which is withdrawn.

The start and finish of text introduced or altered by CEN amendment is indicated in the text by tags **A1** **A1**. Tags indicating changes to CEN text carry the number of the CEN amendment. For example, text altered by CEN amendment A1 is indicated by **A1** **A1**.

It is intended that this British Standard be used in conjunction with the complementary standards BS 8500-1 and BS 8500-2 which give national provisions where they are permitted in EN 206-1:2000 and these standards supersede BS 5328-1:1997, BS 5328-2:1997, BS 5328-3:1990 and BS 5328-4:1990 which will be withdrawn on 1 December 2003.

The UK participation in its preparation was entrusted by Technical Committee B/517, Concrete, to Subcommittee B/517/1, Concrete production and testing, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible international/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.

Draft European Standards (prENs) referred to in this standard that have equivalent national standards are listed as follows:

prEN 12504-4:1998	BS 1881-203, <i>Testing concrete — Part 203: Recommendations for measurement of velocity of ultrasonic pulses in concrete.</i>
prEN 13791:1999	BS 1881-201, <i>Testing concrete — Part 201: Guide to the use of non-destructive methods of test for hardened concrete.</i>

Some of the draft standards referred to in this standard have received negative votes by CEN at the formal vote stage, therefore the use of draft European Standards should be carefully considered.

The UK Technical Committee recommends that purchasers of concrete in the UK specify concrete that has been manufactured and supplied to a recognized third party product quality certification scheme.

Amendment A1 comprises a number of small technical changes, clarifications as to what was intended, replacement of references to draft standards that have now been published and editorial corrections.

Amendments issued since publication

Amd. No.	Date	Comments
13189 Corrigendum No. 1	April 2001	
14857	19 January 2004	See revised national foreword
15359	30 September 2004	See national foreword
15406 Corrigendum No. 2	25 October 2004	Addition of footnote in Subclause 8.2.2
15571	March 2006	See national foreword

This British Standard, having been prepared under the direction of the Sector Committee for Building and Civil Engineering, was published under the authority of the Standards Committee and comes into effect on 15 February 2001

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At the CEN TC 104/SC1 meeting held in Prague, June 2003, BSI requested that the term “conformity to EN 206-1” be clarified. The following resolution was agreed:

“Resolution Prague 2003-4

Conformity to EN 206-1 means conformity to the specification of the concrete to be assessed by application of the conformity criteria in Clause 8. It also requires the producer to comply with the requirements for the production process and the production control.

Concerning the requirements on the production process and the production control, EN 206-1 gives sufficient flexibility to be adjusted to the size of production, the works, the particular equipment and procedures.

Where the producer has failed to comply with any requirements for production process and production control, the producer shall investigate the consequences of the non-compliance and when this results in a non-conformity with respect to Clause 8 or the requirements placed on the concrete, the producer shall declare the concrete as non-conforming. In all cases the cause of the non-compliance with the requirements on the production process and production control shall be investigated and corrected without delay.”

This principle has been incorporated into normative text in BS 8500-2.

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the *BSI Catalogue* under the section entitled “International Standards Correspondence Index”, or by using the “Search” facility of the *BSI Electronic Catalogue* or of British Standards Online.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the EN title page, pages 2 to 69 and a back cover.

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English version

Concrete — Part 1: Specification, performance, production and conformity
(includes amendment A1:2004 and A2:2005)

Béton — Partie 1: Spécification, performances, production
et conformité
(inclut les amendements A1:2004 et A2:2005)

Beton — Teil 1: Festlegung, Eigenschaften, Herstellung
und Konformität
(enthält Änderungen A1:2004 und A2:2005)

This European Standard was approved by CEN on 12 May 2000, and amendment A1 was approved by CEN on 22 October 2003. Amendment A2 was approved by CEN on 12 May 2005.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.



EUROPEAN COMMITTEE FOR STANDARDIZATION
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Contents

	Page
Foreword	6
Introduction	8
1 Scope	9
2 Normative references	10
3 Definitions, symbols and abbreviations	12
3.1 Terms and definitions	12
3.2 Symbols and abbreviations	16
4 Classification	17
4.1 Exposure classes related to environmental actions	17
4.2 Fresh concrete	19
4.2.1 Consistence classes	19
4.2.2 Classes related to maximum aggregate size	20
4.3 Hardened concrete	20
4.3.1 Compressive strength classes	20
4.3.2 Density classes for light-weight concrete	21
5 Requirements for concrete and methods of verification	21
5.1 Basic requirements for constituent materials	21
5.1.1 General	21
5.1.2 Cement	22
5.1.3 Aggregates	22
5.1.4 Mixing water	22
5.1.5 Admixtures	22
5.1.6 Additions (including mineral fillers and pigments)	22
5.2 Basic requirements for composition of concrete	23
5.2.1 General	23
5.2.2 Selection of cement	23
5.2.3 Use of aggregates	23
5.2.4 Use of recycled water	24
5.2.5 Use of additions	24
5.2.6 Use of admixtures	26
5.2.7 Chloride content	26
5.2.8 Concrete temperature	26
5.3 Requirements related to exposure classes	27
5.3.1 General	27
5.3.2 Limiting values for concrete composition	27
5.3.3 Performance-related design methods	27

5.4	Requirements for fresh concrete	28
5.4.1	Consistence	28
5.4.2	Cement content and water/cement ratio	29
5.4.3	Air content	29
5.4.4	Maximum aggregate size	29
5.5	Requirements for hardened concrete	29
5.5.1	Strength	29
5.5.2	Density	30
5.5.3	Resistance to water penetration	30
5.5.4	Reaction to fire	30
6	Specification of concrete	31
6.1	General	31
6.2	Specification for designed concrete	31
6.2.1	General	31
6.2.2	Basic requirements	32
6.2.3	Additional requirements	32
6.3	Specification for prescribed concrete	33
6.3.1	General	33
6.3.2	Basic requirements	33
6.3.3	Additional requirements	33
6.4	Specification of standardized prescribed concrete	33
7	Delivery of fresh concrete	34
7.1	Information from the user of the concrete to the producer	34
7.2	Information from the producer of the concrete to the user	34
7.3	Delivery ticket for ready-mixed concrete	35
7.4	Delivery information for site-mixed concrete	36
7.5	Consistence at delivery	36
8	Conformity control and conformity criteria	36
8.1	General	36
8.2	Conformity control for designed concrete	36
8.2.1	Conformity control for compressive strength	36
8.2.2	Conformity control for tensile splitting strength	39
8.2.3	Conformity control for properties other than strength	39
8.3	Conformity control of prescribed concrete including standardized prescribed concrete	41
8.4	Actions in the case of non-conformity of the product	42

9	Production control	42
9.1	General	42
9.2	Production control systems	43
9.3	Recorded data and other documents	43
9.4	Testing	44
9.5	Concrete composition and initial testing	45
9.6	Personnel, equipment and installation	45
9.6.1	Personnel	45
9.6.2	Equipment and installation	45
9.7	Batching of constituent materials	46
9.8	Mixing of concrete	46
9.9	Production control procedures	46
10	Evaluation of conformity	51
10.1	General	51
10.2	Assessment, surveillance and certification of production control	51
11	Designation for designed concrete	51
Annex A (normative)	Initial test	52
Annex B (normative)	Identity testing for compressive strength	54
Annex C (normative)	Provisions for assessment, surveillance and certification of production control	55
Annex D (informative)	Bibliography	58
Annex E (informative)	Guidance on the application of the equivalent performance concept of concrete properties	59
Annex F (informative)	Recommendations for limiting values of concrete compositions	60
Annex G	<i>Text deleted</i>	62
Annex H (informative)	Additional provisions for high strength concrete	63
Annex J (informative)	Performance-related design methods with respect to durability	65
Annex K (informative)	Concrete families	67

Figures

Figure 1 — Relationships between EN 206-1 and standards for design and execution, standards for constituent materials and test standards.....	7
Figure K.3 — Flow chart for the assessment of membership and conformity of a concrete family.....	68

Tables

Table 1 — Exposure classes.....	17
Table 2 — Limiting values for exposure classes for chemical attack from natural soil and ground water.....	19
Table 3 — Slump classes.....	19
Table 4 — Vebe classes.....	19
Table 5 — Compaction classes.....	20
Table 6 — Flow classes.....	20
Table 7 — Compressive strength classes for normal-weight and heavy-weight concrete.....	20
Table 8 — Compressive strength classes for light-weight concrete.....	21
Table 9 — Classification of light-weight concrete by density.....	21
Table 10 — Maximum chloride content of concrete.....	26
Table 11 — Tolerances for target values of consistence.....	28
Table 12 — Strength development of concrete at 20 °C.....	34
Table 13 — Minimum rate of sampling for assessing conformity.....	37
Table 14 — Conformity criteria for compressive strength.....	38
Table 15 — Confirmation criterion for family members.....	38
Table 16 — Conformity criteria for tensile splitting strength.....	39
Table 17 — Conformity criteria for properties other than strength.....	40
Table 18 — Conformity criteria for consistence.....	41
Tables 19a and 19b — Acceptance numbers for conformity criteria for properties other than strength.....	42
Table 20 — Recorded data and other documents, where relevant.....	44
Table 21 — Tolerances for the batching process of constituent material.....	46
Table 22 — Control of constituent material.....	47
Table 23 — Control of equipment.....	49
Table 24 — Control of production procedures and of concrete properties.....	50
Table B.1 — Identity criteria for compressive strength.....	54
Table F.1 — Recommended limiting values for composition and properties of concrete.....	61
Table H.1 — Control of constituent materials.....	63
Table H.2 — Control of equipment.....	64
Table H.3 — Control of production procedures and of concrete properties.....	64

Foreword

This European Standard has been prepared by Technical Committee CEN/TC 104, Concrete and related products, the Secretariat of which is held by DIN.

This European Standard supersedes ENV 206:1990.

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 June 2001, and conflicting national standards shall be withdrawn at the latest by December 2003.

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 standard together with parts of ENV 13670-1 (Execution of concrete structures) supersedes the European Pre-standard ENV 206:1990 "Concrete — Performance, production, placing and compliance criteria" which was the basis for the preparation of this standard.

In particular, the following items were subject to revision when preparing this standard:

- extension of the classification system for concrete especially with respect to environmental conditions;
- requirements for durability;
- extension of strength classes;
- strength classes for light-weight concrete;
- consideration of additions in the determination of the w/c ratio and the cement content;
- identification of division of technical responsibility between the specifier, producer and user;
- reconsideration of accuracy of weighing equipment;
- reconsideration of curing requirements;
- provisions for conformity control, conformity criteria and identity testing;
- provisions for the evaluation of conformity.

Aspects relating to the execution have, in general, been moved to ENV 13670-1 or other relevant standards.

The context in which this standard functions is illustrated in Figure 1.

This standard is only operable with product standards or equivalent specifications for constituent materials (i.e. cement, aggregates, additions, admixtures and mixing water) and related test methods for concrete. Product standards and test method standards are under preparation by CEN but they will not all be available as European Standards at the date of publication of this standard. For this reason, the latest date of withdrawal of national standards (dow) conflicting with this standard will be the date when all standards listed below, together with the related standards for test methods, are available and implemented as European Standards or ISO Standards where appropriate or have the status required by this standard.

EN 197-1, *Cement — Composition, specifications and conformity criteria Part 1: Common cements*

EN 12620, *Aggregates for concrete including those for use in roads and pavements*

EN 13055-1, *Light-weight aggregates — Part 1: Light-weight aggregates for concrete and mortar*

EN 1008, *Mixing water for concrete — Specifications for sampling, testing and assessing the suitability of water, including wash water from recycling installations in the concrete industry, as mixing water for concrete*

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

EN 450, *Fly ash for concrete — Definitions, requirements and quality control*

EN 13263, *Silica fume for concrete — Definitions, requirements and conformity control*

The Annexes A, B and C are normative. The Annexes D, E, F, H, J and K are informative.

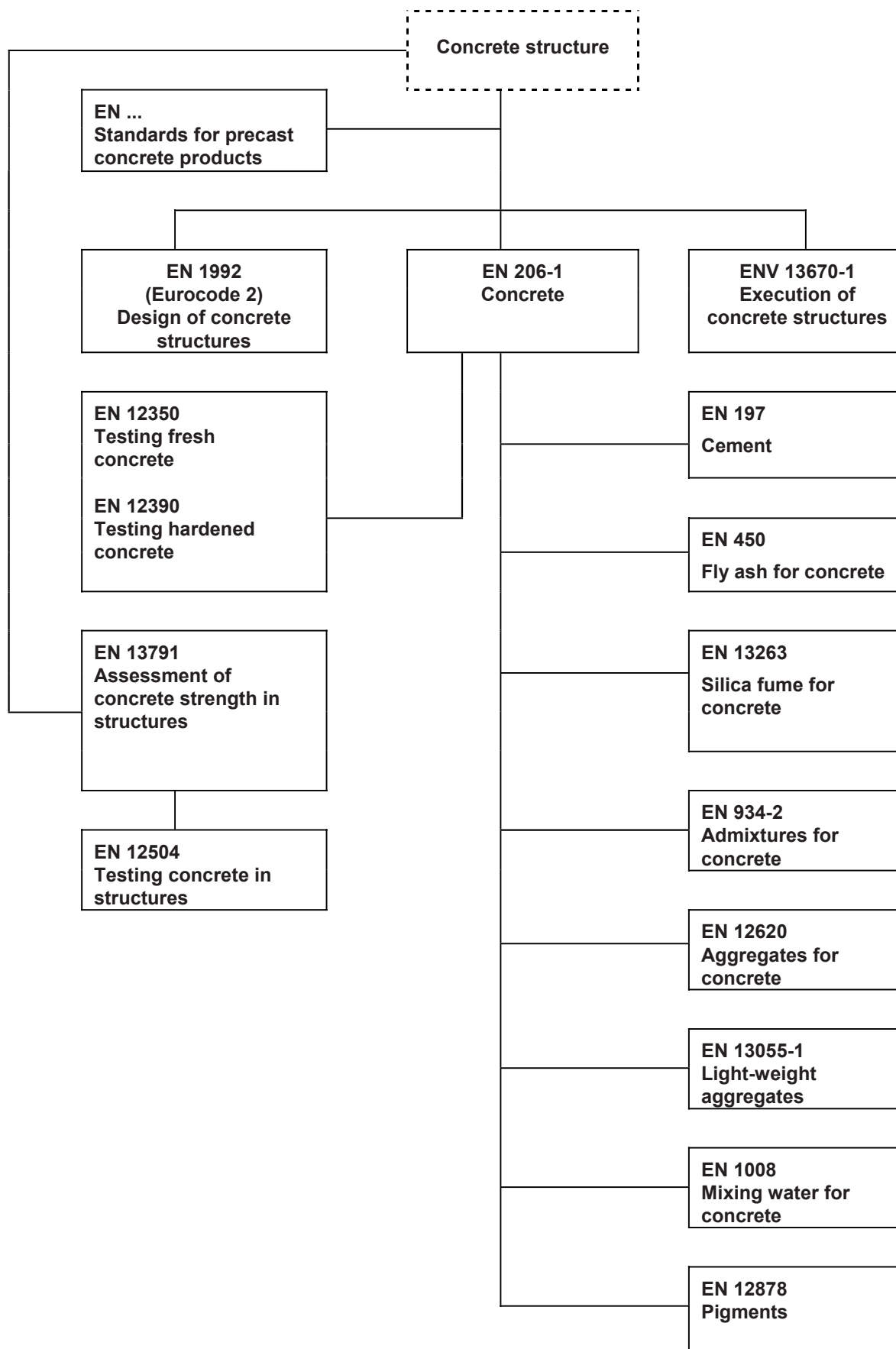


Figure 1 — Relationships between EN 206-1 and standards for design and execution, standards for constituent materials and test standards

Foreword to amendment A1

This document (EN 206-1:2000/A1:2004) has been prepared by Technical Committee CEN/TC 104, Concrete and related products, the Secretariat of which is held by DIN.

This Amendment to the document EN 206-1:2000 shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by January 2005, and conflicting national standards shall be withdrawn at the latest by January 2005.

This document covers matters for which the need for amendments or corrections to EN 206-1:2000 has been identified by CEN/TC 104, Concrete and related products.

The numbering and headlines in the following correspond to those in EN 206-1 for which the amendments and corrections apply.

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

Foreword to amendment A2

This document (EN 206-1:2000/A2:2005) has been prepared by Technical Committee CEN/TC 104 "Concrete and related products", the secretariat of which is held by DIN.

This Amendment to the European Standard EN 206-1:2000 shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by December 2005, and conflicting national standards shall be withdrawn at the latest by December 2005.

This document covers matters for which the need for amendments or corrections to EN 206-1: 2000-12 has been identified by CEN/TC 104 "Concrete and related products".

The numbering and headlines in the following correspond to the those in EN 206-1 for which the amendments and corrections apply.

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

Introduction

This European Standard will be applied in Europe under different climatic and geographical conditions, different levels of protection and under different, well established, regional traditions and experience. Classes for concrete properties have been introduced to cover these situations. Where such general solutions were not possible, the relevant clauses contain permission for the application of national standards or provisions valid in the place of use of the concrete.

During the development of this European Standard, consideration was given to detailing a performance-related approach to the specification of durability. For this, a review of performance-related design and test methods has been undertaken. However, CEN/TC 104 concluded that these methods are not yet sufficiently developed for them to be detailed in this standard, but CEN/TC 104 recognized that some CEN Members have developed confidence in local tests and criteria. Therefore this standard permits the continuation and development of such practices valid in the place of use of the concrete as an alternative to the prescriptive approach. CEN/TC 104 will continue to develop performance-related methods for assessing durability at the European level.

This European Standard incorporates rules for the use of constituent materials that are covered by European Standards. Other by-products of industrial processes, recycled materials etc. are in current use based on local experience. Until European specifications for these materials are available, this standard will not provide rules for their use, but instead refers to national standards or provisions valid in the place of use of the concrete.

This European Standard defines tasks for the specifier, producer and user. For example, the specifier is responsible for the specification of concrete, Clause 6, and the producer is responsible for conformity and production control, Clauses 8 and 9. The user is responsible for placing the concrete in the structure. In practice there may be several different parties specifying requirements at various stages of the design and construction process e.g. the client, the designer, the contractor, the concreting sub-contractor. Each is responsible for passing the specified requirements, together with any additional requirements, to the next party in the chain until they reach the producer. In the terms of this European Standard, this final compilation is known as the "specification". Conversely, the specifier, producer and user may be the same party (e.g. a contractor doing design and build). In the case of ready mixed concrete, the purchaser of the fresh concrete is the specifier and has to give the specification to the producer. This standard also covers the necessary exchange of information between the different parties. Contractual matters are not addressed. Where responsibilities are given for parties involved, these are technical responsibilities.

Notes and footnotes in tables of this standard are normative unless stated otherwise; other notes and footnotes are informative.

Further explanations and guidance on the application of this standard are given in other documents, such as CEN Reports.

1 Scope

This European Standard applies to concrete for structures cast in situ, precast structures, and structural precast products for buildings and civil engineering structures.

The concrete may be mixed on site, ready-mixed concrete or produced in a plant for precast concrete products.

This standard specifies requirements for:

- the constituent materials of concrete;
- the properties of fresh and hardened concrete and their verification;
- the limitations for concrete composition;
- the specification of concrete;
- the delivery of fresh concrete;
- the production control procedures;
- the conformity criteria and evaluation of conformity.

This European Standard applies to concrete compacted to retain no appreciable amount of entrapped air other than entrained air. This standard applies to normal-weight, heavy-weight and light-weight concrete.

Other European Standards for specific products e.g. precast products or for processes within the field of the scope of this standard may require or permit deviations from this standard.

Additional or different requirements may be given in further parts of this standard or in other specific European Standards, for example:

- concrete to be used in roads and other trafficked areas;
- concrete using other materials (e.g. fibres) or constituent materials not covered by 5.1;
- concrete with an upper aggregate size of 4 mm or less (mortar);
- special technologies (e.g. sprayed concrete);
- concrete for disposal of liquids and gaseous waste;
- concrete for vessels for storage of polluting substances;
- concrete for massive structures (e.g. dams);
- dry mixed concrete.

NOTE As long as these standards are not available, provisions valid in the place of use of the concrete may apply. European Standards are under preparation for:

- concrete to be used in roads and other trafficked areas;
- sprayed concrete.

This standard does not apply to:

- aerated concrete;
- foamed concrete;
- concrete with open structure ("no-fines" concrete);
- concrete with density less than 800 kg/m³;
- refractory concrete.

This standard does not cover health and safety requirements for the protection of workers during production and delivery of concrete.

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 (including amendments).

In the case of reference to European draft standards, provisions valid in the place of use of the concrete may be applied until the European Standard is available.

EN 196-2, *Methods of testing cement — Part 2: Chemical analysis of cement*

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

EN 450, *Fly ash for concrete — Definitions, requirements and quality control*

EN 933-1, *Tests for geometrical properties of aggregates — Part 1: Determination of particle size distribution — Sieving method*

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

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*

EN 1097-3, *Tests for mechanical and physical properties of aggregates — Part 3: Determination of loose bulk density and voids*

EN 1097-6, *Tests for mechanical and physical properties of aggregates — Part 6: Determination of particle density and water absorption*

EN 12350-1, *Testing fresh concrete — Part 1: Sampling*

EN 12350-2, *Testing fresh concrete — Part 2: Slump test*

EN 12350-3, *Testing fresh concrete — Part 3: Vebe test*

EN 12350-4, *Testing fresh concrete — Part 4: Degree of compactability*

EN 12350-5, *Testing fresh concrete — Part 5: Flow table test*

EN 12350-6, *Testing fresh concrete — Part 6: Density*

EN 12350-7, *Testing fresh concrete — Part 7: Air content of fresh concrete — Pressure methods*

EN 12390-1, *Testing hardened concrete — Part 1: Shape, dimensions and other requirements for test specimens and moulds*

EN 12390-2, *Testing hardened concrete — Part 2: Making and curing specimens for strength tests*

EN 12390-3, *Testing hardened concrete — Part 3: Compressive strength of test specimens*

EN 12390-6, *Testing hardened concrete — Part 6: Tensile splitting strength of test specimens*

EN 12390-7, *Testing hardened concrete — Part 7: Density of hardened concrete*

EN 12620, *Aggregates for concrete*

EN 12878, *Pigments for colouring of building materials based on cement and/or lime — Specifications and methods of test*

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

prEN 13263:1998, *Silica fume for concrete — Definitions, requirements and conformity control*

prEN 13577:1999, *Water quality — Determination of aggressive carbon dioxide content*

EN 45501:1992, *Metrological aspects of non-automatic weighing instruments*

ISO 2859-1:1999, *Sampling schemes for inspection by attributes — Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection*

ISO 3951:1994, *Sampling procedures and charts for inspection by variables by percent nonconforming*

ISO 4316, *Surface active agents — Determination of pH of aqueous solutions — Potentiometric method*

ISO 7150-1, *Water quality — Determination of ammonium — Part 1: Manual spectrometric method*

ISO 7150-2, *Water quality — Determination of ammonium — Part 2: Automated spectrometric method*

ISO 7980, *Water quality — Determination of calcium and magnesium — Atomic absorption spectrometric method*

DIN 4030-2, *Assessment of water, soil and gases for their aggressiveness to concrete — Part 2: Collection and examination of water and soil samples*

ASTM C 173, *Test method for air content of freshly mixed concrete by the volumetric method*

3 Definitions, symbols and abbreviations

3.1 Terms and definitions

For the purposes of this standard, the following terms and definitions apply:

3.1.1

concrete

material formed by mixing cement, coarse and fine aggregate and water, with or without the incorporation of admixtures and additions, which develops its properties by hydration of the cement

3.1.2

fresh concrete

concrete which is fully mixed and still in a condition that is capable of being compacted by the chosen method

3.1.3

hardened concrete

concrete which is in a solid state and which has developed a certain strength

3.1.4

site-mixed concrete

concrete produced on the construction site by the user of the concrete for his own use

3.1.5

ready-mixed concrete

concrete delivered in a fresh state by a person or body who is not the user. Ready-mixed concrete in the sense of this standard is also:

- concrete produced off site by the user;
- concrete produced on site, but not by the user.

3.1.6

precast concrete product

concrete product cast and cured in a place other than the final location of use

3.1.7

normal-weight concrete

concrete having an oven-dry density greater than 2 000 kg/m³ but not exceeding 2 600 kg/m³

3.1.8

light-weight concrete

concrete having an oven-dry density of not less than 800 kg/m³ and not more than 2 000 kg/m³. It is produced using light-weight aggregate for all or part of the total aggregate

3.1.9

heavy-weight concrete

concrete having an oven-dry density greater than 2 600 kg/m³

3.1.10

high strength concrete

concrete with a compressive strength class higher than C50/60 in the cases of normal-weight or heavy-weight concrete and LC50/55 in the case of light-weight concrete

3.1.11

designed concrete

concrete for which the required properties and additional characteristics are specified to the producer who is responsible for providing a concrete conforming to the required properties and additional characteristics

3.1.12

prescribed concrete

concrete for which the composition of the concrete and the constituent materials to be used are specified to the producer who is responsible for providing a concrete with the specified composition

3.1.13

standardized prescribed concrete

prescribed concrete for which the composition is given in a standard valid in the place of use of the concrete

3.1.14

concrete family

group of concrete compositions for which a reliable relationship between relevant properties is established and documented

3.1.15

cubic metre of concrete

quantity of fresh concrete which, when compacted in accordance with the procedure given in EN 12350-6, occupies a volume of one cubic metre

3.1.16

truck mixer

concrete mixer mounted on a self-propelled chassis capable of mixing and delivering a homogeneous concrete

3.1.17

agitating equipment

equipment generally mounted on a self-propelled chassis and capable of maintaining fresh concrete in a homogeneous state during transport

3.1.18

non-agitating equipment

equipment used for transporting concrete without agitation in the sense of definition 3.1.17, e.g. dump truck or transport hopper

3.1.19

batch

quantity of fresh concrete produced in one cycle of operations of a mixer or the quantity discharged during 1 min from a continuous mixer

3.1.20

load

quantity of concrete transported in a vehicle comprising one or more batches

3.1.21

delivery

process of handing over the fresh concrete by the producer

3.1.22

admixture

material added during the mixing process of concrete in small quantities related to the mass of cement to modify the properties of fresh or hardened concrete

3.1.23

addition

finely divided material used in concrete in order to improve certain properties or to achieve special properties. This standard deals with two types of inorganic additions:

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

3.1.24

aggregate

granular mineral material suitable for use in concrete. Aggregates may be natural, artificial or recycled from material previously used in construction

3.1.25

normal-weight aggregate

aggregate with an oven-dry particle density $> 2\,000\text{ kg/m}^3$ and $< 3\,000\text{ kg/m}^3$, when determined according to EN 1097-6.

3.1.26

light-weight aggregate

aggregate of mineral origin having an oven-dry particle density $\leq 2\,000\text{ kg/m}^3$ when determined according to EN 1097-6 or a loose oven-dry bulk density $\leq 1\,200\text{ kg/m}^3$ when determined according to EN 1097-3

3.1.27

heavy-weight aggregate

aggregate having an oven-dry particle density $\geq 3\,000\text{ kg/m}^3$ when determined according to EN 1097-6

3.1.28

cement (hydraulic binder)

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

3.1.29

total water content

added water plus water already contained in the aggregates and on the surface of the aggregates plus water in the admixtures and in additions used in the form of a slurry and water resulting from any added ice or steam heating

3.1.30

effective water content

difference between the total water present in the fresh concrete and the water absorbed by the aggregates

3.1.31

water/cement ratio

ratio of the effective water content to cement content by mass in the fresh concrete

3.1.32

characteristic strength

value of strength below which 5 % of the population of all possible strength determinations of the volume of concrete under consideration, are expected to fall

3.1.33

entrained air

microscopic air bubbles intentionally incorporated in concrete during mixing, usually by use of a surface active agent; typically between 10 μm and 300 μm in diameter and spherical or nearly so

3.1.34

entrapped air

air voids in concrete which are not purposely entrained

3.1.35

site (construction site)

area where the construction work is undertaken

3.1.36

specification

final compilation of documented technical requirements given to the producer in terms of performance or composition

3.1.37

specifier

person or body establishing the specification for the fresh and hardened concrete

3.1.38

producer

person or body producing fresh concrete

3.1.39

user

person or body using fresh concrete in the execution of a construction or a component

3.1.40

working life

period of time during which the performance of the concrete in the structure will be kept at a level compatible with the fulfilment of the performance requirements of the structure, provided it is properly maintained

3.1.41

initial test

test or tests to check before the production starts how a new concrete or concrete family shall be composed in order to meet all the specified requirements in the fresh and hardened states

3.1.42

identity test

test to determine whether selected batches or loads come from a conforming population

3.1.43

conformity test

test performed by the producer to assess conformity of the concrete

3.1.44

evaluation of conformity

systematic examination of the extent to which a product fulfils specified requirements

3.1.45

environmental actions

those chemical and physical actions to which the concrete is exposed and which result in effects on the concrete or reinforcement or embedded metal that are not considered as loads in structural design

3.1.46

verification

confirmation by examination of objective evidence that specified requirements have been fulfilled

3.2 Symbols and abbreviations

X0	Exposure class for no risk of corrosion or attack
XC	Exposure classes for risk of corrosion induced by carbonation
XD	Exposure classes for risk of corrosion induced by chlorides other than from sea water
XS	Exposure classes for risk of corrosion induced by chlorides from sea water
XF	Exposure classes for freeze/thaw attack
XA	Exposure classes for chemical attack
S1 to S5	Consistence classes expressed by slump
V0 to V4	Consistence classes expressed by Vebe time
C0 to C3	Consistence classes expressed by degree of compactability
F1 to F6	Consistence classes expressed by flow diameter
C.../...	Compressive strength classes in case of normal-weight and heavy-weight concrete
LC.../...	Compressive strength classes in case of light-weight concrete
$f_{ck,cyl}$	Characteristic compressive strength of concrete determined by testing cylinders
$f_{c,cyl}$	Compressive strength of concrete determined by testing cylinders
$f_{ck,cube}$	Characteristic compressive strength of concrete determined by testing cubes
$f_{c,cube}$	Compressive strength of concrete determined by testing cubes
f_{cm}	Mean compressive strength of concrete
$f_{cm,j}$	Mean compressive strength of concrete at the age of (<i>j</i>) days
f_{ci}	Individual test result for compressive strength of concrete
f_{tk}	Characteristic tensile splitting strength of concrete
f_{tm}	Mean tensile splitting strength of concrete
f_{ti}	Individual test result for tensile splitting test of concrete
D	Density class of light-weight concrete
D_{max}	Maximum nominal upper aggregate size
CEM	Cement type according to the series EN 197
σ	Estimate for the standard deviation of a population
s_n	Standard deviation of <i>n</i> consecutive test results
AQL	Acceptance quality level (see ISO 2859-1)
w/c	Water/cement ratio
<i>k</i>	Factor which takes into account the activity of a type II addition
<i>e</i>	Verification scale interval of weighing equipment
<i>m</i>	Load exerted on weighing equipment
<i>n</i>	Number

4 Classification

4.1 Exposure classes related to environmental actions

The environmental actions are classified as exposure classes in Table 1. The given examples are informative.

NOTE The exposure classes to be selected depend on the provisions valid in the place of use of the concrete. This exposure classification does not exclude consideration of special conditions existing in the place of use of the concrete or the application of protective measures such as the use of stainless steel or other corrosion resistant metal and the use of protective coatings for the concrete or the reinforcement.

The concrete may be subject to more than one of the actions described in Table 1 and the environmental conditions to which it is subjected may thus need to be expressed as a combination of exposure classes.

^{A2} For a given structural component, different concrete surfaces may be subject to different environmental actions. ^{A2}

Table 1 — Exposure classes

Class designation	Description of the environment	Informative examples where exposure classes may occur
1 No risk of corrosion or attack		
X0	For concrete without reinforcement or embedded metal: all exposures except where there is freeze/thaw, abrasion or chemical attack For concrete with reinforcement or embedded metal: very dry	Concrete inside buildings with very low air humidity.
2 Corrosion induced by carbonation		
Where concrete containing reinforcement or other embedded metal is exposed to air and moisture, the exposure shall be classified as follows: NOTE The moisture condition relates to that in the concrete cover to reinforcement or other embedded metal, but in many cases, conditions in the concrete cover can be taken as reflecting that in the surrounding environment. In these cases classification of the surrounding environment may be adequate. This may not be the case if there is a barrier between the concrete and its environment.		
XC1	Dry or permanently wet	Concrete inside buildings with low air humidity. Concrete permanently submerged in water.
XC2	Wet, rarely dry	Concrete surfaces subject to long-term water contact. Many foundations.
XC3	Moderate humidity	Concrete inside buildings with moderate or high air humidity. External concrete sheltered from rain.
XC4	Cyclic wet and dry	Concrete surfaces subject to water contact, not within exposure Class XC2.
3 Corrosion induced by chlorides other than from sea water		
Where concrete containing reinforcement or other embedded metal is subject to contact with water containing chlorides, including de-icing salts, from sources other than from sea water, the exposure shall be classified as follows: NOTE Concerning moisture conditions, see also section 2 of this table.		
XD1	Moderate humidity	Concrete surfaces exposed to airborne chlorides.
XD2	Wet, rarely dry	Swimming pools. Concrete exposed to industrial waters containing chlorides.
XD3	Cyclic wet and dry	Parts of bridges exposed to spray containing chlorides. Pavements. Car park slabs.

Table 1 — Exposure classes (*continued*)

Class designation	Description of the environment	Informative examples where exposure classes may occur
4 Corrosion induced by chlorides from sea water		
Where concrete containing reinforcement or other embedded metal is subject to contact with chlorides from sea water or air carrying salt originating from sea water, the exposure shall be classified as follows:		
XS1	Exposed to airborne salt but not in direct contact with sea water	Structures near to or on the coast
XS2	Permanently submerged	Parts of marine structures
XS3	Tidal, splash and spray zones	Parts of marine structures
5 Freeze/thaw attack with or without de-icing agents		
Where concrete is exposed to significant attack by freeze/thaw cycles whilst wet, the exposure shall be classified as follows:		
XF1	Moderate water saturation, without de-icing agent	Vertical concrete surfaces exposed to rain and freezing
XF2	Moderate water saturation, with de-icing agent	Vertical concrete surfaces of road structures exposed to freezing and airborne de-icing agents
XF3	High water saturation, without de-icing agent	Horizontal concrete surfaces exposed to rain and freezing
XF4	High water saturation, with de-icing agent or sea water	Road and bridge decks exposed to de-icing agents. Concrete surfaces exposed to direct spray containing de-icing agents and freezing. Splash zones of marine structures exposed to freezing.
6 Chemical attack		
Where concrete is exposed to chemical attack from natural soils and ground water as given in Table 2, the exposure shall be classified as given below. The classification of sea water depends on the geographical location, therefore the classification valid in the place of use of the concrete applies.		
NOTE A special study may be needed to establish the relevant exposure condition where there is: — limits outside of Table 2; — other aggressive chemicals; — chemically polluted ground or water; — high water velocity in combination with the chemicals in Table 2.		
XA1	Slightly aggressive chemical environment according to Table 2	
XA2	Moderately aggressive chemical environment according to Table 2	
XA3	Highly aggressive chemical environment according to Table 2	