



BSI Standards Publication

Concrete — Specification, performance, production and conformity

National foreword

This British Standard is the UK implementation of EN 206:2013+A2:2021. It supersedes BS EN 206:2013+A1:2016, which is withdrawn.

This British Standard is intended to 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 206:2013+A2:2021. The UK committee draws particular attention to subclause 10.1, which recommends "the inspection and certification of the production control by accredited inspection and certification bodies".

The start and finish of text introduced or altered by amendment is indicated in the text by tags. 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.

The UK participation in its preparation was entrusted to Technical Committee B/517/1, Concrete production and testing.

A list of organizations represented on this committee can be obtained on request to its committee manager.

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Date	Text affected
31 August 2021	Implementation of CEN amendment A2:2021. National foreword updated

English Version

Concrete - Specification, performance, production and conformity

Béton - Spécification, performances, production et conformité

Beton - Festlegung, Eigenschaften, Herstellung und Konformität

This European Standard was approved by CEN on 27 July 2016 and includes Amendment 2 approved by CEN on 4 January 2021.

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 CEN-CENELEC 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 CEN-CENELEC Management Centre has the same status as the official versions.

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European foreword

A2 This document (EN 206:2013+A2:2021) has been prepared by Technical Committee CEN/TC 104 “Concrete and related products”, the secretariat of which is held by SN.

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 September 2021 and conflicting national standards shall be withdrawn at the latest by September 2021.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

Based on a CEN/BT Decision (T 42/2013) EN 12620:2013 was withdrawn. Therefore, this document has been aligned with the specifications given in EN 12620:2002+A1:2008. As soon as CEN/TC 154 publishes a new version of EN 12620, CEN/TC 104 intends to amend EN 206.

This document includes Amendment 1 approved by CEN on 27 July 2016 and Amendment 2 approved by CEN on 4 January 2021.

The start and finish of text introduced or altered by amendment is indicated in the text by tags **A1** and **A2**.

This document supersedes EN 206:2013+A1:2016.

In particular, the following main items had been subject to revision when preparing EN 206:2013:

- a) adding application rules for fibre concrete and concrete with recycled aggregates;
- b) revising *k*-value concept for fly ash and silica fume and adding new rules for ground granulated blast furnace slag;
- c) introduction of principles for the performance concepts for the use of additions, e.g. equivalent concrete performance concept and equivalent performance of combinations concept;
- d) revising and adding new concepts for the conformity assessment;
- e) including EN 206-9 “Additional rules for self-compacting concrete (SCC)”;
- f) including additional requirements for concrete for special geotechnical works (Annex D).

NOTE Annex D was jointly prepared by CEN/TC 104 and CEN/TC 288.

Amendment 2 are changes deemed necessary to clarify guidance for conformity assessment in clause 10.2 and correcting the status of Annex C to informative. **A2**

Figure 1 illustrates the relationships between EN 206 and standards for design and execution, standards for constituents and test standards.

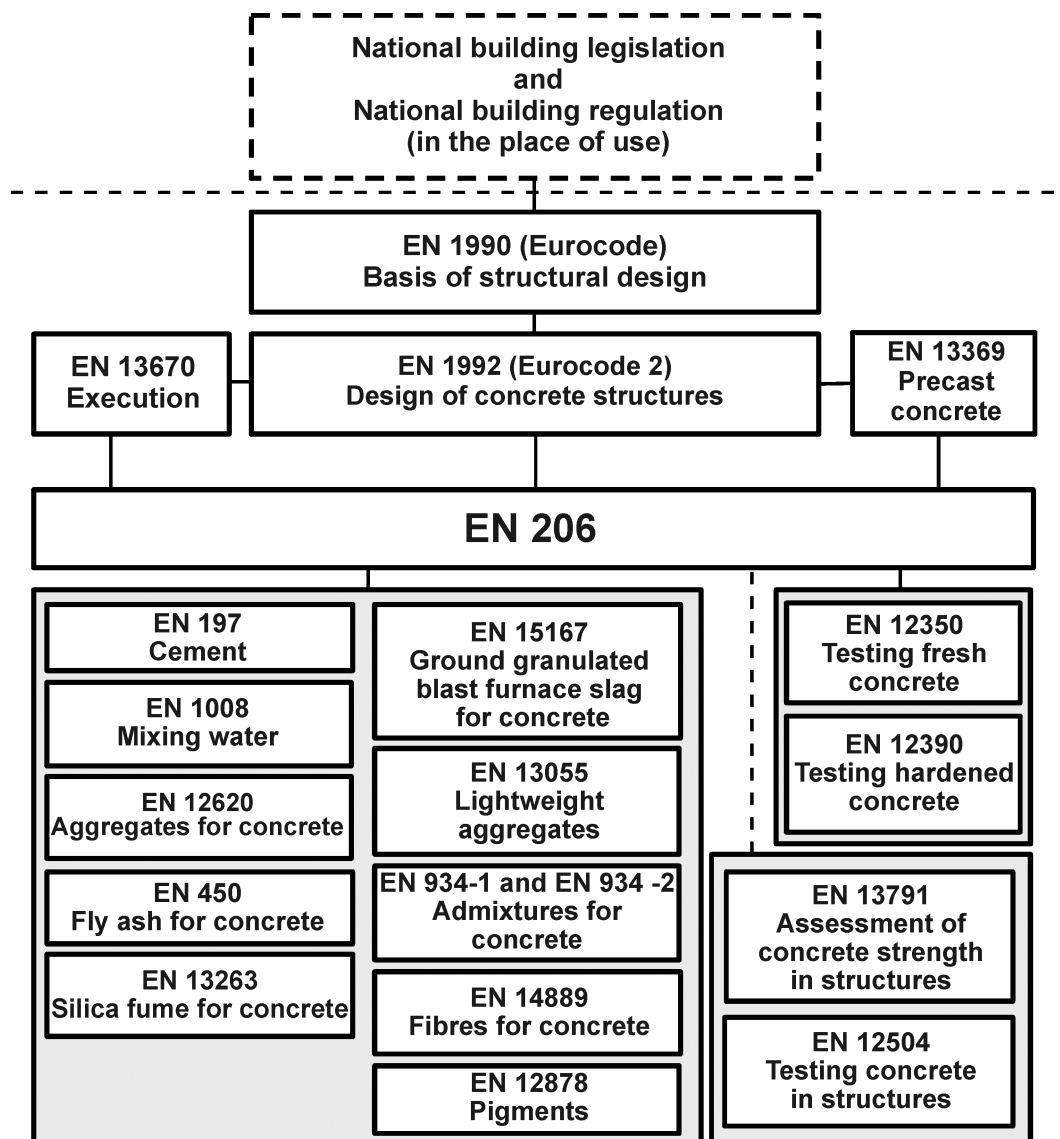


Figure 1 — Relationships between EN 206 and standards for design and execution, standards for constituents and test standards

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

Introduction

This European Standard will be applied 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 provisions valid in the place of use of the concrete.

This European Standard incorporates rules for the use of constituents that are covered by European Standards. Constituents not covered by European Standards may be used in accordance with provisions valid in the place of use of the concrete.

If the concrete is in conformity with the limiting values, the concrete in the structure is deemed to satisfy the durability requirements for the intended use in the specific environmental condition, provided:

- the appropriate exposure classes were selected;
- the concrete has the minimum cover to reinforcement in accordance with the relevant design standard required for the specific environmental condition, e.g. EN 1992-1-1;
- the concrete is properly placed, compacted and cured, e.g. in accordance with EN 13670 or other relevant standards;
- the appropriate maintenance is applied during the working life.

Performance based concepts as alternatives to the concept of limiting values are under development.

Concrete conforming to this European Standard may be assumed to satisfy the basic requirements for materials to be used in all three Execution Classes as defined in EN 13670.

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 of concrete”. Conversely, the specifier, producer and user may be the same party (e.g. a precast concrete manufacturer or a contractor doing design and build). In the case of ready-mixed concrete, the purchaser of the fresh concrete is the specifier who gives the specification of concrete to the producer.

This European 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 Technical Reports.

1 Scope

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

(2) The concrete under this European Standard can be:

- normal-weight, heavy-weight and light-weight;
- mixed on site, ready-mixed or produced in a plant for precast concrete products;
- compacted or self-compacting to retain no appreciable amount of entrapped air other than entrained air.

(3) This standard specifies requirements for:

- the constituents 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.

(4) 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.

(5) Additional or different requirements may be given for specific applications in other European Standards, for example:

- concrete to be used in roads and other trafficked areas (e.g. concrete pavements according to EN 13877-1);
- special technologies (e.g. sprayed concrete according to EN 14487).

(6) Supplementing requirements or different testing procedures may be specified for specific types of concrete and applications, for example:

- concrete for massive structures (e.g. dams);
- dry mixed concrete;
- concrete with a $D_{\max}$ of 4 mm or less (mortar);
- self-compacting concretes (SCC) containing lightweight or heavy-weight aggregates or fibres;
- concrete with open structure (e. g. pervious concrete for drainage).

(7) This standard does not apply to:

- aerated concrete;

- foamed concrete;
- concrete with density less than 800 kg/m³;
- refractory concrete.

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

2 Normative references

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

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 450-1, *Fly ash for concrete — Part 1: Definition, specifications and conformity criteria*

EN 934-1:2008, *Admixtures for concrete, mortar and grout — Part 1: Common requirements*

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

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 1097-6:2013, *Tests for mechanical and physical properties of aggregates — Part 6: Determination of particle density and water absorption*

EN 1536, *Execution of special geotechnical work — Bored piles*

EN 1538, *Execution of special geotechnical work — Diaphragm walls*

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

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

EN 12350-8, *Testing fresh concrete — Part 8: Self-compacting concrete — Slump-flow test*

EN 12350-9, *Testing fresh concrete — Part 9: Self-compacting concrete — V-funnel test*

- EN 12350-10, *Testing fresh concrete — Part 10: Self-compacting concrete — L box test*
- EN 12350-11, *Testing fresh concrete — Part 11: Self-compacting concrete — Sieve segregation test*
- EN 12350-12, *Testing fresh concrete — Part 12: Self-compacting concrete — J-ring test*
- EN 12390-1, *Testing hardened concrete — Part 1: Shape, dimensions and other requirements for 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 12620:2002+A1:2008, *Aggregates for concrete*
- EN 12699, *Execution of special geotechnical work — Displacement piles*
- EN 12878, *Pigments for the colouring of building materials based on cement and/or lime — Specifications and methods of test*
-  
- EN 13055, *Lightweight aggregates* 
- EN 13263-1, *Silica fume for concrete — Part 1: Definitions, requirements and conformity criteria*
- EN 13577, *Chemical attack on concrete — Determination of aggressive carbon dioxide content in water*
- EN 14199, *Execution of special geotechnical works — Micropiles*
- EN 14216, *Cement — Composition, specifications and conformity criteria for very low heat special cements*
- EN 14488-7, *Testing sprayed concrete — Part 7: Fibre content of fibre reinforced concrete*
- EN 14721, *Test method for metallic fibre concrete — Measuring the fibre content in fresh and hardened concrete*
- EN 14889-1:2006, *Fibres for concrete — Part 1: Steel fibres — Definitions, specifications and conformity*
- EN 14889-2:2006, *Fibres for concrete — Part 2: Polymer fibres — Definitions, specifications and conformity*
- EN 15167-1, *Ground granulated blast furnace slag for use in concrete, mortar and grout — Part 1: Definitions, specifications and conformity criteria*
- prEN 16502, *Test method for the determination of the degree of soil acidity according to Baumann-Gully*
- EN ISO 7980, *Water quality — Determination of calcium and magnesium — Atomic absorption spectrometric method (ISO 7980)*

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*

ASTM C 173, *Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method*

3 Terms, definitions, symbols and abbreviations

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1.1 General

3.1.1.1

concrete

fr: béton

de: Beton

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

3.1.1.2

concrete family

fr: famille de béton

de: Betonfamilie

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

3.1.1.3

delivery

fr: livraison

de: Lieferung

process of handing over the fresh concrete by the producer

3.1.1.4

designed concrete

fr: béton à propriétés spécifiées

de: Beton nach Eigenschaften

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

3.1.1.5

design working life

fr: durée de vie de projet

de: Bemessungslebensdauer

assumed period for which a structure or a part of it is to be used for its intended purpose with anticipated maintenance but without major repair being necessary

3.1.1.6**document**

fr: document

de: Dokument

information and its supporting medium, which can be paper, magnetic, electronic or optical computer disc, photograph or reference sample or a combination thereof

3.1.1.7**environmental actions**

fr: actions dues à l'environnement

de: Umwelteinflüsse

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

3.1.1.8**precast element**

fr: élément préfabriqué

de: Fertigteil

concrete element cast and cured in a place other than the final location of use (factory produced or site manufactured)

3.1.1.9**precast product**

fr: produit préfabriqué

de: Fertigteil

precast element manufactured in compliance with the relevant European product standard

3.1.1.10**prescribed concrete**

fr: béton à composition prescrite

de: Beton nach Zusammensetzung

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

3.1.1.11**producer**

fr: producteur

de: Hersteller

person or body producing fresh concrete

3.1.1.12**provisions valid in the place of use**

fr: dispositions en vigueur sur le lieu d'utilisation du béton

de: am Ort der Verwendung geltende Regeln

national provisions given in a National Foreword or National Annex to this European Standard, or in a complementary national standard to this European Standard applicable in the place of use of the concrete

3.1.1.13

ready-mixed concrete

fr: béton prêt à l'emploi

de: Transportbeton

concrete delivered in a fresh state by a person or body who is not the user; in the sense of this standard it is also:

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

3.1.1.14

self-compacting concrete (SCC)

fr: béton auto-plaçant

de: selbstverdichtender Beton

concrete that is able to flow and compact under its own weight, fill the formwork with its reinforcement, ducts, boxouts etc., whilst maintaining homogeneity

3.1.1.15

site-mixed concrete

fr: béton de chantier

de: Baustellenbeton

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

3.1.1.16

site (construction site)

fr: chantier (chantier de construction)

de: Baustelle

area where the construction work is undertaken

3.1.1.17

specification of concrete

fr: spécification du béton

de: Festlegung

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

3.1.1.18

specifier

fr: prescripteur

de: Verfasser der Festlegung

person or body establishing the specification for fresh and hardened concrete

3.1.1.19

standardized prescribed concrete

fr: béton à composition prescrite dans une norme

de: Standardbeton

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

3.1.1.20**user**

fr: utilisateur

de: Verwender

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

3.1.2 Constituents**3.1.2.1****addition**

fr: addition

de: Betonzusatzstoff

finely-divided-inorganic constituent used in concrete in order to improve certain properties or to achieve special properties

3.1.2.2**type I addition**

fr: addition de type I

de: Typ-I-Zusatzstoff

nearly inert addition

3.1.2.3**type II addition**

fr: addition de type II

de: Typ II-Zusatzstoff

pozzolanic or latent hydraulic addition

3.1.2.4**admixture**

fr: adjuvant

de: Betonzusatzmittel

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

3.1.2.5**aggregate**

fr: granulat

de: Gesteinskörnung

natural, artificial, reclaimed or recycled granular mineral constituent suitable for use in concrete

3.1.2.6**all-in aggregate**

fr: grave

de: Gesteinskörnungsgemisch

aggregate consisting of a mixture of coarse and fine aggregates with D greater than 4 mm and $d = 0$ **3.1.2.7****aggregate size**

fr: classe granulaire

de: Korngröße

designation of aggregate in terms of lower (d) and upper (D) sieve sizes expressed as d / D

3.1.2.8

cement

fr: ciment

de: Zement

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

[SOURCE: EN 197-1]

3.1.2.9

finer in concrete

fr: fines du béton

de: Mehlkorn

sum of solid materials in fresh concrete with particle sizes less than or equal to 0,125 mm

3.1.2.10

heavy-weight aggregate

fr: granulats lourds

de: schwere Gesteinskörnung

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

3.1.2.11

lightweight aggregate

fr: granulats légers

de: leichte Gesteinskörnung

aggregate of mineral origin in the oven-dry condition having a 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

3.1.2.12

normal-weight aggregate

fr: granulats courants

de: normale Gesteinskörnung

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

3.1.2.13

polymer fibres

fr: fibres polymères

de: Polymerfasern

straight or deformed pieces of extruded, orientated and cut material, which are suitable to be homogeneously mixed into concrete

[SOURCE: EN 14889-2:2006, 3.2]

3.1.2.14

reclaimed washed aggregate

fr: granulats récupérés par lavage

de: wiedergewonnene gewaschene Gesteinskörnung

aggregates gained by washing fresh concrete

3.1.2.15**reclaimed crushed aggregate**

fr: granulât récupéré par concassage

de: wiedergewonnene gebrochene Gesteinskörnung

aggregate gained by crushing hardened concrete that has not been previously used in construction

3.1.2.16**recycled aggregate**

fr: gravillon recyclé

de: grobe rezyklierte Gesteinskörnung

aggregate resulting from the processing of inorganic material previously used in construction

3.1.2.17**steel fibres**

fr: fibres d'acier

de: Stahlfasern

straight or deformed pieces of cold-drawn steel wire, straight or deformed cut sheet fibres, melt extracted fibres, shaved cold drawn wire fibres or fibres milled from steel blocks, which are suitable to be homogeneously mixed into concrete

[SOURCE: adopted from EN 14889-1:2006, 3.1]

3.1.3 Fresh concrete**3.1.3.1****agitating equipment**

fr: cuve agitatrice

de: Rührwerk

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

3.1.3.2**batch**

fr: gâchée

de: Charge

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

3.1.3.3**cubic metre of concrete**

fr: mètre cube de béton

de: Kubikmeter Beton

quantity of fresh concrete which, when compacted in accordance with the procedure given in EN 12350-6, occupies a volume of 1 m³**3.1.3.4****effective water content**

fr: teneur en eau efficace

de: wirksamer Wassergehalt

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

3.1.3.5

entrained air

fr: air entrainé

de: künstliche Luftporen

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

3.1.3.6

entrapped air

fr: air occlus

de: Lufteinschlüsse

air voids in concrete which are not purposely entrained

3.1.3.7

fresh concrete

fr: béton frais

de: Frischbeton

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

3.1.3.8

load

fr: charge

de: Ladung

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

3.1.3.9

non-agitating equipment

fr: cuve non agitatrice

de: Ausrüstung ohne Rührwerk

equipment used for transporting concrete without agitation (3.1.3.1)

EXAMPLE dump truck or transport hopper

3.1.3.10

passing ability

fr: aptitude à l'écoulement

de: Blockierneigung

ability of fresh concrete to flow through tight openings such as spaces between steel reinforcing bars without segregation or blocking

3.1.3.11

segregation resistance

fr: résistance à la ségrégation

de: Sedimentationsstabilität

ability of fresh concrete to remain homogeneous in composition while in its fresh state

3.1.3.12

slump-flow

fr: étalement au cône d'Abrams

de: Setzfließmaß

mean diameter of the spread of fresh concrete from a standardized slump cone

3.1.3.13**total water content**

fr: teneur en eau totale

de: Gesamtwassergehalt

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

3.1.3.14**truck mixer**

fr: camion malaxeur

de: Fahrmischer

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

3.1.3.15**viscosity of concrete**

fr: viscosité apparente

de: Viskosität

resistance to flow of fresh concrete once flow has started

3.1.3.16**water/cement ratio**

fr: rapport eau/ciment

de: Wasserzementwert

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

Note 1 to entry: Where additions are used, the water/cement ratio is replaced according to 5.4.2 (3).

3.1.4 Hardened concrete**3.1.4.1****lightweight concrete**

fr: béton léger

de: Leichtbeton

concrete in the oven-dry condition having a density of not less than 800 kg/m³ and not more than 2 000 kg/m³

3.1.4.2**hardened concrete**

fr: béton durci

de: Festbeton

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

3.1.4.3**heavy-weight concrete**

fr: béton lourd

de: Schwerbeton

concrete in the oven-dry condition having density greater than 2 600 kg/m³

3.1.4.4

normal-weight concrete

fr: béton de masse volumique normale

de: Normalbeton

concrete in the oven-dry condition having a density greater than 2 000 kg/m³ but not exceeding 2 600 kg/m³

3.1.5 Conformity and production control

3.1.5.1

average outgoing quality

AOQ

fr: qualité moyenne après contrôle

AOQ

de: Durchschlupf

AOQ

percentage of the unknown distribution below the required characteristic value multiplied by the corresponding acceptance probability of that distribution when using the applied conformity assessment

Note 1 to entry: In the case of strength, the word 'required' refers to the characteristic strength for the specified compressive strength class or the characteristic strength of the reference concrete of the family.

3.1.5.2

average outgoing quality limit

AOQL

fr: limite de la qualité moyenne après contrôle

AOQL

de: maximaler Durchschlupf

AOQL

maximum average fraction below the required characteristic value in the accepted (or outgoing) concrete production

3.1.5.3

acceptable quality level

AQL

fr: niveau de qualité acceptable

NQA

de: annehmbare Qualitätsgrenze

AQL

percentage of the unknown distribution worse than the specified characteristic of the property under consideration that is considered satisfactory for the production of concrete

3.1.5.4

characteristic strength

fr: résistance caractéristique

de: charakteristische Festigkeit

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

3.1.5.5**compressive strength class**

fr: classe de résistance à la compression

de: Druckfestigkeitsklasse

classification comprising the type of concrete (normal-weight and heavy-weight or lightweight), the minimum characteristic cylinder strength (150 mm diameter by 300 mm length) and the minimum characteristic cube strength (150 mm edge length)

3.1.5.6**conformity test**

fr: essai de conformité

de: Konformitätsprüfung

test performed by the producer to assess conformity of the concrete

3.1.5.7**evaluation of conformity**

fr: évaluation de conformité

de: Beurteilung der Konformität

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

3.1.5.8**identity test**

fr: essai d'identification

de: Identitätsprüfung

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

3.1.5.9**initial test**

fr: essai initial

de: Erstprüfung

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

3.1.5.10**verification**

fr: vérification

de: Nachweise

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
XC1 to XC4	Exposure classes for risk of corrosion induced by carbonation
XD1 to XD3	Exposure classes for risk of corrosion induced by chlorides other than from sea water
XS1 to XS3	Exposure classes for risk of corrosion induced by chlorides from sea water
XF1 to XF4	Exposure classes for risk of freeze/thaw attack
XA1 to XA3	Exposure classes for risk of chemical attack
S1 to S5	Consistence classes expressed by slump
C0 to C4	Consistence classes expressed by degree of compactability

F1 to F6	Consistence classes expressed by flow diameter
SF1 to SF3	Consistence classes expressed by slump-flow
VS1, VS2	Viscosity classes for the t_{500} time
VF1, VF2	Viscosity classes for the V-funnel flow time, t_v
t_{500}	Time in seconds to flow to a diameter of 500 mm in a slump-flow test
t_v	Time in seconds of the flow in a V-funnel test
PL1, PL2	Passing ability classes for the L-box-test
PJ1, PJ2	Passing ability classes for the J-ring-test
SR1, SR2	Segregation resistance classes
C.../...	Compressive strength classes in case of normal-weight and heavy-weight concrete
LC.../...	Compressive strength classes in case of lightweight concrete
SCC	Self-compacting concrete
ECPC	Equivalent concrete performance concept
EPCC	Equivalent performance of combinations concept
f_{ck}	Characteristic compressive strength of concrete NOTE Where used in this standard this applies to both $f_{ck,cyl}$ and $f_{ck,cube}$.
$f_{ck,cyl}$	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 NOTE Where used in this standard this applies to both $f_{cm,cyl}$ and $f_{cm,cube}$.
$f_{cm,j}$	Mean compressive strength of concrete at the age of (j) days
f_{ci}	Individual test result for compressive strength of concrete
$f_{ctk,sp}$	Characteristic tensile splitting strength of concrete
$f_{ctm,sp}$	Mean tensile splitting strength of concrete
$f_{cti,sp}$	Individual test result for tensile splitting test of concrete
ggbs	Ground granulated blastfurnace slag
Cl, ...	Chloride class
D1,0 to D2,0	Density classes of lightweight concrete
D	Upper sieve size in an aggregate categorised as d / D NOTE EN 12620 permits a defined percentage by mass of particles to be larger than 'D'.
D_{lower}	Smallest value of D for the coarsest fraction of aggregates in the concrete permitted by the specification of concrete

D_{upper}	Largest value of D for the coarsest fraction of aggregates in the concrete permitted by the specification of concrete
D_{max}	Declared value of D of the coarsest fraction of aggregates actually used in the concrete
CEM...	Cement type according to EN 197-1
σ	Estimate for the standard deviation of a population
s_n	Standard deviation of n consecutive test results
AOQ	Average outgoing quality
AOQL	Average outgoing quality limit
AQL	Average quality level
w/c	Water/cement ratio
k	Factor which takes into account the activity of a type II addition
n	Number

4 Classification

4.1 Exposure classes related to environmental actions

(1) The environmental actions are classified by exposure classes; see Table 1. The given examples are informative.

NOTE 1 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.

NOTE 2 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. For a given structural component, different concrete surfaces may be subject to different environmental actions.

(2) In the case of chemical attack, 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.

NOTE 3 Provisions valid in the place of use may cover some of these situations.

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:		
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:		
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

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, the exposure shall be classified as follows:		
XA1	Slightly aggressive chemical environment	Concrete exposed to natural soil and ground water according to Table 2
XA2	Moderately aggressive chemical environment	Concrete exposed to natural soil and ground water according to Table 2
XA3	Highly aggressive chemical environment	Concrete exposed to natural soil and ground water according to Table 2

(3) The aggressive chemical environments classified in Table 2 are based on natural soil and ground water at water/-soil temperatures between 5 °C and 25 °C and a water velocity sufficiently slow to approximate to static conditions. The most onerous value for any single chemical characteristic determines the class. Where two or more aggressive characteristics lead to the same class, the environment shall be classified into the next higher class, unless a special study for this specific case proves that it is not necessary.

Table 2 — Limiting values for exposure classes for chemical attack from natural soil and ground water

Chemical characteristic	Reference test method	XA1	XA2	XA3
Ground water				
SO ₄ ²⁻ mg/l	EN 196-2	≥ 200 and ≤ 600	> 600 and ≤ 3 000	> 3 000 and ≤ 6 000
pH	ISO 4316	≤ 6,5 and ≥ 5,5	< 5,5 and ≥ 4,5	< 4,5 and ≥ 4,0
CO ₂ mg/l aggressive	EN 13577	≥ 15 and ≤ 40	> 40 and ≤ 100	> 100 up to saturation
NH ₄ ⁺ mg/l	ISO 7150-1	≥ 15 and ≤ 30	> 30 and ≤ 60	> 60 and ≤ 100
Mg ²⁺ mg/l	EN ISO 7980	≥ 300 and ≤ 1 000	> 1 000 and ≤ 3 000	> 3 000 up to saturation
Soil				
SO ₄ ²⁻ mg/kg ^a total	EN 196-2 ^b	≥ 2 000 and ≤ 3 000 ^c	> 3 000 ^c and ≤ 12 000	> 12 000 and ≤ 24 000
Acidity according to Baumann Gully ml/kg	prEN 16502	> 200	Not encountered in practice	
^a Clay soils with a permeability below 10 ⁻⁵ m/s may be moved into a lower class. ^b The test method prescribes the extraction of SO ₄ ²⁻ by hydrochloric acid; alternatively, water extraction may be used, if experience is available in the place of use of the concrete. ^c The 3 000 mg/kg limit shall be reduced to 2 000 mg/kg, where there is a risk of accumulation of sulfate ions in the concrete due to drying and wetting cycles or capillary suction.				

4.2 Classes for properties of fresh concrete

4.2.1 Consistence classes

(1) Where concrete is classified with respect to consistence, Tables 3, 4, 5 and 6 apply. In the case of SCC, only the classes in Table 6 apply.

(2) Consistence may also be specified by a target value with tolerances as given in Table 23.

NOTE 1 The classes of consistence in Tables 3 to 6 are not directly related. For earth moist concrete, i.e. concrete with low water content designed to be compacted in special processes, the consistence is not classified.

NOTE 2 For further information see Annex L, line 1.

Table 3 — Slump classes

Class	Slump tested in accordance with EN 12350-2 mm
S1	10 to 40
S2	50 to 90
S3	100 to 150
S4	160 to 210
S5 ^a	≥ 220
^a See Note 1 to 5.4.1.	

Table 4 — Compaction classes

Class	Degree of compactability tested in accordance with EN 12350-4
C0 ^a	≥ 1,46
C1	1,45 to 1,26
C2	1,25 to 1,11
C3	1,10 to 1,04
C4 ^b	< 1,04
^a See Note 1 to 5.4.1.	
^b C4 applies only to lightweight concrete.	

Table 5 — Flow classes

Class	Flow diameter tested in accordance with EN 12350-5 mm
F1 ^a	≤ 340
F2	350 to 410
F3	420 to 480
F4	490 to 550
F5	560 to 620
F6 ^a	≥ 630
^a See Note 1 to 5.4.1.	

Table 6 — Slump-flow classes

Class	Slump-flow ^a tested in accordance with EN 12350-8 mm
SF1	550 to 650
SF2	660 to 750
SF3	760 to 850
^a The classification is not applicable to concrete with $D_{\max}$ exceeding 40 mm.	

4.2.2 Classes for additional properties of SCC

(1) Where self-compacting concrete is classified with respect to viscosity, passing ability or sieve segregation resistance, Tables 7 to 11 apply.

(2) Viscosity may also be specified by a target value with tolerances as given in Table 23.

(3) Passing ability may also be specified by a minimum value when determined by the L-box-Test or by a maximum value when determined by the J-Ring-Test.

(4) Sieve segregation may also be specified by a maximum value.

Table 7 — Viscosity classes – t_{500}

Class	t_{500} ^a tested in accordance with EN 12350-8 s
VS1	< 2,0
VS2	≥ 2,0
^a The classification is not applicable to concrete with $D_{\max}$ exceeding 40 mm.	

Table 8 — Viscosity classes – t_v

Class	t_v ^a tested in accordance with EN 12350-9 s
VF1	< 9,0
VF2	9,0 to 25,0
^a The classification is not applicable to concrete with $D_{\max}$ exceeding 22,4 mm.	

NOTE 1 The classes in Tables 7 and 8 are similar but not exactly correlated.

Table 9 — Passing ability classes - L-box

Class	L-box ratio tested in accordance with EN 12350-10
PL1	≥ 0,80 with 2 rebars
PL2	≥ 0,80 with 3 rebars

Table 10 — Passing ability classes – J-ring

Class	J-ring step ^a tested in accordance with EN 12350-12 mm
PJ1	≤ 10 with 12 rebars
PJ2	≤ 10 with 16 rebars
^a The classification is not applicable to concrete with a maximum aggregate size exceeding 40 mm.	

NOTE 2 The classes in Tables 9 and 10 are similar but not exactly correlated.

Table 11 — Sieve segregation resistance classes

Class	Segregated portion ^a tested in accordance with EN 12350-11 %
SR1	≤ 20
SR2	≤ 15
^a The classification is not applicable to concrete with $D_{\max}$ exceeding 40 mm.	

4.3 Classes for properties of hardened concrete

4.3.1 Compressive strength classes

(1) Where concrete is classified with respect to its compressive strength, Table 12 applies for normal-weight and heavy-weight concrete and Table 13 applies for lightweight concrete. The characteristic compressive strength at 28 days of 150 mm diameter by 300 mm cylinders ($f_{ck,cyl}$) or the characteristic compressive strength at 28 days of 150 mm cubes ($f_{ck,cube}$), tested in accordance with EN 12390-3 may be used for classification.

NOTE For further information see Annex L, line 2.