**National foreword**

EN 206 allows for the definition of national provisions to take account of well-established regional experiences.

The Luxembourg national standards committee ILNAS/TC 102 "Béton" has drafted the National Complement (NC) to the European standard EN 206:2013+A2:2021, which allows the implementation of the latter in Luxembourg.

This document combines the text of the French version of the European Standard ILNAS EN 206:2013+A2:2021 and the Luxembourg provisions.

These provisions supplement or amend the original provisions of the European Standard. These provisions are normative or informative and apply in Luxembourg. As such, this document applies when a national document refers to standard EN 206.

The provisions of the CN are placed inside a frame with a grey background following the corresponding elements of the European standard. The CN article, paragraph, figure or table numbers correspond to the numbers of the same elements of EN 206:2013+A2:2021 that they supplement or modify. Where appropriate, when new elements are added, the numbering shall be continued. The numbers relating to the provisions of CN are preceded by the word “CN”.

This document refers to EN 13670 and EN 13670/CN-LU for the execution of concrete structures, as well as EN 13369 and EN 13369/CN-LU as regards common rules for prefabricated concrete products. These CNs are being drafted on the ILNAS/TC 102 Technical Committee. Pending their publication and in the absence of any formal contradiction, the CDC-BET — Specifications for Concrete Works, as approved by Ministerial Decision No 85559/013887 of 29 May 2007, applies for the execution of concrete structures and EN 13369 applies as such for prefabricated concrete products with the exception of normative references to EN 206, standard replaced by this document and EN 1992-1-1 and EN 1992-1-1 replaced by the normative references in Article CN 2.1 of this document.

Certain notes to Annex L (informative) — *Additional recommendations for certain particular paragraphs* of the European standard useful for comprehension are cited as additional notes in the relevant paragraphs. They shall be preceded by the words “Annex L”.

CN Figure 1 — Relations between EN 206 and calculation and performance standards, as well as standards for constituents and test standards in Luxembourg

*Modifies Figure 1*



National legislation in the field of construction and national regulations in the field of construction (at the place of use)

EN 1990/AN-LU

(Eurocodes)

Basis of structural design

EN 13369/CN-LU

Common rules for prefabricated concrete products \*)

EN 13670/CN-LU

Execution of concrete structures \*)

EN 1992/AN-LU

(Eurocode 2)

Design of concrete structures

**EN 206+CN-LU**

EN 197 Cement

EΝ 12350 Tests for fresh concrete

|  |  |
| --- | --- |
| EN 12620 | Aggregates for concrete |
| EN 13055 | Lightweight aggregates |

EΝ 12390 Tests for hardened concrete

EN 1008 Mixing water for concrete

RILEM CDC1 Freeze/thaw test method without chemical defroster

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| EN 450 | Fly ash for concrete |
| EN 13263 | Silica fume for concrete |
| EN 15167 | Ground blast furnace granulated slag for use in concrete |

RILEM CDC2 Freeze/thaw test method with chemical defroster

EN 13791 Evaluation of the resistance of concrete in structures

EN 934-1

EN 934-2 Concrete additives

EN 12504 Tests for concrete in structures

EN 14889 Fibres for concrete

EN 12878 Pigments

\*) Transitional provisions pending the publication of the CNs concerned: see the National Foreword.

**CN Introduction**

*Supplement to the Introduction*

The European standard EN 206 defines the tasks of the prescriber, the producer and the user. For example, the prescriber is responsible for the specification of concrete, Article 6, and the producer is responsible for monitoring compliance and production, Articles 8 and 9. The user is responsible for using the concrete in the structure.

In practice, it is possible that several different entities specify requirements at different stages of design and construction.

**Each is responsible for the transmission of the specified requirements and any additional requirements to the next link in the chain up to the producer.** For the purposes of European standard EN 206, the final compilation is referred to as “concrete specification”.

In the case of ready-to-use concrete and within the meaning of this document, **the entity ordering fresh concrete is the final prescriber that provides the complete specification of the concrete to the producer.**

As part of CN’s provisions, prescribed composition concretes (PCC) as defined in 3.1.1.10 are excluded from this document.

Attention is also drawn to the fact that:

* the requirement of self compacting concrete has consequences for implementation (e.g. constraints relating to sealing and pressure applied to the formwork).
* the values listed in Annex CN F for the composition and properties of concrete are not nominal values but limit values with the tolerances defined in Article 8 “Conformity control and conformity criteria”

Concrete shall be subject to controls and tests and shall comply with all the requirements laid down in the national implementing standards and documents relating to the calculation and execution of structures and in the national implementing standards and documents relating to the constituents, specification and performance of concrete.

**CN 1 Scope of application**

*Supplement and amendment of Article 1*

*Supplement to subparagraph (1):*

Concretes intended for factory prefabricated products covered by a standard must also comply with the provisions of EN 13369 supplemented by EN 13369/CN-LU \*) and the relevant product standards.

*Amendment of subparagraph (6) and supplement to subparagraph (7):*

This standard does not apply to concretes with a dimension Dmax ≤ 4 mm (mortar).

\*) Transitional provisions pending the publication of the CNs concerned: see the National Foreword.

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| **CN 2 Normative references***Amends Article 2*(1) The following documents, in their entirety or not, are normative references essential to the application of this document. For dated references, only the edition cited shall apply. For undated references, the latest edition of the reference document applies (including any amendments). |
| **CN 2.1 Design of concrete structures** |
| EN 1992-1-1 | Eurocode 2: Design of concrete structures:Part 1-1: General rules and rules for buildings |
| EN 1992-1-1/AN-LU | Eurocode 2: Design of concrete structures:Part 1-1: General rules and rules for buildingsLuxembourg National AnnexParameters determined at national level to be used for the sizing of buildings and civil engineering works to be built in Luxembourg |
| EN 1992-1-2 | Eurocode 2: Design of concrete structures – Part 1-2:General rules - Structural fire design |
| EN 1992-1-2/AN-LU | Eurocode 2: Design of concrete structures – Part 1-2:General rules - Structural fire designLuxembourg National AnnexParameters determined at national level to be used for the sizing of buildings and civil engineering works to be built in Luxembourg |
| EN 1992-2 | Eurocode 2 - Design of concrete structures – Part 2: Concrete bridges – Design and detailing rules |
| EN 1992-2/AN-LU | Eurocode 2 – Design of concrete structures – Part 2:Concrete bridges – Design and detailing rulesLuxembourg National AnnexParameters determined at national level to be used for the sizing of buildings and civil engineering works to be built in Luxembourg |
| EN 1992-3 | Eurocode 2 – Design of concrete structures – Part 3:Silos and tanks |
| EN 1992-3/AN-LU | Eurocode 2 – Design of concrete structures – Part 3.Silos and tanksLuxembourg National AnnexParameters determined at national level to be used for the sizing of buildings and civil engineering works to be built in Luxembourg |
| **CN 2.2 Hydraulic binders** |
| 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 197-2 | Cement – Part 2: :Conformity evaluation |
| EN 197-5 | Cement — Part 5. :Portland Cement Composite CEM II/C-M and Cement Composite CEM VI |
| EN 14216 | Cement:Composition, specifications and conformity criteria of special very low-heat cements |
| **CN 2.3 Aggregates** |
| EN 12620 | Aggregates for concrete |
| EN 13055 | Lightweigh aggregates |
| EN 933-1 | Tests for geometrical properties of aggregates – Part 1: Determination of granularity – Particle size analysis by sieving |
| EN 1097-3 | Tests to determine mechanical and physical properties of aggregates – Part 3:Method for the determination of bulk density and intergranular porosity |
| EN 1097-6: 2013 | Tests to determine mechanical and physical properties of aggregates – Part 6:Determination of actual density and coefficient of water absorption |
| EN 1744-6 | Tests to determine the chemical properties of aggregates – Part 6:Determination of the influence of a recycled aggregate extract on the initial curing time of cement |

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| **CN 2.4 Water** |
| EN 1008 | Mixing water for concrete:Specifications for sampling, testing and assessment of suitability for use, including water from concrete industry processes, such as concrete mixing water |
| EN ISO 7980 | Water quality – Determination of calcium and magnesium – Atomic absorption spectrometry method |
| ISO 7150-1 | Water quality — Determination of ammonium – Part 1:Manual spectrometric method |
| **CN 2.5 Additions** |
| EN 450-1 | Fly ash for concrete – Part 1:Definition, specification and compliance criteria |
| EN 13263-1 | Silica fume for concrete – Part 1:Definitions, requirements and criteria for compliance |
| EN 15167-1 | Ground blast furnace granulated slag for use in concrete, mortar and slurry – Part 1:Definitions, requirements and criteria for compliance |
| EN 12878 | Pigments for staining cement and/or lime building materials Specifications and test methods |
| EN 14889-1: 2006 | Concrete fibres – Part 1:Steel fibres – Definitions, specifications and compliance |
| EN 14889-2: 2006 | Concrete fibres – Part 2:Polymer fibres — Definition, specifications and conformity |
| DIN 51043: 1979-09 | Trass; Requirements, Tests |
| DIN 1100 | Hard aggregates for cement-bound floor screeds:Requirements and test methods |
| **CN 2.6 Additives** |
| EN 934-1: 2008 | Additives for concrete, mortar and slurry – Part 1:Common requirements |
| EN 934-2 | Additives for concrete, mortar and slurry – Part 2:Additives for concrete - Definitions, requirements, conformity, marking and labelling |

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| **CN 2.7 Fresh concrete tests** |
| EN 12350-1 | Tests for fresh concrete – Part 1:Sampling |
| EN 12350-2 | Tests for fresh concrete – Part 2:Slump test |
| EN 12350-4 | Tests for fresh concrete – Part 4:Clamping index |
| EN 12350-5 | Tests for fresh concrete – Part 5:Flow table test |
| EN 12350-6 | Tests for fresh concrete – Part 6:Density |
| EN 12350-7 | Tests for fresh concrete – Part 7:Air content - Compressibility method |
| EN 12350-8 | Test for fresh concrete – Part 8:Self-compacting concrete — Abrams cone flow table test |
| EN 12350-9 | Test for fresh concrete – Part 9:Self-compacting concrete — V funnel flow test |
| EN 12350-10 | Test for fresh concrete – Part 10:Self-compacting concrete — L-box test |
| EN 12350-11 | Test for fresh concrete – Part 11:Self-compacting concrete — Screen stability test |
| EN 12350-12 | Test for fresh concrete – Part 12:Self-compacting concrete — Ring flow test |
| EN 14488-7 | Tests for shotcrete – Part 7:Fibre content of fibre-reinforced concrete |
| EN 14721 | Method of testing metal fibre concrete:Measurement of the fibre content of fresh or hardened concrete |
| ASTM C 173 | Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method |
| Non-standardised | Water content of fresh concrete:DARR method according to DIN 1048-1 cancelled standard |

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| CN 2.8 Tests on hardened concrete |
| EN 12390-1 | Tests for hardened concrete – Part 1:Shape, dimensions and other requirements for test pieces and moulds |
| EN 12390-2 | Tests for hardened concrete – Part 2:Manufacture and preservation of test pieces for resistance tests |
| EN 12390-3 | Tests for hardened concrete – Part 3:Compressive strength of test pieces |
| EN 12390-4 | Tests for hardened concrete – Part 4:Compressive strength - Characteristics of test machines |
| EN 12390-5 | Test for hardened concrete – Part 5:Bending strength on test pieces |
| EN 12390-6 | Tests for hardened concrete – Part 6:Determination of tensile strength by splitting of test pieces |
| EN 12390-7 | Tests for hardened concrete – Part 7:Density of hardened concrete |
| EN 12390-8 | Test for hardened concrete – Part 8:Depth of penetration of water under pressure. |
| EN 12390-10 | Test for hardened concrete – Part 10:Determination of resistance to carbonation of concrete at atmospheric levels of carbon dioxide |
| EN 12390-11 | Test for hardened concrete – Part 11:Determination of the resistance of concrete to chloride penetration, unidirectional diffusion |
| EN 12390-12 | Test for hardened concrete – Part 12:Determination of resistance to concrete carbonation — Accelerated carbonation method |
| EN 12390-13 | Test for hardened concrete – Part 13:Determination of the secant modulus of elasticity in compression |
| EN 12390-14 | Test for hardened concrete – Part 14:Semi-adiabatic method of determining the heat released by concrete during its hardening process |
| EN 12390-15 | Test for hardened concrete – Part 15:Adiabatic method of determining the heat released by concrete during its hardening process |

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| EN 12390-16 | Test for hardened concrete – Part 16:Determination of concrete shrinkage |
| EN 12390-17 | Test for hardened concrete – Part 17:Determination of compressive creep of concrete |
| EN 12390-18 | Test for hardened concrete – Part 18:Determination of chloride migration coefficient |
| RILEM CDC 1 | Freeze/thaw test method without chemical defroster |
| RILEM CDC 2 | Freeze/thaw test method with chemical defroster |
| DIN 52108 | Testing of inorganic non-metallic materials - Wear test using the grinding wheel according to Böhme - Grinding wheel method  |
| CN 2.9 Resistance of concrete in structures |
| EN 12504-1 | Tests for concrete in structures – Part 1:Sprues – Collection, examination and compression testing. |
| EN 12504-2 | Tests for concrete in structures – Part 2:Non-destructive testing – Determination of rebound number. |
| EN 12504-3 | Tests for concrete in structures – Part 3:Determination of the pull-out force. |
| EN 12504-4 | Tests for concrete in structures – Part 4:Determination of ultrasonic pulse velocity. |
| EN 13791 | Assessment of compressive strength in structures and pre-cast concrete components. |
| CN 2.10 Prefabricated concrete products |
| EN 13369 | Common rules for prefabricated concrete products |
| EN 13369/CN-LU | Common rules for prefabricated concrete products Luxembourg national supplement to standard EN 13369 \*) |

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| **CN 2.11 Execution of concrete structures** |
| EN 13670 | Execution of concrete structures |
| EN 13670/CN-LU | Execution of concrete structuresLuxembourg National Supplement to standard EN 13670 \*) |
| EN 1536 | Execution of special geotechnical works - Bored piles |
| EN 1538 | Execution of special geotechnical works - Moulded walls |
| EN 12699 | Execution of special geotechnical works — Piles with soil displacement |
| EN 14199 | Execution of special geotechnical works — Micro-piles |
| **CN 2.13 Concrete exposure** |
| EN 13577 | Chemical attack of concrete:Determination of the aggressive carbon dioxide content of water |
| EN 16502 | Test method for the determination of the degree of acidity of soil according to Baumann-Gully |
| **CN 2.14 Concrete protection** |
| EN 1504 | Products and systems for the protection and repair of concrete structures:Parts 1 to 10 |

\*) Transitional provisions pending the publication of the CNs concerned: see the National Foreword.

*Supplement to paragraph 3.1.1.10*

NOTE: Concrete with a prescribed composition is not standardised in Luxembourg.

*Supplement to paragraph 3.1.1.14*

Self-compacting concrete is a normal concrete of fluid consistency, the rheological characteristics of which in the fresh state confer the ability to fill a mould of any shape as well as the spacing between the reinforcements without segregation and to get compacted by de-aeration autonomously by gravitational force alone.

*Supplement to paragraph 3.1.17*

NOTE: The specification of the technical requirements for fresh and hardened concrete may result from several additional requirements from several prescribers. The final specification of the concrete, resulting from the compilation of all the specified requirements, is transmitted to the concrete producer.

*Supplement to paragraph 3.1.18*

NOTE: Is responsible for the complete transmission of the final concrete specification, the natural or legal person who orders the concrete from the producer.

*Supplement to paragraph 3.1.2.9*

Total quantity of fines, expressed in kg per m3 of concrete, calculated from the sum of the cement content and the content of fines ≤ 0.125 mm from aggregates and additions.

*Supplement to paragraph 3.1.3.4*

In accordance with 5.4.2 (2), the absorbed water is derived from the aggregate absorption coefficient determined in accordance with EN 1097-6. The effective water content is noted Eeff..

*Amends paragraph 3.1.3.13*

Sum of the added water, the water already contained in and on the aggregate surface, the water of the additives, the water of the additions used in the form of suspensions, as well as any water resulting from the addition of ice or steam heating.

**CN 3.1.3.17 Equivalent water/cement ratio**

*Supplement*

The term “equivalent water/cement ratio” is defined by the formula:

(e/c)eq. = eeff. /(c + k ∙ a)

with: (e/c)eq: equivalent water/cement ratio

eeff. : effective water content according to 3.1.3.4

c: cement mass per cubic metre of concrete [kg/m3]

k: coefficient for taking into account the addition considered in accordance with 5.2.5.2.

a: mass of addition per cubic metre of concrete [kg/m3]

**CN 3.1.3.18 Equivalent binder**

*Supplement*

The term “equivalent binder” is defined by the formula:

Leq. = c + k ∙ a

with Léq. : equivalent binder

c: cement mass per cubic metre of concrete [kg/m3]

k: coefficient for taking into account the addition considered in accordance with 5.2.5.2.

a: mass of addition per cubic metre of concrete [kg/m3]

The equivalent water/cement ratio noted (e/c)eq. thus corresponds to eeff./Leq.

**CN 3.1.4.5 High-strength concrete**

*Supplement*

Concrete of strength class greater than or equal to C55/67 for concretes of normal and heavy density and greater than or equal to LC55/67 for light concrete according to Tables 12 and 13 of paragraph 4.3.1.

CN **3.1.6 Classification**

**CN 3.1.6.1 Exposure categories**

*Supplement*

Classification of the chemical and physical environmental conditions to which concrete may be exposed and which may influence over time its durability and structural integrity as well as that of reinforcements, irrespective of the design assumptions.

**CN 3.1.6.2 Concrete categories**

*Supplement*

Concrete categories cover possible combinations of exposure categories for current ranges of application. Limit values for the composition of concrete are defined for each category.

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| *Supplement to paragraph 3.2* |
| XM1 to XM3 | Exposure categories for the risk of concrete attack by abrasion |
| c | Cement mass per cubic metre of concrete [kg/m3] |
| a | Mass of addition per cubic metre of concrete [kg/m3] |
| eeff. | Effective water |
| (e/c)eq. | Equivalent water on cement ratio |
| Leq. | Equivalent binder |

*Supplement to paragraph 4.1*

1. The limit values for the classes of exposure to chemical attack from natural soils and groundwater or surface water given in Table 2 also apply to effluents in contact with the concrete surface, provided that their flow rate is sufficiently low within the meaning of subparagraph (3) of paragraph 4.1 and their temperature is between 5°C and 25°C.
2. Specific studies and specific provisions on concrete performance and/or protection requirements are necessary for chemical attacks that do not meet the descriptions in Table CN 1 and Table 2, e.a.:
* Aggressive environments in industrial environments;
* Aggressive gaseous media;
* Attack by low mineralised water;
* Limit values exceeding the thresholds in Table 2. ;
* Presence of other aggressive chemicals;
* High water flow speed and exposure to chemicals according to Table 2. ;
* Water temperature < 5°C or > 25°C and exposure to chemicals according to Table 2.
1. Certain corrosion and/or attack actions, respectively the combination of these, may require the implementation of constructive provisions and/or specific protective measures as referred to in Note 1 to subparagraph (1) of paragraph 4.1. This shall apply, unless a specific study demonstrates that this is not necessary, e.a. and in a non-exhaustive manner for parts of works such as:
* Vehicle parking lot slabs and ramps;
* Silage silos;
* Parts of structures of purification plants, e.g. scraper tracks
* Singular points of parts of structures subject to actions complementary to those otherwise defined for these elements, e.g. wall bases feet subjected to de-icing agents
* etc.
1. The determination of the nominal coating of reinforcements shall, inter alia, take into account the exposure categories defined below. Additional requirements are defined in EN 1992-1 to 3 and their national annexes AN-LU, EN 13670/CN-LU [[1]](#footnote-1)) and EN 13369/CN-LU \*)
2. Paints and simple coatings are not considered sufficient protection against actions due to the environment. Only surface protection systems in accordance with EN 1504 providing sufficient protection against these actions may be taken into account during the duration of use of the structure.

\*) Transitional provisions pending the publication of the CNs concerned: see the National Foreword.

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| *The following Table CN 1 amends Table 1 of EN 206:***Table CN 1 — Exposure categories (1 of 7)** |
| Category designation | Description of the surroundings | Informative examples illustrating the choice of exposure categories |
| **1 No risk of corrosion or attack** |
| A concrete is unreinforced within the meaning of Class X0 if it does not contain any reinforcement or embedded metal part. |
| X0 | For unreinforced concrete or without embedded metal parts: all exposures except abrasion, chemical attack or freeze-thaw attack. | Frost protected foundations without reinforcements;Unreinforced concrete inside buildings |
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| **Table CN 1 — Exposure categories (2 of 7)** |
| Category designation | Description of the surroundings | Informative examples illustrating the choice of exposure categories |
| **2 Corrosion by carbonation** |
| When reinforced concrete or containing embedded metal parts is exposed to air and humidity, the exposure categories shall be defined as follows: |
| XC1 | Dry or wet at all times | Concrete inside residential buildings where the humidity of the ambient air is usual (including kitchens and bathrooms);Concrete immersed in water permanently |
| XC2 | Wet, rarely dry | Concrete surfaces subject to long-term contact with water;Large number of foundations, parts of buried water tanks |
| XC3 | Moderate humidity | Outdoor concrete sheltered from rainConcrete inside buildings where the humidity of the ambient air is medium or high; |
| XC4 | Alternation of humidity and drying | Concrete surfaces exposed to rain, including surfaces subject to splashes, run-offs and sprays |
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| **Table CN 1 — Exposure categories (3 of 7)** |
| Category designation | Description of the surroundings | Informative examples illustrating the choice of exposure categories |
| **3 Corrosion by chlorides other than seawater** |
| When reinforced concrete or containing embedded metal parts is subjected to contact with water containing chlorides of non-marine origin, including those of de-icing salts, the exposure categories shall be defined as follows: |
| XD1 | Moderate humidity | Concrete surfaces exposed to chlorides transported by air |
| XD2 | Wet, rarely dry | Swimming pools;Concrete exposed to industrial water containing chlorides |
| XD3 | Alternation of humidity and drying | Bridge elements exposed to chloride-containing projections;Roads;Vehicle parking lot slabs and ramps **a** |
| Exposure categories XF2 and XF4 cover the corrosion risks of chlorides conveyed by the de-icing agents. When they apply and another chloride source is excluded, they do not need to be combined with XD exposure categories.**a** Unless a specific study demonstrates that this is not necessary, surface protection systems providing sufficient protection against chloride penetration during the duration of use of the structure shall be implemented. The selected surface protection systems must comply with EN 1504. |
| **Table CN 1 — Exposure categories (4 of 7)** |
| Category designation | Description of the surroundings | Informative examples illustrating the choice of exposure categories |
| **4 Corrosion by seawater chlorides** |
| When reinforced concrete or containing embedded metal parts is subjected to contact with seawater chlorides or to the action of air carrying sea salt, the exposure categories shall be defined as follows: |
| XS1 | Exposed to air carrying sea salt, but not in direct contact with seawater | Structures on or near a coast |
| XS2 | Permanently immersed | Elements of marine structures |
| XS3 | Drawdown zones, areas subject to projections or sprays | Elements of marine structures |
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| **Table CN 1 — Exposure categories (5 of 7)** |
| Category designation | Description of the surroundings | Informative examples illustrating the choice of exposure categories |
| **5 Freeze-thaw attack with or without de-icing agent** |
| When the concrete is subjected to a significant attack due to freeze-thaw cycles while it is wet, the exposure categories shall be defined as follows: |
| XF1**a** | Moderate water saturation without de-icing agent | Vertical concrete surfaces exposed to rain and frost |
| XF2 | Moderate water saturation with de-icing agent | Vertical surfaces of concrete exposed to frost and sprays or projections carrying de-icing agents provided that their water saturation does not require XF4 classification |
| XF3 | High water saturation without de-icing agent | Horizontal surfaces of concrete exposed to rain and frost;Open water tanks;Structural elements in the freshwater drawdown zone |
| XF4**b** | High water saturation with de-icing agents | Roads and decks of bridges exposed to de-icing agents;Horizontal surfaces of concrete subject to freezing and thawing with de-icing agents;Concrete surfaces directly exposed to de-icing agent projections and frost |
| **a** Unless a specific study demonstrates that this is not necessary, specific concrete structural detailing or protective measures, such as EN 1504-compliant surface protection systems, are to be implemented for single points of structural elements subject to actions complementary to those otherwise defined for these elements, e.g. in wall bases, to avoid water saturation with de-icing agents.**b** Unless a specific study demonstrates that this is not necessary, special provisions are needed to ensure freeze-thaw resistance with de-icing agent of mechanically smoothed surfaces. |
| **Table CN 1 — Exposure categories (6 of 7)** |
| Category designation | Description of the surroundings | Informative examples illustrating the choice of exposure categories |
| **6 Chemical attack** |
| When the concrete is subjected to chemical attack by natural soils and groundwater or surface water, the exposure categories shall be defined as follows: |
| XA1 | Environment with low chemical aggressivity | Concrete exposed to soils and natural waters according to Table 2 |
| XA2 | Environment with moderate chemical aggressivity | Concrete exposed to soils and natural waters according to Table 2 |
| XA3 **a** | Environment with high chemical aggressivity | Concrete exposed to soils and natural waters according to Table 2 |
| **a** Unless a specific study shows that this is not necessary, surface protection systems providing sufficient protection against chemical attacks for the duration of use of the structure shall be implemented. The selected surface protection systems must comply with EN 1504 |
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| **Table CN 1 — Exposure categories (7 of 7)** |
| Category designation | Description of the surroundings | Informative examples illustrating the choice of exposure categories |
| **7 Concrete attack by abrasion** |
| When the concrete is subjected to mechanical abrasion attack, the exposure categories shall be defined as follows: |
| XM1 | Wear by moderate abrasion | Industrial slabs or inverts used by tyred vehicles |
| XM2 | Wear by strong abrasion | Industrial slabs or inverts loaded by forklifts on pneumatic tyres or solid rubber tyres |
| XM3 | Very strong abrasion wear | Industrial slabs or inverts loaded by forklifts on hard elastomeric or metal tyres;Surfaces loaded by tracked vehicles;Hydraulic structures loaded by discharged water with medium to high flow velocities |
|  |
| *Supplement to the notes in Table 2*Table 2 – Limit values for exposure categories for chemical attacks by natural soil and groundwater |
| Chemical characteristic | Reference test method | XA1 | XA2 | XA3 |
| **Groundwater** |
| $SO\_{4}^{2-}$in mg/l **d** | EN 196-2 | ≥ 200 and ≤ 600 | > 600 and ≤ 3,000 | > 3,000 and ≤ 6,000 |
| pH **e** | ISO 4316 | ≤ 6.5 and ≥ 5.5 | < 5.5 and ≥ 4.5 | < 4.5 and ≥ 4.0 |
| Aggressive CO2, mg/l | EN 13577 | ≥ 15 and ≤ 40 | > 40 and ≤ 100 | > 100 up to saturation |
| $NH\_{4}^{+}$, in mg/l | ISO 7150-2 | ≥ 15 and ≤ 30 | > 30 and ≤ 60 | > 60 and ≤ 100 |
| Mg2+, in mg/l | EN ISO 7980 | ≥ 300 and ≤ 1,000 | > 1,000 and ≤ 3,000 | > 3,000 up to saturation |
| **Soils** |
| $SO\_{4}^{2-}$ total, in mg/kg **a** | 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,in ml/kg | prEN 16502 | > 200 | Is not encountered in practice |

**a** Clay with a permeability of less than 10-5 m/s may be assigned to a lower category.

**b** The test method prescribes the extraction of SO2– from hydrochloric acid; it is also possible to carry out this extraction with water, if there is experience in this field at the place of use of the concrete.

**c** The limit should be reduced from 3,000 mg/kg to 2,000 mg/kg in case of the risk of accumulation of sulphate ions in concrete due to alternation of dry and wet periods or capillary absorption.

**d** If the sulphate concentration is greater than 600 mg/l or 3,000 mg/kg, the concentration shall be indicated at the time of specification.

**e** If the pH is less than 5.5, the pH shall be indicated when specifying.

Annex L, line 1: Consistency should be specified by target values only in special cases.

*Supplement to paragraph 4.2.1.*

NOTE 3 The compacting mode of concrete must be adapted to its consistency in order to achieve the required mechanical and durability properties.

*Supplement to Table 5*

**Table 5 — Flow table spreading categories**

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| Class | Flow table spreading diameter, test according to EN 12350-5[mm] | Consistency |
| F1 a | ≤ 340 | firm |
| F2 | 350 to 410 | plastic |
| F3 | 420 to 480 | soft |
| F4 | 490 to 550 | very soft |
| F5 | 560 to 620 | fluid |
| F6 a | ≥ 630 | very fluid |
| a See NOTE 1 of 5.4.1. |

Annex L, line 2: In particular cases, intermediate resistance levels may be used in relation to the values shown in Table 12 or 13.

*Supplement to paragraph 4.3.1.*

NOTE 2 See the specifications in paragraph 5.5.1.2. for the determination of the compressive strength at shorter or longer maturities than 28 days.

*Amends subparagraph (1) of paragraph 5.1.2*

1. The suitability for use according to the exposure categories is established for cement conforming to EN 197-1 and EN 197-5 according to Table CN F.2 of the normative annex CN F. The suitability for use for concrete intended for massive structures (e.g. dams, see Article 1 subparagraph (6), first indent) is established for special cements with very low hydration heat conforming to EN 14216.

Annex L, line 3: When cement conforming to EN 14647 or EN 15743 is used, cement transport vehicles, silos and conveyor systems should be emptied before switching to other cements and once they are no longer used.

*Supplement to paragraph 5.1.2.*

1. For hot-weather concreting according to EN 13670/CN-LU \*) cement cooled to a temperature of + 70°C or less is to be used. This in order to help limit the temperature of fresh concrete to a temperature less than or equal to + 30°C.
2. In the case of concretes intended for massive structures, the choice will be directed towards cement with low hydration heat.

\*) Transitional provisions pending the publication of the CNs concerned: see the National Foreword.

*Amends paragraph 5.1.3.*

**CN 5.1.3 Aggregates**

1. General suitability for use shall be established for:
* natural aggregates of normal density, heavy aggregates, as well as air-cooled blast furnace slag in accordance with EN 12620 and meeting the requirements of Table CN E.1 of the normative Annex CN E;
* recycled aggregates that comply with EN 12620 and meet the requirements of Table E.3 of the CN E normative Annex;
* recovered aggregates in accordance with 5.2.3.3;
* lightweight aggregates that comply with EN 13055 and meet the requirements of Table E.4 of the CN E normative Annex.
1. In addition to air-cooled blast furnace slag, other industrially produced artificial aggregates may be used as concrete aggregates, provided that their suitability for use is established in accordance with EN 12620 and they meet the requirements of Table CN E.1 of the CN E normative Annex.
2. The consistency of aggregate performance shall be assessed and verified in accordance with the AVCP 2+ system in accordance with Annex ZA of EN 12620.

*Supplement to paragraph 5.1.6.*

1. The general suitability for use as a type II addition is also established for Trass in accordance with DIN 51043.
2. In application of 5.2.5.1 (2), additions of type I and type II other than those defined in 5.1.6 may be taken into account, if their suitability for use has been validated by the Laboratoire de l’Administration des Ponts et Chaussées of the Grand-Duchy of Luxembourg.

*Amends paragraph 5.1.7.*

**CN 5.1.7 Fibres**

1. General suitability for use shall be established for:
* steel fibres conforming to EN 14889-1 whose consistency of performance has been assessed and verified in accordance with the AVCP 1 system in accordance with Annex ZA of EN 14889-1;
* polymer fibres conforming to EN 14889-2 whose consistency of performance has been assessed and verified in accordance with the AVCP 1 system in accordance with Annex ZA of EN 14889-2.

*Supplement to subparagraph (5) of paragraph 5.2.1*

NOTE: Concretes with a prescribed composition are not standardised in Luxembourg.

*Supplement to paragraph 5.2.2.*

1. As indicated in paragraph 5.3.2, the fields of application of cement according to the exposure categories are defined in Table CN F.2.
2. The combination of two cement qualities in the formulation of a concrete shall be subject to compliance with the conditions laid down in paragraph 5.3.2.

*Supplement to paragraph 5.2.3.1*

1. The aggregate grading is characterised by the grading envelopes defined in Annex U.

*Supplement to paragraph 5.2.3.3*

1. Aggregates recovered by washing may be used without internal screening by the producer as concrete aggregates:
* up to 5% (by mass) of the total quantity of aggregates, for concretes up to strength class C30/37 except for concretes subject to exposure categories XA3 and XF4;
* up to 10 % (by mass) of the total quantity of aggregates, for concretes up to strength class C20/25 Cat.1;
* up to 25 % (by mass) of the total amount of aggregates, for concretes up to strength class C12/15.

*Amends paragraph 5.2.3.4*

1. Recycled aggregates must comply with EN 12620 and meet the requirements of Table E.3 of Annex E.

NOTE No recommendation for the use of recycled sand is given in this standard

Annex L, line 4: Depending on the geological origin of aggregates, appropriate precautions should be observed, taking into account the long-term experience gained with the use of cement with the aggregates in question. CEN/TR 16349 provides a framework for specifying requirements to minimise the risk of a deleterious alkali-silica reaction.

*Supplement to paragraph 5.2.3.5*

1. The geological origin of aggregates must be documented by the producer.
2. When resistance to alkali-silica reactions of aggregates is not established, the alkali reactivity of aggregates must be qualified by a test method defined by the Laboratory of the Laboratoire de l’Administration des Ponts et Chaussées of the Grand-Duchy of Luxembourg.
3. Suitability for use is established by the Laboratoire de l’Administration des Ponts et Chaussées of the Grand-Duchy of Luxembourg according to the qualification chosen.

*Supplement to paragraph 5.2.4.*

1. The use of water recovered from concrete production is not permitted for concretes of strength classes greater than C50/60 or LC50/55 or for concretes with air entrainers. The plant must be equipped with a dosing device for the recovered water.
2. The potential influence of the use of recovered water must be taken into account in case of special requirements (e.g. exposed concrete, aggressive environments, etc.).

Annex L, line 5: The effect of additions on properties other than resistance should be taken into account.

Annex L, line 6: The establishment of suitability for use referred to in (4) and (5) should result from the provisions in force at the place of use of the concrete.

*Amends subparagraph (2) of paragraph 5.2.5.2.1*

1. The concept of coefficient k allows the inclusion of type II additions and certain type I additions:
* the term “water/cement ratio” in 3.1.3.16 is then replaced by the term “equivalent water/cement ratio” according to CN 3.1.3.17

(e/c)eq. = eeff. /(c + k ∙ a)

where

(e/c)eq: equivalent water/cement ratio

eeff. : effective water content according to 3.1.3.4 and CN 3.1.3.4

c: cement mass per cubic metre of concrete [kg/m3]

k: coefficient for taking into account the addition in question

a: mass of addition per cubic metre of concrete [kg/m3]

* the equivalent amount of binder according to CN 3.1.3.18

Leq. = c + k ∙ a

shall not be less than the minimum cement content requirement per cubic metre of concrete for the exposure category concerned (see 5.3.2).

* the mass of cement c shall not be less than 85% by mass of the minimum cement content requirement per cubic metre of concrete for the exposure category concerned (see 5.3.2).

*Amends subparagraph (3) of paragraph 5.2.5.2.1*

1. The rules for applying the concept of coefficient k for fly ash conforming to EN 450-1, silica fumes complying with EN 13263-1, as well as moulded blast furnace granulated slag in accordance with EN 15167-1, used with cement conforming to EN197-1 of type CEM I or CEM II/A and other types of cement specifically named where applicable, are set out in the following paragraphs.

*Supplement to paragraph 5.2.5.2.1*

1. With reference to paragraph 5.2.5.1, the application of the coefficient k concept may be extended to other type II additions or certain type I additions for which durability performance or strength as a criterion for approximation of durability, if any, has been demonstrated as equivalent by comparison in accordance with subparagraph (1) of paragraph 5.2.5.2.1.

*Amends subparagraph (1) of paragraph 5.2.5.2.2*

1. The permitted values for the coefficient k are defined in Table CN 2 according to the type of cement used, the general suitability for use being established for quality cement:

- CEM I

- CEM II/A

- CEM II/B-S

- CEM III/A

*Amends subparagraph (3) of paragraph 5.2.5.2.2*

(3) For use with CEM II/A, CEM II/B-S and CEM III/A cement the maximum amount of fly ash to be taken into account shall comply with the requirement:

fly ash/cement ≤ 0.25, by mass.

*Supplement to paragraph 5.2.5.2.2*

**Table CN 2 – k values to be take into account for fly ash in conformity with EN 450 according to the quality of cement used**

|  |  |
| --- | --- |
| **Cement qualityas per EN 197-1 1)** | **k value** |
| 32.5 N | 32.5 R | 42.5 N | 42.5 R | 52.5 L | 52.5 N | 52.5 R |
| CEM I | CEM I | 0.2 | 0.2 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |
| CEM II | CEM II/A | 0.2 | 0.2 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |
| CEM II/B-S | 0.2 | 0.2 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |
| CEM III | CEM III/A | 0.2 | 0.2 | 0.2 | 0.4 | 0.4 | 0.4 | 0.4 |
| 1) See Table CN F.2 for exposure categories XF and XA |

(5) The concept of the coefficient k for fly ash conforming to EN 450 may be extended to other types of cement conforming to EN 197-1 for which durability performance has been demonstrated as equivalent by applying the principles of paragraph 5.2.5.3.

*Supplement to the NOTE of paragraph 5.2.5.2.3*

The use of class 2 silica fumes is not provided for in the national provisions.

*Amends subparagraph (1) of paragraph 5.2.5.2.4*

1. A coefficient k of 0.6 is allowed for concrete whose cement is of type CEM I or CEM II/A according to EN 197‑1.
2. For use with CEM I type cement, the maximum quantity of moulded blast furnace granulated slag to be taken into account shall comply with the requirement:

 moulded blast furnace granulated slag/cement ≤ 0.33, by mass.

For use with CEM II/A type cement, the maximum quantity of moulded blast furnace granulated slag to be taken into account shall comply with the requirement:

 moulded blast furnace granulated slag/cement ≤ 0.25, by mass.

1. If a larger quantity of moulded blast furnace granulated slag is used, the excess shall not be taken into account for the calculation of the ratio of water/(cement + k × moulded blast furnace granulated slag) or for the minimum cement dosing.
2. Application of the coefficient k concept for moulded blast furnace granulated slag is not permitted for exposure categories XF2 and XF4.
3. The joint use of moulded blast furnace granulated slag with fly ash or silica fumes is not permitted.

Annex L, line 7: A coefficient k of 0.6 for concrete whose cement is of type CEM I or CEM II/A according to EN 197-1 is recommended for moulded blast furnace granulated slag in accordance with EN 15167-1. The maximum quantity of moulded blast furnace granulated slag should comply with the recommendation: moulded blast furnace granulated slag/cement ≤ 1.0 by mass. If a larger quantity of moulded blast furnace granulated slag is used, the excess should not be taken into account, neither for the calculation of the water/(cement + k x moulded blast furnace granulated slag) ratio or for the minimum cement dosing.

Annex L, line 8: If the compatibility test for the air-entraining agent combined with other additives has not been carried out by the supplier of the additive, it should be carried out as part of the initial test.

*Supplement to paragraph 5.2.6.*

1. The compatibility of the additive of a combination of additives with cement or cement combination used for concrete production shall be validated by initial tests.
2. The minimum cement levels as prescribed in Annex F cannot be reduced by the use of additives.
3. Additives must not contain substances in such quantities that they would be harmful to concrete or would affect the corrosion protection of metal elements embedded in concrete or mortar. See provisions of paragraph 5.2.8. for chloride content.
4. Concretes with a consistency grade greater than or equal to S4, V4, C3 or F4 shall be produced with fluidising additives.
5. The water content of liquid additives dosed to more than 3 l/m3 of concrete shall be taken into account in the calculation of the equivalent effective water/binder ratio.

Annex L, line 9: This standard provides rules for the production of concrete containing a specified amount of fibre. When specific design parameters are required, the test procedures and conformity documentation should be agreed upon.

*Supplement to paragraph 5.2.8.*

1. Suitability for use shall be established for additives with a total chloride content of <= 0.10% by mass.
2. Additives with a chloride content declaration may be used if the maximum chloride content of concrete in relation to the cement mass does not exceed the value given in Table 15 for the selected class.

*Supplement to paragraph 5.2.9.*

1. With reference to EN 13670/CN-LU\*) the following provisions shall be complied with:
* generally, the temperature of fresh concrete shall not exceed + 30°C, unless special arrangements have been made to avoid negative impacts on the quality of hardened concrete;
* when the air temperature is between -3°C and +5°C, the concrete temperature shall not be less than +8°C at the time of its implementation. It must be at least +10°C when low hydration heat cement is used or in case of cement dosing less than 280 kg/m³;
* when the air temperature is below -3°C, the temperature of the concrete must be at least +10°C at the time of its implementation.

\*) Transitional provisions pending the publication of the CNs concerned: see the National Foreword

*Amendment to subparagraph (2) of paragraph 5.3.2*

*The 4th indent is replaced by:*

* minimum compressive strength class of concrete;

*Supplement to paragraph 5.3.2.*

1. The requirements for the composition and properties of concrete are determined by Table CN F.1 of Annex CN F and by the following provisions:
2. The values in Table CN F.1 apply to cement conforming to EN 197-1, EN 197-5 and cement conforming to EN 14216.
3. The fields of application of the different cement grades according to the exposure categories are defined in Table CN F.2
4. In case of a chemical attack due to sulphates, sulphate resistant cement is to be used from exposure category XA2.
5. The combination of two cement grades conforming to EN 197-1 in the formulation of concrete is possible provided that the following provisions and restrictions are respected:
* the fields of application of the two cement grades according to Table CN F.2 cover the specified exposure categories;
* the requirements of Table CN F.1 as well as any additional cement requirements apply to the mixture of the two cement grades;
* two grades of cement of the same type and notation but of different strength classes
* may be combined without restriction;
* the inclusion of an addition for the calculation of the equivalent binder content is not permitted.
1. Special case of combination of cement with CEM III/C type blast furnace cement:
* depending on the exposure categories to be covered and the type of cement chosen for this combination, the maximum permitted percentage of CEM III/C type cement in the cement mixture is given in Tables CN F.3.1 and CN F.3.2.
1. The maximum content of fines < 0.125 mm depending on the cement content of concrete is given in Tables CN F.4 and CN F.5.
2. In accordance with paragraph 4.1, certain corrosion and/or attack actions, respectively the combination thereof, may require the implementation of structural detailing and/or specific protective measures such as EN 1504 compliant surface protection systems. This applies unless a specific study shows that it is not necessary.
3. In the presence of aggressive chemical agents other than those listed in Table 2, see paragraph 4.1.

*Amends the NOTE to paragraph 5.3.3*

NOTE European performance test methods are being developed or published, e.g. EN 12390-10, EN 12390-11, EN 12390-12, EN12390-18 and CEN/TR 15177. The framework conditions for the equivalent durability determination procedure have been published as CEN/TR 16563.

Annex L, line 10: Due to the lack of precision of the test methods beyond certain consistency values, it is recommended to use the tests indicated only for:

a sagging of ≥ 10 mm and ≤ 210 mm;

a tightening index ≥ 1.04 and < 1.46;

a flow diameter > 340 mm and ≤ 620 mm;

a spreading diameter at Abrams cone > 550 mm and ≤ 850 mm.

*Supplement to paragraph 5.4.1.*

1. The preferred test methods to be used for consistency measurement are the sagging test for firm consistency concrete and the flow table test for concretes of plastic-to-fluid consistency.
2. When the user wishes to verify the consistency of the concrete, the consistency measurement shall be carried out by a qualified test manager designated by the user in accordance with Annex V.
3. The verification shall be carried out at the beginning of the unloading of the concrete and at the latest within 30 minutes of the arrival of the truck at the place of delivery.
4. The verification shall be carried out from a sample of at least 60 dm3 of concrete taken after a re-mixing of at least 60 seconds at a rotational speed of not less than 12 rpm.

Annex L, line 11: For the fine elements of lightweigh aggregates, the test method and criteria should follow the provisions in force at the place of use of the concrete.

|  |
| --- |
| *Supplement to paragraph 5.4.3.*1. For concretes to meet exposure category XF4 by using an air entrainer, the minimum values of air driven at the time of concrete implementation are given in Table CN 3 based on the maximum declared size of the aggregates.

**Table CN 3 – Minimum entrained air values for exposure category XF4** |
| **Dmax**[mm] | **Minimum valuea of the entrained air content**[%-Vol.] |
| 8 | ≥ 6.0 % |
| 16 | ≥ 5.5 % |
| 22 | ≥ 5.0 % |
| 32 | ≥ 4.5 % |
| 63 | ≥ 4.0 % |
| a The minimum on-site control frequency is defined in Table CN V.2 of Annex V |
| (3) The values in Table CN 3 are to be increased by 1% for concretes of consistency grade ≥ F4. |

*Supplement to paragraph 5.5.1.1*

1. As a general rule, the nominal compressive strength of concrete is determined
* from samples taken in accordance with EN 12350-1;
* on cubes with a 150 mm edge conforming to EN 12390-1;
* made and preserved in accordance with EN 12390-2.
1. If a climatic test cabinet ensuring a relative humidity of > 95% is not available for the storage of test pieces from the moment of removal from the mould, they must be kept under water until they are transported to the test laboratory. The test pieces must be protected against desiccation from the moment they are removed until they are handed over to the test laboratory.
2. Cube strength determined "on-site", manufactured and stored in temperature and humidity conditions other than those described in EN 12390-2 may only be used to control concrete hardening and not for quality control, i.e. to allocate a nominal strength class.

Annex L, line 12: The assessment of resistance in the structure or structure element should be based on EN 13791.

*Supplement to paragraph 5.5.1.2*

1. The allocation of a strength class to concrete manufactured with a CEM III blast furnace cement with strength class of 32.5 N is done by determining nominal compressive strength after 56 days.
2. The results of hardening tests, for which the storage conditions of the test pieces correspond to that of the concrete of the structure itself, are not enforceable against the concrete producer.
3. The assessment of the compressive strength of concrete in structures or parts thereof shall be carried out in accordance with EN 13791.

*Amends paragraph 5.5.3.*

**CN 5.5.3 Water penetration resistance**

1. The water penetration resistance is determined in accordance with EN 12390-8.
2. For specified concretes with high resistance to water penetration, the average penetration depth, measured in accordance with EN 12390-8 on test pieces kept under water for 28 days, shall not exceed 50 mm.
3. The number of test pieces to be tested per concrete phase is determined in EN 13670/CN-LU \*).
4. Specified concrete with high water penetration resistance shall be formulated with a water/cement ratio ≤ 0.55 and a cement content ≥ 300 kg/m3.

\*) Transitional provisions pending the publication of the CNs concerned: see the National Foreword.

*Supplement*

* + 1. **Resistance to freezing-thawing and freezing-thawing with de-icing agents.**
1. The composition of concretes subject to XF exposure categories shall take into account the requirements for the concrete composition limits of Annex CN F.
2. The freeze-thaw resistance of concrete shall be assessed in accordance with the RILEM CDC 1: Freeze/thaw test method without chemical defroster.
3. Freeze-thaw resistance with de-icing agents shall be assessed in accordance with the RILEM CDC 2 method: Freeze/thaw test method with chemical defroster.
4. In accordance with paragraph 5.3.3, requirements for XF exposure categories may be established using performance methods and may be specified in terms of performance parameters.

|  |
| --- |
| *Supplement***5.5.6 Abrasion wear resistance** |
| (1) | The composition of concretes subject to XM exposure categories shall take into account the requirements for the concrete composition limits of Annex CN F. |
| (2) | The concrete shall have an abrasion resistance measured in accordance with DIN 52108 according to Böhme with abrasion value limits:* ≤  12 cm3/50 cm2 for exposure category XM1;
* ≤ 9 cm3/50 cm2 for exposure category XM2;
* ≤ 7 cm³/50 cm2  for exposure category XM3.
 |

*Amends subparagraph (2) of paragraph 6.2.1*

1. The abbreviations to be used in the specifications are given in Article 11 and Annex CN W.

*Supplement to (b) of subparagraph (1) of paragraph 6.2.2*

1. where applicable, specify compressive strength at maturities shorter or longer than 28 days in accordance with paragraph 5.5.1.2. ;

*Amends (c) of subparagraph (1) of paragraph 6.2.2*

1. the exposure category(ies) (see Article 11 for abbreviated designations) and the corresponding concrete category where applicable (see Article 11 and Annex CN W);

*Amends (d) of subparagraph (1) of paragraph 6.2.2*

1. *Dinf.*/ Modifies Nominal value Dmax of aggregates;

*Supplement to (e) of subparagraph (1) of paragraph 6.2.2*

NOTE 2 alternatively to the chloride content class, it is possible to indicate the type of use of concrete: unreinforced concrete, reinforced concrete, prestressed concrete.

*Supplement to subparagraph (4) of paragraph 6.2.2*

for self-compacting concrete: an apparent viscosity class according to Table 7 or 8 resp. for particular cases a target value for t500 or tv.

Annex L, line 13: Before specifying the air content at delivery, the prescriber should take into account any air losses during the post-delivery pumping, installation, tightening, etc. operations.

*Supplement to subparagraph (1) of paragraph 6.2.3*

* elastic modulus when the structure is considered sensitive to deviations from the general indicative values of EN 1992-1-1 and its Luxembourg National Annex.

*Supplement to paragraph 6.3.1.*

1. The prescriber has the obligation to provide a complete and comprehensive formulation to the producer.
2. Producer responsibility is limited to compliance with the prescribed formulation. The producer is not responsible for the performance of the concrete produced.

Annex L, line 14: The specified value of the target e/c ratio should be at least 0.02 lower than any expected limit value

*Supplement to paragraph 6.4:*

NOTE Concretes of prescribed composition are not standardised in Luxembourg.

*Supplement to subparagraph (1) of paragraph 7.2*

1. in the case of the supply of concrete intended to be fluidised on site: the consistency grade or consistency referred to before the consistency change by adjuvantation on the site.

*Supplement to Table 16*

**Table 16 – Change in concrete resistance at 20°C**

|  |  |  |
| --- | --- | --- |
| **Resistance change class** | **Change in resistance** | **Estimated resistance ratio***r = fcm,2 / fcm,28* |
| Q | Quick | ≥ 0.5 |
| M | Medium | ≥ 0.3 to < 0.5 |
| S | Slow | ≥ 0.15 to < 0.3 |
| VS | Very slow | < 0.15 |

*Supplement to subparagraph (3) of paragraph 7.2*

When it is agreed that the compressive strength is determined at a later time after 28 days, the resistance change class according to Table 16 shall be determined from the ratio between the mean 2-day compressive strength (fcm,2) and the mean compressive strength at the defined later time.

NOTE Significantly longer cure times may result from this procedure.

*Amends the 9th indent of subparagraph (1) of paragraph 7.3*

* declaration of conformity or non-conformity with EN 206+CN-LU:

“ Compliant with EN 206+CN-LU ”

“ Not compliant with EN 206+CN-LU ”;

*Supplement to subparagraph (1) of paragraph 7.3*

* the validity time limit for unloading;

*Supplement to subparagraph (1) of paragraph 7.3*

* in the event of the addition of water, additives or additions at the site under the conditions laid down in Article 7.5:
* the exact time of the addition;
* the quantity added;
* the volume of concrete in the mixer at the time of addition;
* the mixing time after the addition.

*Amends Part (a) of subparagraph (2) of paragraph 7.3*

1. for concrete with specified properties:
* the resistance class with indication of the term of its determination if it is determined at a term subsequent to 28 days;
* the exposure categories or category of concrete in accordance with Annex CN W with indication of the most restrictive exposure categories (Annex CN W, paragraph W.3) if applicable;
* the class or target value of consistency;
* Dmax;
* special properties, if prescribed

 (e.g. air content, high resistance to water penetration, elastic modulus, etc.);

* the resistance change class;
* the water/cement ratio;
* the chloride content class or alternatively the type of use of concrete: unreinforced concrete, reinforced concrete, prestressed concrete. ;
* in the case of light or heavy concrete:

 the density class or target density;

* the composition limit values of concrete, if specified;
* the type and resistance class of cement, if specified;
* the type of additive and addition, if specified;

*Supplement to Part (b) of subparagraph (2) of paragraph 7.3*

* the weighing of constituents by batch
* the water content of aggregates;
* the types of aggregates.

*Supplement to paragraph 7.5*

1. The provisions of paragraph 7.5 apply to all additions.
2. Responsibility for the quality of the concrete shall be transferred to the party who has requested or is making a modification of the concrete on the site outside the provisions of paragraph 7.5. This amendment cancels the compliance of concrete with EN 206+CN-LU. This cancellation must be notified on the delivery note of the concrete concerned.
3. The provisions of paragraph 9.6.2.3. on the mixer transporting the concrete shall apply

Annex L, line 15: If, on site, additives, pigments, fibres or water are added to the concrete in the mixer truck without the authorisation/supervision of the producer’s quality management staff, or if the added quantity exceeds the quantity allowed by the concrete specification, the batch or concrete load should be recorded as “non-compliant” on the delivery note. The party who authorised this addition is responsible for the consequences and it should be recorded on the delivery note.

*Supplement to Article 7*

* 1. **Transportation of concrete**
1. Fresh concrete of firm consistency can be transported in two-wheeled trailers. The material of the two-wheeled trailer in contact with the concrete must not react with it (e.g. aluminium).
2. Fresh concrete with consistency other than firm must be transported in mixing trucks or trucks fitted with a mixing unit. Before being unloaded on the site, the concrete must be mixed again so as to obtain a homogeneous consistency for use.
3. The re-mixing time after adding an additive to a mixer truck shall not be less than 1 min/m3 nor less than 5 minutes for a load of less than 5 m3. When adding the additive in a mixing truck, the volume of the concrete load must be higher than 0.5 times the volume of the mixing tank.
4. Mixing trucks or trucks with mixing units must be completely unloaded no later than 90 minutes after the concrete has been made at the plant. In the case of the addition of a retardant additive, the maximum waiting time before unloading shall not exceed the specified duration in the initial tests with the corresponding additive determination.

*Amends subparagraph (2) of paragraph 8.2.1.2:*

1. Notwithstanding the sampling requirements set out in 8.1, samples shall be taken after the determination and mixing of all concrete constituents under the responsibility of the producer.

In the event of adjustments to the mixture after the main mixing and before unloading under the conditions laid down in paragraph 7.5, a first sample shall be taken before additions on site and a second sample at unloading.

*Amends subparagraph (3) of paragraph 8.2.1.2*

1. The test result shall be that obtained from the average of the results of at least two test pieces from the same sample and tested at the same time.

Annex L, line 16: These limits are based on the following formula:



where *χ*2 *α*; ν is the quantile *α* a chi-square distribution, with *ν* = n - 1 degrees of freedom.

Annex L, line 17: Since a control map includes successive sampling plans (with a known standard deviation), the characteristic operating curve of the individual sampling plan can be established. The QMAC curve is then determined by multiplying each percentage of all possible results below the characteristic resistance required in production by the corresponding probability of acceptance.

Annex L, line 18: The same approach can be used when the bending resistance is specified.

*Amendment of subparagraph (1) of paragraph 8.3, last sentence*

The water/cement ratio must correspond ± 0.02 to the specified value.

*Amendment of subparagraph (1) of paragraph 9.3, last sentence*

In the absence of legislation requiring a longer period of time, data relating to the control of production must be kept for at least five years.

*Supplement to paragraph 9.6*

1. The producer must appoint a qualified manager for production control. This person must have extensive experience and knowledge in concrete production and control technology. The producer shall ensure that management staff, technical personnel responsible for the production and transport of concrete, as well as technical personnel responsible for production control, undergo, at intervals not exceeding three years, continuous training on the production, control and implementation of concrete, so as to be able to take all necessary measures to ensure production, production control and delivery in accordance with the provisions of this standard.
2. The management staff shall at least hold the Q certificate as defined in Annex V, paragraph V.7.2. Technical personnel shall at least hold the C certificate as defined in Annex V, paragraph V.7.1.

*The following Table CN 26 amends Table 26 of EN 206*

**Table CN 26 — Dosing equipment requirements**

|  |  |
| --- | --- |
| **For mass-dependent dosage** | **Load in % of maximum load a** |
| **Minimum load a up to 20% of maximum load** | **20% of maximum load up to maximum load** |
| Maximum permissible error as % of load | ± 2% | ± 1% |
| **For volume-dependent dosage** | **Volume measured** |
| **< 30 l** | **≥ 30 l** |
| Maximum permissible error as % of volume | ± 3 % | ± 2 % |
| a The minimum load and maximum load are indicated by the equipment manufacturer. |

Annex L, line 19: Dosing tolerances for batches less than 1 m3 should be indicated in the provisions in force at the place of use.

*Amendment to Table 27*

*3rd row of 2nd column*

|  |  |
| --- | --- |
| Additives, additions and fibres used in quantities ≤ 5% of cement mass | ± 3% of required quantity |

*Supplement to paragraph 9.8*

1. In a mixer truck, the duration of complementary mixing following the main mixing should not be less than 1 min/m3, nor less than 5 min for volumes of concrete < 5 m3 after adding additives or fibres. When adding an additive to a mixer truck, the volume of concrete contained must be greater than 0.5 times the nominal volume of the mixing tank.

Annex L, line 20: In a mixer truck, the duration of complementary mixing following the main mixing should not be less than 1 min/m3, nor less than 5 min after the addition of the additives or fibres.

*Amendment to Table 29 (1 of 2)*

*Adding a line*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 15 | Water recovered from processes of the concrete industry | Test of suitability for use according to EN 1008 | To ensure that reclaimed water is free of substances harmful to concrete | Weekly during the 1st month following the commissioning of recovery plants Monthly from 2nd to 6th months included following the commissioning of the recovery plants Semi-annually after the 6th month following the commissioning of recovery plants At least daily during production in case of doubt regarding chloride and sulphate contents |

*Amendment to Table 29 (2 of 2)*

*Modification of line 18*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 18 | Temperature of fresh concrete | Temperature measurement | To assess the achievement of the minimum temperature of 5°C, 8°C or 10°C in accordance with 5.2.9;To assess the evolution towards the temperature limit of 30°C in accordance with 5.2.9;or assess the evolution to a specified limit | In case of doubtWhen the outside temperature is≤ 5°C or ≥ 25°CWhen the temperature is specified:* periodically, as appropriate;
* at every batch or load

when the temperature of the concrete is close to the limit |

*Amends subparagraph (1) of Article 11*

1. When the essential characteristics of a concrete with specified properties are to be provided in abbreviated form, the following designations shall be used:
* reference to this European Standard: EN 206;
* compressive strength class: compressive strength class as defined in Table 12 or 13, e.g. C25/30;

with indication of the term of its determination if it is determined at a term later than 28 days;

* exposure category(ies): category designation(s) according to Table 1. If the concrete is exported, the exposure category(ies) followed by the abbreviation of the name of the country2) which gave the provisions for limit values, the composition of the concrete and its properties or another set of requirements, e.g. XD2(L) when the Luxembourg provisions are applicable;

or the category of concrete according to Annex CN W with an indication of the most restrictive exposure categories;

* consistency: according to the classes defined in 4.2.1 or a target value and method;
* declared value for the largest aggregate actually used in concrete:

dimension Dmax, e.g. Dmax 22;

* density: class designations according to Table 14 or target value, e.g. D1.8;
* maximum chloride content: class defined in Table 15, e.g. Cl 0.20 or alternatively the type of use of concrete: unreinforced concrete, reinforced concrete, prestressed concrete;
* specific properties of concrete if prescribed

(e.g. air content, high resistance to water penetration, elastic modulus, etc.).

1. It is recommended to apply the provisions of Annex CN W.

Annex L, line 21: If concreting on the site is carried out under a wide variety of temperature conditions or if a heat treatment is applied, the producer should be informed so that he can take into account the problematic effects on the properties of the concrete and the need to carry out any further tests.

Annex L, line 22: The proportions of Table E.2, based on experiment, give concrete with normal deformation properties and no test is normally required. In special cases, e.g. span beams, a test is required and the need to carry out this test should be agreed between the producer and the user.

*Supplement to Article B.1*

1. Identification tests for the compressive strength of concrete of normal, light or heavy density delivered on site shall be carried out in accordance with the provisions of Annex CN V.

*Amends subparagraph (1) of Article B.2*

1. When identification tests are to be carried out, the specific volume of concrete shall be defined, e.g.:
* a batch or individual load, in case of doubt about the quality;
* the concrete provided for each floor of a building or a set of beams/slabs or posts/walls of a building or comparable parts of other structures;

By default in the absence of other specifications:

* concrete delivered to a site during periods and in quantities as defined in Table CN V.2 of Annex CN V.

*Amends subparagraph (2) of Article B.2*

1. The minimum number of samples to be taken and the minimum sampling frequency on a specific volume of concrete are set out in Table V.2 of Annex CN V.

*Amends subparagraph (4) of Article B.2*

1. Test pieces for the compressive strength test shall be prepared and stored in accordance with EN 12390-2. The compressive strength of the test pieces shall be determined in accordance with EN 12390-3. In accordance with the provisions of Annex CN V, the test result shall be the average of the individual results obtained on a series of at least three test pieces of the same age, each having been made from a sample taken separately. When the range of individual test results is more than 15% of the average, the results shall not be taken into account unless a more thorough examination enables to find a valid reason for disregarding one of the individual test results. In this case, the test result shall be the average of the two remaining individual test results.

*Supplement to paragraph B.3.1.*

1. The provisions of Annex CN V apply.

Annex L, line 23: Concrete implemented by pumping or under immersed conditions (minimum flow diameter of 560 mm or minimum subsidence of 180 mm) can be produced without the use of a high water reducer/super-plasticiser type additive.

*Amends subparagraph (1) of Article E.1*

1. This Annex is normative with regard to its Article E.2 relating to natural aggregates of normal density, heavy aggregates, as well as air-cooled blast furnace slag complying with EN 12620.
2. This Annex is normative with regard to its Article E.4 on lightweigh aggregates complying with EN 13055.
3. This Annex provides recommendations on the use of recycled gravel complying with EN 12620.

*Amends subparagraph (1) of Article E.2*

1. Table CN E.1 sets out the requirements for the properties of natural aggregates of normal density, heavy aggregates, as well as air-cooled blast furnace slag complying with EN 12620.

|  |
| --- |
| **Table CN E.1 — Requirements for natural aggregates of normal or heavy density, and air-cooled blast furnace slag complying with EN 12620.** |
| Particle size | Concrete structures |
| GravelD/d<4D/d/4 | GC85/20 /GC90/15GT15GT17.5 |
| sand | GF85 |
| Granularity of fillers |
| Sieve sizemm | Percentage by mass of passing fraction |
|  | Overall grading range for individual results | Maximum range declared by the supplier |
| 2 | 100 | - |
| 0.125 | 85 – 100 | 10 |
| 0.063 | 70 – 100 | 10 |
| Shape of gravel | Fl35SI40 |
| Content of shell elements in gravel | SC10 |
| Fines gravel content  | f1.5 |
| sand | f4 |
| LHF/EAF sandcompensating sand | f10f10 |
| Quality of fines \*sandcompensating sand | MB1MB1.5 |
| Sand equivalent | to be declared |
| Fragmentation strength | LA40 |
| Wear resistance | MdeNR |
| Polishing resistance | PSVNR |
| Abrasion resistance | AAVNR |
| Abrasion resistance by studded tyres | AnNR |
| Actual density | to be declared |
| Water absorption | to be declared |
| Bulk density | NR |
|  |

|  |  |
| --- | --- |
| Sensitivity to freezing-thawingSensitivity to action of magnesium sulphate | Concretes according to EN 206+CN-LU by category |
| 0 and 1 | Fnr |
| 2(XF1) | F4 |
| 3, 3HRS6(XF2+XF3) and 6HRS | F2 |
| 4 LP(XF4) | Fnacl6 |
| Volume stability - shrinkage on drying | NR |
| Alkali-silica reaction | to be declared in case of doubt |
| Chlorides | ≤ 0.04% by mass |
| Acid-soluble sulphates* Aggregates other than air-cooled LHF
* Air-cooled LHF aggregates
 | AS0.8AS1.0 |
| Total sulphur* Aggregates other than air-cooled LHF
* Air-cooled LHF aggregates
 | S1.0S2.0 |
| Constituents affecting the density stability of air-cooled LHF | no disintegration of dicalcium silicate and iron |
| \* This test applies to all sands regardless of their fines content. |

*Amends the informative Annex F:*

**Annex CN F**(normative)

**Luxembourg requirements for concrete composition limits**

1. This Annex is normative and provides recommendations on the choice of limit values for the composition of concrete and its properties in function of the exposure categories according to 5.3.2.
2. Table CN F.1 determines the requirements for limit values for composition and properties of concrete according to the exposure categories.
3. Table CN F.2 defines the areas of application of the different cement qualities according to the exposure categories.
4. Table CN F.3.1 defines the areas of application covered for mixtures consisting of a cement authorised for mixing in combination with CEM III/C grade cement based on the exposure categories to be covered and the type of authorised cement chosen for that combination. It gives the maximum permitted mass percentage of CEM III/C cement in the mixture according to the exposure categories to be covered and the type of cement allowed. The provisions of Table CN F.3.1 apply when the cement producer’s declaration of the content of the cement’s principal and secondary constituents is not documented. These provisions apply only to the cement grades listed in Table CN F.3.1.
5. Table CN F.3.2 defines the areas of application covered for different mixtures consisting of a cement authorised for mixing in combination with CEM III/C grade cement based on the exposure categories to be covered and the type of authorised cement chosen for that combination in accordance with paragraph 5.3.2 (10). The formula for calculating the maximum permitted percentage by mass of CEM III/C grade cement in the mixture is described here. The provisions of Table CN F.3.2 apply when the cement producer’s declaration of the content of the cement’s principal and secondary constituents is documented. These provisions apply only to the cement grades listed in Table CN F.3.2.
6. Tables CN F.4 and CN F.5 establish the maximum content of fines < 0.125 mm depending on the cement content of the concrete.
7. The duration of use of a concrete structure depends on its design, concrete properties and execution. The values in Table CN F.1 are based on the assumption of a projected duration of use of the structure of at least 50 years; however, the concrete structure can be designed for a shorter use duration (e.g. 20 years) or longer (e.g. 100 years).
8. The assumption of a planned duration of use in the structure project of at least 50 years presupposes the usual maintenance and repair conditions of the structure.
9. The values in Table CN F.1 refer to the use of common cement conforming to EN 197-1 and EN 197-5, for which suitability for use in a given exposure category has been established and reproduced in Table CN F.2, and to the use of normal and heavy density aggregates, of which *D*max is within the range of 16 mm to 32 mm.

**Table F.1 - Luxembourg requirements for specified limit values applicable to the composition and properties of concrete**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Exposure category** | **X0** | **XC1** | **XC2** | **XC3** | **XC4** | **XS1** | **XS2** | **XS3** | **XD1** | **XD2** | **XD3** | **XF1** | **XF2** | **XF3** | **XF4** | **XA1** | **XA2** | **XA3** | **XM1** | **XM2** | **XM3** |
| **Maximum equivalent e/c ratio a** | – | 0.65 | 0.65 | 0.60 | 0.60 | 0.55 | 0.50 | 0.45 | 0.55 | 0.50 | 0.45 | 0.60 | 0.50 | 0.50 | 0.45 | 0.60 | 0.50 | 0.45 | 0.55 | 0.45 | 0.45 |
| **Minimum strength class b** | C12/15 | C20/25 | C20/25 | C25/30 | C25/30 | C30/37 | C30/37 | C35/45 **c** | C30/37 | C30/37 | C35/45 **c** | C25/30 | C30/37 | C30/37 | C30/37 | C25/30 | C30/37 | C35/45 **c** | C30/37 | C35/45 **c** | C35/45 |
| **Minimum cement content a [kg/m3]** | – | 240 | 240 | 280 | 280 | 320 | 320 | 340 | 320 | 320 | 340 | 280 | 320 | 320 | 340 | 280 | 320 | 340 | 320 **d** | 340 **d** | 340 **d** |
| **Minimum entrained air content [%-Vol.]** | – | – | – | – | – | – | – | – | – | – | – | – | – | – | **e** | – | – | – |  |  |  |
| **Cement quality** | **f** | **f** | **f** | **f** | **f** | **f** | **f** | **f** | **f** | **f** | **f** | **f** | **f** | **f** | **f** | **f** | **f, g** | **f, g** | **f** | **f** | **f** |
| **Aggregate liability to frost damage cat. EN 12620** |  |  |  |  |  |  |  |  |  |  |  | F4 | F2 | F2 | Fnacl 6 |  |  |  |  |  |  |
| **Other requirements** | – | – | – | – | – | – | – | – | – | – | – |  |  |  |  | – |  |  | **h** | **h** | **h** |
| **a** When the concept of coefficient *k* is applied, the maximum equivalent *e*/*c* ratio and the minimum cement content are calculated in accordance with 5.2.5.2.**b** Does not apply to light concrete**c** When using an air-entraining agent, e.g. when exposure category XF4 applies simultaneously, the minimum strength class is lowered by one class**d** The maximum cement content is limited to 360 kg/m3. This limit does not apply to high-resistance concrete**e** The minimum entrained air content prior to concrete implementation is dependent on the maximum nominal diameter of aggregates: ≥ 5.5% for dmax = 8 mm; ≥ 5.0% for dmax = 16 mm; ≥ 4.5% for dmax = 22 mm; ≥ 4.0% for dmax = 32 mm(See 5.4.3)**f** Table CN F.2 determines the areas of application of cement conforming to EN 197-1 and EN 197-5 for concrete making according to the exposure categoriesCements usable for XD exposure categories are also usable for the corresponding XS exposure categories.**g** According to 5.3.2, sulphate resistant cement is to be used from exposure category XA2 in case of chemical attack due to the presence of sulphates**h** The concrete must have an abrasion resistance measured in accordance with DIN 52108 pursuant to Böhme with abrasion value limits≤ 12 cm3/50 cm2 for exposure category XM1≤ 9 cm3/50 cm2 for exposure category XM2≤ 7 cm3/50 cm2 for exposure category XM3 |

**Table CN F.2 — Fields of application of cement conforming to EN 197-1 and EN 197-5 for concrete making according to exposure categories**

|  |  |
| --- | --- |
| **Cement quality pursuant to EN 197-1** | **Exposure categories pursuant to Table CN 1** |
| **X0** | **XC1** | **XC2** | **XC3** | **XC4** | **XD1** | **XD2** | **XD3** | **XF1** | **XF2** | **XF3** | **XF4** | **XA1** | **XA2 a** | **XA3 a** | **XM1** | **XM2** | **XM3** |
| **Portland Cement** | **CEM I** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** |
| **Portland Slag Cement** | **CEM II/A-S** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** |
| **CEM II/B-S** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** |
| **Portland Cement with silica fume** | **CEM II/A-D** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** |
| **Portland Cement with pozzolan** | **CEM II/A-P** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **–** | **X** | **–** | **X** | **X** | **X** | **X** | **X** | **X** |
| **CEM II/B-P** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **–** | **X** | **–** | **X** | **X** | **X** | **X** | **X** | **X** |
| **CEM II/A-Q** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **–** | **X** | **–** | **X** | **X** | **X** | **X** | **X** | **X** |
| **CEM II/B-Q** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **–** | **X** | **–** | **X** | **X** | **X** | **X** | **X** | **X** |
| **Portland cement with fly ash** | **CEM II/A-V** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X)** | **X** | **X** | **X** |
| **CEM II/B-V** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X)** | **X** | **X** | **X** |
| **CEM II/A-W** | **X** | **X** | **X** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** |
| **CEM II/B-W** | **X** | **–** | **X** |  | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** |
| **Portland cement with burnt shale** | **CEM II/A-T** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** |
| **CEM II/B-T** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** |
| **Portland Limestone Cement** | **CEM II/A-L** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **–** | **–** | **–** | **–** | **X** | **–** | **–** | **–** | **–** | **–** |
| **CEM II/B-L** | **X** | **X** | **X** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** |
| **CEM II/A-LL** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** |
| **CEM II/B-LL** | **X** | **X** | **X** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** |
| **Compound Portland Cement** | **CEM II/A-M** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **Xb** | **Xb,f** | **Xb** | **Xb,f** | **Xb** | **Xb** | **Xb** | **Xb** | **Xb** | **Xb** |
| **CEM II/B-M** | **X** | **X** | **X** | **Xc** | **Xc** | **Xc** | **Xc** | **Xc** | **Xc** | **Xc,g** | **Xc** | **Xc,g** | **Xc** | **Xc** | **Xc** | **Xc** | **Xc** | **Xc** |
| **Blast Furnace Cement** | **CEM III/A** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X d** | **X** | **X** | **X** | **X** | **X** | **X** |
| **CEM III/B** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X e** | **X** | **X** | **X** | **X** | **X** | **X** |
| **CEM III/C** | **X** | **X** | **X** | **–** | **–** | **–** | **X** | **–** | **–** | **–** | **–** | **–** | **X** | **X** | **X** | **–** | **–** | **–** |
| **Pozzolanic cement** | **CEM IV/A** | **X** | **–** | **X** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** |
| **CEM IV/B** | **X** | **–** | **X** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** |
| **Compound cement** | **CEM V/A** | **X** | **–** | **X** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** |
| **CEM V/B** | **X** | **–** | **X** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** |
|  |
| **Cement quality pursuant to EN 197-5** | **Exposure categories pursuant to Table CN 1** |
| **X0** | **XC1** | **XC2** | **XC3** | **XC4** | **XD1** | **XD2** | **XD3** | **XF1** | **XF2** | **XF3** | **XF4** | **XA1** | **XA2 a** | **XA3 a** | **XM1** | **XM2** | **XM3** |
| **Compound Portland Cement** | **CEM II/C-M** | **X** | **X** | **X** | **X** | **Xh** | **Xh** | **Xh** | **Xh** | **Xh** |  |  |  | **Xh** | **Xh** | **Xh** | **Xh** | **Xh** | **Xh** |
| **Compound cement** | **CEM VI (S-P)** | **X** | **-** | **X** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** |
| **CEM VI (S-V)** | **X** | **-** | **X** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** |
| **CEM VI (S-L)** | **X** | **-** | **X** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** |
| **CEM VI (S-LL)** | **X** | **-** | **X** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** |

X cement quality usable for this application

– cement quality not usable for this application

**a** If water in contact with the concrete surface has a sulphate content of SO42- > 600 mg/l or if soil in contact with concrete has a sulphate content of SO42- > 3000 mg/kg, high sulphate resistance cement should be used.

**b** are only usable for cement grades CEM II/A-M (S-D), (S-V), (S-T) and (S-LL) and grades CEM II/A-M (S-P) and (P-LL) with restrictions (see f)

**c** are only usable for cement grades CEM II/B-M (S-D), (S-V) and (S-T) as well as grade CEM II/B-M (S-P) with restrictions (see g)

**d** only for strength class ≥ 42.5

**e** only under the following conditions:

* e/c ratio ≤ 0.45
* minimum strength class: C40/50
* minimum cement content: 360 kg/m3
* the use of an air entrainer additive is not mandatory

**f** The exposure categories XF2 and XF4 are not covered for grades CEM II/A-M (S-P) and (P-LL)

**g** The exposure categories XF2 and XF4 are not covered for grade CEM II/B-M (S-P)

**h** Only valid for CEM II/C-M (S-LL)

|  |
| --- |
| **Table CN F.3.1 – Mixture consisting of the following cement EN 197-1 and CEM III/C grade cement as per EN 197-1: maximum permitted percentage by mass of CEM III/C type cement in the mixture according to the exposure categories to be covered and the type of cement chosen when the specific formulation of cement is not documented.** |
| **Cement quality as per EN 197-1 authorised for mixing** | **Maximum percentage by mass of CEM III/C type cement in the mixture with the cement quality authorised for that purpose** |
| **X0** | **XC1** | **XC2** | **XC3** | **XC4** | **XD1** | **XD2** | **XD3** | **XF1** | **XF2** | **XF3** | **XF4** | **XA1** | **XA2 b** | **XA3 b** | **XM1** | **XM2** | **XM3** |
| **Portland Cement** | **CEM I** | **45%** | **–** | **45%** |
| **Portland Slag Cement** | **CEM II/A-S** | **35%** | **–** | **35%** |
| **CEM II/B-S** | **20%** | **–** | **20%** |
| **Portland Limestone Cement** | **CEM II/A-LL** | **35%** | **–** | **–** | **–** | **35%** | **–** | **–** | **–** | **35%** | **–** | **–** | **35%** |
| – mixture not usable for this exposure category**a** If water in contact with the concrete surface has a sulphate content of SO42- > 600 mg/l or if soil in contact with concrete has a sulphate content of SO42- > 3,000 mg/kg, each of the two constituent cements of the mixture must be certified with high sulphate resistance. |

|  |
| --- |
| **Table CN F.3.2 – Mixture consisting of the cement as per EN 197-1 or EN 197-5 and a cement of CEM III/C grade as per EN 197-1: maximum permitted percentage by mass of CEM III/C type cement in the mixture according to the exposure categories to be covered and the type of cement chosen when the specific formulation of cements is documented.** |
|  | **Cement quality as per EN 197-1 authorised for mixing** | **Maximum percentage P by mass of CEM III/C type cement in the mixture with the cement quality authorised for that purpose** |  |
|  | **X0** | **XC1** | **XC2** | **XC3** | **XC4** | **XD1** | **XD2** | **XD3** | **XF1** | **XF2** | **XF3** | **XF4** | **XA1** | **XA2 b** | **XA3 b** | **XM1** | **XM2** | **XM3** |  |
| **Portland Cement** | **CEM I** | **P** | **–** | **P** |
| **Portland Slag Cement** | **CEM II/A-S** | **P** | **–** | **P** |
| **CEM II/B-S** |  |  |  |  |  | **P** |  |  |  |  |  | **–** | **P** |
| **Portland Limestone Cement** | **CEM II/A-LL** | **P** | **–** | **–** | **–** | **P** | **–** | **–** | **–** | **P** | **–** | **–** | **P** |
| **Blast Furnace Cement** | **CEM III/A** | **P** | **–** | **P** |
| **Cement quality as per EN 197-5 authorised for mixing** | **X0** | **XC1 1** | **XC2** | **XC3** | **XC4** | **XD1** | **XD2** | **XD3** | **XF1** | **XF2** | **XF3** | **XF4** | **XA1** | **XA2 b** | **XA3 b** | **XM1** | **XM2** | **XM3** |
| **Compound Portland Cement** | **CEM II/C-M** | **P** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** | **–** |
| P is calculated as follows:whereP: Maximum percentage P by mass of CEM III/C type cement in the mixture, expressed in percent [%]Only a positive value of P is applicable. A negative value is considered to be zero.tcca: Permitted cement clinker rate for the mixture, expressed in percent [%] of the total mass of the main and secondary constituents of this cement as declared by the cement producertcc3c: Clinker rate of CEM III/C cement used for mixing, expressed in percent [%] of the total mass of the main and secondary constituents of this cement as reported by the cement producer– mixture not usable for this exposure category**a** If the water in contact with the surface of the concrete has a sulphate content of SO42- > 600 mg/l or the soil in contact with the concrete has a sulphate content of SO42- > 3000 mg/kg, each of the two cements in the mixture must be certified as highly sulphate resistant. |

**F.1 Maximum fines content of concretes**

(1) The maximum content of fines < 0.125 mm depending on the cement content of concrete is given in Tables CN F.4 and CN F.5:

**Table CN F.4 – Maximum content of fines for concrete with maximum particle size of 16 – 63 mm for concrete of strength class of ≤ C 50/60 resp. ≤ LC 50/60**

|  |  |
| --- | --- |
| Cement content of concrete[kg/m3] | Maximum content of fines < 0.125 mm[kg/m3] \* |
| ≤ 300 | 400 |
| 300 - 400 | Cement content + 100 |
| ≥ 400 | 500 |

\* with the exception of self-compacting concrete

**Table F.5 – Maximum content of fines for concrete with maximum particle size of 16 – 63 mm for concrete of strength class > C 50/60 resp. > LC 50/60**

|  |  |
| --- | --- |
| Cement content of concrete(kg/m3) | Maximum content of fines < 0.125 mm[kg/m3] \* |
| ≤ 400 | 500 |
| 400 - 450 | Cement content + 100 |
| ≥ 450 | 550 |

\* with the exception of self-compacting concrete

*Annex CN U complements the annexes to EN 206:*

**Annex CN U**

(normative)

**Aggregate particle size compositions in concrete**

1. The particle size compositions of aggregates that make up the concrete are described by the percentages in volume of passing fractions with opening square mesh screens 0.125 mm, 0.25 mm, 0.5 mm, 1 mm, 2 mm, 4 mm, 8 mm, 16 mm, 22 mm resp. 32 mm and 63 mm.
2. Particle size distribution of individual aggregates or composite aggregates is determined according to the European standards EN 933-1 on sieves pursuant to ISO 3310.
3. Graphs CN U.1. to CN U.5 of particle size zones based on Dmax.

**Graph CN U.1 — Particle size zones for a maximum aggregate of 8 mm**



**% passing fraction (vol %)**

|  |
| --- |
| **Square mesh sieves (mm)** |
| **1** | **unfavourable** | **4** | **favourable for discontinuous composition** |
| **2** | **usable** | **5** | **unfavourable** |
| **3** | **favourable** |  |  |

**Graph CN U.2 — Particle size zones for a maximum aggregate of 16 mm**



**% passing fraction (vol %)**

|  |
| --- |
| **Square mesh sieves (mm)** |
| **1** | **unfavourable** | **4** | **favourable for discontinuous composition** |
| **2** | **usable** | **5** | **unfavourable** |
| **3** | **favourable** |  |  |

**Graph CN U.3 — Particle size zones for a maximum aggregate of 22 mm**



**% passing fraction (vol %)**

|  |
| --- |
| **Square mesh sieves (mm)** |
| **1** | **unfavourable** | **4** | **favourable for discontinuous composition** |
| **2** | **usable** | **5** | **unfavourable** |
| **3** | **favourable** |  |  |

**Graph CN U.4 — Particle size zones for a maximum aggregate of 32 mm**



**% passing fraction (vol %)**

|  |
| --- |
| **Square mesh sieves (mm)** |
| **1** | **unfavourable** | **4** | **favourable for discontinuous composition** |
| **2** | **usable** | **5** | **unfavourable** |
| **3** | **favourable** |  |  |

**Graph U.5 – Particle size zones for a maximum aggregate of 63 mm**



**% passing fraction (vol %)**

|  |
| --- |
| **Square mesh sieves (mm)** |
| **1** | **unfavourable** | **4** | **favourable for discontinuous composition** |
| **2** | **usable** | **5** | **unfavourable** |
| **3** | **favourable** |  |  |

|  |
| --- |
| *Annex CN V complements the annexes to EN 206:***Annex CN V**(normative)**On-site control and analysis of fresh and hardened concrete**1. This annex sets out the rules for inspecting fresh and hardened concrete for identification testing carried out on test specimens prepared separately on site.
2. This annex applies to concrete of light, normal or heavy density concrete as defined by this standard.
3. This annex is not applicable to the control and assessment of the compressive strength of hardened concrete in structures or parts thereof, for which standards EN 12504 and EN 13791 apply.

**V.1 Monitoring classes**1. On-site control of fresh and hardened concrete grades is carried out on the basis of the assignment to one of the three monitoring classes defined in Table CN V.1. Where a concrete is allocated to several monitoring classes, the highest class is decisive.
 |
|  | **Table CN V.1 — Monitoring classes** |  |
|  | **Criteria** | **Monitoring classes** |  |
| **1** | **2** | **3** |
|  | Strength class for normal and heavy concrete | ≤ C25/30 (1) | ≥ C30/37 et ≤ C50/60 | ≥ C55/67 |  |
|  | Strength class for light concrete of densityD 1.0 to D 1.4 | not applicable | ≤ LC25/28 | ≥ LC30/33 |  |
|  | D 1.6 to D 2.0 |  | ≤ LC35/38 | ≥ LC40/44 |  |
|  | Exposure category | X0,XC,XF1 | XD,XA, ≥XF2 |  |  |
|  | Special properties |  | * concrete with high water penetration resistance
* watertight concrete
* underwater concrete
* concrete with high service temperature
* specific applications as per EN 13670/CN‑LU
 |  |  |
|  | (1) Prestressed concrete of class C25/30 shall be assigned to monitoring class 2. |  |

**V.2. Minimum control and frequency of on-site concrete controls**

1. The main controls on fresh and hardened concrete to be carried out at the site and the minimum frequencies required according to the assigned monitoring class are defined in Table CN V.2.

**Table CN V.2 - Main on-site controls and minimum frequencies required**

|  |  |
| --- | --- |
| **Control item** | **Minimum frequency per monitoring class** |
| **1** | **2** | **3** |
| Delivery slip | each delivery |
| Consistency | in case of doubt | At the 1st implementation of a concrete quality. When making test pieces for compressive strength tests.In case of doubt. |
| Visual inspection of concrete uniformity | occasionally | each delivery |
| Compressive strength on cubes (a) | 3 samples(b) per 300 m3 or 5 days of concreting (c) | 3 samples(b) per 300 m3 or 3 days of concreting (c) | 3 samples(b) per 150 m3 or 2 days of concreting (c) |
| Air content on concrete with air entrainer (d) | not applicable | First 5 deliveries of each concreting and then each 5th delivery |

1. Sampling and compressive strength determination are performed separately for each concrete formulation ≥ C 20/25.
2. The three samples are taken on the same day, at the beginning of each particular volume (300 m3 or 150 m3) resp. on the first day of each concreting period (5 days, 3 days or 2 days) randomly in accordance with EN 12350-1. A cubic test piece is prepared in accordance with Article V.3.2 per sample taken, where appropriate after adjusting the consistency. Three test pieces form a series.
3. The case that provides the highest number of samples must be retained.
4. This control is required for concretes used as part of exposure category XF4 (Cat.4 LP)
5. For the testing of concrete with special properties, e.g. freeze-thaw resistance in the presence of de-icing agents, water penetration resistance, elastic modulus, tensile strength, bending strength, etc., the manufacture of additional test pieces and minimum control frequencies shall be specified separately or are carried out in accordance with Table CN V.3.

**Table CN V.3 – On-site controls and minimum frequencies required for particular properties**

|  |  |  |  |
| --- | --- | --- | --- |
| **Control item** | **Applicable standards and methods** | **Type of test piece** | **Minimum control frequency** |
| Freeze-thaw resistance with de-icing agents Exposure category XF4 | RILEM/CDC 2 | 150 mm edge cube | 2 test pieces per day of concreting |
| Water penetration resistance | EN 12390-8 | 150 mm edge cube | 2 test pieces per concreting phase of a structural element |
| Elastic modulus | DIN 1048 T.5 | cylinder Ø 150 mm; height 300 mm | 6 test pieces at the first delivery of concrete on site |
| Apparent density in fresh condition | EN 12350-6 | minimum frequency of control to be specified by the prescriber or user respectively in case of justified doubt |
| Fresh concrete water content | DARR |
| Particle size analysis on fresh concrete | EN 933-1 |
| Tensile strength by splitting | EN 12390-6 |
| Flexural strength | EN 12390-5 |
| Temperature of fresh concrete | - | in hot weather resp. in cold weather at the start of delivery then each 5th delivery |
| Density of hardened concrete | EN 12390-7 | 150 mm edge cube | during compressive tests |
| Evolution of hardening | - | execution of the control to be specified by the prescriber or the user |
| Structural resistance | EN 12504EN 13791 | carrying out the control to be specified by the prescriber or the user respectively in case of justified doubt |

**V.3 Collection of samples, making and preservation of cubes for identification testing**

**V.3.1 Sampling**

1. Samples are taken on the same day randomly according to EN 12350-1.
2. They must be taken from various batches or loads in accordance with EN 12350-1.

**V.3.2 Manufacture of test pieces**

1. Identification testing for the compressive strength of concrete is carried out only on geometric cubes complying with EN 12390-1, 150 mm edge cube with nominal maximum concrete diameter lower than or equal to 32 mm, manufactured in accordance with EN 12390-2.

**V.3.3 Storing of test pieces**

**V.3.3.1 Storage before removal**

1. The storage of test pieces before removal must be on the site.
2. After making the test pieces, the moulds must be covered in such a way as to prevent the drying of the test pieces and be kept on the lattice of a conditioning bin in accordance with Article V.4 guaranteeing a relative humidity level ≥ 65 % and an ambient temperature of (20 ± 5)°C. The bottom of the bin must be permanently filled with water.
3. The bin is placed in a heated room specifically dedicated for on site concrete controls, at a minimum ambient temperature of 16°C.
4. The test pieces must be removed the next day, no earlier than 16 h after they are made.
5. If the test pieces cannot be removed on the day after they were made (weekend, bank holidays), the moulds must be stored in the conditioning bin until stripping. Stripping must take place no later than 3 days after manufacture.
6. The date and time of stripping must be recorded in a register.
7. The temperature of the air in the conditioning bin must be recorded at least twice a day, once in the morning and once in the afternoon.

**V.3.3.2 Storage after removal**

1. After removal the test pieces must be stored in accordance with EN 12390-2 under standardised conditions under water at (20 ± 2)°C or in an air-conditioned chamber at (20 ± 2)°C and ≥ 95 % relative humidity.
2. In case of storage by the User (e.g. on site or centrally by the construction company), the test pieces are stored under water, in a conditioning bin with thermostatic adjustment at (20 ± 2)°C in accordance with Article V.4 until they are transported to a test laboratory.
3. The bin is placed in an air-conditioned room guaranteeing an ambient temperature of (20 ± 5)°C.
4. The date of transmission to the laboratory must be logged.
5. The temperature of the water in the conditioning bin must be logged at least twice a day, once in the morning and once in the afternoon.

**V.4 Equipment required for the control of concrete on site**

1. Concrete control and the making and storage of test specimens must be carried out with equipment according to Table V.4.

**Table CN V.4 — Concrete control equipment**

|  |  |
| --- | --- |
| **Subject** | **Equipment** |
| Measuring consistency using the flow table test | Flow table, truncated mould and accessories conforming to EN 12350-5. |
| Measuring air content | Manometer unit and accessories conforming to EN 12350-7. |
| On-site manufacture of cubic test pieces | Cubic moulds with 150 mm edges and accessories in conforming to EN 12390-1.Vibrating table or vibrating needle and accessories conforming to EN 12390-2. |
| On-site storage of test pieces before removing | Heated room ensuring a minimum ambient temperature of 15°C. |
|  | Conditioning bin (a) guaranteeing an ambient temperature of (20 ± 5)°C and relative humidity ≥ 65%. |
| Storage by the User of test pieces after removal (standardised storage) | Air-conditioned room ensuring an ambient temperature of (20 ± 5)°C.Conditioning bin (1) to ensure water temperature of (20 ± 2)°C. |

(a) Conditioning bin (or thermostatic bin) whose bottom is filled with water. It is composed of a lattice on which the test pieces are laid before removal. After removal, the test pieces are placed on the bottom of the bin so that they are completely immersed in water. The bin enables the storage of test pieces according to standard at a water temperature of (20 ± 2)°C. It guarantees an ambient air temperature of (20 ± 5)°C and relative humidity ≥ 65 % on the lattice. The test pieces must be protected against water loss by evaporation, draughts, heat, cold and impacts.

1. The equipment including accessories is exclusively dedicated to inspecting concrete on site. They are kept in a specific room, in a clean and operational state. They are subject to an annual conformity check by an external control body (see Article V.10).

**V.5. Identification criteria for compressive strength**

1. For identification testing, compressive strength is determined according to EN 12390-3 on concrete test pieces made on site and stored according to EN 123902.
2. A test result in accordance with Table CN V.5 is based on the average of the results of individual compression tests carried out on a series of three test pieces of the same age derived from samples taken on site from the same concrete formulation.
3. When a test piece presents an individual test result varying by more or less 15% from the average of the results in its series, this series shall not be considered as part of the assessment of the identification criteria, unless a more thorough examination makes it possible to find a valid reason not to take into account one of the individual test results. In this case, the test result shall be the average of the two remaining individual test results.
4. The concrete is presumed to be from a compliant population when the criteria of Table V.5. are met.

**Table CN V.5 – Identification criteria for compressive strength**

|  |  |
| --- | --- |
| **Number n of test results considered** | **Identification criteria (a)** |
| **Criterion 1** | **Criterion 2** |
| **Mean fcm of n results****[N/mm2]** | **Each individual result fci****[N/mm2]** |
| 1 | does not apply | fci ≥ fck-4 |
| 2-4 | fcm ≥ fck + 1 | fci ≥ fck -4 |
| 5-6 | fcm ≥ fck + 2 | fci ≥ fck -4 |
| > 6 | fcm ≥ fck+ 2,5 | fci ≥ fck-4 |

(a) resistances at 28 days, except as specified below. 5.5.1.2

**V.6 Documentation of tests and results**

1. All controls carried out must be documented in such a way as to ensure traceability of the sample of concrete analysed. Each test piece must be identifiable with a marking indicating the site name, test piece number and its manufacture date. This marking must be logged on a sampling note sent with the test piece to the testing laboratory and on a site log with indication of nominal quality of the concrete inspected, concrete delivery slip number, concreted structural section and test results. The assignment of test piece numbers shall be continuous and shall be carried out by incrementation of 1. All documentation must be available for consultation on site. All test results must be forwarded to the Works Management.
2. The Works Management consists of the responsible person(s) designated by the Project Owner and represents the latter during the execution of the works.

**V.7 Internal control**

1. Concrete controls on site must be carried out by qualified User personnel in the case of internal controls.
2. Internal control is part of a quality assurance system to be implemented by the User and structuring the phases of organisation, preparation, controls and documentation of concreting work in order to meet the quality, information and traceability requirements of this standard.
3. The qualified personnel responsible for the control of concrete are composed of one or more test managers and a concrete quality manager.

**V.7.1 Test manager**

1. The sampling, the flow table tests and the making of test pieces are to be carried out by a test manager designated by the User from among his site staff.
2. The on site testing manager must hold a C certificate.
3. The C certificate is granted by an approved continuing vocational training organisation following a qualifying training course dealing with the basic principles:
* of formulation,
* of production,
* of control,
* of assessment,
* of implementation,
* of protection and curing
* of concrete

sanctioned by an examination. The training programme is adopted by the Laboratoire de l’Administration des Ponts et Chaussées of the Grand-Duchy of Luxembourg. The C certificate is valid for three years. It may be renewed every three years by continuing training certification.

1. Controls of concrete delivered on site may be delegated to an external concrete control provider in accordance with Article V.9. Under no circumstances may they be delegated to the Producer or to an external compliance control body.

**V.7.2 Concrete quality manager**

1. The User must appoint a concrete quality manager from among its personnel.
2. The concrete quality manager must be the holder of the Q certificate.
3. The Q certificate is issued by an accredited continuing vocational training organisation after attending and successful completion of a qualifying training covering in an expanded way the technology and implementation of concrete attested by an examination. The training programme is adopted by the Laboratoire de l’Administration des Ponts et Chaussées of the Grand-Duchy of Luxembourg. The Q certificate is valid for three years. It may be renewed every three years by continuing training certification.
4. In particular, the concrete quality manager must fulfil the following tasks:
* implement a quality assurance system for concreting work within the construction company;
* advice and technical assistance within the construction company;
* advice and technical assistance on the site, in particular with regard to implementation,
* curing and protection of concrete;
* training to site personnel, specifically as regards the implementation, curing and protection of concrete;
* management and documentation of ongoing training of C certificate holder(s);
* management of relations with the laboratory responsible for testing hardened concrete (see Article V.8);
* where appropriate, management of technical relations with the concrete control body (see Article V.9);
* management of relations with the external control body (see Article V.10);
* management and documentation of equipment and compliance of concrete control equipment (see Article V.4);
* on site control of fresh and hardened concrete when these controls are not carried out by the site testing manager;
* quality control of tests carried out by the testing manager on site;
* on-site monitoring of tests and implementation of monitoring class 3 concrete and tests and implementation of concrete as part of exposure category XF4 (Cat.4 LP);
* continuous monitoring, assessment and documentation of the conformity of the concrete implemented.
1. The duties of the concrete quality manager may not be delegated to an external body.

**V.8 Laboratory responsible for hardened concrete testing**

1. The tests on hardened concrete carried out as part of the identification test are carried out in accordance with EN 12390. The test laboratory is to be declared by the User before the beginning of the concreting work to the Works Management and the external control body.

**V.9 External concrete control service provider**

1. Sampling, control of the properties of fresh concrete and making test pieces may be delegated for all monitoring classes to an external concrete control service provider. The equipment required to store test pieces before removal must remain available on site. The external concrete control service provider must hold a valid Q certificate. The operator in charge of the tests must hold a valid C certificate.

**V.10 External compliance control**

1. For concrete of monitoring classes 2 and 3, an external control of the application of the provisions of this annex must be carried out by an approved external conformity control body. In general, the external control body shall verify the application and compliance of procedures to be implemented in accordance with this standard.
2. The external control body is mandated by the User.
3. The following information shall be sent in writing to the external control body:
* contact details of the site;
* contact details of the person responsible for the work;
* contact details of the Works Management;
* contact details of the concrete quality manager;
* contact details of the test manager;
* where applicable, contact details for the concrete control body;
* contact details of the testing laboratory;
* quantities of concrete to be implemented according to the monitoring classes;
* planned start and end of work;
* any site shut-downs lasting over four weeks;
1. The external control body is to be designated by the User to the Works Management before the beginning of the concreting work.
2. The tasks of the external control body and the control frequencies are defined in paragraphs V.10.1 and V.10.2.
3. The results of the external control report are documented in an inspection report forwarded to the User and Works Management.

**V.10.1 Tasks of the external control body**

1. Prior to the start of work:
* control of the validity of the C certificate of the test manager and the Q certificate of the concrete quality manager;
* where appropriate, control of the validity of the delegation of control of concrete delivered on site to an external concrete control body in accordance with Article V.9;
* conformity control of control equipment in accordance with Article V.4;
* control of the declaration of a test laboratory in accordance with Article V.8;
* control of monitoring class(es) of concrete to be implemented according to specifications;
* validity control of the certification of production control according to this standard by the concrete production plant(s).
1. During the work:
* control of monitoring and updating of documentation by the User in accordance with Article M.6;
* control of conformity, frequency and execution of on site control of fresh and hardened concrete according to this annex;
* establishment of a list of non-conformities of concrete with the identification criteria for the

compressive strength and other specified special properties;

* control of the performance of the tasks of the person responsible for testing in accordance with

paragraph V.7.1. and the concrete quality manager in accordance with paragraph V.7.2.

**V.10.2 Frequencies**

1. A first control takes place before the start of the concreting work.
2. A second control follows within eight weeks after the beginning of the concreting work.
3. A periodic control is then carried out every 3 months, the last control must be carried out after the completion of the concreting work.

*Annex CN W complements the annexes to EN 206:*

**Annex CN W
(informative)
Recommendations for the choice and specification of a concrete quality**

1. The purpose of Annex N is to inform the prescriber, producer and user of recommendations for choosing concrete quality from among a restricted number of possible combinations. This choice will depend on the strength class according to structural analysis and exposure categories determined specifically in advance by the prescriber, and minimum requirements for concrete quality according to Table F.2 of Annex F. Various combinations of exposure categories are proposed and grouped by concrete category.
2. The use of concrete categories implicitly refers to this standard and implies the requirement of compliance with it.

**W.1 Concrete categories**

1. Concrete categories are set out in Table CN W.1. The categories include combinations of possible exposure categories for common fields of use. Possible strength classes are provided for each category. The concrete category is chosen after determining the exposure category requiring the most restrictive limiting values. All exposure categories determined for a given structural element must be covered by the selected category.
2. **!!Note!!** Coverage indicated for several exposure categories for one category does not mean that these can be combined at random within this category. Thus exposure categories XD (corrosion induced by **chlorides**) cannot be combined with exposure categories XF1 and XF3 (freeze/thaw attack **without** de-icing agent). It is therefore essential to first specifically determine the exposure category(ies) and then to choose a corresponding category.
3. Due to the special requirements to be met for the XM exposure categories – Abrasion attack of concrete, these are not taken into account in the concrete categories. Article W.3 subparagraph (4) shall apply.

**W.2. Recommended strength classes — concrete categories combinations**

1. Tables W.1. and W.2. set out the range of possible choices per concrete category according to the strength class resulting from the structural analysis. The decisive strength class is the highest strength class between that required according to structural analysis and the minimum strength class required according to the concrete category determined.
2. For category 4 LP, only resistance class C 30/37 can be prescribed by default, with lower resistance classes excluded. The higher resistance classes, with or without an air entrainer, must be subject to a conformity check, the terms of which are defined between the producer, the prescriber and the user. Given this exception, strength classes higher than C35/45 may be specified from category 2 where applicable.
3. The compressive strength class to be retained is chosen **after** the determination of the category of concrete according to Article W.1 subparagraph (1). The highest strength class between the minimum strength class defined by the concrete category and that resulting from the static calculation shall be retained. **Choose a category of concrete according to the minimum strength class it defines, in order to match it with the strength class resulting from the structural analysis is counter-productive and may impair the durability of the structure**.

**W.3 Name of categories, documentation of choice and complete designation of concrete for specification and order of concrete**

1. Categories are named according to Table CN W.4. for concrete specification and order. The choice of a category for a building section must be documented by the prescriber on construction drawings indicating the category chosen, followed by the exposure category(ies) determined for this building section in brackets.
2. In accordance with the provisions of Article 11 of this standard, the complete designation of a concrete with specified properties shall be established as follows:
* reference to this European Standard and its National Supplement: EN 206+CN-LU;
* compressive strength class: compressive strength class as defined in Table 12 or 13, e.g. C25/30;

with indication of the term of its determination if it is determined at a term later than 28 days;

* type of use of concrete: unreinforced concrete, reinforced concrete, prestressed concrete;
* exposure category(ies):

indication of class(es) determined in accordance with Table CN 1.

or

* indication of the category of concrete according to this Annex with an indication in parentheses of the most restrictive exposure category(ies) which determined its choice;
* consistency: according to the classes defined in 4.2.1 or a target value and method.
* declared value for the largest aggregate actually used in concrete: dimension Dmax,

for example Dmax 22;

1. If none of the defined concrete categories meet the specified exposure category combination, the latter shall be indicated in accordance with subparagraph (2), 4th indent of Article W.3: indication of class(es) determined according to Table CN 1.
2. Where necessary, additional specifications should be provided, such as for example: (see also paragraph 6.2.3. of this standard)
* field of application;
* density: class designations according to Table 14 or target value, e.g. D1.8;
* maximum chloride content: class defined in Table 15, e.g. Cl 0.20;
* specific properties of concrete if prescribed;
* temperature of fresh concrete;
* water penetration resistance;
* elastic modulus;
* other technical requirements.

**Examples for normal density concrete:**

EN 206+CN-LU

C30/37; Reinforced concrete; Cat.2 (XC4, XF1); F4; Dmax= 22, E= 37,000 MPa; Exposed concrete

EN 206+CN-LU

C25/30; Reinforced concrete; Cat.5 (XC4, XA1); F3; Dmax= 16; High resistance to water penetration

1. The following paragraph of the introduction to this standard is recalled for the record:

*“ This European Standard defines the tasks of the prescriber, the producer and the user. For example, the prescriber is responsible for the specification of concrete, Article 6, and the producer is responsible for monitoring compliance and production, Articles 8 and 9. The user is responsible for using the concrete in the structure. In practice, several different entities may specify requirements at different stages of design and construction, e.g. the customer, designer, contractor and subcontractor responsible for the concreting. Each is responsible for the transmission of the specified requirements and any additional requirements to the next link in the chain, up to the producer. Within the meaning of this European Standard, the final compilation is referred to be the term “concrete specification”. Conversely, the prescriber, producer and user may be the same entity (e.g. a prefabricated concrete producer or a contractor carrying out the design and construction). In the case of ready-to-use concrete, the purchaser of the fresh concrete is the prescriber who provides the concrete specification to the producer (...)”*

1. Under the meaning of this standard and for current ranges of application, it is up to the specifier as designer of the building to define all relevant specifications and requirements to obtain the necessary properties, including fresh concrete where applicable if necessary to obtain the properties of the hardened concrete, e.g. heat released during hydration, particular requirements for the temperature of fresh concrete, development of strength, etc.
2. In the final compilation, in addition to the information to be provided pursuant to Article 7.1, it is up to the user as purchaser of the concrete to include in the specification provided to the producer all requirements on the properties of the concrete relating to implementation, e.g. transportation after delivery, pouring, compacting (consistency class or target value) respectively affecting the progress of the work, e.g. delayed setting, development of strength if not yet specified, etc.
3. In case of conflicting requirements and for specific cases, the prescriber, user and producer must agree on the final compilation of the specification (see 6.1).

**Table CN W.1 — Concrete categories based on combinations of exposure categories for common fields of application and possible strength classes**

|  |  |  |  |
| --- | --- | --- | --- |
| **Category** | **Field of application**  | **Covered exposure categoriesa)** | **Strength class(es) fck possible(s) b)** |
| **X0** | **XC** | **XD** | **XF** | **XA** |
|  | **1** | **2** | **3** | **4** | **1** | **2** | **3** | **1** | **3** | **2** | **4** | **1** | **2c)** | **3c)** | **C12/15** | **C20/25** | **C25/30** | **C30/37** | **≥ C35/45** |
| **0** | Non-reinforced concrete. | **X** |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **X** | **X** |  |  |  |
| **1** | Reinforced concrete inside buildings.Frost-free reinforced concrete, long-term contact with water. *(Large numbers of foundations)* | **X** | **X** | **X** |  |  |  |  |  |  |  |  |  |  |  |  |  | **X** | **X** |  |  |
| **2** | Reinforced concrete inside buildings with a high humidity level.External reinforced concrete, horizontal surfaces sheltered from rain.External reinforced concrete, vertical surfaces.Low chemical aggressivity. | **X** | **X** | **X** | **X** | **X** |  |  |  | **X** |  |  |  | **X** |  |  |  |  | **X** | **X** | **X** |
| **3** | External reinforced concrete, horizontal surfaces without de-icing agents, vertical surfaces with de-icing agents.Moderate chemical aggressivity but SO42- content **≤** 600 mg/l in water or ≤ 3000 mg/kg in soil. | **X** | **X** | **X** | **X** | **X** | **X** | **X** |  | **X** | **X** | **X** |  | **X** | **X** |  |  |  |  | **X** | **X** |
| **3HRSd)** | External reinforced concrete, horizontal surfaces without de-icing agents, vertical surfaces with de-icing agents.Moderate chemical aggressivity, SO42- content **>**  600 mg/l in water or **>** 3000 mg/kg in soil. | **X** | **X** | **X** | **X** | **X** | **X** | **X** |  | **X** | **X** | **X** |  | **X** | **X** |  |  |  |  | **X** | **X** |
| **4LPe)** | External reinforced concrete, horizontal surfaces with de-icing agents. Moderate chemical aggressivity, SO42- content**≤** 600 mg/l in water or **≤** 3000 mg/kg in soil. | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** |  |  |  |  | **X** |  |
| **5** | Reinforced concrete with high resistance to water penetration Low chemical aggressivity | **X** | **X** | **X** | **X** | **X** |  |  |  | **X** |  |  |  | **X** |  |  |  |  | **X** | **X** | **X** |
| **6** | External reinforced concrete, horizontal surfaces without de-icing agents, vertical surfaces with de-icing agents.Frost-free reinforced concrete, chloride present.Strong chemical aggressivity but SO42- content ≤ 600 mg/l in water or ≤ 3000 mg/kg in soil. | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** |  | **X** | **X** | **X** |  |  |  |  | **X** |
| **6HRSd)** | External reinforced concrete, horizontal surfaces without de-icing agents, vertical surfaces with de-icing agents.Strong chemical aggressivity, SO42- content **>** 600 mg/l in water or **>** 3000 mg/kg in soil. | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** |  | **X** | **X** | **X** |  |  |  |  | **X** |

a) See Article W.1 subparagraph (2). For exposure categories XM see W.3. subparagraph (4).

b) See tables CN W.2.1 and CN W.2.2.

c) Use SR cement — sulphate resistant — in the presence of SO42- (> 600 mg/l in water or > 3000 mg/kg in soil).

d) Determination of the rated compressive strength at 56 days if use of class 32.5 N SR CEM III blast furnace cements.

e) Minimum air content in function (Dmax): 4.5% (32), 5% (22), 5.5% (16), 6% (8). See also the provisions of Article W.2, subparagraph (2).

**Table CN W.2 — Possibilities of combinations between strength classes and categories**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Cat.0 | Cat.1 | Cat.2 | Cat.3 | Cat.3HRS | Cat.4LP | Cat.5 | Cat.6 | Cat.6HRS |
| C12/15 |  |  |  |  |  |  |  |  |  |
| C20/25 |  |  |  |  |  |  |  |  |  |
| C25/30 |  |  |  |  |  |  |  |  |  |
| C30/37 |  |  |  |  |  |  |  |  |  |
| ≥ C35/45 |  |  |  |  |  |  |  |  |  |

|  |
| --- |
| Excluded |
| Possible |
| Not recommended |



**Table CN W.3 — Limit values applicable to the composition and properties of concrete by concrete category**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Category** | **Strength class** | **Maximum E/C factor** | **Minimum cement level** | **Min. air content** | **Cement quality** | **Aggregate freeze category** |
| **0** | ≥ C12/15 | --- | --- | --- | **a** | --- |
| **1** | ≥ C20/25 | 0.65 | 240 | --- | **a** | --- |
| **2** | ≥ C25/30 | 0.60 | 280 | --- | **a** | F4 |
| **3** | ≥ C30/37 | 0.50 | 320 | --- | **a** | F2 |
| **3HRS** | ≥ C30/37 | 0.50 | 320 | --- | **a** / SR | F2 |
| **4LP** | C30/37 | 0.45 | 340 | ≥ 4.0% | **a** | Fnacl 6 |
| **5** | ≥ C25/30 | 0.55 | 300 | --- | **a** | F4 |
| **6** | ≥ C35/45 | 0.45 | 340 | --- | **a** | F2 |
| **6HRS** | ≥ C35/45 | 0.45 | 340 | --- | **a** / SR | F2 |

**a** Table CN F.2 determines the fields of application of cement conforming to EN 197-1 and EN 197-5 for concrete making according to the exposure categories

Cements usable for XD exposure categories are also usable for the corresponding XS exposure categories.

**Table CN W.4 - Name of categories for concrete specification**

|  |  |
| --- | --- |
| **Category** | **Name** |
| 0 | Cat.0 |
| 1 | Cat.1 |
| 2 | Cat.2 |
| 3 | Cat.3 |
| 3 HRS | Cat.3 HRS |
| 4 LP | Cat.4 LP |
| 5 | Cat.5 |
| 6 | Cat.6 |
| 6 HRS | Cat.6 HRS |

1. [↑](#footnote-ref-1)