

CHAPTER 1

GENERAL PRINCIPLES

Article 1. Object

This Code on Structural Concrete (*Spanish abbreviation – EHE*) is the regulatory framework laying down the requirements which must be met by concrete structures to satisfy structural safety and security requirements in case of fire, in addition to the protection of the environment, providing procedures which enable their compliance with sufficient technical guarantees to be demonstrated.

The requirements must be met in the design and the construction of concrete structures, as well as during the maintenance thereof.

This Code assumes that the design, construction and inspection of the structures which constitute its scope are carried out by technicians and operators having the necessary expertise and sufficient experience. Furthermore, it is taken as fact that these structures are intended for the use for which they have been designed and shall be suitably maintained during their working life.

The notation, the units and the terminology used in this Code shall be those laid down in Annex 1.

Article 2. Scope

This Code shall apply to all structural concrete structures and elements, for building or for public works, with the following exceptions:

- Composite structural elements of structural steel and concrete, and, in general, mixed structures of structural concrete and other material of a different nature having a load bearing function;
- structures in which the prestressing action is introduced through active reinforcements outside of the depth of the element;
- structures made with special concretes not specifically covered by this Code, such as heavy aggregate concretes, refractory concretes and compound concretes with sawdust or other similar substances;
- structures to be exposed to temperatures over 70°C under normal circumstances;
- concrete pipes used for the distribution of fluid of any kind, and
- dams.

Structural concrete elements may be constructed from plain, reinforced or prestressed concrete.

When, in accordance with the characteristics of the structure, specific legislation on actions exists, this Code shall apply in addition thereto.

When, in the light of the characteristics of the work, defined by the Owners, the structure may be considered as a special or specific work, this Code shall apply together with the amendments and additional provisions laid down by the Designer, under his responsibility, to satisfy the requirements laid down in this Code, with the same level of guarantee.

Article 3. General considerations

All persons involved in the design, construction, inspection and maintenance of concrete structures are obliged to know and apply this Code.

In order to ensure that a concrete structure satisfies the requirements laid down in Article 5 of this Code, persons involved must check compliance with the requirements laid down herein on the design, construction, inspection and maintenance of the structure.

To justify that the structure complies with the requirements laid down in this Code, the Designer and the Project Manager may:

- a) Adopt technical solutions which comply with the procedures laid down in this Code, the implementation of which is sufficient to provide proof of the fulfillment of the requirements laid down herein, or
- b) Adopt alternative solutions which partially or totally deviate from the procedures laid down in this Code. In order to do this, the Designer and the Project Manager may, in line with their competences and under their own responsibility, and upon the agreement of the Owner, adopt alternative solutions (by means of different calculation systems, construction provisions, inspection procedures, etc.) provided that it may be proven by means of documents that the structure fulfils the requirements of this Code due to the fact that its specifications are at least equivalent to those obtained by the implementation of the procedures laid down herein.

Article 4. General conditions

4.1. Administrative conditions

Within the framework of this Code, only construction products lawfully marketed in countries which are members of the European Union or signatories to the agreement on the European Economic Area may be used, and provided these products, fulfilling the regulations in any European country member, guarantee an equivalent level regarding safety and intended use to the one requested in this Code.

This equivalence level will be accredited regarding article 4.2, or, if it is the case, article 16 of the Directive 89/106/CEE of the Council, of 21st December, 1988, regarding the legal, regulatory and administrative requirements of the Member States on construction products.

Specifications in the above paragraphs shall also apply to the construction products produced or legally marketed in a Country with an agreement on the European Economic Area, when this agreement recognizes to these products the same treatment to those produced or marketed in a state member of the European Union. In these cases the level of equivalence shall be checked according to the procedures included in the referred Directive.

For the purposes of this Code, it shall be understood that the UNE, UNE EN or UNE EN ISO standards referred to in the Articles are always the versions listed in Annex No. 2, except in the case of UNE EN standards transposed from EN standards whose reference has been published in the Official Journal of the European Union within the framework of Directive 89/106/EEC relating to construction products, in which case the reference must be linked to the latest Commission Communication which includes this reference.

Quality marks of a voluntary nature which facilitate the fulfilment of the requirements laid down in this Code may be recognised by the Public Administrations competent within the area of construction of any Member State of the European Economic Area and may relate to the design

of the structure, to the products, to the processes for the construction thereof or to the consideration of environmental criteria.

4.2. Technical conditions for conformity with this Code

4.2.1. Technical conditions for products, equipment and systems

The materials and the construction products permanently incorporated into the structures (concrete, cement, aggregates, corrugated steel, manufactured reinforcements, prestressing systems, precast elements, etc.) must possess the appropriate characteristics for the structure to fulfil the requirements laid down in this Code, for which the conformity thereof must be checked pursuant to the criteria laid down in Title 8.

The characteristics of the materials used, where applicable, in the manufacture of the products referred to in the previous paragraph must permit that these, following their manufacture, as appropriate, fulfil the requirements of this Code, for which reason they must comply with the specifications laid down for these materials.

4.2.2. Technical conditions for the design project

The design project must describe the structure, providing justification for the solution adopted and defining the technical requirements of the construction works in sufficient detail in order that they may be unequivocally assessed and interpreted during their execution.

In particular, the design shall describe the planned works in sufficient detail, in such a way that it may be explicitly checked that the solutions adopted fulfil the requirements of this Code and other technical legislation applicable thereto. This definition shall include at least the following information:

- a) the technical characteristics of each construction unit, with an indication of the conditions for the construction thereof and the checks and inspections to be carried out to check the conformity thereof with that indicated in the design,
- b) the minimum technical characteristics which the products, equipment and systems permanently incorporated into the planned structure must fulfill, as well as the conditions for the supply thereof, the quality guarantees and the acceptance inspection which must be carried out.
In light of the possible greater technical guarantees and traceability which may be associated with quality marks, the Designer shall assess the inclusion, in the corresponding memorandum of specific technical requirements, of the requirement to use materials, products or processes which lay down an additional level of guarantee pursuant to Annex 19 to this Code.
- c) the load tests and compulsory verifications on the built structure, as appropriate, and
- d) the instructions for use and maintenance of the structure.

4.2.3. Technical conditions for the construction

Construction work on the structure shall be carried out subject to the design project and to the modifications which, under their responsibility and in line with their competences, are authorised by the Project Manager, with the agreement, where appropriate, of the Owners. Furthermore, they must comply with the Project Manager's Code, to regulations applicable thereto and to standards of good building practice.

During the construction, the inspection activities necessary to check the conformity of the processes used therein, the conformity of the materials and products arriving at the site, as well as the conformity of those which are prepared on-site for the purpose of being definitively incorporated therein shall be implemented.

In response to the same guarantee criteria laid down in the previous section, the Project Manager shall assess the suitability of calling for products or processes that have an additional guarantee level pursuant to Annex 19 to this Code, even in the case where such a requirement has not been laid down in the design.

During the construction of the work, the Project Manager shall draw up the documentation required by law which must, as a minimum, include an inventory listing the main events taking place in the construction, a collection of plans reflecting the final state of the work exactly as constructed and the documentation corresponding to the quality inspection carried out during the work, pursuant to the provisions laid down in the design and in this Code.

Article 5. Requirements

In accordance with current legislation, and for the purpose of guaranteeing the safety of persons, animals and goods, the welfare of society and the protection of the environment, concrete structures must be suitable for use for the entire period of working life for which they have been built. In order to do this, they must satisfy the following requirements:

- a) structural safety and functionality, consisting in reducing, to acceptable limits, the risk that the structure has inadequate mechanical behaviour under the foreseeable actions and influences to which it may be subject during its construction and intended use, taking into account the whole of its working life,
- b) fire safety, consisting in reducing, to acceptable limits, the risk that users of the structure suffer injury arising from an incident of accidental origin, and
- c) hygiene, health and the protection of the environment, as appropriate, consisting in reducing, to acceptable limits, the risk that inappropriate impacts are caused to the environment as a result of the construction of the works.

In order to fulfil the above mentioned requirements, the requirements listed in this Article must be fulfilled. In some cases, the implementation of the procedures laid down in this Code shall suffice for the checking of the requirements, whilst in others, they must be supplemented with that laid down by other regulations in force of a more specific nature in accordance with the use of the structure.

In any case, the Owners must lay down the design working life of the structure at the start of the design, which may be no less than that indicated in the corresponding specific regulations, or, in the absence of these, than the values laid down in Table 5.1.

Table 5.1. Design working life of the various types of structure (1)

Type of structure	Design working life
Structures of a temporary nature ⁽²⁾	Between 3 and 10 years
Replaceable elements not forming part of the main structure (for example, handrails, pipe supports)	Between 10 and 25 years
Agricultural or industrial buildings (or installations) and maritime works	Between 15 and 50 years
Housing or office buildings, bridges or crossings of a total length of less than 10 metres and civil engineering structures (except maritime works) having a low or average economic repercussion	50 years
Buildings of a monumental nature or having a special importance	100 years
Bridges of a total length equal to or greater than 10 metres and other civil engineering structures having a high economic repercussion	100 years

- (1) When a structure consists of different members, different working life values may be adopted for such members, always in accordance with the type and characteristics of the construction thereof.
- (2) In accordance with the purpose of the structure (temporary exposure, etc.). Under no circumstances shall structures with a design working life greater than 10 years be regarded as temporary structures.

The Owners may also lay down other additional requirements, such as, for example, appearance, in which case they must identify the requirements connected with the achievement of the aforementioned additional requirements prior to implementing the design, in addition to the criteria for the checking thereof.

The aforementioned requirements shall be met by means of a design which includes an appropriate selection of the structural solution and the construction materials, a careful construction compliant with the design, a suitable inspection of the design, where appropriate; as well as of the construction and operation, together with an appropriate use and maintenance.

5.1. Demands

The requirements which must be fulfilled by a concrete structure in order to satisfy demands shall be those listed below.

5.1.1. Demands relating to the structural safety requirement

In order to satisfy this requirement, structures must be designed, constructed, inspected and maintained in such a way that they fulfill certain minimum reliability levels for each of the requirements laid down in the following sections, in accordance with the safety system laid down in the group of European standards EN 1990 to EN 1999 "Structural Eurocodes".

It shall be understood that the fulfilment of this Code, supplemented by the corresponding specific regulations relating to actions, shall be sufficient to guarantee that this structural safety requirement is satisfied.

5.1.1.1. Strength and stability requirement

The strength and stability of the structure shall be sufficient in order that no non-permissible risks arise as a consequence of foreseeable actions or influences, both during the construction and the usage phase thereof, being maintained throughout the expected working life of the structure. Furthermore, any extraordinary event must not give rise to consequences that are disproportionate in relation to the original cause.

The reliability level which must be guaranteed in concrete structures shall be defined by their reliability index β_{50} for a reference period of 50 years, which, in general, must not be lower than 3.8. In the case of specific structures or structures of little importance, the Owners may adopt a different index.

The procedures laid down in this Code for the checking of the Ultimate Limit States, together with the other criteria relating to construction and inspection, shall allow this requirement to be met.

5.1.1.2. Aptitude for service requirement

The aptitude for service shall comply with the anticipated use of the structure, in such a way that no unacceptable deformations are produced, the likelihood of a dynamic behaviour unacceptable for the comfort of users is limited to an acceptable level, and, furthermore, there are no unacceptable deteriorations or cracks.

It shall be understood that the structure has acceptable deformations when it fulfils the deflection limits laid down by specific applicable regulations. In the case of building structures, the limits laid down in Section 4.3.3 of the “Structural safety” Basic Document of the Technical Building Code shall be used.

Furthermore, in the absence of specific additional requirements (tightness, etc.), the characteristic crack openings shall be no greater than the maximum crack openings (w_{max}) laid down in Table 5.1.1.2

Table 5.1.1.2

Class of exposure, according to Article 8	w_{max} [mm]	
	Reinforced concrete (for the combination of quasi-permanent actions)	Prestressed concrete (for the combination of frequent actions)
I	0.4	0.2
IIa, IIb, H	0.3	0.2 ⁽¹⁾
IIIa, IIIb, IV, F, Qa ⁽²⁾	0.2	Decompression
IIIc, Qb ⁽²⁾ , Qc ⁽²⁾	0.1	

(1) It must also be checked that the active reinforcements are located in the compressed area of the section, under the combination of quasi-permanent actions.

(2) The limitation relating to the class Q shall only apply in the case where chemical attack may affect the reinforcement. In other cases, the limitation corresponding to the corresponding general class shall apply.

It shall be understood that a structural element has acceptable vibrations when it complies with the limits laid down by specific applicable regulations. In the case of building structures, the limits laid down in Section 4.3.4 of the “Structural safety” Basic Document of the Technical Building Code shall be used.

The procedures laid down in this Code for the checking of the Serviceability Limit States, together with the other criteria relating to construction and inspection, shall allow this requirement to be met.

The level of reliability which must be guaranteed in concrete structures for the aptitude for service thereof shall be defined by their reliability index β_{50} for a period of 50 years, which, under general circumstances, must be no less than 1.5.

5.1.2. Demands relating to the safety requirement in case of fire

In order to satisfy this requirement, where appropriate, works must be designed, constructed, inspected and maintained in such a way that a series of requirements, including the fire resistance of the structure, are fulfilled.

The fulfilment of this Code is not, therefore, sufficient for the fulfillment of this requirement. It shall also be necessary to fulfill the provisions of other applicable regulations in force.

5.1.2.1. Structural fire resistance requirement

The structure must maintain its fire resistance for the time laid down in the corresponding specific regulations applicable thereto in such a way that the propagation of fire is limited and the evacuation of occupants and assistance of fire-fighting and rescue teams facilitated.

In the case of building structures, the fire resistance required for each structural component is defined by that established in the Basic Document DB-SI of the Technical Building Code.

Recommendations are given in Annex 6 to this Code regarding the checking of fire resistance of structural concrete elements for the purpose of preventing a premature collapse of the structure".

5.1.3. Requirements relating to the hygiene, health and environment requirement

When it is established that this requirement has been fulfilled, structures must be designed, constructed and inspected in such a way that the environmental quality requirement of the construction is fulfilled.

The fulfillment of this Code is sufficient for the satisfaction of this requirement without prejudice to the fulfilment of the provisions of the remaining legislation in force of an environmental nature which may be applicable.

5.1.3.1. Environmental quality requirement of the construction

When so required, the construction of the structure must be designed and executed in such a way that the generation of environmental impacts caused thereby is minimized, promoting the reuse of materials and preventing, wherever possible, the generation of waste.