

PART I

**ARTICLES
AND COMMENTS**

Introduction

CHAPTER I

Article 1 Scope of application for the Instruction and prior considerations

This Instruction applies to concrete structures and structural elements, where this definition includes plain, reinforced or prestressed concrete, provided that the prestressing steel is located within the thickness of the element.

The following are expressly excluded from the scope of this Instruction:

- structures constructed with special concretes, such as lightweight, heavyweight or refractory and those compounded with asbestos, sawdust or other similar substances;
- structures that are normally to be exposed to temperatures above 70°C;
- structural elements consisting of mixed concrete and structural steel and, generally, mixed structures of concrete and any other material employed to provide strength;
- dams.

For special work, this Instruction shall be supplemented by the specific applicable regulations, and where these do not exist, by the measures or provisions that derive from the particular characteristics of the actual work itself and its use.

Reinforced or prestressed concrete one-way slabs shall be governed by that established in the Instruction for the Design and Execution of Reinforced or Prestressed Concrete One-way Slabs currently in force, applicable hereon, but shall comply with this Instruction's provisions in all other matters.

This Instruction assumes that the design, construction and control of this type of structure will be carried out by technicians and workers who have the required knowledge and sufficient experience. It is also assumed that the structure shall be put to the intended use and shall be suitably maintained.

The Designer and Project Manager are obliged to be conversant with the provisions of this Instruction and to take them into account. However, in the performance of their duties they may, on their own personal responsibility and with prior justification, use different design systems, constructive arrangements, etc. that do not reduce performance.

In relation to this, as an optional alternative to some of the specifications contained in this Instruction, Annex 13 includes the National Application Document for the UNE-ENV-1992.1.1 European Pre-Standard, the purpose of which is to make it feasible to use the pre-standard, which was provisional at the time of approval of this Instruction and non-mandatory in character.

Within the scope of this Instruction, only those construction materials (cements, aggregates, concretes, steels, etc.) may be employed that are legally marketed in European Union countries or which form part of the Agreement on the European Economic Area and

which are subject to that established in Royal Decree 1630/1992, dated the 20th of December (modified by Royal Decree 1328/1995, dated the 28th of July), which established the dispositions for free circulation of construction materials in accordance with Directive 89/106/EEC. In particular, with regards to the special recognition procedures, the products shall be subject to the provisions of article 9 of the above-mentioned Royal Decree.

COMMENTS

Prestressing action, as established in the article, is introduced by means of pre-deformed reinforcement, consisting of high-strength steel, which is known as prestressing steel. Steel used for reinforced concrete is known as reinforcement.

Structural concrete may be classified by its density as follows:	
Concrete	Density
Normal	Over 2,000 and up to 2,800 kg/m ³
Lightweight	From 1,200 to 2,000 kg/m ³
Heavyweight	Over 2,800 kg/m ³

Since the specifications of lightweight, heavyweight and refractory types of concrete differ from those of normal types of concrete, their use requires specific provisions that should be subject to special norms.

The harmful effects of high temperatures are, in general, greater in dry environments than in humid ones. The limiting of the value of seventy degrees centigrade, as established by this Instruction, is sufficiently safe for all cases. If the temperature exceeds this limit, then specialised texts should be consulted and suitable measures taken.

In special works, such as maritime works or those for nuclear reactors etc., the measures that derive from the work itself and its use shall be adopted. Such measures may require the prudent adaptation of this Instruction's provisions to the corresponding types of works.

Mixed structural elements demand the use of special techniques and specific design methods, since they are not included within the scope of application of this Instruction.

The possibility for the Designer and Project Manager of adopting criteria other than those established in the Instruction, as admitted in the articles, has the purpose, among others, of not detaining the advance of concrete techniques and permitting the adaptation of the works to local circumstances and conditioning factors.

In spite of this, the use of alternative criteria, different to those established by the Instruction (for example, those of UNE-ENV 1992.1.1) should be contemplated with special prudence and due caution, especially the compatibility and coherence of the same, avoiding specifications that do not provide overall consistent solutions or ones that have been thoroughly proven as such in practice.

1.1. Certification and quality marks

This Instruction requires that the construction products covered by it comply with a set of technical specifications, which, in general, are established by reference to regulations, instructions and UNE-EN or UNE standards etc. The purpose of these requirements is to ensure suitability to their intended use.

These products shall be supplied to the works accompanied by the minimum documentation as established in this Instruction, and which shall be eventually modified when the EC mark becomes mandatory for these products. Additionally, and voluntarily, they may include a CC-EHE certificate accrediting the products' compliance with the applicable mandatory specifications of this Instruction; if these are exclusively established by reference to standards, then the CC-EHE certificate may consist of a certificate of compliance with such standards.

The CC-EHE certificate, accrediting the compliance of a product with the mandatory specifications of this Instruction, may be issued by:

- Spanish Bodies –official and private– authorised to carry out certification duties and/or tests within the field of industrial materials, systems and processes, in accordance with Royal Decree 2200/1995 dated the 28th of December. The extent of certification in this case shall be limited to the materials for which these bodies have the corresponding accreditation.
- Public administration (at both State and local government level, within the scope of their respective competence). The exercise of this authority may be performed directly by the corresponding directive centres or through administrative bodies they have designated.

The procedure for the concession, and where applicable, the renewal of the CC-EHE certificate, whoever issues it from those listed in the two previous paragraphs, shall be established by the certifying body on the basis of compliance with the requirements given in Table 1.1.

Table 1.1

By the manufacturer	The testing of product samples taken at the plant at the shipping points. Continuous production monitoring at the plant. To have implemented a quality assurance system in accordance with UNE-EN-ISO 9002.
By the testing laboratory (belonging to the certifying body or authorised in accordance with Royal Decree 2200/1995).	Initial product testing. The testing of samples taken randomly at the plant, market or job-site.
By the certifying body.	Initial inspection and production monitoring at the plant. Continuous monitoring, supervision and evaluation of production control at the plant. Statistical verification of production by comparing the results of the tests carried out by the previously-mentioned laboratory and those obtained by the manufacturer. Audits and monitoring of the manufacturer's quality system in accordance with UNE-EN-ISO 9002. Certification of the product's compliance with the EHE Instruction, if applicable. The obligation of informing the Ministry of Public Works (General Technical Secretary), of the list of the obtained CC-EHE compliance certification, together with those renewed and withdrawn or cancelled for each natural closed half-year period. The certifying body shall make this certification available the public.

The non-compliance of any of the previous requirements or of the mandatory specifications required of the products covered by this Instruction, shall be cause for the withdrawal, cancellation or denial of the CC-EHE certification concession by the certifying body in accordance with its rules of procedure.

Furthermore, the fact that a wide variety of marks, seals, quality certificates, etc, hereinafter termed *quality marks*, exists on the construction product market, makes it advisable to establish the means of recognising such *quality marks* as guarantees that the products displaying them comply with the essential requirements established in this Instruction that apply to them.

Therefore, if a construction product bears a *quality mark* that guarantees compliance with the essential requirements established in this Instruction, it will be recognised as such when the *quality mark* in question is officially approved by a governing board of the public administrations (national or local government level) with competence in the field of construction (public works or building).

The above-mentioned public administrations shall ensure that the approval procedure for the recognition of such *quality marks* guarantees compliance by the corresponding products with the essential requirements established by this Instruction, and that the concession and renewal procedures, together with the causes for denial or withdrawal of the *quality marks* comply with requirements that are identical to those included in Table 1.1 and the following paragraph.

The list of *quality marks* that have been recognised or renewed or withdrawn during the closed natural half-year period shall be communicated to the Ministry of Public Works (General Technical Secretary), and the quality mark issuing body shall make this list available to the public.

The General Technical Secretary of the Ministry of Public Works shall resolve the publication of the CC-EHE certificate and *recognised quality mark* lists in the Official State Bulletin for general knowledge.

The supplier of a product bearing a *certificate* or a *quality mark*, both terms used in the above-described meaning, and who would like the special considerations, granted in certain cases by this Instruction, to apply, shall submit the following documentation:

- A currently-valid CC-EHE *certificate*, issued by an authorised body or competent authority, dated less than two years before the product's supply date.
- A currently-valid document that accredits recognition of the *recognised quality mark* by a competent authority, issued less than two years before the product's supply date. In the case where the product does not bear the *recognised quality mark*, it shall include a currently-valid document, having the same above-mentioned age, which accredits possession of the *recognised quality mark*.

COMMENTS

Within the scope of this Instruction, mandatory certification only exists for those construction products affected by it: the adherence certification, which affects ribbed bars (31.2), the ribbed wires that form part of electro-welded fabric (31.3) and ribbed wires that form part of the basic electro-welded reinforcement in lattice (31.4).

Anyway, this 1st Article regulates the aspects in relation to the special consideration of guaranteeing compliance of the mandatory specifications established in this Instruction by the products, both in the cases of voluntary certification (CC-EHE *certificate*) and in the possession of a *recognised quality mark* (seal or mark etc).

Needless to say that ribbed bars, electro-welded fabrics and basic electro-welded reinforcement, that have a CC-EHE *certificate* or a *recognised quality mark* that guarantees compliance with such mandatory specifications as established in this article, demonstrate that compliance with all requirements, included, that

of adherence. So, the presentation of a specific compliance certificate becomes unnecessary in these circumstances.

In accordance with current legislation, the CC-EHE certificates and recognised quality marks, issued in accordance with this article, that guarantee compliance with the specifications required by this Instruction shall be valid throughout the national territory.

Article 2 Definitions

The terms and expressions employed in this Instruction have the meaning normally assigned to them within the field of structural concrete. In any case, they are generally defined when they first appear in the Instruction.

Article 3 Units, sign convention and notation

The units adopted in this Instruction are those of the International System of Units for Measurement, SI.

The sign and notation convention that is employed complies, in general, with the general standards established for this purpose by the Joint Committee of the CIB-FIP (Euro-International Concrete Committee - International Prestressed Concrete Federation).

The symbols most frequently used in this Instruction are given in Annex 1.

COMMENTS

The system of units mentioned in the article is the *International System of Units for Measurement*, which has been declared of legal use in Spain.

The practical units within the SI system are as follows:

for resistance and stress:	$\text{N/mm}^2 = \text{MN/m}^2 = \text{MPa}$
for forces:	kN
for forces per unit length:	kN/m
for forces per unit of surface area:	kN/m^2
for forces per unit of volume:	kN/m^3
for moments:	m kN

The correspondence between the SI units and those of the metric system – kilopond – second is as follows:

- a) Newton - kilopond
1 N = 0.102 kp \approx 0.1 kp
and inversely
1 kp = 9.8 N \approx 10 N

- b) Newton per square millimetre - kilopond per square centimetre
1 $\text{N/mm}^2 = 10.2 \text{ kp/cm}^2 \approx 10 \text{ kp/cm}^2$
and inversely
1 $\text{kp/cm}^2 = 0.098 \text{ N/mm}^2 \approx 0.1 \text{ N/mm}^2$

Article 4 Project Documents

4.1 General

In those works contracted or executed by the public administrations, the provisions of the Law on Public Administration Contracts, the General Regulations for State Contracting, and the General Administrative Clauses for the Contracting-out of Public works currently in force, shall apply

All projects shall consist of the following:

- A Project Report which describes the objective of the works, including the background and prior situation, the needs to be satisfied and the justification of the adopted solution, providing details of all factors that are to be taken into account.
- The general and detailed drawings that are necessary so that the works are perfectly defined, together with those that delimit the terrain occupation and the restitution of obligations and other easements, where applicable and any services affected by its execution.
- The particular technical specifications, containing the description of the works and which regulate the execution of the same, expressing the manner in which it is to be carried out, of the measurement of the executed units, quality control and the technical obligations that correspond to the contractor.
- A geotechnical study of the terrain on which the work is to be executed, except where this is incompatible with the nature of the works.
- A budget, broken down or not into several partial costs, containing the unit and breakdown prices, together with statements of measurements and precise costing details.
- A works development programme plan, with time and cost provisions where necessary.
- All types of reference on which the works layout is based.
- Any and all documentation as required by the relevant law and regulations.

In all cases, the various documents that compose a draft project, survey or project of any kind shall be produced in such a way that a competent professional other than the author shall be able to interpret them and direct the work from them.

COMMENTS

The quality of the works shall depend, in first place, on the quality of the project. For this reason, it is recommended that it be supervised by a professional other than the author who produced it.

The geotechnical study has to be detailed accordingly with the characteristics of the construction and the soil. It could be not necessary if complete information is previously obtained. In the other case tests and studies have to be done in order to guarantee the designed construction.

4.2 Project Report

4.2.1 General Norms

The project report shall take into consideration social, economic, aesthetic and environmental factors. In addition, the adopted justification, in its technical and economic aspects, together with the specifications for each of the projected works shall be presented. This shall provide details of prior data, design methods, planned control modes and any testing performed, the details of which shall be included in special appendices.

Other appendices shall contain: the soil foundation survey, the materials and the tests performed on them, the rationale for the design and the prices adopted, the bases fixed for costing the work units and proposed fixed items, the works budget and the forecast cost of any required expropriations and the restoration of affected services and easements, where applicable.

4.2.2 Design Appendix

All project reports shall contain a design appendix, which provides reasonable justification of compliance, in accordance with the standards established in this Instruction, with the conditions required of the overall structure and of each individual part that it may be divided into, in order to guarantee safety and good service.

Its content and presentation shall be such that the calculations may be reproduced by third parties. For this reason, the following shall be included:

- a) The simplifications performed on the real structure in order to transform it into an ideal design, which shall be described in detail, indicating the structural typology adopted for the whole and its parts, including dimensions, mechanical properties of the sections needed, types of node connections, and support conditions.
- b) The indications required to identify the designed element, by means of appropriate references to drawings or additional sketches.
- c) The strength and deformation properties assumed for the structure's materials and, where appropriate, for the supporting ground.
- d) The actions considered, their possible combinations, and the safety factors to be taken into consideration in each case.
- e) The performed analysis. In particular, it shall be stated whether it is static or dynamic, linear or non-linear, together with the type of details adopted for the structure (bars, finite elements, finite strips, etc.).

When a different notation is used from that in this Instruction, the equivalence between that used and the one defined here shall be given. If it is not possible to provide this equivalence, the notation shall be described in detail.

COMMENTS

It is recommended that whenever convenient, drawings be employed to provide clear descriptions of the structure.

Among these material specifications, mention may be made of stress-deformation diagrams, longitudinal modulus of deformation, strength, shrinkage deformation, creep and thermal coefficients and, where applicable, the allowed ground stress.

4.2.3 Computer Calculations

4.2.3.1 The use of computer programs

When design calculations are performed on a computer, the Design Appendix shall be supplemented with specific sections containing the various stages that are resolved with each program, and where the sections form complete, sequential units.

The identification, purpose and application scope of each program used shall be provided.

COMMENTS

It should be taken into account that the project author shall pay special attention to the control of programs within the corresponding scope of application and to the checking of entered data and obtained results.

In particular, attention is called to the problem involved in employing integrated programs, which are not sufficiently transparent, for automatic structure design.

The use of programs that do not possess sufficient documentation is not recommended. The minimum is defined as follows:

- Its name, version and date.
- The name and qualification of the author(s).
- The name and address of the distributing organisation.
- Examples of resolved structures.

It is important to be able to count on the technical assistance of the program's author or distributor who can guarantee the elimination of operating errors or defects.

4.2.3.2 The presentation of data and results

The data listing shall contain both the data entered by the designer and the data generated by the program, so that all the characteristics considered are fully defined, and it shall also contain specific indications with regards to notation, units and sign criteria for the quantities employed.

The output listing shall define the results required to fully justify the solution obtained.

COMMENTS

It is recommended, for the data and results description, to include drawings and graphs that facilitate its understanding and comparison.

It is also recommended, for all table form results lists, to include in their headers the notation and units for each quantity considered and that this header is repeated on each page.

4.3 Drawings

The drawings shall be sufficiently descriptive for the work to be executed with precision for which reason it must be possible to deduce the auxiliary working drawings from them and the measurements upon which the appropriate evaluations are to be based.

The dimensions on all drawings shall be stated in metres with at least two decimal places. As an exception to this, the diameters of reinforcement bars and piping etc., shall be stated in millimetres and the \varnothing symbol shall be placed after the corresponding figure.

Except in special cases, it shall be possible to take the measurements of all elements without using more dimensions than those stated. In particular, where a detailed layout of reinforcing bars is not given, it shall be possible to deduce all relevant geometric dimensions directly from the drawings by means of appropriate notes or additional specifications that unequivocally define them.

They shall contain all necessary details, especially those for special arrangements, such as that of supporting and connecting.

Similarly, indications shall be given, where applicable, with regards to the camber that it would be convenient to make in the formwork, according to the proposed execution process.

Each structure drawing shall have a table of concrete types (in accordance with 39.2), with their specific properties, and the strength properties of the steels used in the elements defined on the drawing. It shall also show the proposed types of control and safety factors adopted for the design.

In the case of prestressed concrete, the prestressing programme shall be given, in accordance with 67.8.2.

The Designer shall be responsible for setting the minimum strength for the concrete of the member at the time of the prestressing and anchoring of the steel, together with the maximum permissible stresses during the various stages of the prestressing programme.

COMMENTS

The provisions in relation to the units in which the measurements are expressed tend to facilitate rapid understanding of the drawings, in addition to simplifying the drawing work since it removes the need for indications of m and cm etc.

When an exact number of metres is to be stated, this shall be written in accordance with that established in the relevant section, the corresponding figure followed by the decimal point and two zeros.

4.4 Document Containing Particular Technical Specifications

With the aim of regulating the execution of the works, the document containing the technical specifications shall, either expressly or by reference to Instructions, regulations or standards, specify the required properties for the materials and the various work units, the types of control specified for materials and execution, and, where appropriate, the dimensional tolerances of the finished elements. Under no circumstances shall these specifications contain statements or clauses of an economic nature which should be included in the administrative clauses. In all cases, the technical specifications shall specifically establish the following data in relation to the materials to be used in the works:

- Type, strength class and any other additional properties, where appropriate, of the cement
- Types of reinforcing and prestressing steel
- Type codes of the concretes employed, in accordance with the format indicated in 39.2.

If, as frequently occurs, different types of the same material are proposed for the same works, each type shall be detailed separately, indicating the areas in which they are to be employed.

When a material is required to have special characteristics that are **to** be determined by means of testing procedures not included in existing standards, the specifications document shall specifically establish the values that such characteristics are to meet and the testing procedures to be followed in order to measure them.

When the manner of work execution requires special conditions, these shall be fully detailed, including:

- the arrangement for centering and formwork, when not of the usual types;

- the concrete casting process, with special reference to joints (contraction joints and construction joints, etc.);
- the prestressing and grouting processes, in the case of prestressed concrete;
- the striking of centering and formwork.
- dimensional tolerances.

Where necessary, the technical specifications shall require that a notice be fixed in a suitable place on the work-site indicating the maximum load that the structure is intended to support. It may be useful to place such notices on structures where it is convenient for the user to be made aware of the load magnitudes.

The technical specification shall also provide details of the methods used for measuring and evaluating the various works units and the accounting for fixed items, establishing the guarantee period and specifying the proposed acceptances standards and tests.

COMMENTS

As far as the technical specifications are concerned, it will normally be sufficient to make reference to the corresponding articles in this Instruction, supplementing them, where necessary, with those particular conditions that are considered useful to establish.

Dimensional tolerances shall be compatible with the proposed execution conditions.

4.5 Budget

The budget shall break down or not into several partial costs, containing the unit and breakdown prices, together with statements of measurements and precise costing details.

The price calculations for the various work units shall be performed on the basis of the direct or indirect costs required for their execution, but under no circumstances shall they include any Value Added Tax that may be due on the delivery of goods or provision of services.

The following shall be considered as direct costs:

- Labour costs, including bonuses, expenses and social security payments, for all those directly involved with the execution of the work unit.
- Material costs, at on-site prices, that are included in the work unit or are required for its execution.
- Personnel, fuel and electricity costs etc., that occur through the operation of the machinery and installations employed in the execution of the work unit.
- The amortisation and maintenance costs for the above-mentioned machinery and installations.

The following shall be considered as indirect costs: The cost of on-site office installation, communications, the building of stores, workshops, temporary accommodation for the workforce and laboratories, etc., together with the costs for technical and administrative staff exclusively assigned to the project, and any unforeseen expenses. All these costs, with the exception of those specified in the Cost Plan as accounted for under work units or fixed entries, shall be expressed as a percentage of direct costs, the same for all work units, established in each case by the Project Designer in view of the nature of the proposed works, the budget size and the estimated execution period.

In particular, the control costs, obtained in accordance with the adopted types of control, shall be explicitly shown.

The result of summing the products of the number of each work unit, multiplied by its unit price and of the fixed entries shall be designated the Material Execution Budget

In the case of public works for the State General Administration or its autonomous Bodies, it will be necessary to take into consideration any applicable supplementary rules applying to unit price calculations that may have been established by the corresponding ministerial department for projects drawn up by its services.

COMMENTS

It is recommended that the measurements are performed by expressing: excavations and fill-ins in cubic metres, formwork in square metres, concrete in cubic metres, reinforcing and prestressing steels in kilos and anchorage, sheathing, grouting mortars in the most suitable units and other specific units for the prestressing technique, together with the centering or ancillary elements that are required in accordance with the proposed construction process.

The separate inclusion of the concrete, steel, excavations and centering, together with their independent prices, highlights the relative importance of the costs of each of these elements, and above all, enables any modification that is required to be introduced in the volumes of the various work units to be accurately evaluated.

Whenever permitted by the applicable legislation, it is useful for the control costs to be stated separately on the budget. If a control body is employed, then its selection should be carried out in agreement with the Works Manager. It is recommended that the payment of control is not carried out through the constructor.

4.6 Work Programme

The work programme shall specify the deadlines, by which the various basic parts into which the works may be broken down, shall be completed, and shall determine the corresponding payments that are due at each one.

4.7 Project modifications

In those cases where the project is modified during works execution, the appropriate amendments shall be made to the calculations, drawings and other documents that are affected by the modifications, before the changes are executed and as often as necessary, so that the finished work is exactly defined in the final modified documents. Additionally, in order to prevent any confusion, all modified documents shall be cancelled.

COMMENTS

Whenever a modification is made to a drawing, the previous copies shall be stamped CANCELLED, and the modified drawing shall be endorsed with the issue date and reference.

At least one copy shall be maintained of each successive drawing, however, at the actual work-site the copies affected by the modification and which are replaced by the modified drawings shall be removed, or better still, destroyed in order to prevent any possible confusion.

4.8 The preferential application of public administration contract legislation

In a situation of conflict or difficulty resulting from differences or possible discrepancies between the currently-applicable public administration contract legislation and the contents of this Instruction, in reference to this chapter, which might give rise to differing interpretations or conflicting provisions, the above-mentioned contract legislation shall always take precedence.

4.9 Final works documentation

As soon as the works have terminated, the Project Manager shall provide the Owner with the following documents as a minimum: a report containing the main incidents that occurred during execution, a set of drawings that reflect the final state of the works as constructed, and documentary evidence that the specifications established in Section 6 *Control* of this Instruction have been met.