ANNEX 4

Recommendations for selecting the type of cement to be used in structural concrete

1. Introduction

The current Guidelines on the acceptance of cement generally regulate the conditions which cement must meet in order to be used. This recommendations Annex is only included in order to facilitate the selection, by the Designer or Technical Management, of the type of cement to be used in each case.

The type of cement must be selected bearing in mind at least the following criteria:

a) application of the concrete, in accordance with section 2 of this Annex;
b) concreting circumstances, in accordance with section 4 of this Annex;
c) environmental aggression conditions to which the concrete element will be subject, in accordance with section 5 of this Annex.

2. Selecting the type of cement according to the concrete application

The recommended cements according to their application are indicated in Table A.4.2.

TABLE A.4.2
Types of cement according to the concrete application

APPLICATION	RECOMMENDED CEMENTS
Plain concrete	All common cements, except for types CEM II/A-Q, CEM II/B-Q, CEM II/A-W, CEM II/B-W, CEM II/A-T, CEM II/B-T and CEM III/C. Cements for special uses ESP VI-1 (*).
Reinforced concrete	All common cements except for types CEM II/A-Q, CEM II/B-Q, CEM II/A-W, CEM II/B-W, CEM II/A-T, CEM II/B-T, CEM III/C and CEM V/B.
Prestressed concrete including structural precast concrete	Common cements (**) of types CEM I, CEM II/A-D, CEM II/A-V, CEM II/A-P and CEM II/A-M (V-P) (***).
Reinforced concrete precast structural elements	Common cements (**) of types CEM I, CEM II/A, are highly recommended and common cement of type CEM IV/A, is recommended when this is determined by a specific experimental study.
Large volumes of plain or reinforced concrete	Common cements of types CEM III/B and CEM IV/B are highly recommended and common cements of types CEM II/B, CEM III/A, CEM IV/A and CEM V/A are recommended. Cements for special uses ESP VI-1 (*). The additional characteristic of low heat (LH) and very low heat (VLH) is highly recommended where applicable.
High-strength concrete	Common cements of type CEM I are highly recommended and common cements of types CEM II/A-D and CEM II/A 42,5 R are recommended. The other common cements of type CEM II/A may be recommended when this is determined by a specific experimental study.
Concrete for urgent and rapid repairs	Common cements of types CEM I, CEM II/A-D and calcium aluminate cement (CAC).
Concrete for rapid formwork removal and stripping	Common cements (**) of types CEM I and CEM II.
Sprayed concrete	Common cements of types CEM I and CEM II/A.
Concrete with potentially reactive aggregates (****)	Common cements of types CEM III, CEM IV, CEM V, CEM II/A-D, CEM II/B-S and CEM II/B-V are highly recommended and common cements of types CEM II/B-P and CEM II/B-M are recommended.

(*) In the case of large volumes of plain concrete.
(**) Among the cements indicated, those with a high initial strength are preferable.
(***) The inclusion of cements CEM II/A-V, CEM II/A-P and CEM II/A-M (V-P) as being appropriate for the prestressed concrete application is coherent with the possibility, contemplated in the EHE, of using fly ash in a quantity not exceeding 20% of the cement weight in the prestressed concrete.
(****) For this application, cements with a low alkaline content or those cited in the table are recommended.

3. Selecting the type of cement according to specific structural applications

3.1 Cements recommended for foundations

Table A.4.3.1 indicates the cements recommended for use in the production of concrete intended for foundations.

TABLE A.4.3.1

APPLICATION	RECOMMENDED CEMENTS
Plain concrete foundations	Common cements of type CEM IV/B are highly recommended and the other common cements are recommended, except for CEM II/A-Q, CEM II/B-Q, CEM II/A-W, CEM II/B-W, CEM II/A-T and CEM II/B-T. In all cases the additional characteristic of low heat (LH) is recommended. The requirements for using the additional characteristic of sulphate resistance (SR) or sea water resistance (MR) must be met where applicable.
Reinforced concrete foundations	Common cements of types CEM I and CEM II/A are highly recommended and the other common cements are recommended, except for CEM III/B, CEM IV/B, CEM II/A-Q, CEM II/B-Q, CEM II/A-W, CEM II/B-W, CEM II/A-T and CEM II/B-T. The requirements for using the additional characteristic of sulphate resistance (SR) or sea water resistance (MR) must be met where applicable.

3.2 Cements recommended for port and maritime works

Table A.4.3.2 indicates the cements recommended for use in the production of concrete intended for the construction of plain, reinforced or prestressed concrete structures forming part of port and maritime works.

TABLE A.4.3.2

APPLICATION	TYPE OF CONCRETE	RECOMMENDED CEMENTS
Port and maritime works	Plain	Common cements, except for types CEM III/C, CEM II/A-Q, CEM II/B-Q, CEM II/A-W, CEM II/B-W, CEM II/A-T and CEM II/B-T.
	Reinforced	Common cements, except for types CEM II/A-Q, CEM II/B-Q, CEM II/A-W, CEM II/B-W, CEM II/A-T, CEM II/B-T, CEM III/C and CEM V/B.
	Prestressed	Common cements (*) of types CEM I, CEM II/A-D, CEM II/A-P, CEM II/A-V and CEM II/A-M (V-P).

(*) Among the cements indicated, those with a high initial strength are preferable.

The use of any particular type of cement, with the MR additional characteristic where necessary, shall depend on the concrete requirements, provided that there are no special circumstances advising against its use.

3.3 Cements recommended for dams

Table A.4.3.3 indicates the cements recommended for use in the production of concrete intended for the construction of dams.

TABLE A.4.3.3

APPLICATION	RECOMMENDED CEMENTS
Vibrated concrete dams	Common cements of types CEM II/A, CEM III/A, CEM III/B and CEM IV/A.
Compacted concrete dams	Common cements of types CEM III, CEM IV and CEM V; Cements for special uses ESP VI-1; Very low heat special cements of types VLH III, VLH IV and VLH V, and. Blastfurnace cements with a low initial strength L.

Type CEM I cements may also be used where an addition compatible with the design requirements is added in sufficient quantity to the concrete.

It is recommended that the cements used are in a low strength class (32,5) and also that the heat of hydration is particularly taken into account. As a result, the use of cements with the additional characteristic of low heat or very low heat is generally advisable.

3.4 Cements recommended for hydraulic works other than dams

Table A.4.3.4 indicates the cements recommended for use in the production of concrete intended for the construction of water transport structures which do not form part of the main body of dams.

TABLE A.4.3.4

APPLICATION	TYPE OF CONCRETE	RECOMMENDED CEMENTS
Concrete pipes, channels and other hydraulic applications	Plain	Common cements, except for types CEM II/A-Q, CEM II/B-Q, CEM II/A-W, CEM II/B-W, CEM II/A-T, CEM II/B-T and CEM III/C.
	Reinforced	Common cements, except for types CEM II/A-Q, CEM II/B-Q, CEM II/A-W, CEM II/B-W, CEM II/A-T, CEM II/B-T, CEM III/C and CEM V/B.
	Prestressed	Common cements of types CEM I, CEM II/A-D, CEM II/A-V, CEM II/A-P and CEM II/A-M (V-P).

4. Selecting the type of cement according to the concreting circumstances

The cements recommended according to the placing conditions are indicated in Table A.4.4.

TABLE A.4.4

Types of cement according to the concreting circumstances

CONCRETING CIRCUMSTANCES	RECOMMENDED CEMENTS
Concreting in cold weather (*) (**)	Common cements of types CEM I, CEM II/A and CEM IV/A.
Concreting in dry and windy environments and, in general, in conditions which accelerate the drying of the concrete (**)	Common cements of types CEM I and CEM II/A.
Strong sunlight and concreting in hot weather (**)	Common cements of types CEM II, CEM III/A, CEM IV/A and CEM V/A.

(*) In these circumstances, the additional characteristic of low heat (LH) should not be used.
(**) In these circumstances, the appropriate measures specified in the corresponding regulations and, where applicable, in the Guidelines on Structural Concrete (EHE) must be taken during the execution or placing process.

5. Selecting the type of cement according to the exposure class

The cements recommended according to the exposure class of the environment in which the structural element will be located are indicated in Table A.4.5.

TABLE A.4.5

Types of cement according to the exposure class

EXPOSURE CLASS	TYPE OF PROCESS (aggression due to)	RECOMMENDED CEMENTS
I	None	All those recommended according to the application.
II	Corrosion of reinforcements other than as a result of chlorides	CEM I, any CEM II (preferably CEM II/A), CEM III/A and CEM IV/A.
III (*)	Corrosion of reinforcements by marine chlorides	Cements of types CEM II/S, CEM II/V (preferably CEM II/B-V), CEM II/P (preferably CEM II/B-P), CEM II/A-D, CEM III, CEM IV (preferably CEM IV/A) and CEM V/A are highly recommended.
IV	Corrosion of reinforcements by non-marine chlorides	Preferably CEM I and CEM II/A and also the same ones as for exposure class III.
Q (**)	Concrete attacked by sulphates	The same ones as for exposure class III.
Q	Leaching of concrete due to pure or acid water or water containing aggressive CO^2	Common cements of types CEM II/P, CEM II/V, CEM II/A-D, CEM II/S, CEM III, CEM IV and CEM V.
Q	Alkali-aggregate reactivity	Cements with a low alkaline content (***)(sodium and potassium oxides) in which $(Na_2 O)eq = Na_2 O (\%) + 0'658\ K_2 O (\%) < 0'60$.

(*) In this exposure class, the requirements for using the additional characteristic of sea water resistance (MR) must be met as established by the Guidelines on Structural Concrete (EHE).

(**) In this exposure class, the requirements for using the additional characteristic of sulphate resistance (SR), where the specific class is Qb or Qc, must be met as established in this Code. In cases where the element is in contact with sea water, the requirements for using the additional characteristic of sea water resistance (MR) must be met.

(***) The cements cited in Table A4.2 for concretes containing potentially reactive aggregates (which would require cements with a low alkaline content) are also recommended.