ANNEX 1

Notation and units.

1 Notation

This Annex includes only those symbols which are most often used in this Code.

1.1 Latin upper case

A	Area. Water content of concrete. Ultimate strain.
A_c	Area of a concrete section.
A_{ct}	Area of the tension zone of a concrete section.
A_e	Effective area.
$A_{e,k}$	Characteristic value of the seismic action.
A_i	Initial area of a cross-section.
A_k	Characteristic value of an accidental action.
A_l	Area of the longitudinal reinforcements.
A_p	Total cross-sectional area of the active reinforcements.
A'_p	Total cross-sectional area of the active reinforcements in the compression zone.
A_s	Cross-sectional area of a tension reinforcement (simplification: A).
A_{sc}	Cross-sectional reinforcement area of a strut.
A'_s	Cross-sectional area of a compression reinforcement (simplification: A').
A_{s1}	Cross-sectional area of a tension or less compressed reinforcement (simplification: A_1).
A_{s2}	Cross-sectional area of a compression or more highly compressed reinforcement (simplification: A_2).
$A_{s,req}$	Required section of steel.
$A_{s,actual}$	Actual section of steel.
A_{st}	Cross-sectional area of a transverse reinforcement (simplification: A_t).
A_{sw}	Total area of punching shear reinforcement within a perimeter concentric to the support or loaded area.
C	Torsional moment of inertia. Cement content of concrete.
C_d	Permitted limit value for the Limit State to be checked.
C_s	Chloride concentration in the surface of the concrete.
C_{th}	Critical chloride concentration.
D	Effective chloride diffusion coefficient.
D_0	Basic curing parameter.
D_1	Curing parameter as a function of cement type.
E	Modulus of elasticity
E_c	Modulus of elasticityof concrete.
E_d	Design value of the effect of actions.
$E_{d,stb}$	Design value of the effects of stabilising actions.
$E_{d,dst}$	Design value of the effects of destabilising actions.
E_{oj}	Initial longitudinal modulus of elasticityof concrete at age of *d* days.
E_j	Instantaneous secant longitudinal modulus of elasticity of concrete at the age of *d* days.
E_p	Longitudinal modulus of elasticityof active reinforcement.
E_s	Modulus of elasticity of steel.

F	Action. Fly ash content of concrete.
F_d	Design value of an action.
F_{eq}	Value of the seismic action.
F_k	Characteristic value of an action.
F_m	Mean value of an action.
F_{sd}	Design punching shear force.
$F_{sd, ef}$	Effective design punching shear force.
G	Permanent load. Transverse modulus of elasticity.
G_k	Characteristic value of a permanent load.
G_{kj}	Characteristic value of permanent actions.
G^*_{kj}	Characteristic value of permanent actions with a non-constant value.
I	Moment of inertia.
I_c	Moment of inertia of a concrete section.
I_e	Equivalent moment of inertia.
ICES	Index of contribution of the structure to the sustainability.
ISMA	Index of environmental sensitivity.
K	Any coefficient or factor.
K_c	Stiffness of a support. Carbonation coefficient.
K_{Cl}	Coefficient of chloride penetration.
K_{ec}	Equivalent stiffness of a support.
K_n	Estimating coefficient for checking the strength of concrete.
K_t	Stiffness of torsional tie.
L	Length. Thermal weighting factor.
M	Bending moment.
M_a	Total bending moment.
M_d	Design bending moment.
M_f	Cracking moment under simple bending.
M_g	Moment due to permanent loads.
M_{ref}	Reference bending moment associated with a given depth x/d.
M_u	Ultimate bending moment.
N	Normal force.
N_d	Design value of normal force.
N_k	Axil force acting on a member.
N_u	Ultimate normal force.
P	Prestressing force, ultimate load.
P_k	Characteristic value of the prestressing force.
P_{kf}	Final characteristic value of the prestressing force.
P_{ki}	Initial characteristic value of the prestressing force.
P_o	Tensioning force.
Q	Variable load.
Q_k	Characteristic value of Q.
R_d	Design value of the structural resistance.
R_F	Design value of the fatigue strength.
S	Stress. First-order moment of an area.
S_d	Design value of the actions.
S_F	Design value of the effect of fatigue sections.
S_{u1}	Ultimate sliding shear force due to compression.
S_{u2}	Ultimate sliding shear force due to tension.
S_{su}	Contribution of the perpendicular reinforcement in plane P to the shear strength.
T	Torsional moment. Temperature.
T_a	Mean ambient temperature during production.
T_c	Maximum curing temperature during production.
T_d	Design torsional moment.
T_u	Ultimate torsional moment.
U_c	Mechanical capacity of concrete.

U_s Mechanical capacity of steel (simplification: U).
V Shear force. Volume.
V_{cu} Contribution of the concrete to the shear capacity in the Ultimate Limit State.
V_{cd} Design value of the component, parallel to the section, of the resultant of normal stresses.
V_{corr} Corrosion rate.
V_d Design shear force.
V_{pd} Design value of the component of the prestressing force parallel to the section under study.
V_{rd} Effective design shear force.
V_{su} Contribution of the steel to shear force in the Ultimate Limit State.
V_u Ultimate shear force.
W Wind load. Section modulus.
W_c Volume of confined concrete.
W_{sc} Volume of hoops and stirrups.
X Reaction or force in general, parallel to the x axis.
Y Reaction or force in general, parallel to the y axis.
Z Reaction or force in general, parallel to the z axis.
Z_m Mean value of the maximum water penetration depths in concrete.

1.2 Latin lower case

a Distance. Deflection.
a_r Redistribution length.
b Width; width of a cross-section.
b_e Effective width of the flange in a T-beam.
b_w Width of the web or rib in a T-beam.
c Cover.
c_{air} Coefficient of aireantes.
c_{env} Coefficient of ambient.
c_h Horizontal or lateral cover.
c_v Vertical cover.
d Effective depth. Diameter.
d' Distance from the most compressed fibre of the concrete to the centre of gravity of the compression reinforcement ($d'=d_2$).
e Eccentricity. Hypothetical thickness.
e_e Equivalent eccentricity.
f Strength. Deflection.
f_{1cd} Maximum strength of compressed concrete.
f_{2cd} Strength of concrete for biaxial compression states.
f_{3cd} Strength of concrete for triaxial compression states.
f_c Compressive strength of concrete.
f_{cc} Compressive strength of confined concrete.
f_{cd} Design compressive strength of concrete.
f_{cf} Flexural strength of concrete.
f_{cj} Compressive strength of concrete at age of d days.
f_{ck} Characteristic compressive strength of concrete.
$f_{ck,j}$ Characteristic compressive strength of concrete at age of d days.
f_{cm} Mean compressive strength of concrete.
$f_{c,actual}$ Actual characteristic strength of concrete.
f_{ct} Tensile strength of concrete.
$f_{ct,d}$ Design tensile strength of concrete.
$f_{ct,k}$ Characteristic tensile strength of concrete.
$f_{ct,fl}$ Flexural strength of concrete.

$f_{ct,m}$	Mean tensile strength of concrete.
f_{cv}	Virtual design shear strength of concrete.
$f_{c,est}$	Estimated characteristic strength.
f_{max}	Maximum tensile stress.
f_{maxk}	Ultimate stress of steel in active reinforcements.
f_{pd}	Design strength of active reinforcements.
f_{pk}	Characteristic yield strength of active reinforcements.
f_{py}	Apparent yield strength of active reinforcements.
f_s	Ultimate stress of steel.
f_{td}	Design tensile strength of steel in hoops or stirrups.
f_y	Yield strength of 0.2%.
$f_{yc,d}$	Design compressive strength of steel.
f_{yd}	Design yield strength of a steel.
f_{yk}	Characteristic yield strength of passive reinforcements.
$f_{yl,d}$	Design strength of steel in a longitudinal reinforcement.
$f_{yp,d}$	Design strength of reinforcement A_p.
$f_{yt,d}$	Design strength of steel in reinforcement A_t.
g	Distributed permanent load. Acceleration due to gravity.
g_d	Design permanent load.
h	Overall depth or diameter of a cross-section. Thickness. Hours.
h_e	Effective thickness.
h_f	Thickness of the plate in a T-beam.
h_o	Actual thickness of the wall in the case of hollow sections.
i	Radius of gyration.
i^2_s	Radius of gyration of the set of reinforcements about the axis.
j	Number of days.
k	Any coefficient or factor with dimensions.
l	Length; span.
l_b	Anchorage length.
l_e	Buckling length.
l_o	Distance between points of zero moment.
m	Bending moment per unit length or width.
n	Number of objects taken into account. Coefficient of equivalence.
p_f	Overall probability of failure.
q	Distributed variable load.
q_d	Design overload.
r	Radius.
r_{min}	Minimum cover.
r_{nom}	Nominal cover.
s	Spacing. Standard deviation.
s_m	Mean spacing.
s_t	Spacing between planes of transverse reinforcements.
s_l	Spacing between longitudinal reinforcements in a section.
t	Time. Theoretical age.
t_d	Design working life.
t_g	Characteristic working life.
t_i	Corrosion start time.
t_L	Considered working life.
t_p	Corrosion propagation time.
t_s	Age of concrete at start of shrinkage.
u	Perimeter.
v_{corr}	Velocity of corrosion.
w	Crack opening.
w_k	Characteristic crack opening.
w_{max}	Maximum crack opening.
X	Coordinate. Neutral axis depth.

Y		Coordinate. Depth of rectangular stress diagram.
Z		Coordinate. Lever arm.

1.3 Greek lower case

Alpha	α	Angle. Non-dimensional coefficient.
Beta	β	Angle. Non-dimensional coefficient. Reliability index.
Gamma	γ	Weighting or safety factor. Specific gravity.
	γ_a	Partial safety factor for an accidental action.
	γ_m	Reduction factor for material strength.
	γ_c	Safety or reduction factor for concrete strength.
	γ_s	Safety or reduction factor for yield strength of steel.
	γ_f	Safety or weighting factor for actions.
	γ_g	Partial safety factor for a permanent action.
	γ^*_g	Partial safety factor for a permanent action with a non-constant value.
	γ_p	Partial safety factor for a prestressing action.
	γ_q	Partial safety factor for a variable action.
	γ_{fq}(ó γ_q)	Weighting factor for a variable load.
	γ_{fW}(ó γ_W)	Weighting factor for a wind load.
	γ_n	Complementary safety or weighting factor for actions.
	γ_r	Safety factor for cracking.
	γ_t	Safety factor for working life.
Delta	δ	Variation coefficient.
Epsilon	ε	Relative strain.
	ε_c	Relative strain of concrete.
	ε_{cc}	Relative creep strain.
	ε_{c0}	Average of the initial maximum compressive strain in the concrete.
	ε_{cp}	Strain in the concrete under the action of total prestressing.
	ε_{cs}	Relative shrinkage strain.
	ε_{cs0}	Basic shrinkage coefficient.
	$\varepsilon_{c\sigma}$	Tensile strain in the concrete.
	ε_{sm}	Mean elongation of reinforcements.
	ε_{cu}	Ultimate bending strain in the concrete.
	ε_{max}	Elongation under maximum load.
	ε_p	Strain in the active reinforcements.
	ε_{p0}	Strain in the adherent active reinforcement under the action of total prestressing.
	ε_{rf}	Final shrinkage value of the concrete after introducing prestressing.
	ε_s	Relative strain of steel.
	ε_{s1}	Relative strain of the more highly tensioned or less compressed reinforcement (ε_1).
	ε_{s2}	Relative strain of the more highly compressed or less tensioned reinforcement (ε_2).
	ε_u	Ultimate concentrated remaining elongation.
	ε_{u5}	Ultimate concentrated remaining elongation determined on the base of five times the diameter.
	ε_y	Elongation corresponding to the yield strength of steel.
Eta	η	Reduction factor for shear stress; area reduction coefficient.
Theta	θ	Angle.
Lambda	λ	Non-dimensional coefficient.
	λij	Coefficient of value.
Mu	μ	Reduced or relative bending moment. Coefficient of friction in curve.
Nu	ν	Reduced or relative normal stress.
Xi	ξ	Non-dimensional coefficient.
Rho	ρ	Steel ratio ρ = As/Ac. Presstresing steel relaxation.

	ρ_f	Final value of steel relaxation.
	ρ_e	Quantity of longitudinal reinforcement in the slab.
Sigma	σ	Normal stress.
	σ_c	Stress in the concrete.
	σ_{cd}	Design stress of the concrete.
	σ_{cgp}	Compressive stress at the centre of gravity of the active reinforcements.
	σ_{cp}	Tension in the concrete in the fiber corresponding to the center of gravity of the active armors due to the action of the prestressed one, the own weight and the dead load
	$\sigma c,_{RF}$	Maximum stress for the combination of fatigue.
	σp	Stress in the active reinforcements.
	σpi	Initial stress in the active reinforcements.
	$\sigma p,_{P0}$	Stress in the active reinforcement due to the characteristic prestressing value at the moment when the tie rod is checked.
	σ_s	Stress in the steel.
	σ_{sd}	Design stress of passive reinforcements.
	$\sigma_{sd,c}$	Design compressive strength of steel.
	σ_{sp}	Design stress of active reinforcements.
	σ_{s1}	Stress in the more highly tensioned or less compressed reinforcement (σ1).
	σ_{s2}	Stress in the more highly compressed or less tensioned reinforcement (σ2).
	σ_I	Main tensile stress.
	σ_{II}	Main compressive stress.
Tau	τ	Tangential stress.
	τ_b	Bond stress.
	τ_{bm}	Mean bond stress.
	τ_{bu}	Ultimate bond stress.
	$\tau_{c,RF}$	Maximum shear stress for the combination of fatigue.
	τ_{md}	Mean value of the shear stress.
	τ_{rd}	Design value of the shear strength of concrete.
	τ_{sd}	Nominal design tangential stress.
	τ_{td}	Design value of the tangential torsional stress.
	τ_{tu}	Ultimate value of the tangential torsional stress.
	τ_w	Tangential stress in the web.
	τ_{wd}	Design value of τ_w.
	τ_{wu}	Ultimate value of the tangential stress in the web.
Phi	φ	Non-dimensional coefficient.
	φ_t	Creep development coefficient over time *t*.
Psi	ψ	Non-dimensional coefficient.
	$\psi_{o,i\ Qki}$	Representative combination value of concomitant variable actions.
	$\psi_{1,1\ Qki}$	Representative frequent value of decisive variable actions.
	$\psi_{2,i\ Qki}$	Representative quasi-permanent values of variable actions with decisive action or with accidental action.
Omega	ω	Mechanical ratio: $\omega = A_s f_{yd} / A_c f_{cd}$.
	ω_w	Volumetric mechanical ratio of confinement.

1.4 Mathematical and special symbols

Σ	Sum.
Δ	Difference; increment.
$\varnothing$	Diameter of a bar.
$\not>$	No greater than.
$\not<$	No less than.
ΔP_i	Instantaneous losses of force.
ΔP_{dif}	Delayed losses of force.
$\Delta \sigma_{pd}$	Increase in stress due to external loads.
$\Delta \sigma_{pr}$	Loss due to relaxation at constant length.
ΔP_1	Losses of force due to friction.
ΔP_2	Losses of force due to wedge penetration.
ΔP_3	Losses of force due to elastic shortening of the concrete.
ΔP_{4f}	Final losses due to shrinkage of the concrete.
ΔP_{5f}	Final losses due to creep of the concrete.
ΔP_{6f}	Final losses due to relaxation of the steel.

2 Units and convention on signs

The units used in this Code correspond to those of the International System of Units (SI).

The convention on signs and notation used comply, in the main, with the general rules laid down for this purpose by the FIB (Fédération Internationale du Béton).

The system of units referred to in the articles is the International System of Units (SI) which may be legally used in Spain.

The practical units of the SI system are as follows:

for strengths and stresses:	$N/mm^2 = MN/m^2 = MPa$
for forces:	kN
for forces per unit length:	kN/m
for forces per unit area:	kN/m^2
for forces per unit volume:	kN/m^3
for moments:	kNm

The correspondence between the units of the International System of Units (SI) and the traditional Spanish system of units 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
$1\ N/mm^2 = 10.2\ kp/cm^2 \approx 10\ kp/cm^2$
and inversely
$1\ kp/cm^2 = 0.098\ N/mm^2 \approx 0.1\ N/mm^2$