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SS-EN 1992-2:2005

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Eurokod 2: Dimensionering av betongkonstruktioner – Del 2: Broar

Eurocode 2 – Design of concrete structures – Part 2: Concrete bridges – Design and detailing rules

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Europastandarden EN 1992-2:2005 gäller som svensk standard. Detta dokument innehåller den officiella engelska versionen av EN 1992-2:2005.

Denna standard ersätter SS-ENV 1992-2, utgåva 1.

The European Standard EN 1992-2:2005 has the status of a Swedish Standard. This document contains the official English version of EN 1992-2:2005.

This standard supersedes the Swedish Standard SS-ENV 1992-2, edition 1.

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 1992-2

October 2005

ICS 93.040; 91.010.30; 91.080.40

Supersedes ENV 1992-2:1996

English Version

Eurocode 2 - Design of concrete structures - Concrete bridges - Design and detailing rules

Eurocode 2 - Calcul des structures en béton - Partie 2: Ponts en béton - Calcul et dispositions constructives

Eurocode 2 - Planung von Stahlbeton- und Spannbetontragwerken - Teil 2: Betonbrücken - Planungs- und Ausführungsregeln

This European Standard was approved by CEN on 25 April 2005.

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This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: rue de Stassart, 36 B-1050 Brussels

Ref. No. EN 1992-2:2005: E

NOTE This contents list includes sections, clauses and annexes that have been introduced or modified in EN 1992-2.

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Foreword

This European Standard (EN 1992-2:2005) has been prepared by Technical Committee CEN/TC 250 "Structural Eurocodes", the secretariat of which is held by BSI. CEN/TC 250 is responsible for all Structural Eurocodes.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by April 2006, and conflicting national standards shall be withdrawn at the latest by March 2010.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

This Eurocode supersedes ENV 1992-2.

Background to the Eurocode programme

See EN 1992-1-1.

Status and field of application of Eurocodes

See EN 1992-1-1.

National Standards implementing Eurocodes

See EN 1992-1-1.

Links between Eurocodes and harmonised technical specifications (ENs and ETAs) for products

See EN 1992-1-1.

Additional information specific to EN 1992-2 and link to EN 1992-1-1

EN 1992-2 describes the principles and requirements for safety, serviceability and durability of concrete structures, together with specific provisions for bridges. It is based on the limit state concept used in conjunction with a partial factor method.

— EN 1992-2 gives Principles and Application Rules for the design of bridges in addition to those stated in EN 1992-1-1. All relevant clauses of EN 1992-1-1 are applicable to the design of bridges unless specifically deleted or varied by EN 1992-2. It has been appropriate to introduce in EN 1992-2 some material, in the form of new clauses or amplifications of clauses in EN 1992-1-1, which is not bridge specific and which strictly belongs to EN 1992-1-1. These new clauses and amplifications are deemed valid interpretations of EN 1992-1-1 and designs complying with the requirements of EN 1992-2 are deemed to comply with the Principles of EN 1992-1-1.

— clauses in EN 1992-2 that modify those in EN 1992-1-1 are numbered by adding '100' to the corresponding clause number in EN 1992-1-1.

— when additional clauses or sub-clauses are introduced in EN 1992-2, these are numbered by adding '101' to the last relevant clause or sub-clause in EN 1992-1-1.

For the design of new structures, EN 1992-2 is intended to be used, for direct application, together with other parts of EN 1992, Eurocodes EN 1990, 1991, 1997 and 1998.

EN 1992-2 also serves as a reference document for other CEN/TCs concerning structural matters.

EN 1992-2 is intended for use by:

— committees drafting other standards for structural design and related product, testing and execution standards;

— clients (e.g. for the formulation of their specific requirements on reliability levels and durability);

— designers and constructors;

— relevant authorities.

Numerical values for partial factors and other reliability parameters are recommended as basic values that provide an acceptable level of reliability. They have been selected assuming that an appropriate level of workmanship and of quality management applies. When EN 1992-2 is used as a base document by other CEN/TCs the same values need to be taken.

National Annex for EN 1992-2

This standard gives values with notes indicating where national choices may have to be made. Therefore the National Standard implementing EN 1992-2 should have a National Annex containing all Nationally Determined Parameters to be used for the design of bridges to be constructed in the relevant country.

National choice is allowed in EN 1992-2 through the following clauses:

3.1.2 (102)P	5.3.2.2 (104)	6.8.1 (102)	9.1 (103)
3.1.6 (101)P	5.5 (104)	6.8.7 (101)	9.2.2 (101)
3.1.6 (102)P	5.7 (105)	7.2 (102)	9.5.3 (101)
3.2.4 (101)P	6.1 (109)	7.3.1 (105)	9.7 (102)
4.2 (105)	6.1 (110)	7.3.3 (101)	9.8.1 (103)
4.2 (106)	6.2.2 (101)	7.3.4 (101)	11.9 (101)
4.4.1.2 (109)	6.2.3 (103)	8.9.1 (101)	113.2 (102)
5.1.3 (101)P	6.2.3 (107)	8.10.4 (105)	113.3.2 (103)
5.2 (105)	6.2.3 (109)	8.10.4 (107)	

Where references to National Authorities is made in this standard, the term should be defined in a Country's National Annex.

SECTION 1 General

The following clauses of EN 1992-1-1 apply.

1.1.1 (1)P	1.1.2 (3)P	1.2.2	1.5.2.1
1.1.1 (2)P	1.1.2 (4)P	1.3 (1)P	1.5.2.2
1.1.1 (3)P	1.2 (1)P	1.4 (1)P	1.5.2.3
1.1.1 (4)P	1.2.1	1.5.1 (1)P	1.5.2.4

1.1 Scope

1.1.2 Scope of Part 2 of Eurocode 2

(101)P Part 2 of Eurocode 2 gives a basis for the design of bridges and parts of bridges in plain, reinforced and prestressed concrete made with normal and light weight aggregates.

(102)P The following subjects are dealt with in Part 2.

Section 1: General
Section 2: Basis of design
Section 3: Materials
Section 4: Durability and cover to reinforcement
Section 5: Structural analysis
Section 6: Ultimate limit states
Section 7: Serviceability limit states
Section 8: Detailing of reinforcement and prestressing tendons — General
Section 9: Detailing of members and particular rules
Section 10: Additional rules for precast concrete elements and structures
Section 11: Lightweight aggregate concrete structures
Section 12: Plain and lightly reinforced concrete structures
Section 113: Design for the execution stages

1.106 Symbols

For the purpose of this standard, the following symbols apply.

NOTE The notation used is based on ISO 3898:1987. Symbols with unique meanings have been used as far as possible. However, in some instances a symbol may have more than one meaning depending on the context.

Latin upper case letters

A Accidental action

A Cross sectional area

A_c Cross sectional area of concrete

A_{ct} Area of concrete in tensile zone

A_p Area of a prestressing tendon or tendons

A_s Cross sectional area of reinforcement

$A_{s,min}$ minimum cross sectional area of reinforcement

A_{sw}	Cross sectional area of shear reinforcement
D	Diameter of mandrel
D_{Ed}	Fatigue damage factor
E	Effect of action
E_{c}, $E_{c(28)}$	Tangent modulus of elasticity of normal weight concrete at a stress of $\sigma_c = 0$ and at 28 days
$E_{c,eff}$	Effective modulus of elasticity of concrete
E_{cd}	Design value of modulus of elasticity of concrete
E_{cm}	Secant modulus of elasticity of concrete
$E_c(t)$	Tangent modulus of elasticity of normal weight concrete at a stress of $\sigma_c = 0$ and at time t
E_p	Design value of modulus of elasticity of prestressing steel
E_s	Design value of modulus of elasticity of reinforcing steel
EI	Bending stiffness
EQU	Static equilibrium
F	Action
F_d	Design value of an action
F_k	Characteristic value of an action
G_k	Characteristic permanent action
I	Second moment of area of concrete section
J	Creep function
K_c	Factor for cracking and creep effects
K_s	Factor for reinforcement contribution
L	Length
M	Bending moment
M_{Ed}	Design value of the applied internal bending moment
M_{rep}	Cracking bending moment
N	Axial force or number of cyclic loads in fatigue
N_{Ed}	Design value of the applied axial force (tension or compression)
P	Prestressing force
P_0	Initial force at the active end of the tendon immediately after stressing
Q_k	Characteristic variable action
Q_{fat}	Characteristic fatigue load
R	Resistance or relaxation function
S	Internal forces and moments
S	First moment of area
SLS	Serviceability limit state
T	Torsional moment

T_{Ed}	Design value of the applied torsional moment
ULS	Ultimate limit state
V	Shear force
V_{Ed}	Design value of the applied shear force
Vol	Volume of traffic
X	Advisory limit on percentage of coupled tendons at a section

Latin lower case letters

a	Distance
a	Geometrical data
Δa	Deviation for geometrical data
b	Overall width of a cross-section, or actual flange width in a T or L beam
b_w	Width of the web on T, I or L beams
c_{min}	Minimum cover
d	Diameter; Depth
d	Effective depth of a cross-section
d_g	Largest nominal maximum aggregate size
e	Eccentricity
f	Frequency
f_c	Compressive strength of concrete
f_{cd}	Design value of concrete compressive strength
f_{ck}	Characteristic compressive cylinder strength of concrete at 28 days
f_{cm}	Mean value of concrete cylinder compressive strength
f_{ctb}	Tensile strength prior to cracking in biaxial state of stress
f_{ctk}	Characteristic axial tensile strength of concrete
f_{ctm}	Mean value of axial tensile strength of concrete
f_{ctx}	Appropriate tensile strength for evaluation of cracking bending moment
f_p	Tensile strength of prestressing steel
f_{pk}	Characteristic tensile strength of prestressing steel
$f_{p0,1}$	0,1% proof-stress of prestressing steel
$f_{p0,1k}$	Characteristic 0,1 % proof-stress of prestressing steel
$f_{0,2k}$	Characteristic 0,2 % proof-stress of reinforcement
f_t	Tensile strength of reinforcement
f_{tk}	Characteristic tensile strength of reinforcement
f_y	Yield strength of reinforcement
f_{yd}	Design yield strength of reinforcement

f_{yk}	Characteristic yield strength of reinforcement
f_{ywd}	Design yield of shear reinforcement
h	Height
h	Overall depth of a cross-section
i	Radius of gyration
k	Coefficient; Factor
l	Length, span or height
m	Mass or slab components
n	Plate components
q_{ud}	Maximum value of combination reached in non linear analysis
r	Radius or correcting factor for prestress
$1/r$	Curvature at a particular section
s	Spacing between cracks
t	Thickness
t	Time being considered
t_0	The age of concrete at the time of loading
u	Perimeter of concrete cross-section, having area A_c
u	Component of the displacement of a point
v	Component of the displacement of a point or transverse shear
w	Component of the displacement of a point or crack width
x	Neutral axis depth
x,y,z	Coordinates
x_u	Neutral axis depth at ULS after redistribution
z	Lever arm of internal forces

Greek upper case letters

Φ	Dynamic factor according to EN 1991-2

Greek lower case letters

α	Angle; Ratio; Long term effects coefficient or ratio between principal stresses
α_e	E_s/E_{cm} ratio
α_h	Reduction factor for θ_l
β	Angle ; Ratio; Coefficient
γ	Partial factor
γ_A	Partial factor for accidental actions A
γ_C	Partial factor for concrete
γ_F	Partial factor for actions, F
$\gamma_{F,fat}$	Partial factor for fatigue actions

$\gamma_{C,fat}$	Partial factor for fatigue of concrete
γ_O	Overall factor
γ_G	Partial factor for permanent actions, G
γ_M	Partial factor for a material property, taking account of uncertainties in the material property itself, in geometric deviation and in the design model used
γ_P	Partial factor for actions associated with prestressing, P
γ_Q	Partial factor for variable actions, Q
γ_S	Partial factor for reinforcing or prestressing steel
$\gamma_{S,fat}$	Partial factor for reinforcing or prestressing steel under fatigue loading
γ_f	Partial factor for actions without taking account of model uncertainties
γ_g	Partial factor for permanent actions without taking account of model uncertainties
γ_m	Partial factors for a material property, taking account only of uncertainties in the material property
δ	Increment/redistribution ratio
ξ	Creep redistribution function or bond strength ratio
ζ	Reduction factor/distribution coefficient
ε_c	Compressive strain in the concrete
ε_{ca}	Autogeneous shrinkage
ε_{cc}	Creep strain
ε_{cd}	Desiccation shrinkage
ε_{c1}	Compressive strain in the concrete at the peak stress f_c
ε_{cu}	Ultimate compressive strain in the concrete
ε_u	Strain of reinforcement or prestressing steel at maximum load
ε_{uk}	Characteristic strain of reinforcement or prestressing steel at maximum load
θ	Angle
θ_l	Inclination for geometric imperfections
λ	Slenderness ratio or damage equivalent factors in fatigue
μ	Coefficient of friction between the tendons and their ducts
ν	Poisson's ratio
ν	Strength reduction factor for concrete cracked in shear
ρ	Oven-dry density of concrete in kg/m^3
$\rho_{1\,000}$	Value of relaxation loss (in %), at 1 000 hours after tensioning and at a mean temperature of 20 °C
ρ_l	Reinforcement ratio for longitudinal reinforcement
ρ_w	Reinforcement ratio for shear reinforcement
σ_c	Compressive stress in the concrete

σ_{cp}	Compressive stress in the concrete from axial load or prestressing
σ_{cu}	Compressive stress in the concrete at the ultimate compressive strain ε_{cu}
τ	Torsional shear stress
ϕ	Diameter of a reinforcing bar or of a prestressing duct
ϕ_n	Equivalent diameter of a bundle of reinforcing bars
$\varphi(t,t_0)$	Creep coefficient, defining creep between times t and t_0, related to elastic deformation at 28 days
φ_{fat}	Damage equivalent impact factor in fatigue
$\varphi(\infty,t_0)$	Final value of creep coefficient
ψ	Factors defining representative values of variable actions
ψ_0	for combination values
ψ_1	for frequent values
ψ_2	for quasi-permanent values
χ	Ageing coefficient

SECTION 2 Basis of Design

All the clauses of EN 1992-1-1 apply.

SECTION 3 Materials

The following clauses of EN 1992-1-1 apply.

3.1.1 (1)P
3.1.1 (2)
3.1.2 (1)P
3.1.2 (3)
3.1.2 (4)
3.1.2 (5)
3.1.2 (6)
3.1.2 (7)P
3.1.2 (8)
3.1.2 (9)
3.1.3 (1)
3.1.3 (2)
3.1.3 (3)
3.1.3 (4)
3.1.3 (5)
3.1.4 (1)P
3.1.4 (2)
3.1.4 (3)
3.1.4 (4)
3.1.4 (5)
3.1.4 (6)
3.1.5 (1)
3.1.7 (1)
3.1.7 (2)
3.1.7 (3)
3.1.8 (1)
3.1.9 (1)
3.1.9 (2)
3.2.1 (1)P
3.2.1 (2)P
3.2.1 (3)P
3.2.1 (4)P
3.2.1 (5)
3.2.2 (1)P
3.2.2 (2)P
3.2.2 (3)P
3.2.2 (4)P
3.2.2 (5)
3.2.2 (6)P
3.2.3 (1)P
3.2.4 (2)
3.2.5 (1)P
3.2.5 (2)P
3.2.5 (3)P
3.2.5 (4)
3.2.6 (1)P
3.2.7 (1)
3.2.7 (2)
3.2.7 (3)
3.2.7 (4)
3.3.1 (1)P
3.3.1 (2)P
3.3.1 (3)
3.3.1 (4)
3.3.1 (5)P
3.3.1 (6)
3.3.1 (7)P
3.3.1 (8)P
3.3.1 (9)P
3.3.1 (10)P
3.3.1 (11)P
3.3.2 (1)P
3.3.2 (2)P
3.3.2 (3)P
3.3.2 (4)P
3.3.2 (5)
3.3.2 (6)
3.3.2 (7)
3.3.2 (8)
3.3.2 (9)
3.3.3 (1)P
3.3.4 (1)P
3.3.4 (2)
3.3.4 (3)
3.3.4 (4)
3.3.4 (5)
3.3.5 (1)P
3.3.5 (2)P
3.3.6 (1)P
3.3.6 (2)
3.3.6 (3)
3.3.6 (4)
3.3.6 (5)
3.3.6 (6)
3.3.6 (7)
3.3.7 (1)P
3.3.7 (2)P
3.4.1.1 (1)P
3.4.1.1 (2)P
3.4.1.1 (3)P
3.4.1.2.1 (1)P
3.4.1.2.1 (2)
3.4.1.2.2 (1)P
3.4.2.1 (1)P
3.4.2.1 (2)P
3.4.2.1 (3)
3.4.2.2 (1)

3.1 Concrete

3.1.2 Strength

(102)P The strength classes (C) in this code are denoted by the characteristic cylinder strength f_{ck} determined at 28 days with a minimum value of C_{min} and a maximum value of C_{max}.

NOTE The values of C_{min} and C_{max} for use in a Country may be found in its National Annex. The recommended values are C30/37 and C70/85 respectively.

3.1.6 Design compressive and tensile strengths

(101)P The value of the design compressive strength is defined as

$$f_{cd} = \alpha_{cc} f_{ck}/\gamma_C \tag{3.15}$$

where:

γ_C is the partial safety factor for concrete, see 2.4.2.4, and

α_{cc} is the coefficient taking account of long term effects on the compressive strength and of unfavourable effects resulting from the way the load is applied.

NOTE The value of α_{cc} for use in a Country should lie between 0,80 and 1,00 and may be found in its National Annex. The recommended value of α_{cc} is 0,85.

(102)P The value of the design tensile strength, f_{ctd}, is defined as:

$$f_{ctd} = \alpha_{ct} f_{ctk,0,05}/\gamma_C$$

where:

γ_C is the partial safety factor for concrete, see 2.4.2.4, and

α_{ct} is a coefficient taking account of long term effects on the tensile strength and of unfavourable effects, resulting from the way the load is applied.

NOTE The value of α_{ct} for use in a Country should lie between 0,80 and 1,00 and may be found in its National Annex. The recommended value of α_{ct} is 1,0.

3.2 Reinforcing steel

3.2.4 Ductility characteristics

(101)P The reinforcement shall have adequate ductility as defined by the ratio of tensile strength to the yield stress, $(f_t/f_y)_k$ and the elongation at maximum force, ε_{uk}.

NOTE The classes of reinforcement to be used in bridges in a Country may be found in its National Annex. The recommended classes are Class B and Class C.

SECTION 4 Durability and cover to reinforcement

The following clauses of EN 1992-1-1 apply.

4.1 (1)P	*4.2 (3)*	*4.4.1.2 (4)*	*4.4.1.2 (13)*
4.1 (2)P	*4.3 (1)P*	*4.4.1.2 (5)*	*4.4.1.3 (1)P*
4.1 (3)P	*4.3 (2)P*	*4.4.1.2 (6)*	*4.4.1.3 (2)*
4.1 (4)	*4.4.1.1 (1)P*	*4.4.1.2 (7)*	*4.4.1.3 (3)*
4.1 (5)	*4.4.1.1 (2)P*	*4.4.1.2 (8)*	*4.4.1.3 (4)*
4.1 (6)	*4.4.1.2 (1)P*	*4.4.1.2 (10)*	
4.2 (1)P	*4.4.1.2 (2)P*	*4.4.1.2 (11)*	
4.2 (2)	*4.4.1.2 (3)*	*4.4.1.2 (12)*	

4.2 Environmental conditions

(104) Water penetration or the possibility of leakage from the carriageway into the inside of voided structures should be considered in the design.

(105) For a concrete surface protected by waterproofing the exposure class should be given in a Country's National Annex.

NOTE For surfaces protected by waterproofing the exposure class for use in a Country may be found in its National Annex. The recommended exposure class for surfaces protected by waterproofing is XC3.

(106) Where de-icing salt is used, all exposed concrete surfaces within x m of the carriageway horizontally or within y m above the carriageway should be considered as being directly affected by de-icing salts. Top surfaces of supports under expansion joints should also be considered as being directly affected by de-icing salts.

NOTE 1 The distances x and y for use in a Country may be found in its National Annex. The recommended value for x is 6m and the recommended value for y is 6m.

NOTE 2 The exposure classes for surfaces directly affected by de-icing salts for use in a Country may be found in its National Annex. The recommended classes for surfaces directly affected by de-icing salts are XD3 and XF2 or XF4, as appropriate, with covers given in Tables 4.4N and 4.5N for XD classes.

4.3 Requirements for durability

(103) External prestressing tendons should comply with the requirements of National Authorities.

4.4 Methods of verifications

4.4.1 Concrete cover

4.4.1.2 Minimum cover, c_{min}

(109) Where in-situ concrete is placed against an existing concrete surface (precast or in-situ) the requirements for cover to the reinforcement from the interface may be modified.

NOTE The requirements for use in a Country may be found in its National Annex.