SLOVENSKI STANDARD

SIST ENV 1992-3:2004

01-september-2004

Evrokod 2: Projektiranje betonskih konstrukcij – 3. del: Betonski temelji

Eurocode 2: Design of concrete structures - Part 3: Concrete foundations

Eurocode 2: Planung von Stahlbeton- und Spannbetontragwerken - Teil 3: Fundamente

Eurocode 2: Calcul des structures en béton - Partie 3: Structures de fondations

Ta slovenski standard je istoveten z: ENV 1992-3:1998

ICS:

91.010.30	Tehniļ ni vidiki	Technical aspects
91.080.40	Betonske konstrukcije	Concrete structures

SIST ENV 1992-3:2004 **en**

EUROPEAN PRESTANDARD
PRÉNORME EUROPÉENNE
EUROPÄISCHE VORNORM

ENV 1992-3

December 1998

ICS 91.010.30

Descriptors: civil engineering, concrete structures, foundations, design, building codes, computation

English version

Eurocode 2: Design of concrete structures - Part 3: Concrete foundations

Eurocode 2: Calcul des structures en béton - Partie 3: Structures de fondations

Eurocode 2: Planung von Stahlbeton- und Spannbetontragwerken - Teil 3: Fundamente

This European Prestandard (ENV) was approved by CEN on 28 November 1996 as a prospective standard for provisional application.

The period of validity of this ENV is limited initially to three years. After two years the members of CEN will be requested to submit their comments, particularly on the question whether the ENV can be converted into a European Standard.

CEN members are required to announce the existence of this ENV in the same way as for an EN and to make the ENV available promptly at national level in an appropriate form. It is permissible to keep conflicting national standards in force (in parallel to the ENV) until the final decision about the possible conversion of the ENV into an EN is reached.

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

Central Secretariat: rue de Stassart, 36 B-1050 Brussels

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Foreword

Objectives of the Eurocodes

(1) The "Structural Eurocodes" comprise a group of standards for the structural and geotechnical design of buildings and civil engineering works.

(2) They cover execution and control only to the extent that is necessary to indicate the quality of the construction products, and the standard of the workmanship needed to comply with the assumptions of the design rules.

(3) Until the necessary set of harmonized technical specifications for products and for the methods of testing their performances are available, some of the Structural Eurocodes cover some of these aspects in informative annexes.

Background of the Eurocode programme

(4) The Commission of the European Communities (CEC) initiated the work of establishing a set of harmonized technical rules for the design of building and civil engineering works which would initially serve as an alternative to the different rules in force in the various Member States and would ultimately replace them. These technical rules became known as the "Structural Eurocodes".

(5) In 1990, after consulting their respective Member States, the CEC transferred the work of further development, issue and updating of the Structural Eurocodes to CEN, and the EFTA Secretariat agreed to support the CEN work.

(6) CEN Technical Commission CEN/TC 250 is responsible for all Structural Eurocodes.

Eurocode programme

(7) Work is in hand on the following Structural Eurocodes, each generally consisting of a number of parts:

EN 1991 Eurocode 1	Basis of design and actions on structures
EN 1992 Eurocode 2	Design of concrete structures
EN 1993 Eurocode 3	Design of steel structures
EN 1994 Eurocode 4	Design of composite steel and concrete structures
EN 1995 Eurocode 5	Design of timber structures
EN 1996 Eurocode 6	Design of masonry structures
EN 1997 Eurocode 7	Geotechnical design
EN 1998 Eurocode 8	Design provisions for earthquake resistance of structures
EN 1999 Eurocode 9	Design of aluminium alloy structures

(8) Separate sub-committees have been formed by CEN/TC 250 for the various Eurocodes listed above.

(9) This Part 3 of Eurocode 2 is being published as a European Prestandard (ENV) with an initial life of three years.

(10) This Prestandard is intended for experimental applications and for the submission of comments.

(11) After approximately two years CEN members will be invited to submit formal comments to be taken into account in determining future actions.

(12) Meanwhile feedback and comments on this Prestandard should be sent to the Secretariat of CEN/TC 250/SC 2 at the following address:

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or to your national Standards Organization.

National Application Documents (NAD's)

(13) In view of the responsibilities of authorities in member countries for safety, health and other matters covered by the essential requirements of the Construction Products Directive (CPD), certain safety elements in this ENV have been assigned indicative values which are identified by |_| ("boxed values"). The authorities in each member country are expected to assign definitive values to these safety elements.

(14) Some of the supporting European or International standards may not be available by the time this Prestandard is issued. It is therefore anticipated that a National Application Document giving definitive values for safety elements, referencing compatible supporting standards and providing national guidance on the application of this Prestandard, will be issued by each member country or its Standards Organization.

(15) It is intended that this Prestandard is used in conjunction with the NAD valid in the country where the building or civil engineering works is located.

Matters specific to this Prestandard

(16) The scope of this Part of Eurocode 2 is defined in 1.1.4. Additional Parts of Eurocode 2 which are already issued are indicated in 1.1.3 of ENV 1992-1-1; these cover additional technologies or applications, and will complement and supplement this Part.

(17) In using this Prestandard in practice, particular regard should be paid to the underlying assumptions and conditions given in 1.3 of ENV 1992-1-1.

(18) The seven chapters of this Prestandard are complemented by four Informative Annexes. Some of the more detailed Application Rules, which are needed in particular cases, have been moved out of the main part of the text for clarity.

(19) As indicated in paragraph (14) of this Foreword, reference should be made to National Application Documents which will give details of compatible supporting standards to be used, in particular with regard to execution documents for geotechnical work, piling and deep foundations. For this Part of Eurocode 2, particular attention is drawn to the Prestandard ENV 206 (Concrete – Performance, production, placing and compliance criteria), and the durability requirements given in 4.1 of this Prestandard.

(20) In developing this Prestandard, background documents have been prepared, which give commentaries on and justifications for some of the provisions in this Prestandard.

For ENV 1992-3, the following additional sub-clauses apply:

(21) This Part 3 of Eurocode 2 complements ENV 1992-1-1 for the particular design aspects of foundation structures.

(22) The framework and structure of this Part 3 correspond to ENV 1992-1-1. However, Part 3 contains Principles and Application Rules only which are specific to foundation structures.

(23) Where a particular sub-clause of ENV 1992-1-1 is not mentioned in this ENV 1992-3, that sub-clause of ENV 1992-1-1 applies as far as is deemed appropriate in each case.

Some Principles and Application Rules of ENV 1992-1-1 are modified or replaced in this Part 3, in which case they are superseded.

Where a Principle or Application Rule in ENV 1992-1-1 is modified or replaced, the new number is identified by the addition of 100 to the original number. Where a new Principle or Application Rule is added, it is identified by a number which follows the last number of ENV 1992-1-1 with 100 added to it.

A subject not covered by ENV 1992-1-1 is introduced in this Part by a new sub-clause. The sub-clause number for this follows the most appropriate clause number in ENV 1992-1-1.

(24) The numbering of equations, figures, footnotes and tables in this Part follow the same principles as the clause numbering in (23) above.

1 Introduction

1.1 Scope

Addition after Clause 1.1.3 P (2):

1.1.4 Scope of Part 3 of Eurocode 2

P (101) This Prestandard provides additional rules for the design of concrete elements in foundations, for buildings and civil engineering works and is concerned with the requirements for stability, strength, serviceability and durability for such elements.

P (102) This Prestandard does not cover the cast-in-place piles that are installed as displacement piles.

[NOTE: ENV 1997-1 gives rules for the geotechnical aspects of the design and ENV 1998-1 gives the special requirements of seismic design.]

1.4 Definitions

Addition after Clause 1.4.2 P (2):

1.4.3 Special terms used in Part 3 of Eurocode 2

P (101) The special terms used in this Part and their definitions are as follows:

Ground:	Soil, rock and fill existing in place prior to the execution of the construction work.
Ground-structure interaction:	The mutual influence of the deformations of the ground and structural system, taking into account the complete soil-structure system as well as the resulting stresses.
Piles:	For definitions see EN 1536 and other relevant documents.

2 Basis of design

2.1 Fundamental requirements

Addition after Principle P (4):

P (105) The design of concrete foundations shall take into account the mutual influence of the deformations of the ground and the structural system.

P (106) Concrete foundations shall be sized in accordance with ENV 1997-1.

(107) The existence of expansive soils should be adequately considered. Special provisions should be taken in such cases.

2.3 Design requirements

2.3.3 Partial safety factors for ultimate limit states

Replacement of Clause 2.3.3.1 by:

2.3.3.1 Partial safety factors for actions

P (101) Unless stated otherwise, for persistant and transient design situations, the stability and strength of both the structures and the ground shall be verified using the partial safety factors given in Table 2.1 in ENV 1997-1. Each of the three Cases A, B and C shall be considered separately as relevant.

(102) For detailed information, reference should be made to Clause 2.4 in ENV 1997-1.

(103) For civil engineering works, the values of γ_F and ψ should be taken from the relevant Eurocode or should be specified for the particular project.

(104) For temporary structures and transient design situations, smaller values of partial factors may be used, where it can be justified on the basis of the consequences, see for example, ENV 1991-1, clauses 1.5.2.3, 1.5.3.14, 9.4.2 and Informative Annex A "Partial factor design".

P (105) For accidential design situations, the partial safety factors for all actions are equal to 1.

2.3.3.2 Partial safety factors for materials

Addition after Application Rule (6):

P (107) The design values of the strength properties of ground materials shall be calculated in accordance with ENV 1997-1.

P (108) Uncertainties related to the cross-section of piles and concreting procedure shall be allowed for in design.

(109) In the absence of other provisions, for the design resistance of cast in place piles without permanent casing,

a) the partial safety factor for concrete given in ENV 1992-1-1 should be multiplied by $\lfloor \underline{1.1} \rfloor$, and

b) the diameter of the piles in the design calculations should be taken as $\lfloor \underline{0,95} \rfloor$ times the nominal diameter, d_{nom}, however not greater than d_{nom}-$\lfloor \underline{20} \rfloor$ mm and not less than d_{nom}-$\lfloor \underline{50} \rfloor$ mm.

2.5 Analysis

Addition after Clause 2.5.3.7:

2.5.3.8 Deep footings and pile caps

(101) Footings and pile caps with $a_c/h \leq 2$ may be analysed using strut and tie models where a_c denotes the projection of the footing or pile cap from the column's or pile's face end where h is the depth of the footing or pile cap respectively.

Addition after Clause 2.5.5:

2.5.6 Special requirements for foundations

2.5.6.1 General

P (101) Where relevant, the analysis of the structural system as a whole supported by the ground shall consider the interaction between the ground, the foundation and supported superstructure.

2.5.6.2 Design models for shallow foundations

(101) For the design of shallow foundations, appropriately simplified models for the description of the soil structure-interaction may be used.

2.5.6.3 Piled foundations

P (101) For the strength design of individual piles the actions shall be determined taking into account the interaction between the piles, the pile cap and the supporting soil.

P (102) Where the piles are located in several rows, the action on each pile shall be evaluated by considering the interaction between the piles.

(103) This interaction may be neglected when their spacing is greater than $\lfloor \underline{3} \rfloor$ times the pile diameter.

3 Material properties

3.1 Concrete

3.1.1 General

Addition after Application Rule (5):

(106) Unless otherwise specified in this Part 3, the provisions of EN 1536: "Execution of special geotechnical work – Bored piles. Prefabricated concrete foundation piles" apply for bored and prefabricated piles, respectively.

P (107) The composition and the design strength of concrete shall take into account the requirements of durability, workability, environmental and soil conditions.

3.1.2 Normal weight concrete

3.1.2.4 Strength classes of concrete

Addition after Application Rule (3):

(104) Unless otherwise specified, the design strength class of concrete used for bored piles should range between C |20/25| and C |30/37|, see EN 1536.

Addition after Clause 3.1.2.5.5:

3.1.3 Maximum size of aggregate

(101) In bored piles, the nominal maximum size of the aggregates should not exceed:

– 0,25 times the inner diameter of the reinforcing cage or,
– 32 mm or the half of the clear distance of the longitudinal bars, whichever is the less,
– 0,75 times the thickness of the concrete cover or the distance between a temporary casing and the reinforcing bars.

Addition after Clause 3.4.2.1:

3.5 Spacers

P (101) Spacers shall be made of durable materials that will not corrode.

(102) Adequate number of robust spacers should be used to secure the reinforcement against displacement during concreting. See, for example 8.2.5 of EN 1536.

4 Section and member design

4.1 Durability requirements

4.1.3 Design

4.1.3.3 Concrete cover

Replacement of Application Rules (8) to (11) by:

(108) Taking into account the uneven nature of the support of cast-in-place foundations the nominal cover specified in the drawings should be based on the minimum cover of Table 4.2 in ENV 1992-1-1 and should be increased by a minimum allowance (Δh) as follows:

– Footings and pile caps:	|20| mm
– Beam and column like structures:	|15| mm
– Walls:	|10| mm

(109) In cast-insitu foundations, the nominal concrete cover including the minimum allowance Δh to reinforcement specified in the drawings should not be less than the following values:

– Surface cast against unprepared ground:	|75| mm
– Surface cast against prepared ground:	|40| mm
– Surface cast against concrete blinding:	|35| mm
– Column and wall footings except bottom:	|40| mm
– Beam and column like structures except bottom:	|35| mm
– Walls outer surface:	|30| mm

– Piles, cast-in-place: 7.7.4 of EN 1536 applies.

(110) For temporary works and where justified by production and quality control the values in (109) may be reduced by |15| mm.

(111) A blinding layer of concrete may be used under concrete elements to cover the soil and to avoid contamination, wetting of the subsoil and to maintain a flat surface for the structural concrete.

4.3 Ultimate limit states

4.3.1 Ultimate limit states for bending and longitudinal force

Addition after Clause 4.3.1.3:

4.3.1.4 Foundations

4.3.1.4.1 Plain concrete

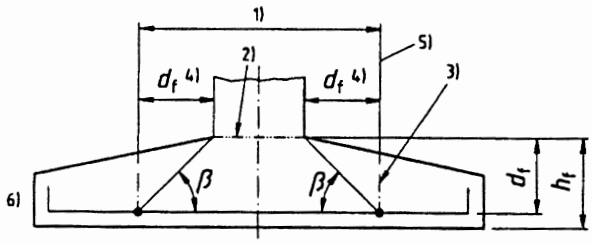
(101) Plain concrete may be used where (a) the eccentricity of loading is not significant, (b) reliance on the tensile strength of concrete is acceptable in design and (c), where relevant, the tensile stresses due to shrinkage are taken into account. For further information see ENV 1992-1-6.

4.3.4 Punching

4.3.4.1 General

Replacement of Application Rule (3) by:

(103) An appropriate design model for checking punching shear failure at the ultimate limit state in foundation slabs is shown in Figure 4.116.



1 critical area
2 loaded area
3 critical section
4 possible position of punching shear reinforcement
5 critical perimeter
6 foundation slab

Figure 4.116: Design model for punching shear at the ultimate limit state in foundation slabs

4.3.4.2 Scope and definitions

4.3.4.2.2 Critical perimeter

Addition after Application Rule (4):

(105) The provisions in paragraphs (1) to (4) in 4.3.4.2.2 of ENV 1992-1 apply also to foundation slabs, however, with the modification that the distance of the critical perimeters from the loaded area is assumed to be 1,0 d_f (see Figure 4.116).

4.3.5 Ultimate limit states induced by structural deformations (buckling)

4.3.5.1 Scope and definitions

Addition after Application Rule (5):

(106) Slender piles passing through water or thick deposits of very weak soil (characteristic undrained shear strength < |15| kN/m^2 (0,015 N/mm^2)) should be checked against buckling in accordance with 4.3.5 in ENV 1992-1-1.

4.4 Serviceability limit states

4.4.2 Limit states of cracking

4.4.2.1 General considerations

Addition after Principle P (9):

(110) For crack control the minimum concrete cover to reinforcement should be used (see 4.1.3.3 of ENV 1992-1-1).

(111) In reinforced concrete members in environmental conditions according to exposure class 2 of Table 4.1 in ENV 1992-1-1, crack control may be ommitted at sections below the lowest ground water level.

5 Detailing provisions

5.1 General

Addition after Principle P (4):

(105) A reinforced structural member may contain unreinforced parts treated as plain concrete provided that the designer verifies that the tensile stresses in those parts caused by actions are within appropriate limits, see, for example, 4.3.2.1 (102) in ENV 1992-1-6.

Addition after Clause 5.4.8.3:

5.4.9 Particular aspects of foundations

5.4.9.1 Anchorage

(101) The anchorage should comply with sections 5.2.3 and 5.2.6 in ENV 1992-1-1. See also Informative Appendix 106 of this Part 3.

5.4.9.2 Structural members

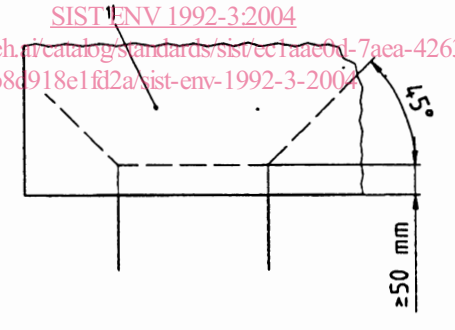
5.4.9.2.1 Pile caps

(101) The distance from the outer edge of the pile to the edge of the pilecap should be such that the tie forces in the pile cap can be properly anchored. The expected deviation of the pile on site should be taken into account.

(102) The main tensile reinforcement to resist the action effects should be concentrated to the stress zones between the tops of the piles. If the area of this reinforcement is at least equal to the minimum reinforcement (see ENV 1992-1-1), evenly distributed bars along the bottom surface of the member can be omitted. Also the sides and the top surface of the member may be unreinforced if there is not risk of tension developing in these parts of the member.

(103) Welded transverse bars may be used for the anchorage of the tension reinforcement. In this case the transverse bar may be considered to be part of the transverse reinforcement in the anchorage zone of the reinforcing bar considered.

(104) The compression caused by the support reaction from the pile may be assumed to spread at |45| degree angles from the edge of the pile (see Fig. 5.121). This compression may be taken into account when calculating the anchorage length ("direct support").



1 compressed area

Figure 5.121: Compressed area increasing the anchorage capacity