
**Eurocode 2: Projektiranje betonskih konstrukcij - 1-6. del: Splošna pravila za
nearnirane betonske konstrukcije**

Eurocode 2: Design of concrete structures - Part 1-6: General rules - Plain concrete structures

Eurocode 2: Planung von Stahlbeton- und Spannbetontragwerken - Teil 1-6: Allgemeine Regeln - Tragwerke aus unbewehrtem Beton

Eurocode 2: Calcul des structures en béton - Partie 1-6: Règles générales - Structures en béton non armé

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EUROPEAN PRESTANDARD

ENV 1992-1-6

PRÉNORME EUROPÉENNE

EUROPÄISCHE VORNORM

October 1994

ICS 91.040.00; 91.080.40

Descriptors: buildings, concrete structure, computation, building codes, rules of calculation

English version

**Eurocode 2: Design of concrete structures - Part
1-6: General rules - Plain concrete structures**

Eurocode 2: Calcul des structures en béton -
Partie 1-6: Règles générales - Structures en
béton non armé

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Spannbetontragwerken - Teil 1-6: Allgemeine
Regeln - Tragwerke aus unbewehrtem Beton

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This European Prestandard (ENV) was approved by CEN on 1993-06-25 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 an European Standard (EN).

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.

CEN members are the national standards bodies of Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

CEN

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 performance 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". [SIST ENV 1992-1-6:2004](https://standards.iteh.ai/catalog/standards/sist/8b200159-84ea-4443-a87f-9c261880c24/sist-env-1992-1-6-2004)
<https://standards.iteh.ai/catalog/standards/sist/8b200159-84ea-4443-a87f-9c261880c24/sist-env-1992-1-6-2004>
- (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 Committee CEN/TC250 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/TC250 for the various Eurocodes listed above.

- (9) This Part 1-6 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 application 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/TC250/SC2 at the following address:

Deutsches Institut für Normung e.V. (DIN)
Burggrafenstrasse 6
D - 10787 Berlin
phone: (+49) 30 - 26 01 - 25 01
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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 (NAD) 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 Eurocode 2 is defined in 1.1.1 of ENV 1992-1-1 and the scope of this Part of Eurocode 2 is defined in 1.1.2. Additional Parts of Eurocode 2 which are planned are indicated in 1.1.3 of ENV 1992-1-1; these will 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 Appendices which have the same normative status as the chapters to which they relate. These Appendices have been introduced by moving some of the more detailed Principles/Application Rules, which are needed in particular cases, out of the main part of the text to aid its 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. For this Part of Eurocode 2, particular attention is drawn to the approved Prestandard ENV 206 (Concrete - performance, production, placing and compliance criteria), and the durability requirements given in 4.1 of this Prestandard.
- (20) The provisions of this Prestandard are based substantially on the 1978 edition of the CEB Model Code and other more recent CEB and FIP documents.
- (21) 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 1992-1-6, the following additional sub-clauses apply:

- (22) This Part 1-6 of Eurocode 2 complements ENV 1992-1-1 for the particular aspects of plain concrete structures.
- (23) The framework and structure of this Part 1-6 correspond to ENV 1992-1-1. However, Part 1-6 contains Principles and Application Rules which are specific to structures made with plain concrete.
- (24) Where a particular sub-clause of ENV 1992-1-1 is not mentioned in this ENV 1992-1-6, that sub-clause of ENV 1992-1-1 applies as far as deemed appropriate in each case.

Some Principles and Application Rules of ENV 1992-1-1 are modified or replaced in this Part, 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.

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

1 INTRODUCTION

This clause of ENV 1992-1-1 is applicable except as follows:

1.1. SCOPE**1.1.2 SCOPE OF PART 1-6 OF EUROCODE 2**

Replacement of Principle P(1) by:

P(101) Part 1-6 of ENV 1992 provides supplementary rules to the general rules given in ENV 1992-1-1 for the design of components in building and civil engineering works in plain concrete made with normal weight aggregate as defined in ENV 206 (see 1.1.3 of Part 1-1 for supplementary parts covering additional methods of construction, materials, and type of structure).

Addition after Principle P(5):

(106) This Part 1-6 applies to members, for which the effects of dynamic actions may be neglected. Such members may include:

- plain concrete members mainly subjected to compression other than that due to prestressing, e.g. walls, columns, arches, and tunnels;

- plain concrete strip and pad footings for foundations;

- plain concrete retaining walls.

P(107) This Part 1-6 may also be used for members made with lightweight aggregate concrete with closed structure according to ENV 1992-1-4 and for precast concrete elements and structures covered by ENV 1992-1-3. However, in these cases the design rules may be modified accordingly.

P(108) This Part 1-6 does not preclude the provision of steel reinforcement needed to satisfy serviceability and/or durability requirements, nor reinforcement in certain parts of the members. This reinforcement may be taken into account for local ultimate limit state verifications as well as for checks in the serviceability limit states.

(109) Examples of such reinforcement is the joint reinforcement in the top of a wall to avoid splitting and the joint reinforcement for columns into a footing.

P(110) For plain precast concrete it is, in addition, necessary to comply with ENV 1992-1-3. For lightweight aggregate concrete with closed structure see ENV 1992-1-4.

1.4 DEFINITIONS**1.4.2 SPECIAL TERMS USED IN PART 1-6 OF EUROCODE 2**

Replacement of Principles P(1) and P(2) by:

P(101) Plain concrete member: Structural concrete member having no reinforcement (plain concrete) or less reinforcement than the minimum amounts defined in section 5.4 "Structural Members" of ENV 1992-1-1.

1.7 SPECIAL SYMBOLS USED IN THIS PART 1-6 OF EUROCODE 2
1.7.2 LATIN UPPER CASE LETTERS

Addition:

- $A_{c,eff}$ Effective cross section (4.3.1.2(107))
- I_y, I_z Second moment of cross-sectional area related to the y- and z-axis respectively
- N_{Rd} Resisting design axial compression force

1.7.3 LATIN LOWER CASE LETTERS

Addition:

- a Projection of a pad footing from the columns face
- e_a Additional eccentricity covering the effects of geometrical imperfections
- e_0 First order eccentricity
- e_y, e_z Components of an eccentricity e in direction of the y- and z-axes respectively
- e_{tot} Total eccentricity
- f_{ctd} Design value of the tensile strength of concrete
- h_f Depth of a pad footing
- h_w Overall depth of a wall
- i Radius of gyration
- l_h Clear horizontal length of a wall between vertical restraints (Fig. 4.135)
- l_{ht} Horizontal length of a transverse wall stabilizing the wall under consideration
- l_w Clear height of a wall (Fig. 4.135)
- l_0 Effective length of a compression member

1.7.4 GREEK SYMBOLS

Addition:

- α Reduction coefficient to allow for the effect of long term loading on the concrete compression strength
- β Effective height coefficient: $\beta = l_0/l_w$

γ_n	Additional partial safety factor for concrete
λ	Slenderness ratio: $\lambda = l_0/i$
σ_{cm}	Average concrete compressive stress
σ_{ct}	Concrete tensile stress
σ_{gd}	Design value of the ground pressure
σ_{sd}	Design value of the applied normal stress
τ_{sd}	Design value of the applied shear stress

2 BASIS OF DESIGN

This clause of ENV 1992-1-1 is applicable except as follows:

2.3 DESIGN REQUIREMENTS

2.3.3 PARTIAL SAFETY FACTORS FOR ULTIMATE LIMIT STATES

2.3.3.2 Partial Safety Factors for Materials

Addition after Application Rule (6):

P(107) Due to the less ductile properties of plain concrete, the partial safety factor for concrete in compression and tension shall be multiplied with a coefficient γ_n .

(108) It is recommended to multiply the partial safety factors γ_c for concrete given in Table 2.3 in ENV 1992-1-1 by $\gamma_n = \underline{1.2}$ in compression and $\gamma_n = \underline{1.2}$ in tension, that is

for fundamental combinations: $\gamma_c = \underline{1.80}$ in compression and $\gamma_c = \underline{1.80}$ in tension,

for accidental design situations (except earthquakes): $\gamma_c = \underline{1.56}$ in compression and $\gamma_c = \underline{1.56}$ in tension.

2.5 ANALYSIS

2.5.3 CALCULATION METHODS

2.5.3.2 Types of Structural Analysis

2.5.3.2.2 Ultimate Limit States

Replacement of clause 2.5.3.2.2 in ENV 1992-1-1 by:

P(101) Since plain concrete members have limited deformability, linear analysis with redistribution or a plastic approach to analysis, e.g. methods without an explicit check of the deformation capacity, shall not be used unless their application can be justified.

(102) Structural analysis may be based on the non-linear or the linear elastic theory. In the case of a non-linear analysis (e.g. fracture mechanics) a check of the deformation capacity should be performed.