SLOVENSKI STANDARD
SIST ENV 1992-2:2004

01-september-2004

Eurocode 2: Projektiranje betonskih konstrukcij – 2. del: Betonski mostovi

Eurocode 2: Design of concrete structures - Part 2: Concrete bridges

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

Eurocode 2: Calcul des structures en béton - Partie 2: Ponts en béton

Ta slovenski standard je istoveten z: ENV 1992-2:1996

ICS:

91.010.30	Tehniļ ni vidiki	Technical aspects
91.080.40	Betonske konstrukcije	Concrete structures
93.040	Gradnja mostov	Bridge construction

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EUROPEAN PRESTANDARD

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EUROPÄISCHE VORNORM

ENV 1992-2

September 1996

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

English version

Eurocode 2: Design of concrete structures - Part 2: Concrete bridges

Eurocode 2: Calcul des structures en béton - Partie 2: Ponts en béton

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

This European Prestandard (ENV) was approved by CEN on 1995-09-28 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 existance 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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CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

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

Ref. No. ENV 1992-2:1996 E

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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 Committee 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 action 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 of structures for earthquake resistance
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 2 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/-TC250/SC2 at the following address:

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Burggrafenstrasse 6
D - 10787 Berlin
phone: (+49) 30 - 26 01 - 25 01
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or to your national Standards Organisation.

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 Organisation.

(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 of 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 in ENV 1992-1-1 are complemented by four Appendices. Some of the more detailed Principles / 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. For this Part of Eurocode 2, particular attention is drawn to the Prestandard 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 1992-2, the following additional subclauses apply:

(21) This Part 2 of Eurocode 2 complements ENV 1992-1-1 for the particular aspects of concrete bridges.

(22) The framework and structure of this Part 2 correspond to ENV 1992-1-1. However, Part 2 contains Principles and Application Rules which are specific to concrete bridges.

(23) Where a particular subclause of ENV 1992-1-1 is not mentioned in this ENV 1992-2, that subclause of ENV 1992-1-1 applies as far as deemed appropriate in each case.
Some Principles and Application Rules in ENV 1992-1-1 are modified or replaced in this Part 2, 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 subclause. The subclause 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.

(25) The scope of this Part 2 of Eurocode 2 is defined in 1.1.2 below. Additional Parts of Eurocode 2 and other Standards or Prestandards to which reference is made are also indicated in 1.1.2.

(26) For the application of this Part 2 of Eurocode 2 it is assumed that the relevant authorities or clients:
- define the load model and the characteristic values of the traffic loads according to ENV 1991-3 ;
- define, with regard to the environmental conditions of exposure, the verification criteria for the serviceability limit states; see 4.4.0.3 of this Part 2 for a possible classification.

1 Introduction

1.1 Scope

1.1.2 Scope of Part 2 of Eurocode 2

Replacement of this subclause in ENV 1992-1-1 by:

P(101) Part 2 of Eurocode 2 provides rules for the structural design of concrete bridges, which apply complementary to Parts 1-1, 1-3 and 1-5 of Eurocode 2. Unless stated otherwise in this Part 2, the Principles and Application Rules in these other Parts are applicable to bridges.

P(102) This Part 2 refers to road bridges, footbridges and railway bridges, the structure of which is made of reinforced and/or prestressed normal weight concrete. In addition, this Part 2 can be used for high strength concrete and lightweight aggregate concrete provided that the rules for these materials can be justified.

P(103) This Part 2 does not provide rules specific to other structural forms covered in the other Parts of Eurocode 2. In addition, when considering the effects on the structural design of structural bearings, barriers and other bridge equipment, reference shall be made to other relevant documents or specifications for the particular project (e.g., for road bridges some detailing rules concerning barriers and parapets are given in ENV 1991-3).

P(104) The engineering rules related to wind, earthquake and, if relevant, to other actions, given in Eurocode 1 and Eurocode 8 for bridges are applicable.

(105) When using this Part 2, where relevant, reference should be made to the following European Prestandards:

ENV 1991-1-1	Eurocode 1 Part 1-1	Basis of design
ENV 1991-2-1	Eurocode 1 Part 2-1	Densities, self-weight and imposed loads
ENV 1991-2-4	Eurocode 1 Part 2-4	Wind actions
ENV 1991-2-5	Eurocode 1 Part 2-5	Thermal actions
ENV 1991-3	Eurocode 1 Part 3	Traffic loads on bridges
ENV 1992-1-2	Eurocode 2 Part 1-2	Structural Fire Design
ENV 1992-1-3	Eurocode 2 Part 1-3	Precast concrete structures
ENV 1992-1-4	Eurocode 2 Part 1-4	Lightweight concrete
ENV 1992-1-5	Eurocode 2 Part 1-5	Unbonded and external prestressing tendons
ENV 1992-1-6	Eurocode 2 Part 1-6	Plain concrete
ENV 1992-3	Eurocode 2 Part 3	Concrete foundations
ENV 1997-1	Eurocode 7 Part 1	Geotechnical design
ENV 1998-2	Eurocode 8 Part 2	Earthquake resistance-Part: Bridges

1.2 Distinction between principles and application rules

Paragraphs P(1) to P(6) are replaced by the following :

(101) Depending on the character of the individual clauses, distinction is made in this Eurocode between principles and application rules.

(102) The principles comprise :

- general statements and definitions for which there is no alternative;
- requirements and analytical models for which no alternative is permitted unless specifically stated.

(103) The principles are identified by a letter P preceding the paragraph number in brackets.

(104) The application rules are generally recognised rules which follow the principles and satisfy their requirements. It is permissible to use alternative design rules different from the application rules given in the Eurocode, provided that it is shown that the alternative rules accord with the relevant principles and are at least equivalent with regard to the resistance, serviceability and durability achieved for the structure with the present Eurocode.

(105) In this Part, the application rules are identified by a number in brackets, as in this paragraph.

1.4 Definitions

1.4.1 Terms common for all Eurocodes

Addition after Principle P(3):

P(104) In addition to ISO 8930, the terminology used in ENV 1991-1 and ENV 1991-3 applies.

P(105) The following terms are used in common for all Eurocodes dealing with bridges (in brackets the French and German translations):

bridge (pont, Brücke) : civil engineering construction works mainly intended to carry loads related to communication over a natural obstacle or a communication line. This includes all types of bridges, especially road bridges, footbridges, railway bridges, canal bridges, airplane bridges.

abutment (culée, Widerlager) : any end support of a bridge without rigid continuity with the deck. Rigid abutments and flexible abutments should be distinguished where relevant.

pier (pile, Pfeiler) : intermediate support of a bridge, situated under the deck.

bearing (appareil d'appui, Lager) : structural device located between the deck and an abutment or pier of the bridge and transferring loads of the deck to the abutment or pier and, where relevant, allowing displacements.

cable stay (hauban, Schrägseil) : tensioned element acting as adjustable passive suspender of a cross-linked frame formed by the deck, the pylons and the cable stays.

prestress (précontrainte, Vorspannung) : permanent effect due to controlled forces and/or controlled deformations imposed on a structure. Various types of prestress shall be distinguished from each other as relevant (for example prestress by tendons, prestress by imposed deformation at supports).

headroom (hauteur libre, lichte Höhe) : the free height available for traffic.

P(106) For the terminology used for the verification of fatigue, ENV 1993-1-1 applies.

1.4.2 Special terms used in Part 2 of Eurocode 2

Addition after Principle P(2):

P(103) **coupling joints** : joints at locations where tendons are coupled.

1.6 Symbols common to all Eurocodes

1.6.3 Greek lower case letters

Addition at the end of this subclause:

ψ_1' Infrequent combination value

1.7 Special symbols used in this Part 2 of Eurocode 2

1.7.3 Latin lower case symbols

Addition:

f_{pt} Guaranteed ultimate tensile strength of prestressing steel used for stay cables

2 Basis of design

2.2 Definitions and classifications

2.2.1 Limit states and design situations

2.2.1.1 Limit States

Replacement of Application Rule (4) by:

(104) Ultimate limit states which may require consideration include:

- loss of equilibrium of the structure or any part of it, considered as a rigid body.
- failure by excessive deformation, rupture, or loss of stability of the structure or any part of it, including supports and foundations.
- failure caused by fatigue.

See 4.2, 4.3.

2.2.2 Actions

2.2.2.2 Characteristic values of actions

Addition after Principle P(5):

(106) During execution design values of loads should be calculated allowing for the equipment in use and an additional variable and free load due to persons, equal to |1 kN/m²|, should be taken into account.

2.2.2.3 Representative values of variable actions

Replacement of Principle P(2) by:

P(102) Other representative values are expressed in terms of the characteristic value Q_k by means of a factor ψ_i. These values are defined as

- combination value : $\psi_0 Q_k$
- infrequent value : $\psi_1' Q_k$
- frequent value : $\psi_1 Q_k$
- quasi-permanent value : $\psi_2 Q_k$

Replacement of Principle P(4) by:

P(104) Factors ψ_i applicable to some relevant actions are given in Eurocode 1. Values of factors ψ_i for actions not given in Eurocode 1 shall be selected with due regards to the physical characteristics of the action.

2.2.3 Material properties

2.2.3.1 Characteristic values

Replacement of Application Rule (4) by:

(104) The approach in P(1) applies also to the verification of fatigue.

2.3 Design requirements

2.3.2 Ultimate limit states

2.3.2.2 Combinations of actions

Replacement of this subclause by:

P(101) For road bridges, footbridges and railway bridges, the combinations of actions defined in ENV 1991-3 shall be used. For other types of bridges the combinations shall be specified from relevant documents. For verification of fatigue see 4.3.7.2 of this Part 2.

(102) In general it is not necessary to take climatic temperature effects into account for the ultimate limit states.

P(103) Settlements shall be taken into account if they cause action effects which are significant compared to those from the direct actions.

(104) If settlements are taken into account, appropriate estimate values of predicted settlements should be used.

2.3.3 Partial safety factors for ultimate limit states

2.3.3.1 Partial safety factors for actions on bridge structures

Replacement of this subclause by:

(101) Partial safety factors should be taken from ENV 1991-3.
If not stated otherwise, γ_P = |1,0| should be assumed for the effects of prestress.

(102) For verification of fatigue see 4.3.7.

(103) Where, according to 2.3.2.3 P(3) in ENV 1992-1-1, favourable and unfavourable parts of a permanent action need to be considered as individual actions, the favourable part should be associated with $\gamma_{G,inf}$ = |0,95| and the unfavourable part with $\gamma_{G,sup}$ = |1,05|.

(104) Prestressing. For the evaluation of local effects (anchorage zones, bursting stresses) an effect equivalent to the characteristic breaking load should be applied to the tendons (see 2.5.4 in ENV 1992-1-1).

2.3.3.2 Partial safety factors for materials

Replacement of Application Rule (5) by:

(105) These values apply for fatigue verification.

2.3.4 Serviceability limit states

Replacement of Application Rule (7) by:

(107) The simplified combinations of actions in 2.3.4 (7) of ENV 1992-1-1 do not apply to bridges.

Addition after Principle P(8):

P(109) The combinations of actions for serviceability limit states are defined in ENV 1991-3 and ENV 1992-1-1. For imposed deformations not covered by relevant standards appropriate estimate values shall be used.

2.5 Analysis

2.5.1 General provisions

2.5.1.2 Load cases and combinations

Replacement of Application Rule (4) by:

(104) 2.5.1.2 (4) in ENV 1992-1-1 does not apply to bridges.

2.5.1.3 Imperfections

Replacement of Application Rule (3) by:

(103) In the absence of other provisions, the influence of structural imperfections may be assessed by representing them as an effective geometrical imperfection using a procedure as given in (4) of subclause 2.5.1.3 in ENV 1992-1-1.

Replacement of Application Rules (5) to (8) by:

(105) Application Rules (5) to (8) in 2.5.1.3 of ENV 1992-1-1 do not apply to bridges.

2.5.2 Idealisation of the structure

2.5.2.1 Structural models for overall analysis

Replacement of Application Rule (5) by:

(105) Application Rule (5) in 2.5.2.1 of ENV 1992-1-1 does not apply to bridges.

2.5.2.2 Geometrical data

2.5.2.2.1 Effective width of flanges

Replacement of Application Rules (2) to (5) by:

(102) For analysis, when a great accuracy is not required, a constant width may be assumed over the whole span.

(103) For the analysis of the internal forces and moments, the verification at the ultimate limit state, the verification of the limit state of vibration and the calculation of deformations at the serviceability limit state, the actual flange width may be used.

(104) For the verification of stresses and crack widths at the serviceability limit state, and the verification of fatigue, the effective width for a symmetrical T-beam may be taken as:

$$b_{eff} = b_w + \frac{1}{5} l_0 \leq b \qquad (2.113)$$

and, for an edge beam (i.e. with flange on one side only)

$$b_{eff} = b_w + \frac{1}{10} l_0 \leq b_1 \text{ (or } b_2) \qquad (2.114)$$

(for the notations see Figures 2.102 and 2.103 below).

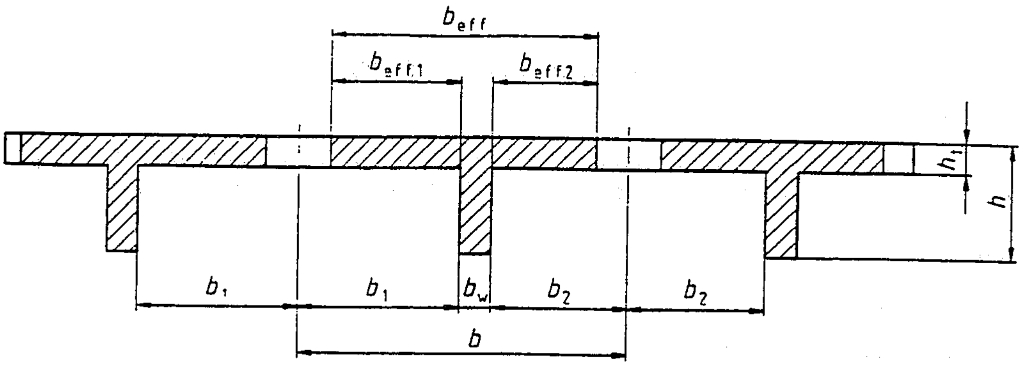
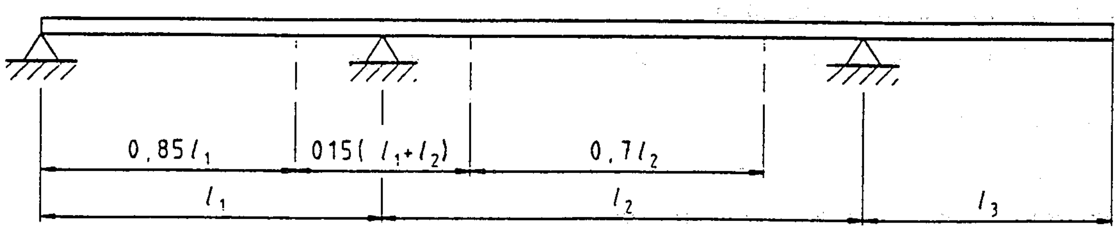


Figure 2.102: Definitions of dimensions of effective width of flanges

(105) The distance ℓ_0 between points of zero moment may be obtained from Figure 2.103 for typical cases.



$\ell_0 = 2\ \ell_3$ for cantilever

Figure 2.103: Approximate effective spans for calculation of effective width ratios

The following conditions should be satisfied:

i) The length of the cantilever should be less than half the adjacent span.
ii) The ratio of adjacent spans should lie between 1 and 1,5.

(106) For the dispersion of prestressing forces in T-beams see 4.2.3.5.3 in ENV 1992-1-1.

2.5.3 Calculation methods

2.5.3.1 Basic considerations

Replacement of Principle P(4) and Application Rule (5) by:

(104) Global analysis for imposed deformations due to temperature and shrinkage effects should be considered for the serviceability limit state, where relevant.

2.5.3.3 Simplifications

Replacement of Application Rules (2) by:

(102) The Application Rules (2), (3), (5) and (6) in ENV 1992-1-1 do not apply to bridges.

2.5.3.5 Analysis of slabs

2.5.3.5.1 Scope

Addition after Application Rule (3):

(104) For concentrated loads on bridge decks the theoretical loaded area used in the analysis should be taken as follows:

- for bending moments: according to chapter 4.3.2 of ENV 1991-3.
- for shear forces:an area limited by the critical perimeter given for punching shear according to 4.3.4.2 in ENV 1992-1-1.

3 Material properties

3.2 Reinforcing steel

3.2.2 Classification and geometry

Addition after Principle P(8):

(109) In general, only high ductile steel B500B according to ENV 10080 should be used for bridges.

4 Section and member design

4.1 Durability requirements

4.1.3 Design

4.1.3.3 Concrete cover

Addition after Application Rule (12):

(113) In general, the minimum concrete cover to a duct should not be less than |50mm|.
In the case of watertight concrete of class C40/50 (see ENV 206, Table 3 and 7.3.1.5) and above or concrete surfaces coated by impermeable adherent films, the minimum concrete cover to pretensioned tendons should not be less than |40mm|.
If tendons are placed under the surface of carriageway slabs or top slabs of footbridges and the surface is directly exposed to de-icing agents, the minimum cover to tendons and ducts should not be less than |80mm|.

(114) The minimum concrete cover to reinforcing steel should not be less than |30mm|.
Where the concrete surface is directly exposed to de-icing agents, saturated salt air, abrasive action by sea water or chemical environment (for example bridges over non-electrified railways) the minimum cover to reinforcing steel should not be less than |50mm|.

(115) In a highly aggressive chemical environment according to Table 4.1, Line 5c, in ENV 1992-1-1 a protective barrier should be provided to prevent direct contact with the aggressive media.