
**Eurocode 3: Projektiranje jeklenih konstrukcij - Del 4-2: Silosi, rezervoarji
in cevovodi – Rezervoarji (prevzet ENV 1993-4-2:1999 z metodo platnice)**

Eurocode 3: Design of steel structures - Part 4 -2: Silos, tanks and pipelines –
Tanks

Eurocode 3: Calcul des structures en acier - Partie 4 -2: Silos, réservoirs et
canalisations – Réservoirs

Eurocode 3: Bemessung und Konstruktion von Stahlbauten - Teil 4 -2: Silos,
Tankbauwerke und Rohrleitungen – Tankbauwerke

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Deskriptorji: jeklene konstrukcije, konstrukcijska jekla, rezervoarji, projektiranje, računanje

ICS 23.020.10; 91.010.30; 91.080.10

Referenčna številka
SIST ENV 1993-4-2:2001 ((sl),en)

Nadaljevanje na straneh od II do V in od 1 do 49

NACIONALNI UVOD

Predstandard SIST ENV 1993-4-2 ((sl),en), Eurocode 3: Projektiranje jeklenih konstrukcij - Del 4-2: Silosi, rezervoarji in cevovodi – Rezervoarji, prva izdaja, 2001, ima status slovenskega predstandarda in je z metodo platnice prevzet evropski predstandard ENV 1993-4-2 (en), Eurocode 3: Design of steel structures - Part 4-2: Silos, tanks and pipelines - Tanks, September 1999.

NACIONALNI PREDGOVOR

Evropski predstandard ENV 1993-4-2:1999 je pripravil tehnični odbor Evropskega komiteja za standardizacijo CEN/TC 250 Konstrukcijski evrokodi.

Pripravo tega predstandarda sta CEN poverila Evropska komisija in Evropsko združenje za prosto trgovino.

Odločitev za prevzem tega predstandarda po metodi platnice je sprejela delovna skupina USM/TC KON/WG 3 Jeklene konstrukcije, ki je pripravila tudi nacionalni dokument za uporabo v Sloveniji, potrdil pa tehnični odbor USM/TC KON Konstrukcije.

Ta slovenski predstandard se lahko uporablja samo v skladu z nacionalnim dokumentom, ki je sestavni del SIST ENV 1993-4-2:2001.

Ta slovenski predstandard je dne 2000-12-04 odobril direktor USM.

Rok veljavnosti tega predstandarda je do izdaje evropskega standarda EN 1993-4-2.

ZVEZE S STANDARDI

S prevzemom tega evropskega predstandarda veljajo za omejeni namen referenčnih standardov vsi standardi, navedeni v izvorniku, razen tistih, ki so že sprejeti kot nacionalni standardi:

SIST ENV 1991-1:1998	((sl),en)	Eurocode 1: Osnove projektiranja in vplivi na konstrukcije - 1. del: Osnove projektiranja
SIST ENV 1991-2-1:1998	((sl),en)	Eurocode 1: Osnove projektiranja in vplivi na konstrukcije - Del 2-1: Vplivi na konstrukcije – Gostote, lastna teža in koristne obtežbe
SIST ENV 1991-2-3:1998	((sl),en)	Eurocode 1: Osnove projektiranja in vplivi na konstrukcije - Del 2-3: Vplivi na konstrukcije - Obtežbe snega
SIST ENV 1991-2-4:1998	((sl),en)	Eurocode 1: Osnove projektiranja in vplivi na konstrukcije - Del 2-4: Vplivi na konstrukcije - Vplivi vetra
SIST ENV 1993-1-1:1996	((sl),en)	Eurocode 3: Projektiranje jeklenih konstrukcij - Del 1-1: Splošna pravila in pravila za stavbe
SIST ENV 1993-1-1:1996/A1:1996	((sl),en)	Projektiranje jeklenih konstrukcij – Del 1-1: Splošna pravila in pravila za stavbe - Dodatka D in K
SIST ENV 1993-1-1:1996/A2:2001	((sl),en)	Projektiranje jeklenih konstrukcij – Del 1-1: Splošna pravila in pravila za stavbe - Dodatki G, H, J, N in Z
SIST ENV 1993-1-2:1999	((sl),en)	Projektiranje jeklenih konstrukcij – Del 1-2: Splošna pravila - Projektiranje požarnovarnih konstrukcij
SIST ENV 1993-1-3:2001	((sl),en)	Projektiranje jeklenih konstrukcij – Del 1-3: Splošna pravila - Dodatna pravila za hladnooblikovane tankostenske profile in pločevine

SIST ENV 1993-1-4:2001	((sl),en)	Projektiranje jeklenih konstrukcij – Del 1-4: Splošna pravila - Dodatna pravila za nerjavna jekla
SIST ENV 1993-1-5:2001	((sl),en)	Projektiranje jeklenih konstrukcij – Del 1-5: Splošna pravila - Dodatna pravila za ravninske pločevinaste konstrukcije (ortotropne plošče) brez prečne obremenitve
SIST ENV 1993-1-6:2001	((sl),en)	Projektiranje jeklenih konstrukcij – Del 1-6: Splošna pravila - Dodatna pravila za lupinaste konstrukcije
SIST ENV 1993-1-7:2001	((sl),en)	Projektiranje jeklenih konstrukcij – Del 1-7: Splošna pravila - Dodatna pravila za ravninske pločevinaste konstrukcije (ortotropne plošče), obremenjene s prečno obtežbo
SIST ENV 1993-2:2001	((sl),en)	Projektiranje jeklenih konstrukcij – 2. del: Jekleni mostovi
SIST ENV 1993-3-1:2001	((sl),en)	Projektiranje jeklenih konstrukcij – Del 3-1: Stolpi, jambori in dimniki - Stolpi in jambori
SIST ENV 1993-3-2:2001	((sl),en)	Projektiranje jeklenih konstrukcij – Del 3-2: Stolpi, jambori in dimniki – Dimniki
SIST ENV 1993-4-1:2001	((sl),en)	Projektiranje jeklenih konstrukcij – Del 4-1: Silosi, rezervoarji in cevovodi – Silosi
SIST ENV 1993-4-3:2001	((sl),en)	Projektiranje jeklenih konstrukcij - Del 4-3: Silosi, rezervoarji in cevovodi - Cevovodi
SIST ENV 1993-5:2001	((sl),en)	Projektiranje jeklenih konstrukcij – 5. del: Piloti in zagatne stene
SIST ENV 1993-6:2001	((sl),en)	Projektiranje jeklenih konstrukcij – 6. del: Žerjavne proge

OPOMBI

- <https://standards.itech.ai/catalog/standards/sist/3299381f-ce36-4d6a-9962-48677928a565/sist-env-1993-4-2-2001>
- Povsod, kjer se v besedilu predstandarda uporablja izraz “evropski predstandard”, v SIST ENV 1993-4-2:2001 to pomeni “slovenski predstandard”.
 - Nacionalni uvod in nacionalni predgovor nista sestavni del predstandarda.

VSEBINA

Stran

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Nacionalni dokument za uporabo v Sloveniji

Za vrednosti parametrov, podanih v okvirju (večinoma delni varnostni faktorji odpornosti ali zunanjih vplivov), se v SIST ENV 1993-4-2:2001 privzamejo priporočene vrednosti, podane v ENV 1993-4-2:1999.

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ICS 23.020.10; 91.010.30; 91.080.10

English version

**Eurocode 3: Design of steel structures - Part 4-2: Silos, tanks
and pipelines - Tanks**

Eurocode 3: Calcul des structures en acier - Partie 4-2:
Silos, réservoirs et canalisations - Réservoirs

Eurocode 3: Bemessung und Konstruktion von Stahlbauten
- Teil 4-2: Silos, Tankbauwerke und Rohrleitungen -
Tankbauwerke

This European Prestandard (ENV) was approved by CEN on 25 December 1998 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.

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

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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 harmonised technical specifications for products and for methods of testing their performance is available, some of the Structural Eurocodes cover some of these aspects in informative annexes.

Background to 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 works 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:
<https://standards.iteh.ai/catalog/standards/sist/3299381f-ce36-4d6a-9962-4607928a565/sist-env-1993-4-2-2001>
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 structures.
- (8) Separate sub-committees have been formed by CEN/TC 250 for the various Eurocodes listed above.
- (9) This Part 4-2 of ENV 1993 is being published by CEN 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 on this Prestandard to be taken into account in determining future actions.
- (12) Meanwhile feedback and comments on this Prestandard should be sent to the Secretariat of Sub-committee CEN/TC 250/SC 3 at the following address:

BSI Standards
British Standards House
389 Chiswick High Road
London W4 4AL
England

or to your national standards organisation.

National Application Documents (NADs)

(13) In view of the responsibilities of the 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 review the "boxed values" and may substitute alternative definitive values for these safety elements for use in national application.

(14) Some of the necessary supporting European or International Standards might not be available by the time this Prestandard is issued. It is therefore anticipated that a National Application Document (NAD) giving any substitute definitive values for safety elements, referencing compatible supporting Standards and providing guidance on the national 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 in which the building or civil engineering work is located.

Matters specific to this Prestandard

(16) The list of parts of ENV 1993 that are currently envisaged is:

- ENV 1993-1-1 General rules and rules for buildings;
- ENV 1993-1-2 Supplementary rules for structural fire design;
- ENV 1993-1-3 Supplementary rules for cold formed thin gauge members and sheeting;
- ENV 1993-1-4 Supplementary rules for stainless steels;
- ENV 1993-1-5 Supplementary rules for the strength and stability of planar plated structures without transverse loads;
- ENV 1993-1-6 Supplementary rules for the strength and stability of shell structures;
- ENV 1993-1-7 Supplementary rules for the strength and stability of planar plated structures with transverse loads;
- ENV 1993-2 Steel bridges;
- ENV 1993-3-1 Towers and masts;
- ENV 1993-3-2 Chimneys;
- ENV 1993-4-1 Silos;
- ENV 1993-4-2 Tanks;
- ENV 1993-4-3 Pipelines;
- ENV 1993-5 Piling;
- ENV 1993-6 Crane supporting structures;
- ENV 1993-7 Marine and maritime structures;
- ENV 1993-8 Agricultural structures.

(17) Safety factors for 'product type' tanks (factory production) can be specified by the appropriate authorities. When applied to 'product type' tanks, the factors in A.3.1 are for guidance purposes only. They are provided to show the likely levels needed to achieve consistent reliability with other designs.

(18) There are parallel standards on tanks in preparation by CEN/TC 265. They reflect current practice within the oil, petrochemical and chemical industry, which is still based on the concept of permissible stresses.

Although the principles of limit states design are being used more and more by the construction industry, experience of their application to steel storage tanks is still limited.

It is envisaged that there will be a move towards greater use of limit states design as more experience is gained and designers become more familiar with the methodology.

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1 General

1.1 Scope

(1)P Part 4.2 of Eurocode 3 provides principles and application rules for the structural design of vertical cylindrical above ground steel tanks for the storage of liquid products with the following characteristics

- a) characteristic internal pressures not less than -100mbar and not more than 500mbar¹⁾;
- b) design metal temperature in the range of -196°C to +300°C;
- c) maximum design liquid level not higher than the top of the cylindrical shell.

(2)P This part is concerned only with the requirements for resistance and stability of steel tanks. All other design requirements are covered by prEN265001 for ambient temperature tanks or by prENV 265002 for cryogenic tanks. These other requirements include fabrication, erection and testing, functional performance, and details like man-holes, flanges, and filling devices.

(3)P Provisions concerning the special requirements of seismic design are provided in ENV 1998-4 (Eurocode 8 Part 4 "Design of structures for earthquake resistance: Silos, tanks and pipelines"), which complements the provisions of Eurocode 3 specifically for this purpose.

(4) The design of supporting structures for tanks are dealt with in ENV 1993-1-1.

(5) Foundations in reinforced concrete for steel tanks are dealt with in ENV 1992 and ENV 1997.

(6) Numerical values of the specific actions on steel tanks to be taken into account in the design are given in ENV 1991-4 "Actions in Silos and Tanks". Additional provisions for tank actions are given in annex A to this Part 4.2 of Eurocode 3.

(7) This Part 4.2 does not cover:
– floating roofs and floating covers;
– resistance to fire (refer to ENV 1993-1-2).

(8) The circular planform tanks covered by this standard are restricted to axisymmetric structures, though they can be subject to unsymmetrical actions, and can be unsymmetrically supported.

1.2 Distinction between principles and application rules

(1)P Depending on the character of the individual paragraphs, a distinction is made in this Part between principles and application rules.

(2)P The principles comprise:

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

(3) The principles are identified by the letter P following the paragraph number.

(4)P The application rules are generally recognised rules that follow the principles and satisfy their requirements. Alternative design rules different from the application rules given in the Eurocode may be used, provided that it is shown that the alternative rule accords with the relevant principles and has at least the same reliability.

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

¹⁾ All pressures are in mbar gauge unless otherwise specified

1.3 Normative references

This European Prestandard incorporates, by dated and undated reference, provisions from other standards. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to, or revisions of, any of these publications apply to the European Prestandard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

- ENV 1090 *Execution of steel structures;*
- ENV 1991 *Eurocode 1: Basis of design and actions on structures;*
Part 1: *Basis of design;*
Part 2.1: *Densities, self weight and imposed loads;*
Part 2.2: *Actions on structures exposed to fire;*
Part 2.3: *Snow loads;*
Part 2.4: *Wind loads;*
Part 2.5: *Thermal loads;*
Part 4: *Actions on silos and tanks;*
- ENV 1993 *Eurocode 3: Design of steel structures;*
Part 1.1: *General rules and rules for buildings;*
Part 1.3: *General rules - supplementary rules for cold formed thin gauge members and sheeting;*
Part 1.6: *General rules - supplementary rules for the strength and stability of shell structures;*
Part 1.7: *General rules - supplementary rules for planar plated structures loaded transversely;*
Part 4.1: *Silos;*
- ENV 1997 *Eurocode 7: Geotechnical design;*
- ENV 1998 *Eurocode 8: Design provisions for earthquake resistance of structures;*
Part 4: *Silos, tanks and pipelines;*
- prEN 265001 *Specification for the design and manufacture of site built, vertical, cylindrical, flat bottomed, above ground, welded, metallic tanks for the storage of liquids at ambient temperatures;*
- prEN 265002 *Specification for the design and manufacture of welded, metallic tanks for the storage of liquids at cryogenic temperatures;*
- ISO 1000 *SI Units;*
- ISO 8930 *General principles on reliability for structures - List of equivalent terms.*

1.4 Definitions

(1) The terms that are defined in ENV 1991-1 for common use in the Structural Eurocodes and the definitions given in ISO 8930 apply to this Part 4.2 of ENV 1993, unless otherwise stated, but for the purposes of this Part 4.2 the following supplementary definitions are given:

1.4.1 shell. A structure formed from a curved thin plate. This term also has a special meaning for tanks: see 1.7.2.

1.4.2 axisymmetric shell. A shell structure whose geometry is defined by rotation of a meridional line about a central axis.

1.4.3 box. A structure formed from an assembly of flat plates into a three-dimensional enclosed form. For the purposes of this standard, the box has dimensions that are generally comparable in all directions.

NOTE: There is no direction that can be compared with the span of a box girder bridge.

1.4.4 meridional direction. The tangent to the tank wall in a vertical plane at any point. It varies according to the structural element being considered. Alternatively, it is the vertical or inclined direction on the surface of the structure that a rain drop would take in sliding down the surface.

1.4.5 circumferential direction. The horizontal tangent to the tank wall at any point. It varies around the tank, lies in the horizontal plane and is tangential to the tank wall irrespective of whether the tank is circular or rectangular in plan.

1.4.6 middle surface. This term is used to refer to both the stress-free middle surface when a shell is in pure bending and the middle plane of a flat plate that forms part of a box.

1.5 S.I. units

(1)P S.I. units shall be used in accordance with ISO 1000.

(2) For calculations, the following consistent units are recommended:

– dimensions and thicknesses	:	m	mm
– unit weight	:	kN/m ³	N/mm ³
– forces and loads	:	kN	N
– line forces and line loads	:	kN/m	N/mm
– pressures and area distributed actions	:	kPa	MPa
– unit mass	:	kg/m ³	kg/mm ³
– acceleration	:	km/s ²	m/s ²
– membrane stress resultants	:	kN/m	N/mm
– bending stress resultants	:	kNm/m	Nmm/mm
– stresses and elastic moduli	:	kPa	MPa (=N/mm ²)

(3) Conversion factors

$$1 \text{ mbar} = 100 \text{ N/m}^2 = 0,1 \text{ kPa}$$

1.6 Symbols used in Part 4.2 of Eurocode 3

1.6.1 Roman upper case letters

<i>A</i>	area of cross-section
<i>A</i> ₁ , <i>A</i> ₂	area of top, bottom flange of roof centre ring
<i>D</i>	diameter of tank
<i>E</i>	Young's modulus
<i>H</i>	height of part of shell wall to liquid surface; maximum design liquid height
<i>H</i> ₀	height of the tank shell
<i>I</i>	second moment of area of cross-section
<i>K</i>	coefficient for buckling design
<i>L</i>	height of shell segment or stiffener
	shear length
<i>M</i>	bending moment in structural member
<i>N</i>	axial force in structural member
<i>P</i>	vertical load on roof rafter
<i>R</i>	radius of curvature of shell which is not cylindrical
<i>T</i>	temperature
<i>W</i>	elastic section modulus; weight