SLOVENSKI STANDARD
oSIST prEN 1993-4-2:2024

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Evrokod 3 - Projektiranje jeklenih konstrukcij - 4-2. del: Rezervoarji

Eurocode 3 - Design of steel structures - Part 4-2: Tanks

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

Eurocode 3 - Calcul des structures en acier - Partie 4-2 : Réservoirs

Ta slovenski standard je istoveten z: **prEN 1993-4-2**

ICS:

23.020.10	Nepremične posode in rezervoarji	Stationary containers and tanks
91.010.30	Tehnični vidiki	Technical aspects
91.080.13	Jeklene konstrukcije	Steel structures

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English Version

Eurocode 3 - Design of steel structures - Part 4-2: Tanks

Eurocode 3 - Calcul des structures en acier - Partie 4-2 : Réservoirs

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

This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 250.

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Recipients of this draft are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

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

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European foreword

This document (prEN 1993-4-2:2024), 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 and has been assigned responsibility for structural and geotechnical design matters by CEN.

This document is currently submitted to the CEN Enquiry.

This document will supersede EN 1993-4-2:2007 and its amendments and corrigenda.

The first generation of EN Eurocodes was published between 2002 and 2007. This document forms part of the second generation of the Eurocodes, which have been prepared under Mandate M/515 issued to CEN by the European Commission and the European Free Trade Association.

The Eurocodes have been drafted to be used in conjunction with relevant execution, material, product and test standards, and to identify requirements for execution, materials, products and testing that are relied upon by the Eurocodes.

The Eurocodes recognize the responsibility of each Member State and have safeguarded their right to determine values related to regulatory safety matters at national level through the use of National Annexes.

0 Introduction

0.1 Introduction to the Eurocodes

The Structural Eurocodes comprise the following standards generally consisting of a number of Parts:

— EN 1990, Eurocode — Basis of structural and geotechnical design

— EN 1991, Eurocode 1 — 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 of structures for earthquake resistance

— EN 1999, Eurocode 9 — Design of aluminium structures

— New parts are under development, e.g. Eurocode for design of structural glass

0.2 Introduction to the EN 1993 series

EN 1993 applies to the design of buildings and civil engineering works in steel. It complies with the principles and requirements for the safety and serviceability of structures, the basis of their design and verification that are given in EN 1990 – Basis of structural and geotechnical design.

EN 1993 is concerned only with requirements for resistance, serviceability, durability and fire resistance of steel structures. Other requirements, e.g. concerning thermal or sound insulation, are not covered.

EN 1993 is subdivided in various parts:

EN 1993-1, *Design of Steel Structures — Part 1: General rules and rules for buildings;*

EN 1993-2, *Design of Steel Structures — Part 2: Bridges;*

EN 1993-3, *Design of Steel Structures — Part 3: Towers, masts and chimneys;*

EN 1993-4, *Design of Steel Structures — Part 4: Silos and tanks;*

EN 1993-5, *Design of Steel Structures — Part 5: Piling;*

EN 1993-6, *Design of Steel Structures — Part 6: Crane supporting structures;*

EN 1993-7, *Design of steel structures — Part 7: Sandwich panels.*

EN 1993-1 in itself does not exist as a physical document, but comprises the following 14 separate parts, the basic part being EN 1993-1-1:

EN 1993-1-1, *Design of Steel Structures — Part 1-1: General rules and rules for buildings;*

EN 1993-1-2, *Design of Steel Structures — Part 1-2: Structural fire design;*

EN 1993-1-3, *Design of Steel Structures — Part 1-3: Cold-formed members and sheeting;*

NOTE Cold formed hollow sections supplied according to EN 10219 are covered in EN 1993-1-1.

EN 1993-1-4, *Design of Steel Structures — Part 1-4: Stainless steel structures;*

EN 1993-1-5, *Design of Steel Structures — Part 1-5: Plated structural elements;*

EN 1993-1-6, *Design of Steel Structures — Part 1-6: Strength and stability of shell structures;*

EN 1993-1-7, *Design of Steel Structures — Part 1-7: Plate assemblies with elements under transverse loads;*

EN 1993-1-8, *Design of Steel Structures — Part 1-8: Joints;*

EN 1993-1-9, *Design of Steel Structures — Part 1-9: Fatigue;*

EN 1993-1-10, *Design of Steel Structures — Part 1-10: Material toughness and through-thickness properties;*

EN 1993-1-11, *Design of Steel Structures — Part 1-11: Tension components;*

EN 1993-1-12, *Design of Steel Structures — Part 1-12: Additional rules for steel grades up to S960;*

EN 1993-1-13, *Design of Steel Structures — Part 1-13: Beams with large web openings;*

EN 1993-1-14, *Design of Steel Structures — Part 1-14: Design assisted by finite element analysis.*

All subsequent parts EN 1993-1-2 to EN 1993-1-14 treat general topics that are independent from the structural type such as structural fire design, cold-formed members and sheeting, stainless steels, plated structural elements, etc.

All subsequent parts numbered EN 1993-2 to EN 1993-7 treat topics relevant for a specific structural type such as steel bridges, towers, masts and chimneys, silos and tanks, piling, crane supporting structures, etc. EN 1993-2 to EN 1993-7 refer to the generic rules in EN 1993-1 and supplement, modify or supersede them.

0.3 Introduction to EN 1993-4-2

EN 1993-4-2 gives design requirements for the structural design of tanks for the storage of liquid and liquified gas products. It gives design rules that supplement the generic rules in the many parts of EN 1993-1. This document is intended for clients, designers, contractors and relevant authorities.

0.4 Verbal forms used in the Eurocodes

The verb “shall” expresses a requirement strictly to be followed and from which no deviation is permitted in order to comply with the Eurocodes.

The verb “should” expresses a highly recommended choice or course of action. Subject to national regulation and/or any relevant contractual provisions, alternative approaches could be used/adopted where technically justified.

The verb “may” expresses a course of action permissible within the limits of the Eurocodes.

The verb “can” expresses possibility and capability; it is used for statements of fact and clarification of concepts.

0.5 National Annex for EN 1993-4-2

National choice is allowed in this standard where explicitly stated within notes. National choice includes the selection of values for Nationally Determined Parameters (NDPs).

The national standard implementing EN 1993-4-2 can have a National Annex containing all national choices to be used for the design of buildings and civil engineering works to be constructed in the relevant country.

When no national choice is given, the default choice given in this standard is to be used.

When no national choice is made and no default is given in this standard, the choice can be specified by a relevant authority or, where not specified, agreed for a specific project by appropriate parties.

National choice is allowed in EN 1993-4-2 through notes to the following clauses:

4.3.2(3)	4.3.3(2)	4.4.1(3)	4.4.2(4)
4.4.3(2)	4.11(4)	7.1.3(1)	8.4.7(1)
10.2(1)	10.2(9)	10.3(2)	

National choice is allowed in EN 1993-4-2 on the application of the following informative annexes:

None

The National Annex can contain, directly or by reference, non-contradictory complementary information for ease of implementation, provided it does not alter any provisions of the Eurocodes.

1 Scope

1.1 Scope of EN 1993-4-2

(1) EN 1993-4-2 provides rules for structural design of vertical cylindrical, conical and pedestal above-ground steel tanks for the storage of liquid and liquified gas products.

(2) EN 1993-4-2 is applicable to the design for resistance of cylindrical walls and flat bottoms constructed using unstiffened plates. The design of conical and dome roofs as shell structures (unsupported) or as supported on a structural framework (supported) are also covered.

(3) EN 1993-4-2 is only applicable to the requirements for resistance and structural stability of steel tanks.

(4) EN 1993-4-2 only covers steel tank structures in Tank Groups 1, 2 and 3, as defined in this document.

NOTE Tank Group 4 is not defined in this standard (see 3.1.41).

(5) This document is applicable to tanks within the following dimensional limits (see EN 1991-4):

Tank aspect ratio $h_S/d < 10$

Tank total height $h_S < 70$ m

Tank diameter $d < 100$ m

(6) This standard includes suitable rules for the design of tanks intended to store solids suspended in a liquid, where the appropriate global density of the mixture is used.

NOTE Tanks used for the separation of mineral particles of different density fall into this category.

(7) EN 1993-4-2 does not apply to the following:

a) tanks with gross capacity less than 5 m³ (5 000 l);

b) dished-end tanks that have a diameter less than 5 m;

c) tanks with characteristic internal pressures above the liquid surface greater than 50 kPa (500 mbar)[1] (see pressure equipment directive);

d) design metal temperatures outside the ranges defined in Clause 5, with −50 °C being the lowest temperature for the application of this document;

e) tanks of rectangular and other non-circular planforms;

f) tanks exposed to fire;

g) floating roofs and floating covers;

h) ancillary structures such as stairways, platforms, nozzles, piping and access doors.

(8) This document does not cover

a) the special requirements for seismic design of tanks,

[1] All pressures are in bar gauge unless otherwise specified.

b) the design of a supporting structure,

c) the design of ancillary structures such as stairways, platforms, pipe racks and ladders,

d) the design of an aluminium roof structure on a steel tank,

e) reinforced concrete foundations for steel tanks,

f) the design of a conical hopper,

g) the design of a transition junction between the base of a cylindrical shell wall and a conical hopper,

h) the design of a supporting ring girder in an elevated tank.

1.2 Assumptions

(1) Unless specifically stated, EN 1990, the EN 1991 series and the EN 1993-1 series apply.

(2) The design methods given in this document apply if:

— the execution quality is as specified in EN 1090-2, and

— the construction materials and products used are as specified in the relevant parts of the EN 1993 series, or in the relevant material and product specifications.

(3) This standard applies to axisymmetric structures, but includes the effects of unsymmetrical actions (e.g. wind), and unsymmetrically supported tanks (e.g. on discrete supports).

(4) EN 1993-4-2 is intended to be used in conjunction with EN 1990, with EN 1991-4, with the other Parts of EN 1991, with EN 1993-1-6 and EN 1993-4-1, with the other Parts of EN 1993, with EN 1992 and with the other Parts of EN 1994 to EN 1999 relevant to the design of tanks. Matters that are already covered in those documents are not repeated.

(5) 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 quality management applies.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 1090-2, *Execution of steel structures and aluminium structures — Part 2: Technical requirements for steel structures*

EN 1990:2023,[2] *Eurocode — Basis of structural and geotechnical design*

EN 1991 (all parts), *Eurocode 1 — Actions on structures*

EN 1993 (all parts), *Eurocode 3 — Design of steel structures*

[2] As impacted by EN 1990:2023/prA1:2024

3 Terms, definitions, symbols, sign conventions and units

3.1 Terms and definitions

For the purposes of this document, the terms and definitions from EN 1990, ISO 8930 and the following apply.

3.1.1
axial direction
x
vertical direction on the shell wall

Note 1 to entry: For a cylindrical wall, the axial and meridional directions are identical.

3.1.2
axisymmetric shell
shell structure whose geometry is defined by rotation of a meridional line about a central axis

3.1.3
base ring or annular plate
structural member that passes around the circumference of the structure beneath the cylindrical shell wall and is required to ensure that the assumed boundary conditions are achieved in practice

3.1.4
catch basin
external tank structure to contain liquid that could escape by leakage or accident from the primary tank

Note 1 to entry: This type of structure is usually used where the primary tank contains toxic or hazardous liquids. A catch basin also effectively reduces the requirement for an extensive area of liquid containment around the tank.

3.1.5
circumferential direction
θ
horizontal tangent to the shell wall at any point

Note 1 to entry: It varies around the tank, lies in the horizontal plane and is tangential to the shell wall.

3.1.6
continuously supported tank
tank in which all positions around the circumference are supported in an identical manner

Note 1 to entry: Minor departures from this condition (e.g. a small opening) need not affect the applicability of the definition.

3.1.7
course
section of the height of a cylindrical wall constructed from a single plate thickness or between ring stiffeners, usually made up of several strakes (see 3.1.39)

Note 1 to entry: The cylindrical shell wall of the tank is formed by making horizontal joints between a series of short cylindrical sections, termed strakes, each formed by making vertical joints between individual curved plates.

3.1.8
curb angle
light ring attached to the top of the cylindrical shell wall of a tank

3.1.9
discrete support
situation in which a tank is supported using a local bracket or column, giving a limited number of narrow supports around the tank circumference

3.1.10
eaves junction
joint between a cylindrical wall and a roof structure

Note 1 to entry: See also curb angle and primary ring.

3.1.11
externally stiffened wall
tank wall with stiffeners attached to the outside of the tank wall

3.1.12
fixed shell roof
roof structure that is attached to the top of the cylindrical wall

Note 1 to entry: This term includes both roofs supported on rafters or a structural frame and an unstiffened shell roof (sometimes referred to as unsupported).

3.1.13
floating roof
roof structure that floats on the surface of the stored liquid, sliding up and down within the tank as the liquid level varies

3.1.14
gas/vapour pressure
pressure in the space above the surface of the stored liquid

3.1.15
ground supported tank
tank where the shell structure is uniformly supported on a horizontal foundation supported directly by the ground

3.1.16
hopper
converging section towards the bottom of a tank

Note 1 to entry: It is used to channel liquids towards a gravity discharge outlet (usually when they contain suspended solids).

3.1.17
horizontally corrugated wall
shell wall constructed from corrugated steel sheets where the troughs pass around the circumference of the tank

3.1.18
internally stiffened wall
tank wall with stiffeners attached to the inside of the tank wall