SLOVENSKI STANDARD
oSIST prEN 1993-1-2:2022

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Evrokod 3: Projektiranje jeklenih konstrukcij - 1-2. del: Splošna pravila - Požarnoodporno projektiranje

Eurocode 3: Design of steel structures - Part 1-2: General rules - Structural fire design

Eurocode 3: Bemessung und Konstruktion von Stahlbauten - Teil 1-2: Allgemeine Regeln - Tragwerksbemessung für den Brandfall

Eurocode 3 - Calcul des structures en acier - Partie 1-2 : Règles générales - Calcul du comportement au feu

Ta slovenski standard je istoveten z: prEN 1993-1-2

ICS:

13.220.50	Požarna odpornost gradbenih materialov in elementov	Fire-resistance of building materials and elements
91.010.30	Tehnični vidiki	Technical aspects
91.080.13	Jeklene konstrukcije	Steel structures

oSIST prEN 1993-1-2:2022 **en,fr,de**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

DRAFT
prEN 1993-1-2

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ICS 13.220.50; 91.010.30; 91.080.13

Will supersede EN 1993-1-2:2005

English Version

Eurocode 3: Design of steel structures - Part 1-2: General rules - Structural fire design

Eurocode 3 - Calcul des structures en acier - Partie 1-2 : Règles générales - Calcul du comportement au feu

Eurocode 3: Bemessung und Konstruktion von Stahlbauten - Teil 1-2: Allgemeine Regeln - Tragwerksbemessung für den Brandfall

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

If this draft becomes a European Standard, CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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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 1993-1-2:2022) 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 1993-1-2:2005 and its 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.

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 EN 1993 (all parts)

EN 1993 (all parts) 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 design.

EN 1993 (all parts) 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: Steel 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: Design of 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 steels;*

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: Strength and stability of planar plated structures transversely loaded;*

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

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

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

EN 1993-1-11, *Design of Steel Structures — Part 1-11: Design of structures with tension components made of steel;*

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 like 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 like 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, where relevant.

0.3 Introduction to prEN 1993-1-2

prEN 1993-1-2 describes the principles, requirements and rules for the structural design of steel buildings exposed to fire. The focus in prEN 1993-1-2 is on design methods and design rules for individual members (beams, columns, beam-columns), joints and skeletal structures (frames) regarding resistance and stability under fire conditions.

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 prEN 1993-1-2

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 prEN 1993-1-2 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 1993-1-2 through notes to the following clauses:

4.5 (1) 7.5 (2) – 2 choices

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 prEN 1993-1-2

(1) This document provides rules for the design of steel structures for the accidental situation of fire exposure. This Part of EN 1993 only identifies differences from, or supplements to, normal temperature design.

(2) This document applies to steel structures required to fulfil a loadbearing function.

(3) This document does not include rules for separating function.

(4) This document gives principles and application rules for the design of structures for specified requirements in respect of the aforementioned function and the levels of performance.

(5) This document applies to structures, or parts of structures, that are within the scope of EN 1993-1-1 and are designed accordingly.

(6) This document is intended to be used in conjunction with EN 1991-1-2, EN 1993-1-1, EN 1993-1-3, EN 1993-1-4, EN 1993-1-5, EN 1993-1-6, EN 1993-1-7, EN 1993-1-8, EN 1993-1-11, EN 1993-1-13 or EN 1993-1-14.

1.2 Assumptions

(1) Unless specifically stated, EN 1990, EN 1991(all parts) and EN 1993-1-1 apply.

(2) The design methods given in prEN 1993-1-2 are applicable if

— the execution quality is as specified in EN 1090-2 and/or EN 1090-4, and

— the construction materials and products used are as specified in prEN 1993-1-1:2020, Table 5.1 and Table 5.2 and in prEN 1993-1-3:2022, Table 5.1 and Table 5.2, or in the relevant material and product specifications.

(3) In addition to the general assumptions of EN 1990 the following assumptions apply:

— the choice of the relevant design fire scenario is made by appropriate qualified and experienced personnel, or is given by the relevant national regulation;

— any fire protection measure taken into account in the design will be adequately maintained.

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.

NOTE See the Bibliography for a list of other documents cited that are not normative references, including those referenced as recommendations (i.e. through 'should' clauses) and permissions (i.e. through 'may' clauses).

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

EN 1090-4, *Execution of steel structures and aluminium structures - Part 4: Technical requirements for cold-formed structural steel elements and cold-formed structures for roof, ceiling, floor and wall applications*

prEN 1990:2020, *Eurocode - Basis of structural and geotechnical design*

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

prEN 1991-1-2:2021, *Eurocode 1 - Actions on structures - Part 1-2: Actions on structures exposed to fire,*

prEN 1993-1-1:2020, *Eurocode 3 -Design of steel structures - Part 1-1: General rules: General rules and rules for buildings*

prEN 1993-1-3:2022, *Eurocode 3 - Design of steel structures - Part 1-3: General rules: Supplementary rules for cold formed steel members and sheeting*

EN 1993-1-4, *Eurocode 3 - Design of steel structures - Part 1-3: General rules: Supplementary rules for stainless steels*

prEN 1993-1-5:2022, *Eurocode 3 - Design of steel structures - Part 1-5: Plated structural elements*

EN 1993-1-6, *Eurocode 3 - Design of steel structures - Part 1-6: Strength and Stability of Shell Structures*

EN 1993-1-7, *Eurocode 3 - Design of steel structures - Part 1-7: Plate assemblies with elements under transverse loads*

prEN 1993-1-8:2021, *Eurocode 3 - Design of steel structures - Part 1-8: General rules: Design of joints*

EN 1993-1-11, *Eurocode 3 - Design of steel structures - Part 1-11: Design of structures with tension components*

EN 1993-1-13:2022, *Eurocode 3 - Design of steel structures - Part 1-13: Beams with web openings*

EN 1993-1-14, *Eurocode 3 - Design of steel structures - Part 1-14: Design assisted by finite element analysis*

3 Terms, definitions and symbols

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 1990, EN 1991-1-2 and the following apply.

3.1.1

box value of section factor

ratio between the exposed surface area of a notional bounding box to the section and the volume of steel

3.1.2

critical temperature of structural steel element

temperature for a given load level, at which failure is expected to occur in a structural steel element assuming a uniform temperature distribution

3.1.3

effective yield strength

stress level for a given temperature, at which the stress-strain relationship of steel is truncated to provide a yield plateau

3.1.4

fire protection material

any material or combination of materials applied to a structural member for the purpose of increasing its fire resistance

3.1.5

part of structure

isolated part of a structure with appropriate support and boundary conditions

3.1.6

section factor

ratio between the exposed surface area and the volume of steel for a steel member, or ratio between the internal surface area of the exposed encasement and the volume of steel for an enclosed member

3.2 Symbols

For the purposes of this document, the following symbols apply.

3.2.1 Latin upper case letters

A_i an elemental area of the cross-section with a temperature θ_i;

A_m surface area exposed to fire of a member per unit length [m²/m];

A_m/V section factor of unprotected steel members [m⁻¹];

A_p appropriate area of fire protection material per unit length of the member [m²/m];

A_p/V section factor for steel members insulated by fire protection material [m⁻¹];

C_i protection coefficient of member face i;

E_a modulus of elasticity of steel for normal temperature design;

$E_{a,\theta}$ slope of the linear elastic range for steel at elevated temperature θ_a;

E_d design effect of actions at normal temperature, determined in accordance with EN 1991-1-1;

$E_{fi,d}$ design effect of actions for the fire situation, determined in accordance with prEN 1991-1-2, including the effects of thermal expansions and deformations;

$E_{p0,2,\theta}$ tangent modulus at $f_{p0,2,\theta}$;

$F_{b,Rd}$ design bearing resistance per bolt according to EN 1993-1-8;

$F_{b,fi,t,Rd}$ design bearing resistance per bolt in the fire situation at time t;

$F_{v,Rd}$ design shear resistance per bolt per shear plane calculated assuming that the shear plane passes through the threads of the bolt according to EN 1993-1-8;

$F_{v,fi,t,Rd}$ design shear resistance per bolt per shear plane in the fire situation at time t;

$F_{w,Rd}$ design resistance per unit length of a fillet weld according to EN 1993-1-8;

$F_{w,fi,t,Rd}$ design resistance per unit length of a fillet weld in the fire situation at time t;

I_f radiative heat flux from an opening;

I_z radiative heat flux from a flame;

$I_{z,i}$ radiative heat flux from a flame to a column face i;

L system length of a column in the relevant storey;

L_i length along axis between the opening and the relevant point;

M number of openings on side m;

$M_{b,fi,t,Rd}$ design buckling resistance moment in the fire situation at time t;

$M_{c,Rd}$ plastic moment resistance of the gross cross-section $M_{pl,Rd}$ for normal temperature design; the elastic moment resistance of the gross cross-section $M_{el,Rd}$ for normal temperature design;

M_{cr} elastic critical moment for lateral torsional buckling based on the gross cross-sectional properties, taking into account loading conditions, actual moment distribution and lateral restraints;

$M_{fi,t,Rd}$ design moment resistance in the fire situation at time t;

$M_{fi,\theta,Rd}$ design moment resistance of the cross-section for a uniform temperature θ_a;

N number of openings on side n;

$N_{b,fi,t,Rd}$ design buckling resistance in the fire situation at time t of a compression member;

N_{cr} elastic critical axial force for the relevant buckling mode based on the gross cross-sectional properties, using the buckling length under fire conditions;

$N_{fi,t,Rd}$ design resistance in the fire situation at time t of a tension member with a non-uniform temperature distribution across the cross-section;

$N_{fi,\theta,Rd}$ design resistance of a tension member with a uniform temperature θ_a;

$N_{t,Rd}$ design tension resistance of the cross-section $N_{pl,Rd}$ for normal temperature design, according to EN 1993-1-1;

$R_{fi,d,t}$ design resistance in the fire situation at time t;

$R_{fi,d,0}$ value of $R_{fi,d,t}$ for time $t = 0$;

T_f temperature of fire [K];

T_m temperature of the steel member [K];

T_o flame temperature at the opening [K];

T_x flame temperature at the flame tip [813 K];

T_z flame temperature [K];

$T_{z,1}$ flame temperature [K] from Annex B of prEN 1991-1-2:2021, level with the bottom of a beam;

$T_{z,2}$ flame temperature [K] from Annex B of prEN 1991-1-2:2021, level with the top of a beam;

V volume of a member per unit length;

$V_{c,Rd}$ design value of the resistance to shear force for normal temperature design, according to EN 1993-1-1;

$V_{fi,t,Rd}$ design shear resistance in the fire situation at time t;

X_k characteristic value of a strength or deformation property (generally f_k or E_k) for normal temperature design to EN 1993-1-1).

3.2.2 Latin lower case letters

a_z absorptivity of flames;

c_a specific heat of steel;

c_p specific heat of the fire protection material;

d effective cross-sectional dimension;

d_i cross-sectional dimension of member face i;

d_p thickness of fire protection material;

d_f thickness of the fire protection material. ($d_f = 0$ for unprotected members.);

f modification factor for $\chi_{LT,fi}$;

$f_{p,\theta}$ proportional limit for steel at elevated temperature θ_a;

$f_{u,\theta}$ ultimate strength at elevated temperature, allowing for strain-hardening;

f_y yield strength at 20 °C;

$f_{y,\theta}$ effective yield strength of steel at elevated temperature θ_a;

$f_{y,i}$ nominal yield strength f_y for the elemental area A_i taken as positive on the compression side of the plastic neutral axis and negative on the tension side;

h_{eq} equivalent height of the opening;

$\dot{h}_{net,d}$ design value of the net heat flux per unit area;

h_z height of the top of the flame above the bottom of the beam;

i column face indicator (1), (2), (3) or (4);

$k_{b,\theta}$ reduction factor determined for the appropriate bolt temperature;

k_c correction factor for moment distribution;

$k_{E,\theta}$ reduction factor for the slope of the linear elastic range at the steel temperature θ_a reached at time t;

$k_{E,\theta,com}$ reduction factor for the slope of the linear elastic range at the maximum steel temperature in the compression flange $\theta_{a,com}$ reached at time t;

$k_{p0,2,\theta}$ reduction factor for the 0,2% proof strength at the steel temperature θ_a reached at time t;

k_{sh} correction factor for the shadow effect;

$k_{u,\theta}$ reduction factor for the ultimate strength at the steel temperature θ_a reached at time t;

k_θ relative value of a strength or deformation property of steel at elevated temperature θ_a;

$k_{w,\theta}$ strength reduction factor for welds at elevated temperature;

$k_{y,\theta}$ reduction factor for the yield strength at the steel temperature θ_a reached at time t;

$k_{y,\theta,com}$ reduction factor for the yield strength of steel at the maximum temperature in the compression flange $\theta_{a,com}$ reached at time t;

$k_{y,\theta,i}$ reduction factor for the yield strength of steel at temperature θ_i;

$k_{y,\theta,max}$ reduction factor for the yield strength of steel at the maximum steel temperature $\theta_{a,max}$ reached at time t;

$k_{y,\theta,web}$ reduction factor for the yield strength of steel at the steel temperature θ_{web};

k_y interaction factor for buckling about y-y axis;

k_z interaction factor for buckling about z-z axis;

k_{LT} interaction factor for lateral torsional buckling;

l length at 20 °C ; a distance from an opening, measured along the flame axis;

l_{fi} buckling length of a column for the fire design situation;

s horizontal distance from the centreline of a column to a wall of a fire compartment;

t time in fire exposure;

w_i width of an opening;

z_i distance from the plastic neutral axis to the centroid of the elemental area A_i.

3.2.3 Greek upper case letters

Δt time interval;

Δl temperature induced expansion;

$\Delta\theta_{a,t}$ increase of the steel uniform temperature distribution in a cross-section during the time interval Δt;

$\Delta\theta_{g,t}$ increase of the ambient gas temperature during the time interval Δt.

3.2.4 Greek lower case letters

α imperfection factor for flexural buckling;

α_c convective heat transfer coefficient;

α_{LT} imperfection factor for lateral-torsional buckling;

β_M equivalent uniform moment factors;

γ_{M0} partial factor for resistance of cross-sections at normal temperature;

γ_{M2} partial factor at normal temperature;

$\gamma_{M,fi}$ partial factor for the relevant material property, for the fire situation;

ε material parameter depending on f_y, at normal temperature;

ε_f emissivity of a flame; the emissivity of an opening;

ε_{fi} material parameter depending on f_y, for the fire situation;

ε_m surface emissivity of the member;

ε_z emissivity of a flame;

$\varepsilon_{z,m}$ total emissivity of the flames on side m;

$\varepsilon_{z,n}$ total emissivity of the flames on side n;

ε_θ strain at the steel temperature θ_a;

η_{fi} reduction factor applied to E_d in order to obtain $E_{fi,d}$;

θ temperature;

θ_a steel temperature [°C];

$\theta_{a,cr}$ critical temperature of steel;

$\theta_{g,t}$ ambient gas temperature at time t;

θ_{web} average temperature in the web of the section;

θ_i temperature in elemental area A_i;

κ_1 adaptation factor for non-uniform temperature across the cross-section;

κ_2 adaptation factor for non-uniform temperature along the beam;

λ thermal conductivity;

λ_i flame thickness for an opening i;

$\overline{\lambda}$ relative slenderness for flexural buckling;

$\overline{\lambda}_\theta$ relative slenderness for flexural buckling at the steel temperature θ_a;