

# **SLOVENSKI STANDARD**

## **SIST EN 1999-1-2:2023**

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**Nadomešča:**

**SIST EN 1999-1-2:2007**

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### **Evrokod 9 - Projektiranje konstrukcij iz aluminijevih zlitin - 1-2. del: Projektiranje požarnovarnih konstrukcij**

Eurocode 9 - Design of aluminium structures - Part 1-2: Structural fire design

Eurocode 9 - Bemessung und Konstruktion von Aluminiumtragwerken - Teil 1 2: Tragwerksbemessung für den Brandfall

Eurocode 9 - Calcul des structures en aluminium - Partie 1-2: Calcul du comportement au feu

**Ta slovenski standard je istoveten z: EN 1999-1-2:2023**

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91.010.30	Tehnični vidiki	Technical aspects
91.080.17	Aluminijaste konstrukcije	Aluminium structures

**SIST EN 1999-1-2:2023**

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EUROPEAN STANDARD  
NORME EUROPÉENNE  
EUROPÄISCHE NORM

**EN 1999-1-2**

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English Version

**Eurocode 9 - Design of aluminium structures - Part 1-2:  
Structural fire design**

Eurocode 9 - Calcul des structures en aluminium -  
Partie 1-2: Calcul du comportement au feu

Eurocode 9 - Bemessung und Konstruktion von  
Aluminiumtragwerken - Teil 1 2:  
Tragwerksbemessung für den Brandfall

This European Standard was approved by CEN on 2 January 2023.

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. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

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

**CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels**

## Contents

## Page

European foreword.....	4
Introduction .....	5
1 Scope.....	7
1.1 Scope of EN 1999-1-2 .....	7
1.2 Assumptions.....	7
2 Normative references.....	8
3 Terms, definitions and symbols.....	8
3.1 Terms and definitions .....	8
3.2 Symbols and abbreviations .....	9
4 Basis of design.....	13
4.1 General.....	13
4.2 Nominal fire exposure .....	13
4.3 Physically based fire exposure.....	13
4.4 Actions.....	14
4.5 Design values of material properties.....	14
4.6 Verification methods .....	14
4.7 Member analysis .....	15
4.8 Analysis of part of the structure .....	15
4.9 Global structural analysis .....	15
5 Material properties .....	16
5.1 General.....	16
5.2 Thermal properties.....	16
5.2.1 Aluminium alloys .....	16
5.2.2 Fire protection materials .....	18
5.3 Mechanical properties of aluminium alloys.....	18
5.3.1 Strength and deformation properties .....	18
5.3.2 Unit mass.....	21
6 Tabulated design data .....	21
7 Simplified design methods .....	22
7.1 General.....	22
7.2 Resistance .....	23
7.2.1 Classification of cross-sections .....	23
7.2.2 Tension members .....	23
7.2.3 Beams .....	23
7.2.4 Columns .....	25
7.3 Aluminium temperature development.....	26
7.3.1 Unprotected interior aluminium members.....	26
7.3.2 Interior aluminium structures insulated by fire protection material.....	29
7.3.3 Interior aluminium structures in a void that is protected by heat screens.....	30
7.3.4 Exterior aluminium structures .....	31
8 Advanced design methods .....	31
8.1 General.....	31

8.2	Thermal analysis .....	32
8.3	Mechanical analysis .....	32
8.4	Validation of advanced design methods.....	33
<b>Annex A (informative) Properties of aluminium alloys and/or tempers not listed in</b>		
	EN 1999-1-1 .....	34
A.1	Use of this Informative annex .....	34
A.2	Scope and field of application .....	34
<b>Annex B (informative) Heat transfer to external structural aluminium members .....</b>		
B.1	Use of this Informative Annex.....	35
B.2	Scope and field of application .....	35
B.3	General rules .....	35
B.3.1	Basis.....	35
B.3.2	Conventions for dimensions .....	35
B.3.3	Heat balance .....	35
B.3.4	Overall configuration factors .....	38
B.4	Column not engulfed in flame .....	38
B.4.1	Radiative heat transfer.....	38
B.4.2	Flame emissivity .....	43
B.4.3	Flame temperature .....	44
B.4.4	Flame absorptivity .....	44
B.5	Beam not engulfed in flame .....	44
B.5.1	Radiative heat transfer.....	44
B.5.2	Flame emissivity .....	46
B.5.3	Flame temperature .....	47
B.5.4	Flame absorptivity .....	48
B.6	Column engulfed in flame.....	48
B.7	Beam fully or partially engulfed in flame .....	50
B.7.1	Radiative heat transfer.....	50
B.7.2	Flame emissivity .....	54
B.7.3	Flame absorptivity .....	54
	<b>Bibliography .....</b>	<b>55</b>

**EN 1999-1-2:2023 (E)****European foreword**

This document (EN 1999-1-2:2023) has been prepared by Technical Committee CEN/TC250 “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 European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by September 2027, and conflicting national standards shall be withdrawn at the latest by March 2028.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 1999-1-2:2007.

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.

The main changes compared to the previous edition are listed below:

- Some reorganization of the text and its coherence with other Eurocodes;
- Improvement of figures;
- Update of symbols, alignment across the Eurocodes;
- Improved clarity and consistency.

Any feedback and questions on this document should be directed to the users’ national standards body. A complete listing of these bodies can be found on the CEN website.

According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye and the United Kingdom.

## 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

The Eurocodes are intended for use by designers, clients, manufacturers, constructors, relevant authorities (in exercising their duties in accordance with national or international regulations), educators, software developers, and committees drafting standards for related product, testing and execution standards.

NOTE Some aspects of design are most appropriately specified by relevant authorities or, where not specified, can be agreed on a project-specific basis between relevant parties such as designers and clients. The Eurocodes identify such aspects making explicit reference to relevant authorities and relevant parties.

### 0.2 Introduction to EN 1999 (all parts)

EN 1999 (all parts) applies to the design of buildings and civil engineering and structural works made of aluminium. 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 1999 (all parts) is only concerned with requirements for resistance, serviceability, durability and fire resistance of aluminium structures. Other requirements, e.g. concerning thermal or sound insulation, are not considered.

EN 1999 (all parts) does not cover the special requirements of seismic design. Provisions related to such requirements are given in EN 1998, which complements, and is consistent with EN 1999.

Eurocode 9 is subdivided various parts:

- EN 1999-1-1 Design of Aluminium Structures — Part 1-1: General rules.
- EN 1999-1-2 Design of Aluminium Structures — Part 1-2: Structural fire design.
- EN 1999-1-3 Design of Aluminium Structures — Part 1-3: Structures susceptible to fatigue.

**EN 1999-1-2:2023 (E)**

- EN 1999-1-4 Design of Aluminium Structures — Part 1-4: Cold-formed structural sheeting.
- EN 1999-1-5 Design of Aluminium Structures — Part 1-5: Shell structures.

**0.3 Introduction to EN 1999-1-2**

This document describes the principles, requirements and rules for the structural design of aluminium buildings exposed to fire. The focus in EN 1999-1-2 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 EN 1999-1-2**

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 EN 1999-1-2 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 1999-1-2 through the following clauses:

4.5(1)	7.2.1(1)	7.2.3(5)	7.2.4(4)
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National choice is allowed in EN 1999-1-2 on the application of the following informative annexes:

Annex A	Annex B
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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 1999-1-2

(1) This document deals with the design of aluminium structures for the accidental situation of fire exposure and is intended to be used in conjunction with EN 1999-1-1, EN 1999-1-3, EN 1999-1-4 and EN 1999-1-5. This document only identifies differences from, or supplements to, normal temperature design.

(2) This document applies to aluminium structures required to fulfil a load bearing function.

(3) 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.

(4) This document applies to structures, or parts of structures, that are within the scope of EN 1999-1-1 and are designed accordingly.

(5) The methods given in this document are applicable to the following aluminium alloys:

EN AW-3004 – H34	EN AW-5083 – O and H12	EN AW-6063 – T5 and T6
EN AW-5005 – O and H34	EN AW-5454 – O and H34	EN AW-6082 – T4 and T6
EN AW-5052 – H34	EN AW-6061 – T6	

(6) The methods given in this document are applicable also to other aluminium alloy/tempers of EN 1999-1-1, provided that either all necessary information on properties at elevated temperatures are available or the simplified assumptions in 5.2.1 are applied.

## 1.2 Assumptions

(1) 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 active and passive fire protection systems taken into account in the design will be adequately maintained.

(2) For the design of new structures, EN 1999 is intended to be used, for direct application, together with EN 1990, EN 1991, EN 1992, EN 1993, EN 1994, EN 1995, EN 1997 and EN 1998.

(3) EN 1999 is intended to be used in conjunction with:

- European Standards for construction products relevant for aluminium structures
- EN 1090-1, *Execution of steel structures and aluminium structures - Part 1: Requirements for conformity assessment of structural components*
- EN 1090-3, *Execution of steel structures and aluminium structures - Part 3: Technical requirements for aluminium structures*

## EN 1999-1-2:2023 (E)

## 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 1990, *Eurocode - Basis of structural design*

prEN 1991-1-2:2021,<sup>1</sup> *Eurocode 1 — Actions on structures - Part 1-2: General actions - Actions on structures exposed to fire*

EN 1999-1-1:2023, *Eurocode 9 — Design of aluminium structures - Part 1-1: General rules*

## 3 Terms, definitions and symbols

### 3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 1990 and prEN 1991-1-2:2021 and the following apply.

#### 3.1.1

##### **part of structure**

isolated part of a structure with appropriate support and boundary conditions

#### 3.1.2

##### **fire protection material**

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

#### 3.1.3

##### **section factor**

ratio of the exposed surface area to the volume of aluminium or, in case of enclosed members, of the exposed encasement to the volume of aluminium

#### 3.1.4

##### **box value of section factor**

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

#### 3.1.5

##### **critical temperature of a structural aluminium member**

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

#### 3.1.6

##### **effective 0,2 % proof strength**

for a given temperature, the stress level at which the stress-strain relationship of aluminium gives a 0,2 % permanent strain

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<sup>1</sup> Under preparation.

### 3.2 Symbols and abbreviations

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

#### Latin upper case letters:

$A_i$	an elemental area of the cross-section with a temperature $\theta_i$
$A_m$	exposed surface area of a member per unit length
$A_m/V$	section factor of unprotected aluminium members
$A_p$	area of the inner surface of the fire protection material per unit length of the member
$A_p/V$	section factor for aluminium members insulated by fire protection material members
$C_i$	protection coefficient of member face $i$
$E_{al}$	modulus of elasticity of aluminium for normal temperature design
$E_{al,\theta}$	modulus of elasticity for aluminium at elevated temperature $\theta_{al}$
$E_d$	design effect of actions at normal temperature, determined in accordance with EN 1990 and EN 1991-1-1
$E_{d,fi}$	design effect of actions for the fire situation, determined in accordance with prEN 1991 1-2:2021, including the effects of thermal expansions and deformations
$I_f$	radiative heat flux from an opening
$I_z$	radiative heat flux from a flame to the beam face
$I_{z,i}$	radiative heat flux from a flame to a column face
$L$	system length of a column in the relevant storey
$L_H$	horizontal projection of the flame (from the facade)
$L_i$	length along axis between the opening and the relevant point
$L_L$	flame height (from the upper part of the window)
$L_x$	distance from the opening measured along the flame axis
$M_{b,Rd}$	design buckling resistance moment for normal temperature design, according to EN 1999-1-1:2023
$M_{Ed,fi}$	design moment for the fire situation
$M_{b,Rd,fi,t}$	design buckling resistance moment in the fire situation at time $t$
$M_{Rd,fi,t}$	design moment resistance in the fire situation at time $t$ of a cross-section with a non-uniform temperature distribution

## EN 1999-1-2:2023 (E)

$M_{Rd}$	design moment resistance of the cross-section for normal temperature design, either $M_{c,Rd}$ or $M_{u,Rd}$
$N_{b,Rd}$	design buckling resistance of a compressed member for normal temperature design according to EN 1999-1-1:2023
$N_{Ed,fi}$	design axial force for the fire situation
$N_{b,Rd,fi,t}$	design buckling resistance in the fire situation at time $t$ of a compressed member
$N_{Rd,fi,t}$	design resistance in the fire situation at time $t$ of a tension member with a non-uniform temperature distribution across the cross-section
$N_{Rd,fi,\theta}$	design resistance of a tension member with a uniform temperature $\theta_{al}$
$R_{d,fi,t}$	design resistance in the fire situation at time $t$
$T_f$	temperature of fire
$T_m$	temperature of the aluminium member
$T_o$	flame temperature at the opening
$T_x$	flame temperature at the flame tip
$T_z$	flame temperature
$T_{z,1}$	flame temperature from Annex B of prEN 1991-1-2:2021, at the bottom of a beam
$T_{z,2}$	flame temperature from Annex B of prEN 1991-1-2:2021, at the top of a beam
$V$	volume of a member per unit length
$V_{Rd}$	design shear resistance of the net cross-section for normal temperature design, according to EN 1999-1-1:2023.
$V_{Ed,fi}$	design shear force for the fire situation
$V_{Rd,fi,t}$	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 1999-1-1:2023

**Latin lower case letters:**

$a_z$	absorptivity of flames
$c_{al}$	specific heat of aluminium
$c_p$	specific heat of the fire protection material
$d_{eq}$	effective cross-sectional dimension
$d_f$	flame thickness
$d_i$	cross-sectional dimension of member face $i$
$d_p$	thickness of fire protection material
$f_{0,\theta}$	effective 0,2 % proof strength at elevated temperature, $\theta_{al}$
$h_{eq}$	equivalent height of the opening
$h_{net,d}$	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
$k_\theta$	relative value of a strength or deformation property of aluminium at elevated temperature $\theta_{al}$
$k_{0,\theta}$	strength reduction factor for the 0,2 % proof strength at the temperature $\theta_{al}$
$k_{0,\theta,i}$	reduction factor for the effective 0,2 % proof strength at the temperature $\theta_i$ in the elemental area $A_i$ .
$k_{0,\theta,max}$	the strength reduction factor for 0,2 % proof strength at the maximum aluminium temperature
$k_{sh}$	correction factor for the shadow effect
$l$	length at 20 °C; distance from an opening, measured along the flame axis
$l_{fi}$	buckling length of a column for the fire design situation
$m$	number of openings on side $m$
$n$	number of openings on side $n$
$s$	horizontal distance from the centreline of a column to a wall of a fire compartment
$t$	time in fire exposure
$w_t$	width of an opening
$z_i$	distance from the plastic neutral axis to the centroid of the elemental area $A_i$

## EN 1999-1-2:2023 (E)

## Greek lower-case letters

$\alpha_c$	heat transfer coefficient for convection
$\alpha_r$	heat transfer coefficient for radiation
$\gamma_{M,fi}$	partial safety factor for the relevant material property for the fire situation
$\eta_{fi}$	reduction factor applied to $E_d$ in order to obtain $E_{fi,d}$
$\theta$	temperature in °C
$\theta_{al}$	aluminium temperature
$\theta_{(t)}$	ambient gas temperature at time $t$
$\theta_{al(t)}$	aluminium temperature at time $t$
$\theta_{al,max(t)}$	maximum temperature of the cross section reached at time $t$
$\varepsilon_f$	emissivity of a flame; emissivity of an opening
$\varepsilon_m$	surface emissivity of the component
$\varepsilon_z$	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 $n$
$K$	adaptation factor
$\lambda_{al}$	thermal conductivity of aluminium
$\lambda_p$	thermal conductivity of the fire protection material
$\mu_0$	degree of utilization at time $t = 0$
$\rho_{al}$	density of aluminium
$\rho_p$	the density of the fire protection material
$\Sigma$	Stefan Boltzmann constant [ $56,7 \times 10^{-12}$ kW/(m <sup>2</sup> K <sup>4</sup> )]
$\phi_f$	overall configuration factor of the member for radiative heat transfer from the opening
$\phi_{f,i}$	configuration factor of member face $i$ for an opening
$\phi_z$	overall configuration factor of the member for radiative heat transfer from the flame
$\phi_{z,i}$	configuration factor of member face $i$ for a flame
$\phi_{z,m}$	overall configuration factor of the column for heat from flames on side $m$