SLOVENSKI STANDARD
oSIST prEN 1999-1-2:2021

01-maj-2021

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: **prEN 1999-1-2**

ICS:

13.220.50	Požarna odpornost gradbenih materialov in elementov	Fire-resistance of building materials and elements
91.010.30	Tehnični vidiki	Technical aspects
91.080.17	Aluminijaste konstrukcije	Aluminium structures

oSIST prEN 1999-1-2:2021 **en,fr,de**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

DRAFT
prEN 1999-1-2

March 2021

ICS 13.220.50; 91.010.30; 91.080.17

Will supersede EN 1999-1-2:2007

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 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.

This draft European Standard was established by CEN 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.

CEN members are the national standards bodies of 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, Turkey and United Kingdom.

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.

Warning : This document is not a European Standard. It is distributed for review and comments. It is subject to change without notice and shall not be referred to as a European Standard.

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

This document (prEN 1999-1-2:2021) 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 document will supersede 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.

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>

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 Eurocode 9

EN 1999 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 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 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.

EN 1999 is subdivided in five parts:

— EN 1999-1-1 Design of Aluminium Structures: General structural rules.

— EN 1999-1-2 Design of Aluminium Structures: Structural fire design.

— EN 1999-1-3 Design of Aluminium Structures: Structures susceptible to fatigue.

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

— EN 1999-1-5 Design of Aluminium Structures: 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 prEN 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) NOTE

4.7(1) NOTE

7.2.1 (1) NOTE

7.2.3 (5) NOTE

7.2.4 (4) NOTE

National choice is allowed in EN 1999-1-2 on the application of the following informative annexes:

Annex A (informative) Properties of aluminium alloys and/or tempers not listed in EN 1999-1-1

Annex B (informative) Heat transfer to external structural aluminium members

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, if reliable material 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, EN 1998 and EN 1999.

(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*

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 and geotechnical design*

EN 1991-1-2, *Eurocode 1: Actions on structures - Part 1-2: General actions - Actions on structures exposed to fire*

EN 1999-1-1, *Eurocode 9: Design of aluminium structures - Part 1-1: General structural 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 EN 1991-1-2 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

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 θi

A_m exposed surface area of a member per unit length [m^2/m]

A_m /V section factor of unprotected aluminium members [m^{-1}];

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 [m^{-1}]

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, θ_{al}

E_d design effect of actions at normal temperature, determined in accordance with EN 1990 and EN 1991-1-1

$E_{fi,d}$ design effect of actions for the fire situation, determined in accordance with EN 1991-1-2, 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

$M_{fi,Ed}$ design moment for the fire situation

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

$M_{fi,t,Rd}$ design moment resistance in the fire situation at time *t* of a cross-section with a non-uniform temperature distribution

M_{Rd} is the moment resistance of the cross-section for normal temperature design, either $M_{c,Rd}$ or $M_{u,Rd}$

$N_{b,Rd}$ buckling resistance of a compressed member for normal temperature design according to EN 1999-1-1

$N_{fi,Ed}$ design axial force for the fire situation

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

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

$N_{fi,q,Rd}$ design resistance of a tension member with a uniform temperature θ_{al}

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

T_f temperature of fire [K]

T_m temperature of the aluminium 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 1991-1-2:20XX, at the bottom of a beam

$T_{z,2}$ flame temperature [K] from Annex B of prEN 1991-1-2:20XX, at the top of a beam

V volume of a member per unit length

V_{Rd} shear resistance of the net cross-section for normal temperature design, according to EN 1999-1-1.

$V_{fi,Ed}$ design shear force for the fire situation

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

X_k characteristic value of a strength or deformation property (generally fk or Ek) for normal temperature design to EN 1999-1-1

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

$f_{o,\theta}$ effective 0,2 % proof strength at elevated temperature, θ_{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_θ relative value of a strength or deformation property of aluminium at elevated temperature θa

$k_{o,\theta}$ strength reduction factor for the 0,2 proof strength at at temperature θ_{al}

$k_{o,\theta,i}$ is the reduction factor for the effective 0,2 % proof strength at the temperature θ_i in the elemental area A_i.

$k_{o,\theta max}$ the strength reduction factor for the 0,2 proof strength at the maximum aluminium temperature

k_{sh} correction factor for the shadow effect

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

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

Greek lower-case letters

α_c heat transfer coefficient for convection [kW/m²K]

α_r heat transfer coefficient for radiation [kW/m²K]

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

η_{fi} reduction factor applied to Ed in order to obtain Efi,d

θ temperature in °C

θ_{al} aluminium temperature

$\theta_{(t)}$ ambient gas temperature at time t (°C)

$\theta_{al(t)}$ aluminium temperature at time t (°C)

$\theta_{al,max}$ maximum temperature of the cross section reached at time t

ε_f emissivity of a flame; the emissivity of an opening

ε_m surface emissivity of the component

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

κ adaptation factor

λ_{al} thermal conductivity of aluminium

λ_p thermal conductivity of the fire protection material

μ_0 degree of utilization at time $t = 0$

ρ_{al} density of aluminium

ρ_p the density of the fire protection material

σ Stefan Boltzmann constant [56,7 × 10^{-12} kW/(m^2K^4)]

ϕ_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

ϕ_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

$\phi_{z,n}$ overall configuration factor of the column for heat from flames on side n

μ_0 degree of utilization at time $t = 0$

ρ_{al} density of aluminium

ρ_p the density of the fire protection material

4 Basis of design

4.1 General

(1) Where mechanical resistance in the case of fire is required, aluminium structures shall be designed and constructed in such a way that they maintain their load bearing function during the relevant fire exposure.

(2) Deformation criteria shall be applied where the means of protection require consideration of the deformation of the load bearing structure.

(3) Consideration of the deformation of the load bearing structure may be neglected when the efficiency of the means of protection has been evaluated according to 5.2.2.

(4) Deformation criteria shall be applied where the design criteria for separating elements require consideration of the deformation of the load bearing structure.

(5) Consideration of the deformation of the load bearing structure may be neglected when the separating elements fulfil requirements of a nominal fire exposure, see 4.2.

4.2 Nominal fire exposure

(1) For standard fire exposure, elements shall comply with the following function as defined in EN 1991-1-2:

— Load bearing function only: mechanical resistance (R).

(2) Function R may be assumed to be satisfied where load bearing is maintained during the required time of fire exposure.

(3) When the external fire exposure curve is used, the same function shall apply, with the reference to this specific curve identified by the letters "ef".

4.3 Physically based fire exposure

(1) The load bearing function may be assumed to be ensured if collapse is prevented during the complete duration of the fire, including the cooling phase or during a required period of time according to 4.4 (4) of prEN 1991-1-2:20XX.

4.4 Actions

(1) Thermal and mechanical actions shall be taken from EN 1991-1-2.

4.5 Design values of material properties

(1) Design values of mechanical material properties (strength and stiffness) $X_{fi,d}$ are defined in Formula (4.1):

$$X_{fi,d} = k_\theta X_k / \gamma_{M,fi} \quad (4.1)$$

where

X_k is the characteristic value of a strength or stiffness property (generally f_k or E_k) for normal temperature design according to EN 1999-1-1;

k_θ is the temperature-dependent reduction factor for a strength or stiffness property ($X_{k,\theta}/X_k$);

$\gamma_{M,fi}$ is the partial factor for the relevant mechanical material property in the fire situation.

NOTE The value of $\gamma_{M,fi}$ is 1,0 unless the National Annex gives a different value.