SLOVENSKI STANDARD
oSIST prEN 1999-1-4:2021

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Evrokod 9 - Projektiranje konstrukcij iz aluminijevih zlitin - 1-4. del: Hladno oblikovane konstrukcijske pločevine

Eurocode 9: Design of aluminium structures - Part 1-4: Cold-formed structural sheeting

Eurocode 9: Bemessung und Konstruktion von Aluminiumtragwerken - Teil 1-4: Kaltgeformte Profiltafeln

Eurocode 9 - Calcul des structures en aluminium - Partie 1-4 : Tôles de structure formées à froid

Ta slovenski standard je istoveten z: **prEN 1999-1-4**

ICS:

91.010.30	Tehnični vidiki	Technical aspects
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English Version

Eurocode 9: Design of aluminium structures - Part 1-4: Cold-formed structural sheeting

Eurocode 9 - Calcul des structures en aluminium - Partie 1-4 : Tôles de structure formées à froid

Eurocode 9: Bemessung und Konstruktion von Aluminiumtragwerken - Teil 1-4: Kaltgeformte Profiltafeln

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 1999-1-4:2021) 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 is currently submitted to the CEN Enquiry.

This document will supersede EN 1999-1-4:2007.

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 1999-1-4

This document gives design requirements for cold-formed trapezoidal aluminium sheeting. It applies to cold-formed aluminium products made from hot rolled or cold rolled sheet or strip that have been cold-formed by such processes as cold-rolled forming or press-breaking.

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” express 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 1999-1-4

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

The national standard implementing EN 1999-1-4 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 document is to be used.

When no national choice is made and no default is given in this document, 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 1999-1-4 through the following clauses:

4(4) NOTE 1

5.1(3) NOTE

9.3(3) NOTE

A.4.4(3)

National choice is allowed in EN 1999-1-4 on the application of the following informative annexes:

Annex B (Informative) Durability of fasteners

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 1999-1-4

(1)P This document gives design requirements for cold-formed trapezoidal aluminium sheeting. It applies to cold-formed aluminium products made from hot rolled or cold rolled sheet or strip that have been cold-formed by such processes as cold-rolled forming or press-breaking.

NOTE 1 The rules in this part complement the rules in other parts of EN 1999-1.

NOTE 2 The execution of aluminium structures made of cold-formed structures for roof, ceiling, floor and wall applications is covered in EN 1090-5.

(2) This document gives methods for stressed-skin design using aluminium sheeting as a structural diaphragm.

(3) This document does not apply to cold-formed aluminium profiles like C- and Z- profiles nor cold-formed and welded circular or rectangular hollow sections.

(4) This document gives methods for design by calculation and for design assisted by testing. The methods for the design by calculation apply only within stated ranges of material properties and geometrical properties for which sufficient experience and test evidence is available. These limitations do not apply to design by testing.

(5) This document does not cover load arrangement for loads during execution and maintenance.

1.2 Assumptions

(1) For the design of new structures, prEN 1999 (all parts) 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.

EN 1999 (all parts) 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 1090-5: Technical requirements for cold-formed structural aluminium elements and cold-formed structures for roof, ceiling, floor and wall applications

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.

prEN 1990:2020, *Basis of structural design*

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 1999-1-1 and the following apply.

3.1.1
base material
flat sheet aluminium material out of which profiled sheets are made by cold forming

3.1.2
proof strength of base material
0,2 % proof strength f_0 of the base material

3.1.3
diaphragm action
structural behaviour involving in-plane shear in the sheeting

3.1.4
partial restraint
restriction to some extent of the lateral or rotational displacement of a cross-section part, that increases its buckling resistance

3.1.5
restraint
full restriction of the lateral displacement or rotational movement of a plane cross-section part, that increases its buckling resistance

3.1.6
relative slenderness
normalised, material related slenderness ratio

3.1.7
stressed-skin design
design method that takes into account the contribution made by diaphragm action in the sheeting to the stiffness and strength of a structure

3.1.8
support
location at which a member is able to transfer forces or moments to a foundation, or to another structural component

3.1.9
effective thickness
design value of the thickness to allow for local buckling of plane cross section part

3.1.10
reduced effective thickness
design value of the thickness to allow for distortional buckling of stiffeners in a second step of the calculation procedure for plane cross section parts, where local buckling is taken into account in the first step

3.2 Symbols

For the purposes of this document, the symbols given in EN 1999-1-1 and the following apply.

Latin upper-case letters

$F_{v,Rk}$ characteristic shear resistance

$F_{t,Rk}$	characteristic tension resistance
$R_{p0,2}$	0,2 % proof strength in material standard
R_m	ultimate tensile strength in material standard
S_f, S_w	spring stiffness of connection of sheeting
$V_{b,Rd}$	design value for shear resistance

Latin lower-case letters

a_{ol}	length of overlap of trapezoidal sheeting
a_{per}	spacing between the centres of the perforations in sheeting
b_b	width of building
b_p	notional flat width of plane cross-section part
b_{rib}	pitch of the profile
d	diameter of the fastener
d_{per}	diameter of the perforations in sheeting
d_w	diameter of the washer or the head of the fastener
f_{bv}	shear buckling strength
$f_{u,min}$	minor ultimate tensile strength of connected parts
$f_{u,sup}$	ultimate tensile strength of the supporting component into which a screw is fixed
f_y	yield strength of supporting component of steel
h_a, h_b	distance from compression flange to grooves measured perpendicular to the flange
h_b	height of the columns along the building
h_{sa}, h_{sb}	height of grooves in webs measured perpendicular to the web
h_w	height of profile
k	linear spring stiffness
k_f	coefficient for spring stiffness of connection of sheeting
k_{ol}	coefficient for calculating the spring stiffness of connections at overlaps of sheeting
k_σ	buckling coefficient for compression stress
k_τ	buckling coefficient for shear stress
l_a	effective bearing length
n	number of tests
n_c	number of pitches between the longitudinal edge of the sheeting to same edge of the next sheeting
n_p	number of whole pitches with double sheeting within the width n_c times the pitch

$q_{bv,Ed}$	vertical load per unit area acting on the roof (snow, self-weight and wind compression)
$q_{h,Ed}$	horizontal load per length acting along the roof diaphragm
s_a, s_b	width of parts between grooves in webs
s_d	total developed slant height of the web
s_n	distance from neutral axis to nearest groove on the compression side of the web
s_p	slant height of the largest plane part in the web
s_{per}	slant height of the perforated portion of the web, centric in the web height
s_s	bearing length
s_{sa}, s_{sb}	width of grooves in webs
s_w	slant height of the web, between the midpoints of the web-to-flange corners
t	design thickness
t_{min}	thickness of the thinner connected part or sheet
t_{nom}	nominal thickness
t_{sup}	thickness of the supporting member in which the screw is fixed
v_h	maximum horizontal deformation of the roof diaphragm due to $q_{h,Ed}$
x_s	distance from the studied section to a hinged support or a point of counter flexure of the deflection curve for elastic buckling under an axial force only

Greek upper-case letters

θ	rotation

Greek lower-case letters

$\bar{\lambda}_{lim}$	plateau length for plate buckling
$\bar{\lambda}_p$	plate relative slenderness
$\bar{\lambda}_s$	relative slenderness for stiffener
$\bar{\lambda}_w$	web relative slenderness
μ_{so}	factor which accounts for the increase of bending moment resistance of sheeting with side overlaps
$\sigma_{cr,sa}$	elastic buckling stress of stiffener
φ	angle between two plane parts of a cross-section
ϕ	slope of the web relative to the flanges
ψ	stress relation factor
ω_x	factor to allow for second moment due to axial force and deflection

3.3 Geometry and conventions

3.3.1 Cross-sectional shapes

(1) Cold-formed sheets have, within the permitted tolerances, a constant nominal thickness over their entire length and have a uniform cross-section along their length.

(2) The cross-sections of cold formed profiled sheets comprise a number of plane cross-section parts joined by curved parts.

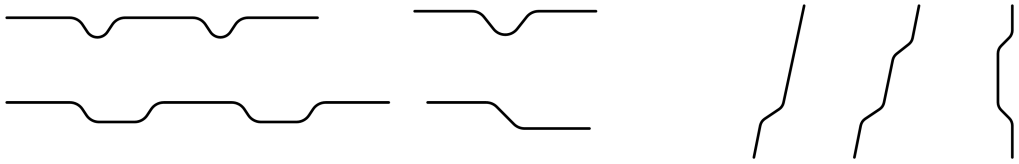
(3) Example of typical forms of cross-sections for cold formed profiled sheets are shown in Figure 3.1.

(4) Cross-sections of cold formed sheets can either be unstiffened or incorporate longitudinal stiffeners in their webs or flanges, or in both.

3.3.2 Stiffener shapes

(1) Typical shapes of stiffeners for cold formed sheets are shown in Figure 3.2.

Figure 3.1 — Examples of cold-formed profiled sheeting



a) grooves **b) folds**

Figure 3.2 — Typical intermediate longitudinal stiffeners

3.3.3 Cross-sectional dimensions

(1) Overall dimensions of cold-formed sheeting, including overall width b, overall height h, internal bend radius r and other external dimensions denoted by symbols without subscripts, are measured to the outer contour of the section, unless stated otherwise, see Figure 7.1.

(2) Unless stated otherwise, the other cross-sectional dimensions of cold-formed sheeting, denoted by symbols with subscripts, such as b_p, h_w or s_w, are measured either to the midline of the material or the midpoint of the corner.

(3) In the case of sloping webs of cold-formed profiled sheets, the slant height s is measured parallel to the slope.

(4) The developed height of a web is measured along its midline, including any web stiffeners.

(5) The developed width of a flange is measured along its midline, including any intermediate stiffeners.

(6) The thickness t is an aluminium design thickness if not otherwise stated. See 3.2.

3.3.4 Convention for member axis

(1) For profiled sheets the following axis convention is used in EN 1999-1-4:

— *y-y* axis parallel to the plane of sheeting;

— *z-z* axis perpendicular to the plane of sheeting.

4 Basis of design

(1)P The design of cold-formed sheeting shall be in accordance with the general rules in EN 1990 and EN 1999-1-1.

(2)P Appropriate partial factors shall be adopted for ultimate limit states and serviceability limit states.

(3) For verification by calculation at ultimate limit states the partial factor γ_M shall be taken as follows:

— resistance of cross-sections and members to instability: γ_{M1}

— resistance of cross-sections in tension to fracture: γ_{M2}

— resistance of joints: γ_{M3}

NOTE For the values of γ_{M1} and γ_{M2}, see EN 1999-1-1. For joints in cold-formed sheeting $\gamma_{M3} = \gamma_{M2}$.

(4) In the design of structures, a distinction should be made between various 'structural classes', based on the level of contribution of cold-formed aluminium members or sheeting to the strength and stability of the overall structure or that of individual structural elements. These structural classes are associated with different requirements in the applicable product and execution standards for cold-formed aluminium members and sheeting, and shall be determined as follows:

Structural Class I: Construction where cold-formed members or sheeting relative slenderness are designed to contribute to the overall strength and stability of a structure;

Structural Class II: Construction where cold-formed members or sheeting relative slenderness are designed to contribute to the strength and stability of individual structural elements;

Structural Class III: Construction where cold-formed members or sheeting relative slenderness are used as an element that only transfers loads to the structure. Sheeting and sandwich panels in Structural Class III can be differentiated in:

— structural or

— non-structural.

NOTE 1 Permitted application of non-structural cold-formed sheeting in Structural Class III can be set by the National Annex.

NOTE 2 EN 1090-1 and EN 1090-4 cover requirements for execution of structural sheeting and of cold-formed members. EN 14782 covers non-structural cold-formed sheeting for structural class III.