SLOVENSKI STANDARD
SIST EN 1999-1-4:2023

01-september-2023

Nadomešča:
SIST EN 1999-1-4:2007
SIST EN 1999-1-4:2007/A1:2012
SIST EN 1999-1-4:2007/AC:2010

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: EN 1999-1-4:2023

ICS:

91.010.30	Tehnični vidiki	Technical aspects
91.080.17	Aluminijaste konstrukcije	Aluminium structures

SIST EN 1999-1-4:2023 **en,fr,de**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 1999-1-4

March 2023

ICS 91.010.30; 91.080.17

Supersedes EN 1999-1-4:2007

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 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.

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, Türkiye and United Kingdom.

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

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

Ref. No. EN 1999-1-4:2023 E

Contents

Page

European foreword

This document (EN 1999-1-4:2023) 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 1999-1-4:2007.

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

— Some reorganization of the text and its coherence with EN 1999-1-1 and the other Eurocodes;

— New general provisions for cold-formed profiles (i.e. not only profiled sheeting);

— New provisions for static overlapping system of sheeting with single or double overlap;

— New provisions for trapezoidal sheeting with side overlaps;

— Clarification of the behaviour of diaphragm at the end of a building;

— Improvement of wording.

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.

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.

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

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.

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 in various parts:

— EN 1999-1-1 Eurocode 9 — Design of Aluminium Structures — Part 1-1: General rules;

— EN 1999-1-2 Eurocode 9 — Design of Aluminium Structures — Part 1-2: Structural fire design;

— EN 1999-1-3 Eurocode 9 — Design of Aluminium Structures — Part 1-3: Structures susceptible to fatigue;

— EN 1999-1-4 Eurocode 9 — Design of Aluminium Structures — Part 1-4: Cold-formed structural sheeting;

— EN 1999-1-5 Eurocode 9 — Design of Aluminium Structures — Part 1-5: Shell structures.

0.3 Introduction to EN 1999-1-4

This document gives design requirements for cold-formed trapezoidal aluminium sheeting made from hot rolled or cold rolled sheet or strip.

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 EN 1999-1-4

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 1999-1-4 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 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 1999-1-4 through the following clauses:

4(4)	5.1(3)	9.3(3)	A.4.4(3)

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

Annex B

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) EN 1999-1-4 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) EN 1999-1-4 gives methods for stressed-skin design using aluminium sheeting as a structural diaphragm.

(3) EN 1999-1-4 does not apply to cold-formed aluminium profiles like C- and Z- profiles nor cold-formed and welded circular or rectangular hollow sections.

(4) EN 1999-1-4 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) EN 1999-1-4 does not cover load arrangement for loads during execution and maintenance.

1.2 Assumptions

(1) 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.

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 1090-5, *Execution of steel structures and aluminium structures — Part 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.

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*

EN 1999-1-1, *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, EN 1999-1-1 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

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

A_g	area of the gross cross-section
$A_{g,sh}$	value of A_g for a cross-section with sharp corners
$F_{n,Rd}$	net section design resistance
$F_{v,Rk}$	characteristic shear resistance
$F_{t,Rk}$	characteristic tension resistance
I_g	moment of inertia of the gross cross-section
$I_{g,sh}$	value of I_g for a cross-section with sharp corners
$R_{p0,2}$	0,2 % proof stress given by the product 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	overall width of the flange
b_{bu}	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 sealing washer respectively 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	overall height of the profile

h_a, h_b	distance from compression flange to grooves measured perpendicular to the flange
h_{bu}	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
r	internal bend radius
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

γ_{M3}	resistance of joints
$\overline{\lambda}_{lim}$	plateau length for plate buckling
$\overline{\lambda}_{p}$	plate relative slenderness
$\overline{\lambda}_{s}$	relative slenderness for stiffener
$\overline{\lambda}_{w}$	web relative slenderness
μ_{so}	factor which accounts for the increase of bending moment resistance of sheeting with side overlaps
$\sigma_{com, Ed}$	the maximum compressive stress in a plane element or stiffener
$\sigma_{cr,sa}$	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 order moment distribution 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.

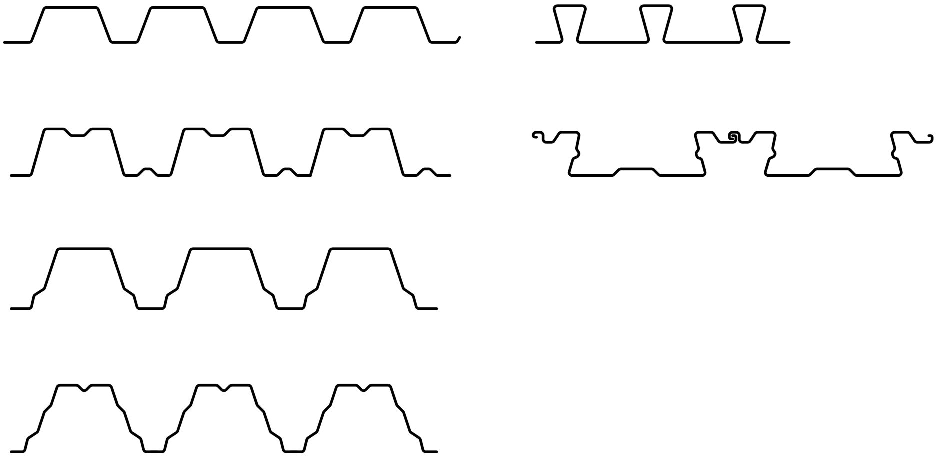
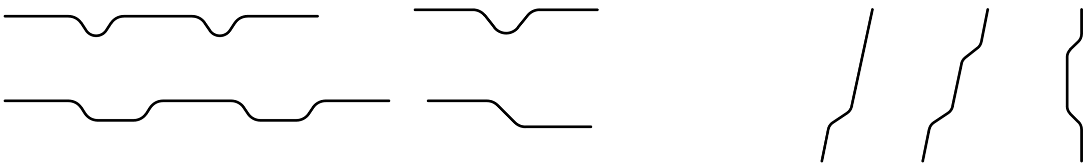


Figure 3.1 — Examples of cold-formed profiled sheeting



a) grooves in flanges **b) folds in webs**

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 5.2.2.

3.3.4 Convention for member axis

(1) For profiled sheets the following axis convention is used in this standard:

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

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