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BSI Group Headquarters

389 Chiswick High Road London W4 4AL

Tel: +44 (0)20 8996 9000

Fax: +44 (0)20 8996 7400

www.bsigroup.com

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Interested committees:

Title: Draft BS EN 1993-3 Eurocode 3. Design of steel structures. Part 3: Towers, masts and chimneys.

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Responsible Committee Secretary: Ms Aský Destá (BSI)

Direct tel: 0208 996 7171

E-mail: asky.desta@bsigroup.com

Full document details: 24/30443599 DC

Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

For national standards, comments will be reviewed by the relevant UK national committee and the resulting standards published as a British Standard.

UK Vote

Please indicate whether you consider the UK should submit a negative (with supporting technical reasons) or positive vote on this draft. Please indicate if you are aware of any reason why this draft standard should not be published as a British Standard.

Submission of Comments

- **Annotated drafts are not acceptable and will be rejected.**
- All comments should be submitted online at <https://standardsdevelopment.bsigroup.com/>. You will need to register in order to comment.

Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/ Figure/Table/Note	Type of comment	Comment (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	

English Version

Eurocode 3 - Design of steel structures - Part 3: Towers, masts and chimneys

Eurocode 3 - Calcul des structures en acier - Partie 3 :
Tours, mâts et cheminées

Eurocode 3 - Bemessung und Konstruktion von
Stahlbauten - Teil 3: Türme, Maste und Schornsteine

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.

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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.

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

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European foreword

This document (prEN 1993-2:2024) 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 1993-3-1:2006, EN 1993-3-2:2006 and their 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.

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 the EN 1993 series

(1) EN 1993 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 and geotechnical design.

(2) EN 1993 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.

(3) 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: 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: Sandwich panels*.

(4) 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 steel structures*;

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: Plate assemblies with elements under transverse loads*;

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

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

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

EN 1993-1-11, *Design of Steel Structures — Part 1-11: Tension components*;

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*.

(5) 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.

(6) 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 them.

0.3 Introduction to EN 1993-3

EN 1993-3 describes the principles and application rules for the safety, serviceability and durability of steel structures for towers, masts and chimneys.

EN 1993-3 gives design rules in supplement to the generic rules in the EN 1993-1 series.

EN 1993-3 is intended to be used with EN 1990, the EN 1991 series and the parts of EN 1992 to EN 1998 when steel structures or steel components for towers and masts, chimneys are referred to.

Matters that are already covered in those documents are not repeated.

EN 1993-3 is intended for use by

- committees drafting design related product, testing and execution standards,
- clients (e.g. for the formulation of their specific requirements),

- designers and constructors,
- relevant authorities.

Numerical values for partial factors and other reliability parameters in EN 1993-3 are recommended as basic values that provide an acceptable level of reliability. They have been selected assuming that an appropriate level of workmanship and quality management applies.

Provisions have been included to allow for the possible use of a different partial factor for resistance in the case of those structures or elements the design of which has been the subject of an agreed type testing programme.

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 1993-3

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 1993-3 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 1993-3 through notes to the following clauses:

4.1(3)	4.2.3(2)	6.3.1(2)	7.2(4)
7.4(4)	8.1(1)	8.2.4.1(7)	8.3.1(2)
8.3.3(2)	8.3.4.2(2)	10.3(5)	B.3.2(3)
B.3.3(3)	B.5.1(1)	B.5.2(3)	B.5.3(1)
B.5.4(1)	C.3(3)	C.5(8)	D.5(2)
E.4(5)	E.6.2.1(1)	E.6.2.2(3)	

National choice is allowed in EN 1993-3 on the application of the following informative annex:

Annex F

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) This document provides rules for structural design of towers, masts and chimney structures, that fall into any of the following classifications, with the exceptions given in (3), (4) and (5).

(2) This document is applicable to:

- a) self-supporting towers and guyed masts with or without attachments. The shafts of towers and masts can be of lattice type or of circular or polygonal cross-section.
- b) chimney structures of circular cross-section that are cantilevered, supported at intermediate levels or guyed.

NOTE 1 The structures are mainly exposed to wind loading.

NOTE 2 For overhead transmission line towers see also the EN 50341 series.

(3) This document does not apply to:

- a) polygonal and circular lighting columns covered by the EN 40 series;

NOTE The EN 40 series specifies the requirements and dimensions for lighting columns and it applies to post top columns not exceeding 20 m height and to post top lanterns and columns with brackets not exceeding 18 m height for side entry lanterns.

- b) wind turbine towers (see the EN 61400 series)
- c) overhead line towers covered by the EN 50341 series.

(4) This document does not cover special provisions for seismic design, which are given in the EN 1998 series.

(5) Special measures that might be necessary to limit the consequences of accidents are not covered in this document. For resistance to fire, see EN 1993-1-2.

(6) Provisions for the guys of guyed structures are given in EN 1993-1-11 and supplemented in this document.

(7) For provisions concerning aspects such as chemical attack, thermo-dynamical performance or thermal insulation of chimneys see EN 13084-1. For the design of liners see EN 13084-6.

NOTE 1 Foundations are covered in the EN 1997 series. See also EN 13084-1.

NOTE 2 Wind loads and procedures for the wind response of structures are specified in EN 1991-1-4.

Assumptions

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

(2) The design methods given in this document are applicable if

- the execution quality is as specified in Annex E and EN 1090-2 and for the execution of chimneys, also in EN 13084-6,

and

- the construction materials and products used are as specified in the relevant parts of the EN 1993 series or, for materials other than steel, in the relevant material and product specifications.

NOTE Execution is covered in this document to the extent that is necessary to indicate the quality of the construction materials and products and the standard of workmanship on site needed to comply with the assumptions of the design rules.

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*

EN 1990:2023,¹ *Eurocode — Basis of structural and geotechnical design*

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

EN 1993 (all parts), *Eurocode 3 — Design of steel structures*

EN 13084-9, *Free-standing chimneys — Part 9: Lifetime management — Monitoring, inspection, maintenance, remedial and reporting; Operations and actions required*

EN ISO 5817:2023, *Welding — Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) — Quality levels for imperfections (ISO 5817:2023)*

3 Terms, definitions and symbols

3.1 Terms and definitions

For the purposes of this document, the terms in EN 1990 and EN 1993-1-1 and the following terms apply.

3.1.1

aerodynamic measures

surface features to forestall coordinated vortex shedding that could generate intolerable resonant oscillation

Note 1 to entry: Aerodynamic measures can be spoiler, helical strakes, shrouds or slats.

3.1.2

anchor bolt

bolt for the connection of the structure to the foundation

3.1.3

base plate

horizontal plate fixed to the base of a structural shell or shaft or leg

¹ As impacted by EN 1990:2023/prA1:2024

3.1.4**chimney**

construction work or building component that conducts waste gases, or other flue gases, supply or exhaust air to the atmosphere

Note 1 to entry: See also EN 13084-1. Where the term “chimney” is used in this standard, only the loadbearing part (structural shell) is meant.

3.1.5**damper**

device that supplements the structural damping and thus limits the response of a structure or of a guy

Note 1 to entry: This definition of damper refers to a vibration damper, which is different from a flow damper that is an internal gas flow regulation device in liners.

3.1.6**discrete ancillary item**

any non-structural component that is concentrated within a short vertical distance, such as dish reflectors, aerials, lighting, platforms, handrails, insulators and other items

3.1.7**double-wall chimney**

chimney consisting of an outer steel structural shell and one inner liner which carries the flue gases

3.1.8**flanges**

plate welded transverse to the member to enable connection to other members using bolts

Note 1 to entry: Flanges are used both between structural sections and in liners and the flanges are in contact with each other. For chimneys the term “flange” is referred to as “junction flange” in the EN 13084 series.

3.1.9**global analysis**

determination of a consistent set of internal forces and moments in a structure, that are in equilibrium with a particular set of actions on the structure

3.1.10**guy**

tension-only member providing lateral support in conjunction with two or more counterparts at the same level

Note 1 to entry: Guys are also known as stay. One guy with a termination at each end constitutes a guy assembly. The lower end of the guy assembly is anchored to the ground or on a structure and generally incorporates a means of adjusting the tension in the guy. Specific definitions of guys, their make-up and fittings, are specified in Annex B.

3.1.11**guyed structure**

steel structure stabilized at discrete intervals in its height by guys that are anchored to the ground or to a permanent structure

Note 1 to entry: The shaft of a guyed structure can be of lattice type or of circular or polygonal closed cross-section.

3.1.12

initial guy tension

tension in the guy at its anchorage to the ground, in the absence of meteorological actions and at an agreed reference temperature

3.1.13

leg members

steel members forming the main load-bearing components of the lattice structure

3.1.14

linear ancillary item

any non-structural components that extend over several panels, such as waveguides, feeders, ladders and pipework

3.1.15

liner

element supporting the lining system, contained within the structural shell

3.1.16

lining system

total system separating the flue gases from the structural shell in a chimney

Note 1 to entry: This comprises a liner and its supports, the space between the liner and structural shell and insulation, where existing.

3.1.17

local analysis

structural analysis of a part of the structure, including fatigue analysis

3.1.18

mast

guyed steel structure

3.1.19

multi-flue chimney

group of two or more chimneys structurally interconnected or a group of two or more liners within a structural shell

3.1.20

panel (of a tower or mast)

any convenient portion of a lattice tower or mast of lattice type that is subdivided vertically for the purpose of determining projected areas and wind drag

Note 1 to entry: Panels are typically, but not necessarily, taken between intersections of legs and primary bracings.

3.1.21

primary bracing members

members other than legs, carrying forces due to the loads imposed on the lattice structure

3.1.22**projected area**

area of the element considered, when projected on to a plane normal to the wind direction considered, including ice where relevant

Note 1 to entry: For wind blowing other than normal to one face of the structure, a reference face is used for the projected area (see prEN 1991-1-4:2024, Annex E).

3.1.23**secondary bracing members**

members used to reduce the buckling lengths of other lattice members

3.1.24**self-supported structure**

cantilevered steel structure whose supporting shaft is not connected with any other construction above the base level

3.1.25**shaft**

vertical steel structure of a tower or a mast, which can be of lattice type with triangular, square or rectangular cross-section or of closed circular or polygonal cross-section (monopole)

3.1.26**single-wall chimney**

chimney whose structural shell also conducts the flue gases

Note 1 to entry: It can be fitted with thermal insulation and/or internal lining. The term can also refer to a chimney with a liner that conducts the flue gases and a surrounding lattice structure.

3.1.27**structural shell**

main load-bearing steel structure of a chimney, excluding any flanges (referred to as “windshield” in the EN 13084 series)

3.1.28**tower**

self-supported cantilevered steel structure

3.1.29**wind drag**

resistance to the flow of wind offered by the elements of a tower, mast or chimney and any ancillary items that it supports, given by the product of the drag coefficient and the reference projected area

3.2 Symbols

3.2.1 General

- (1) In addition to those symbols given in EN 1993-1-1, the following symbols apply.
 (2) Further symbols are defined where they first occur.

3.2.2 Latin upper-case letters

C_1	factor accounting for the bending moment diagram for the calculation of the elastic critical moment for lateral torsional buckling
C_u, C_v	equivalent uniform moment factors
D	diameter of structure
$F_{h,Ed}$	force
$F_{h,dyn,Ed}$	dynamic force
$F_{h,stat,Ed}$	static force
$F_{t,Rd}$	design tension resistance of a bolt
H	height of structure
I_{pp}	moment of inertia of the effective part of the packing plate
I_v	moment of inertia about the v-v axis
$I_{v,ch}$	moment of inertia about the v-v axis of one chord of the built-up section
K	effective slenderness factor
K_1	modification factor for horizontal members of K - and X -brace without plan bracing
L_d	length of diagonal member
L_h	length of horizontal member
L_o	critical system length
$M_{j,Ed}$	design bending moment
$M_{j,Rd}$	design moment resistance
$M_{u,Rk}$	characteristic value of the resistance to bending moment about u-u axis
$M_{v,Rk}$	characteristic value of the resistance to bending moment about v-v axis
N_c	axial compression force
$N_{c,Rd}$	design compressive resistance
$N_{cr,Sv}$	elastic critical axial force for built-up sections accounting for the shear stiffness
$N_{j,Ed}$	design value of the axial force
$N_{j,Rd}$	design axial resistance
N_t	axial tension force
$N_{t,Rd}$	design tension resistance
$N_{t,b,Rd}$	design tension resistance of bolts
$N_{t,f,Rd}$	design tension resistance from bending of the flange

$P_{m,w}(z)$	force in the tower leg member at height z due to mean-wind load (see prEN 1991-1-4:2024, J.2.2.3(1))
$P_{t,w}(z)$	force in the tower leg member at height z due to along-wind gust buffeting (see prEN 1991-1-4:2024, J.2.2.3(1))
R_b	radius to centre of ring flange bolt holes
R_f	radius of ring flange outer edge
R_m	average radius of shell
S_p	total effective load effect of the patch loads for masts (see prEN 1991-1-4:2024, J.3.3.2.4(3))
T_{life}	design life of the structure in years
W_u	section modulus for bending about u-u axis
$W_{eff,u}$	effective section modulus for bending about u-u axis
$W_{el,u}$	elastic section modulus for bending about u-u axis
W_v	section modulus for bending about v-v axis
$W_{eff,v}$	effective section modulus for bending about v-v axis
$W_{el,v}$	elastic section modulus for bending about v-v axis

3.2.3 Latin lower-case letters

$\bar{b}$	width of compression leg
c_{ext}	external corrosion allowance
c_{int}	internal corrosion allowance
e	eccentricity
$f_{y,f}$	yield strength of flange
h_s	pitch of strakes
i_v	radius of gyration about the v-v axis
k_b	factor to increase the tensile stresses of shells calculated with beam theory
k_2	coefficient to calculate the design tension resistance of a bolted circular flange connection
k_3	coefficient to calculate the design tension resistance of a bolted circular flange connection
$k_{uu}, k_{vu}, k_{vu}, k_{vv}$	interaction factors for angle section members in bending and axial compression
l_s	length of strakes
m	negative inverse slope of the fatigue strength curve
$m_{pl,Rd}$	plastic bending moment resistance of the flange
m_y	circumferential bending moments per unit length
p	percentage of the axial force
q_p	peak wind pressure
r_1	radius of the convex part of the bearing

r_2	radius of the concave part of the bearing
t_f	ring flange thickness
t_s	depth of strakes
u	deflection
u_{dyn}	dynamic deflection
u_{stat}	static deflection

3.2.4 Greek upper-case symbols

$\Delta\sigma_c$	reference value of fatigue strength at $N_c = 2 \times 10^6$ stress cycles
$\Delta\sigma_E$	stress range associated to N cycles
θ_1	auxiliary angle in spherical pinned connections
θ_2	auxiliary angle in spherical pinned connections
ϕ	inclination of the mast axis at its base
ψ	impact factor

3.2.5 Greek lower-case symbols

$\alpha_{2,u}, \alpha_{3,u}, \alpha_{4,u}$	resistance factors for angle sections for bending about u-u axis depending on the class of the cross section
$\alpha_{2,v}, \alpha_{3,v}, \alpha_{4,v}$	resistance factors for angle sections for bending about v-v axis depending on the class of the cross section
γ_{Ff}	partial factor for fatigue
γ_{Mt}	partial factor for resistance of guys and their terminations
δ_s	logarithmic decrement of structural damping
χ_{min}	minimum reduction factor for flexural buckling of angle section members
χ_u, χ_v	reduction factor due to flexural buckling about u-u axis and v-v axis, respectively
λ	slenderness for the relevant buckling mode
$\bar{\lambda}_p$	relative slenderness for plate buckling
$\bar{\lambda}_{\text{Sv}}$	relative slenderness for flexural buckling of built-up members accounting for the shear stiffness
$\bar{\lambda}_v$	relative slenderness for v-v axis
$\bar{\lambda}_{\text{eff}}$	effective relative slenderness
$\bar{\lambda}_p$	relative slenderness parameter for plate buckling
ξ	equivalence factor to transfer $\Delta\sigma$ to $N_c = 2 \times 10^6$ cycles
ξ	exponent of the interaction equations for angle section members
ρ	reduction factor
ρ_u	reduction factor to determine the resistance of class 4 angle sections for bending about u-u axis

ρ_v	reduction factor to determine the resistance of class 4 angle sections for bending about v-v axis
ψ	ratio of the end moments
ψ_1	coefficient
ω	reduction factor of buckling strength of single angle members

3.3 Convention for cross-section axes

- (1) The convention for axes of standard member sections adopted in this document is as shown in EN 1993-1-1:2022, Figure 3.1.
- (2) For built-up members the convention for axes is that of EN 1993-1-1:2022, 8.4.
- (3) For Schifflerized angles, see Figure 3.1.

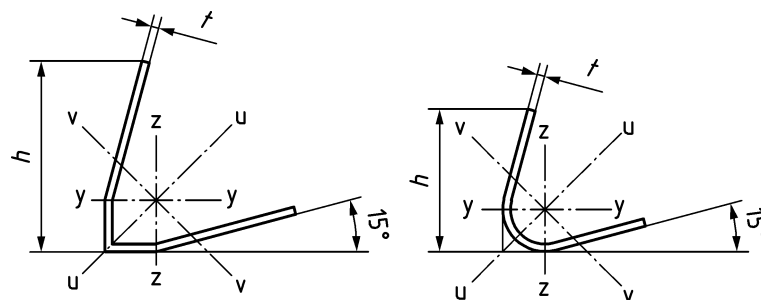


Figure 3.1 — Dimensions and axes for Schifflerized angle sections

4 Basis of design

4.1 General rules

- (1) The design of towers, masts and chimneys shall be in accordance with the general rules given in EN 1990 and the EN 1991 series and the specific design provisions for steel structures given in the EN 1993-1 series.
- (2) Structures designed according to this document shall be executed according to EN 1090-2, EN 1090-4 and Annex E with construction materials and products used as specified in the relevant parts of EN 1993 or, for materials other than steel, in the relevant material and product specifications.
- (3) For design, construction and maintenance of chimneys the fundamental requirements specified in EN 13084-9 shall apply, additionally to the requirements in EN 1993-1-1:2022, Clause 4.
- (3) Structures guyed at two or more levels and classified as consequence class 3 (as defined in EN 1990:2023, Clause A.3) should be designed to withstand the rupture of one guy without collapsing. Use Annex D (normative) for checking of guyed masts for guy rupture.

NOTE The National Annex can give information on guy rupture.

4.2 Actions and environmental influences

4.2.1 Permanent actions

4.2.1.1 Self-weights

- (1) Self-weight should be determined in accordance with EN 1991-1-1.
- (2) Self-weight of guys should be determined in accordance with EN 1993-1-11.
- (3) The permanent actions should include the estimated self-weight of all permanent structures and other elements, including fittings, coatings and other loads.
- (4) The self-weight of chimneys and their lining should be determined taking account of insulation and long-term effects of dust loads, clinging ash, fluids, or moisture on the density of linings if relevant.
- (5) In calculating self-weight, the full thickness of the structure should be considered, with no loss due to corrosion. Where self-weight acts favourably, thickness reduction due to corrosion should be considered.

4.2.1.2 Initial guy tensions

- (1) The initial guy tensions should be considered as permanent forces, equivalent to pretension of the guy, see EN 1993-1-11.
- (2) Adjustment for initial guy tensions should be provided. If not, the range of initial tensions that might arise should be considered adequately in the design, see EN 1993-1-11.
- (3) See E.6.2.3 for recommendations on values of initial guy tensions.

4.2.2 Variable actions

4.2.2.1 Wind actions

- (1) Wind actions should be taken from EN 1991-1-4.
- (2) Wind loads should be applied on the external surfaces of the structure and on wind exposed ancillary components, for example a ladder.
- (3) Vortex shedding that cause cross wind vibrations should be considered.
- (4) Uneven wind pressure distribution (ovalling) or interference effects should be considered if the relevant criteria are exceeded, see 7.4.
- (5) Interference galloping, classical galloping and rain-wind induced vibrations should be considered if the relevant criteria are exceeded, see EN 1991-1-4.
- (6) Wind induced vibrations can be reduced by installing damping devices or aerodynamic measures. Use damping devices according to Annex A (normative) when vibrations can lead to damage or to exceeding the criteria of serviceability limit state.
- (7) Reductions for temporary use may be applied according to EN 1991-1-4.

4.2.2.2 Atmospheric ice loads

- (1) Ice load should be taken from EN 1991-1-9.
- (2) Actions from ice should be considered both by their gravity effects and their effect on wind actions.

NOTE For sites exposed to ice loads, ice formation on structures can grow to considerable thicknesses, and combined with wind, the increased wind drag due to iced members can govern the design.

- (3) Wind load on iced structures should be taken from EN 1991-1-4.

(4) When estimating the weight of the ice on a lattice structures, it may normally be assumed that all structural members, components of ladders, ancillaries, etc. are covered with ice having the same thickness over the whole surface of the member, see Figure 4.1.

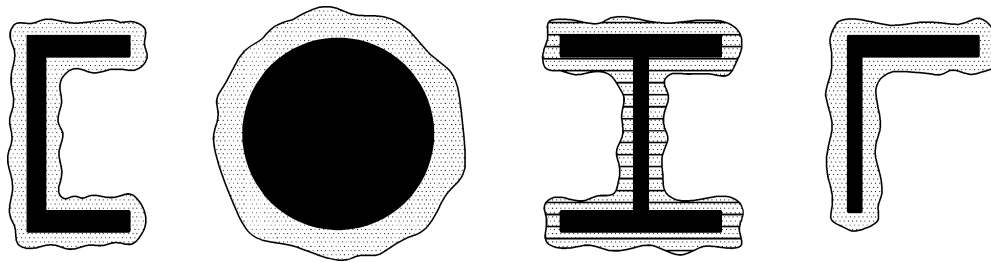


Figure 4.1 — Ice thickness on structural members

(5) As the ice can deposit asymmetrically on towers and masts, this should be considered.

NOTE Asymmetrical icing can be of particular interest for masts where icing on the different guys can vary considerably causing bending effects in the mast column. Asymmetrical ice on the guys can partly be caused by asymmetrical ice accretion depending on wind direction and partly caused by unequal shedding of ice from the guys.

(6) Asymmetric icing on a mast should be taken into consideration by applying the appropriate ice to the mast shaft and to all guys apart from:

- the guy or guys in one lane of the top guy level; and as a separate case:
- the guy or guys in two lanes of the top guy level.

(7) When placing a structure, on which icing is expected, near to passing traffic or buildings, the danger of damage from the impact of falling ice should be considered according to EN 1991-1-9.

4.2.2.3 Temperature actions

(1) Temperature actions should be determined from EN 1991-1-5 for environmental temperatures.

(2) In chimneys, temperatures from operational effects should be considered, see EN 13084-1.

(3) The temperature action should be composed of a temperature uniformly distributed over the structure and differential temperature action caused by meteorological and operational effects including those arising from an imperfect gas flow.

4.2.2.4 Live loads

(1) Publicly accessible towers should be treated as buildings, with variable actions as prescribed by EN 1991-1-1.

(2) Members that are within 30° to the horizontal should be designed to carry the weight of a person which for this purpose may be taken as a concentrated vertical load of 1,0 kN.

(3) Temporary equipment load should be considered.

(4) Personal loads on platforms and railing should be considered.

(5) The following personal and equipment loads should be used on the structure, if no higher loads are specified.

- a) For ladders and similar accessible elements: a vertical point load of 1,5 kN.

- b) For platforms and similar accessible elements: a distributed vertical load of 2,0 kN/m² or a vertical point load of 1,5 kN in unfavourable position, whatever is relevant for the respective verification.
- c) For platforms carrying temporary equipment loads should be considered, if higher loads are not specified: a vertical point load of 3 kN at the most unfavourable position.
- d) For all platforms, ladders and similar: Horizontal loads from a person due to movement and wind on that person: a horizontal load of 0,5 kN.
- e) For railings: a horizontal load of 0,5 kN/m.

(6) If access to the structure in strong wind or ice cover conditions is prohibited, the respective combination factor of temporary personal and equipment loads in the presence of wind or ice may be set to 0.

NOTE For climbing ladders, platforms and railings used to access stationary machinery, the EN ISO 14122 series can be considered.

4.2.2.5 Special actions for chimneys

(1) For chimneys the following actions should be considered (see EN 13084-1, EN 13084-6 and EN 13084-7):

- direct or indirect chemical action of the flue gases on the supporting steel structure
- influence of the internal pressure from the flue gases
- fire in the flue
- explosion and implosion

(2) The load bearing structure should not fail due to fire action, and any other parts near the chimney should not be heated to their ignition temperature.

4.2.3 Other actions

(1) Seismic actions should be determined from EN 1998.

(2) Actions during execution should be considered taking due account of the construction scheme and transient design situations. The appropriate load combinations and reduction factors may be obtained from EN 1991-1-6.

NOTE The National Annex can give information on the choice of load combinations, loads and combination factors during different phases of construction.

(3) In case that accidental and collision actions should be considered, see EN 1991-1-7.

(4) Where considered necessary, actions from settlement of foundations should be assessed. Special considerations should be required for lattice towers founded on individual leg foundations and for differential settlement between the mast base and any guy foundations.

(5) Actions arising from the fitting and anchoring of safety access equipment may be determined according to EN 795. Where the proposed safe method of working requires the use of Work Positioning Systems or mobile fall arrest systems points of attachment should be adequate, see EN 365.

4.3 Ultimate limit state verifications

(1) For design values of actions, combination and partial factors see EN 1990. The partial factors for gravity loads and mean value of the initial tensions in guys should be taken as specified in EN 1990:2023, Clause A.3.

4.4 Design assisted by testing

(1) For structures or elements that are subject to an agreed full-scale testing programme, the general requirements specified in EN 1990 should be satisfied.

(2) The logarithmic decrement of structural damping may be determined by testing.

NOTE Guidance for the determination of δ_s is given in A.6.2.

5 Materials

5.1 Structural steel

5.1.1 General

(1) For requirements and properties of structural steel, see EN 1993-1-1, EN 1993-1-3, EN 1993-1-4 and EN 1993-1-11.

5.1.2 Material properties

(1) Due account should be taken of the variation of mechanical properties of the steels due to ambient and operational temperatures, see 5.1.2(5) and 5.1.2(6).

(2) For toughness requirements of structural carbon steel, see EN 1993-1-1:2022, 5.2.3 and EN 1993-1-10. If the structure can be exposed to ice accumulation during its lifetime, the resulting low temperatures should be considered to specify toughness requirements.

(3) For toughness requirements of stainless steel, see prEN 1993-1-4:2023, 2.1.4 and EN 1993-1-10.

(4) For chimneys, where temperatures exceed 400 °C, the effects of temperature creep should be considered to avoid creep rupture, see EN 13084-6.

(5) For properties of structural carbon and stainless steel of chimneys at high temperatures, see EN 13084-7. Temperature due to flue gases should be considered where they directly impact the temperature of the structural elements of the structure. Also, EN 13084-6 provides guidance.

5.2 Connection devices

(1) For requirements and properties for bolts and welding consumables, see EN 1993-1-8.

5.3 Guys and fittings

(1) For requirements and properties of ropes, strands, wires and fittings, use EN 1993-1-11 and Annex B (normative).

6 Durability

6.1 General

(1) Durability should be satisfied by complying with the verification of the fatigue design situation (see Clause 10) and appropriate corrosion protection.

(2) The design service life should be as specified by the relevant authority or, where not specified, agreed for a specific project by the relevant parties, see EN 1990:2023, Clause A.3.3.

6.2 Corrosion

(1) Suitable corrosion protection, appropriate to the location of the structure, its design life and maintenance regime, should be provided.

NOTE Additional information of corrosion protection can be found in EN 1090-2.

(2) In unsealed hollow structures sufficient ventilation should be provided to prevent condensation, see EN ISO 12944-3.

(3) All connections should be designed to eliminate or minimize moisture retention, especially for weathering steel.

NOTE The following measures can be used as good practice:

- a) for example, orientation of members, edge and pitch distance, etc., are taken into consideration, or detailed protection of these connections is provided;
- b) vegetation at the ground line is maintained clear of the structure; and
- c) direct embedment into the soil is avoided and foundation attachments are coated to minimize the potential for corrosion due to contact with soil and exposure to constant moisture.

6.3 Corrosion allowance for chimneys

(1) Allowance for corrosion should be the sum of external (c_{ext}) and internal allowances (c_{int}). Where relevant these allowances should be applied in all or part of each 10-year period defined in Table 6.1.

(2) This total allowance should be added to the thickness needed to satisfy the requirements for strength and stability of the members.

6.3.1 External corrosion allowance

(1) External corrosion allowance should be appropriate to the environmental conditions.

(2) For corrosivity categories C2 to C4 according to EN ISO 12944-2 the values of external corrosion allowance in Table 6.1 are recommended.

NOTE 1 The National Annex can give different values for the external allowance c_{ext} than those given in Table 6.1.

NOTE 2 Additional information of material loss for hot dip galvanised steel can be found in EN ISO 12944-2:2017, Table 1.