SLOVENSKI STANDARD
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Evrokod 3: Projektiranje jeklenih konstrukcij – 3-1. del: Stolpi, jambori in dimniki - Stolpi in jambori

Eurocode 3 - Design of steel structures - Part 3-1: Towers, masts and chimneys - Towers and masts

Eurocode 3 - Bemessung und Konstruktion von Stahlbauten - Teil 3-1: Türme, Maste und Schornsteine - Türme und Maste

Eurocode 3 - Calcul des structures en acier - Partie 3-1: Tours, mâts et cheminées - Pylônes et mâts haubanés

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ICS:

91.010.30	Tehniļ ni vidiki	Technical aspects
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EUROPEAN STANDARD

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English Version

Eurocode 3 - Design of steel structures - Part 3-1: Towers, masts and chimneys - Towers and masts

Eurocode 3 - Calcul des structures en acier - Partie 3-1: Tours, mâts et cheminées - Pylônes et mâts haubannés

Eurocode 3 - Bemessung und Konstruktion von Stahlbauten - Teil 3-1: Türme, Maste und Schornsteine - Türme und Maste

This European Standard was approved by CEN on 9 January 2006.

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 Central Secretariat 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 Central Secretariat has the same status as the official versions.

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Contents

Foreword

This European Standard EN 1993-3-1, Eurocode 3: Design of steel structures: Part 3.1: Towers, masts and chimneys – Towers and masts, has been prepared by Technical Committee CEN/TC250 « Structural Eurocodes », the Secretariat of which is held by BSI. CEN/TC250 is responsible for all Structural Eurocodes.

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of an identical text or by endorsement, at the latest by April 2007 and conflicting National Standards shall be withdrawn at latest by March 2010.

This Eurocode supersedes ENV 1993-3-1.

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

Background of the Eurocode programme

In 1975, the Commission of the European Community decided on an action programme in the field of construction, based on article 95 of the Treaty. The objective of the programme was the elimination of technical obstacles to trade and the harmonisation of technical specifications.

Within this action programme, the Commission took the initiative to establish a set of harmonised technical rules for the design of construction works which, in a first stage, would serve as an alternative to the national rules in force in the Member States and, ultimately, would replace them.

For fifteen years, the Commission, with the help of a Steering Committee with Representatives of Member States, conducted the development of the Eurocodes programme, which led to the first generation of European codes in the 1980s.

In 1989, the Commission and the Member States of the EU and EFTA decided, on the basis of an agreement[1] between the Commission and CEN, to transfer the preparation and the publication of the Eurocodes to the CEN through a series of Mandates, in order to provide them with a future status of European Standard (EN). This links *de facto* the Eurocodes with the provisions of all the Council's Directives and/or Commission's Decisions dealing with European standards (e.g. the Council Directive 89/106/EEC on construction products – CPD – and Council Directives 93/37/EEC, 92/50/EEC and 89/440/EEC on public works and services and equivalent EFTA Directives initiated in pursuit of setting up the internal market).

The Structural Eurocode programme comprises the following standards generally consisting of a number of Parts:

EN 1990 Eurocode 0: Basis of structural 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

[1] Agreement between the Commission of the European Communities and the European Committee for Standardisation (CEN) concerning the work on EUROCODES for the design of building and civil engineering works (BC/CEN/03/89).

EN 1998 Eurocode 8: Design of structures for earthquake resistance

EN 1999 Eurocode 9: Design of aluminium structures

Eurocode standards recognise the responsibility of regulatory authorities in each Member State and have safeguarded their right to determine values related to regulatory safety matters at national level where these continue to vary from State to State.

Status and field of application of Eurocodes

The Member States of the EU and EFTA recognise that Eurocodes serve as reference documents for the following purposes :

- as a means to prove compliance of building and civil engineering works with the essential requirements of Council Directive 89/106/EEC, particularly Essential Requirement N°1 - Mechanical resistance and stability - and Essential Requirement N°2 - Safety in case of fire;
- as a basis for specifying contracts for construction works and related engineering services;
- as a framework for drawing up harmonised technical specifications for construction products (ENs and ETAs)

The Eurocodes, as far as they concern the construction works themselves, have a direct relationship with the Interpretative Documents[2] referred to in Article 12 of the CPD, although they are of a different nature from harmonised product standard[3]. Therefore, technical aspects arising from the Eurocodes work need to be adequately considered by CEN Technical Committees and/or EOTA Working Groups working on product standards with a view to achieving a full compatibility of these technical specifications with the Eurocodes.

The Eurocode standards provide common structural design rules for everyday use for the design of whole structures and component products of both a traditional and an innovative nature. Unusual forms of construction or design conditions are not specifically covered and additional expert consideration will be required by the designer in such cases.

National Standards implementing Eurocodes

The National Standards implementing Eurocodes will comprise the full text of the Eurocode (including any annexes), as published by CEN, which may be preceded by a National title page and National foreword, and may be followed by a National annex (informative).

The National Annex (informative) may only contain information on those parameters which are left open in the Eurocode for national choice, known as Nationally Determined Parameters, to be used for the design of buildings and civil engineering works to be constructed in the country concerned, i.e. :

- values for partial factors and/or classes where alternatives are given in the Eurocode,
- values to be used where a symbol only is given in the Eurocode,
- geographical and climatic data specific to the Member State, e.g. snow map,
- the procedure to be used where alternative procedures are given in the Eurocode,
- references to non-contradictory complementary information to assist the user to apply the Eurocode.

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[2] According to Art. 3.3 of the CPD, the essential requirements (ERs) should be given concrete form in interpretative documents for the creation of the necessary links between the essential requirements and the mandates for hENs and ETAGs/ETAs.

[3] According to Art. 12 of the CPD the interpretative documents should :
a) give concrete form to the essential requirements by harmonising the terminology and the technical bases and indicating classes or levels for each requirement where necessary ;
b) indicate methods of correlating these classes or levels of requirement with the technical specifications, e.g. methods of calculation and of proof, technical rules for project design, etc. ;
c) serve as a reference for the establishment of harmonised standards and guidelines for European technical approvals.
The Eurocodes, *de facto*, play a similar role in the field of the ER 1 and a part of ER 2.

Links between Eurocodes and product harmonized technical specifications (ENs and ETAs)

There is a need for consistency between the harmonised technical specifications for construction products and the technical rules for works[4]. Furthermore, all the information accompanying the CE Marking of the construction products which refer to Eurocodes should clearly mention which Nationally Determined Parameters have been taken into account.

Additional information specific to EN 1993-3-1 and EN 1993-3-2

EN 1993-3 is the third part of six parts of EN 1993 - Design of Steel Structures - and describes the principles and application rules for the safety and serviceability and durability of steel structures for towers and masts and chimneys. Towers and masts are dealt with in Part 3-1; chimneys are treated in Part 3-2.

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

EN 1993-3 is intended to be used with Eurocodes EN 1990 - Basis of design, EN 1991 - Actions on structures and the parts 1 of EN 1992 to EN 1998 when steel structures or steel components for towers and masts and 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.

Annex B of EN 1993-3-1 has been prepared to supplement the provisions of EN 1991-1-4 in respect of wind actions on lattice towers and guyed masts or guyed chimneys.

As far as overhead line towers are concerned all matters related to wind and ice loading, loading combinations, safety matters and special requirements (such as for conductors, insulators, clearance, etc.) are covered by the CENELEC Code EN 50341, that can be referred to for the design of such structures.

The strength requirements for steel members given in this Part may be considered as 'deemed to satisfy', rules to meet the requirements of EN 50341 for overhead line towers, and may be used as alternative criteria to the rules given in that Standard.
Part 3.2 has been prepared in collaboration with Technical Committee CEN/TC 297: Free standing chimneys.

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.

[4] See Art.3.3 and Art.12 of the CPD, as well as clauses 4.2, 4.3.1, 4.3.2 and 5.2 of ID 1.

National Annex for EN 1993-3-1

This standard gives alternative procedures, values and recommendations for classes with notes indicating where national choices may have to be made. Therefore the National Standard implementing EN 1993-3-1 should have a National Annex containing all Nationally Determined Parameters to be used for the design of buildings and civil engineering works to be constructed in the relevant country.

National choice is allowed in EN 1993-3-1 through paragraphs:

- 2.1.1(3)P
- 2.3.1(1)
- 2.3.2(1)
- 2.3.6(2)
- 2.3.7(1)
- 2.3.7(4)
- 2.5(1)
- 2.6(1)
- 4.1(1)
- 4.2(1)
- 5.1(6)
- 5.2.4(1)
- 6.1(1)
- 6.3.1(1)
- 6.4.1(1)
- 6.4.2(2)
- 6.5.1(1)
- 7.1(1)
- 9.5(1)
- A.1(1)
- A.2(1)P (2 places)
- B.1.1(1)
- B.2.1.1(5)
- B.2.3(1)
- B.2.3(3)
- B.3.2.2.6(4)
- B.3.3(1)
- B.3.3(2)
- B.4.3.2.2(2)
- B.4.3.2.3(1)
- B.4.3.2.8.1(4)
- C.2(1)
- C.6.(1)
- D.1.1(1)
- D.1.2(2)
- D.3(6) (2 places)

- D.4.1(1)
- D.4.2(3)
- D.4.3(1)
- D.4.4(1)
- F.4.2.1(1)
- F.4.2.2(2)
- G.1(3)
- H.2(5)
- H.2(7)

1 General

1.1 Scope

1.1.1 Scope of Eurocode 3

See 1.1.1 of EN 1993-1-1.

1.1.2 Scope of Part 3.1 of Eurocode 3

(1) This Part 3.1 of EN 1993 applies to the structural design of lattice towers and guyed masts and to the structural design of this type of structures supporting prismatic, cylindrical or other bluff elements. Provisions for self-supporting and guyed cylindrical towers and chimneys are given in Part 3.2 of EN 1993. Provisions for the guys of guyed structures, including guyed chimneys, are given in EN 1993-1-11 and supplemented in this Part.

(2) The provisions in this Part of EN 1993 supplement those given in Part 1.

(3) Where the applicability of a provision is limited, for practical reasons or due to simplifications, its use is explained and the limits of applicability are stated.

(4) This Part does not cover the design of polygonal and circular lighting columns, which is covered in EN 40. Lattice polygonal towers are not covered in this Part. Polygonal plated columns (monopoles) may be designed using this Part for their loading. Information on the strength of such columns may be obtained from EN 40.

(5) This Part does not cover special provisions for seismic design, which are given in EN 1998-3.

(6) Special measures that might be necessary to limit the consequences of accidents are not covered in this Part. For resistance to fire, reference should be made to EN 1993-1-2.

(7) For the execution of steel towers and masts, reference should be made to EN 1090.

NOTE: Execution is covered to the extent that is necessary to indicate the quality of the construction materials and products that should be used and the standard of workmanship on site needed to comply with the assumptions of the design rules.

1.2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this European Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this European Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies.

EN 40	*Lighting columns*
EN 365	*Personal protective equipment against falls from a height. General requirements for instructions for use, maintenance, periodic examination, repair, marking and packaging*
EN 795	*Protection against falls from a height. Anchor devices. Requirements and testing*
EN 1090	*Execution of steel structures and aluminium structures*
EN ISO 1461	*Hot dip galvanized coatings on fabricated iron and steel articles. Specifications and test methods*
EN ISO 14713	*Protection against corrosion of iron and steel in structures. Zinc and aluminium coatings. Guidelines*
ISO 12494	*Atmospheric icing of structures*
EN ISO 12944	*Corrosion protection of steel structures by protective paint systems.*

1.3 Assumptions

(1) See 1.3 of EN 1993-1-1.

1.4 Distinction between principles and application rules

(1) See 1.4 of EN 1993-1-1.

1.5 Terms and definitions

(1) The terms and definitions that are defined in EN 1990 clause 1.5 for common use in the Structural Eurocodes apply to this Part 3.1 of EN 1993.

(2) Supplementary to Part 1 of EN 1993, for the purposes of this Part 3.1, the following definition apply:

1.5.1
global analysis
the 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.

1.5.2
tower
a self-supporting cantilevered steel lattice structure of triangular, square or rectangular plan form, or circular and polygonal monopoles.

1.5.3
guyed mast
a steel lattice structure of triangular, square or rectangular plan form, or a cylindrical steel structure, stabilized at discrete intervals in its height by guys that are anchored to the ground or to a permanent structure.

1.5.4
shaft
the vertical steel structure of a mast.

1.5.5
leg members
steel members forming the main load-bearing components of the structure.

1.5.6
primary bracing members
members other than legs, carrying forces due to the loads imposed on the structure.

1.5.7
secondary bracing members
members used to reduce the buckling lengths of other members.

1.5.8
schifflerized angles
modified 90° equal-leg hot rolled angles, each leg of which has been bent to incorporate a 15° bend such that there is an angle of 30° between the outer part of each leg and the axis of symmetry (see Figure 1.1).

1.5.9
wind drag
the resistance to the flow of wind offered by the elements of a tower or guyed mast and any ancillary items that it supports, given by the product of the drag coefficient and a reference projected area, including ice where relevant.

1.5.10
linear ancillary item
any non-structural components that extend over several panels, such as waveguides, feeders, ladders and pipework.

1.5.11
discrete ancillary item
any non-structural component that is concentrated within a few panels, such as dish reflectors, aerials, lighting, platforms, handrails, insulators and other items.

1.5.12
projected area
the shadow area of the element considered, when projected on to an area parallel to the face of the structure normal to the wind direction considered, including ice where relevant. For wind blowing other than normal to one face of the structure, a reference face is used for the projected area. (See Annex A and Annex B.)

1.5.13
panel (of a tower or mast)
any convenient portion of a tower or mast that is subdivided vertically for the purpose of determining projected areas and wind drag. Panels are typically, but not necessarily, taken between intersections of legs and primary bracings.

1.5.14
section (of a tower or mast)
any convenient portion of a tower or mast comprising several panels that are nearly or exactly similar, used for the purpose of determining wind drag.

1.5.15
guy
a tension-only member, connected at each end to terminations to form a guy assembly that provides horizontal support to the mast at discrete levels. 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.

NOTE 1: Although the terms “stay” and “guy” are generally interchangeable, the word “guy” has been used throughout this document.

NOTE 2: Specific definitions of guys, their make-up and fittings, are provided in Annex D.

1.5.16
damper
a device that increases the structural damping and thus limits the response of a structure or of a guy.

1.6 Symbols

(1) In addition to those given in EN 1993-1-1, the following main symbols are used:

Latin upper case letters

D_b diameter of the circle through the centre of the bolt hole
D_i diameter of the leg member
G gust response factor
M bending moment
N tension force, number of cycles
N_i number of cycles
N_b axial force
T design life of the structure in years

Latin lower case letters

b width of a leg of an angle
$c_e(z)$ exposure factor
$c_s c_d$ structural factor
e eccentricities
h width of a leg of an angle
k_p prying effect factor
k_σ buckling coefficient
m slope of the S-N curve
n number of bolts
r_1 radius of the convex part of the bearing
r_2 radius of the concave part of the bearing
t thickness

Greek upper case letters

ϕ is the inclination of the mast axis at its base
$\Delta\sigma_E$ stress range

Greek lower case letters

β_A factor for effective area
γ_M partial factor
δ_s logarithmic decrement of structural damping
ε coefficient depending on f_y
$\overline{\lambda}$ non-dimensional slenderness parameter, equivalence factor
$\overline{\lambda}_p$ non-dimensional slenderness for plate buckling
$\overline{\lambda}_{p,1}$ non-dimensional slenderness parameter for plate buckling of leg 1 of angle
$\overline{\lambda}_{p,2}$ non-dimensional slenderness parameter for plate buckling of leg 2 of angle
ρ reduction factor

(2) Further symbols are defined where they first occur.

1.7 Convention for cross section axes

(1) The convention for axes of angle sections adopted in this Part of EN 1993 is as shown in Figure 1.1.

NOTE: This avoids the confusion inherent in adopting different conventions for hot rolled angles and cold formed angles.

(2) For built-up members the convention for axes is that of Figure 6.9 of EN 1993-1-1.

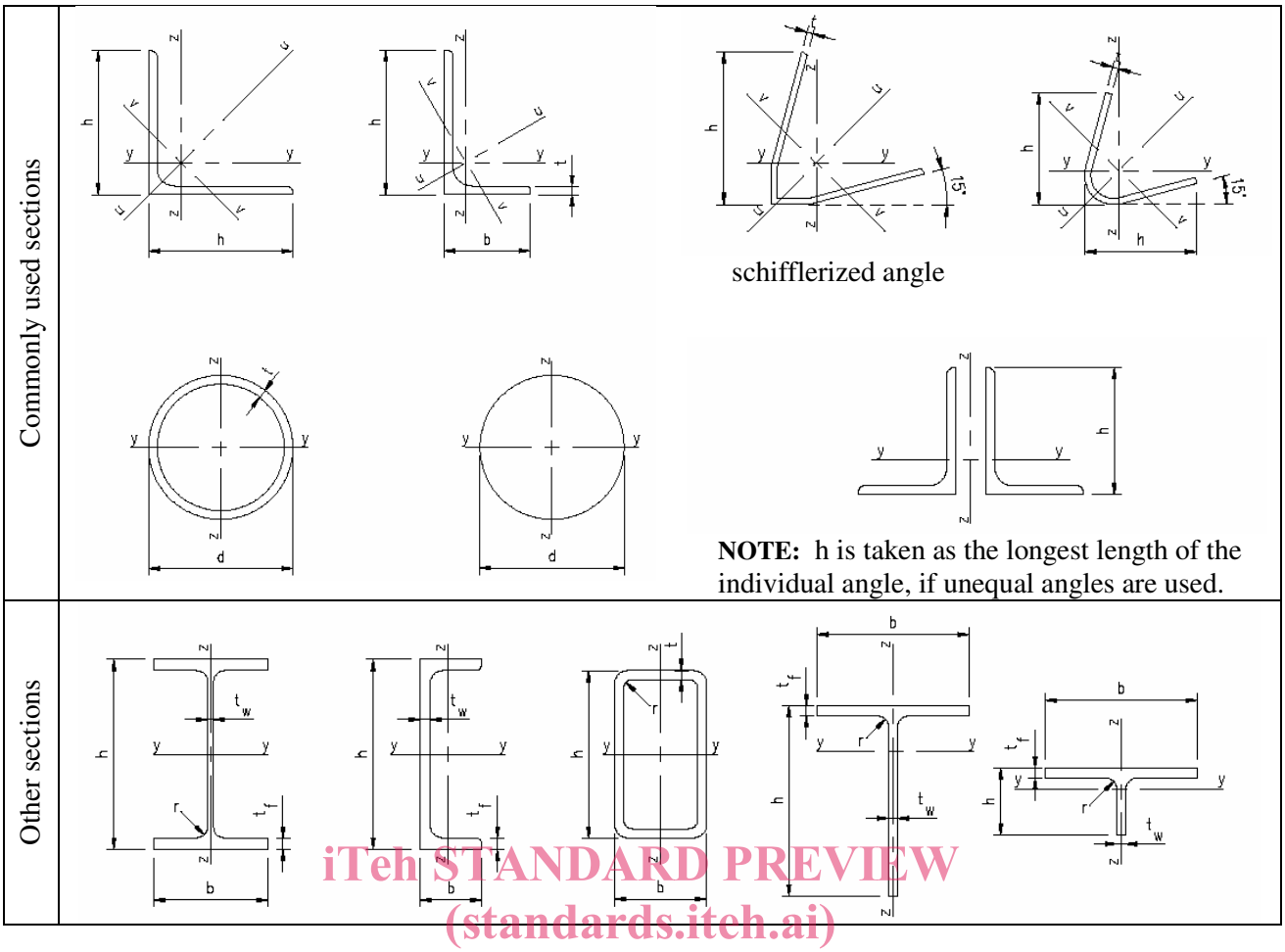

Figure 1.1 Dimensions and axes of sections

2 Basis of design

2.1 Requirements

2.1.1 Basic requirements

(1)P The design of steel towers and guyed masts shall be in accordance with the general rules given in EN 1990.

(2) The provisions for steel structures given in EN 1993-1-1 should also be applied.

(3)P In addition, guyed masts of high reliability (as defined in 2.1.2) shall be designed to withstand the rupture of one guy without collapsing.

NOTE: The National Annex may give information on guy rupture. It is recommended to use the guidance given in Annex E.

2.1.2 Reliability management

(1) Different levels of reliability may be adopted for the ultimate limit state verifications of towers and masts, depending on the possible economic and social consequences of their collapse.

NOTE: For the definition of different levels of reliability see Annex A.