SLOVENSKI STANDARD

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Evrokod 1: Vplivi na konstrukcije – 1-4. del: Splošni vplivi – Obtežbe vetra

Eurocode 1: Actions on structures - Part 1-4: General actions - Wind actions

Eurocode 1: Einwirkungen auf Tragwerke - Teil 1-4: Allgemeine Einwirkungen - Windlasten

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Eurocode 1 : Actions sur les structures - Partie 1-4 : Actions générales - Actions du vent

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ICS:

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SIST EN 1991-1-4:2005 **en**

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 1991-1-4

April 2005

ICS 91.010.30

Supersedes ENV 1991-2-4:1995

English version

Eurocode 1: Actions on structures - Part 1-4: General actions - Wind actions

Eurocode 1: - Actions sur les structures - Partie 1-4: Actions générales - Actions du vent

Eurocode 1: Einwirkungen auf Tragwerke - Teil 1-4: Allgemeine Einwirkungen - Windlasten

This European Standard was approved by CEN on 4 June 2004.

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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EUROPEAN COMMITTEE FOR STANDARDIZATION
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Foreword

This document EN 1991-1-4:2005 has been prepared by Technical Committee CEN/TC250 "Structural Eurocode", the secretariat of which is held by BSI.

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of an identical text or by endorsement, at the latest by October 2005, and conflicting national standards shall be withdrawn at the latest by March 2010.

According to the CEN/CENELEC Internal Regulations, the national standards 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, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

This European Standard supersedes ENV 1991-2-4: 1995.

CEN/TC 250 is responsible for all Structural Eurocodes.

Background of the Eurocode programme

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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.

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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 :	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

[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 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

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)

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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 standards[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 full compatibility of these technical specifications with the Eurocodes.

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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.

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

[3] According to Art. 12 of the CPD the interpretative documents shall :

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.

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.

The National annex 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 and/or classes where alternatives are given in the Eurocode,

– values to be used where a symbol only is given in the Eurocode,

– country specific data (geographical, climatic, etc.), e.g. wind map,

– the procedure to be used where alternative procedures are given in the Eurocode.

It may also contain

– decisions on the use of informative annexes, and

– references to non-contradictory complementary information to assist the user to apply the Eurocode.

Links between Eurocodes and harmonised technical specifications (ENs and ETAs) for products

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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.

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Additional information specific for EN 1991-1-4

EN 1991-1-4 gives design guidance and actions for the structural design of buildings and civil engineering works for wind.

EN 1991-1-4 is intended for the use by clients, designers, contractors and relevant authorities.

EN 1991-1-4 is intended to be used with EN 1990, the other Parts of EN 1991 and EN 1992-1999 for the design of structures.

National annex for EN 1991-1- 4

This standard gives alternative procedures, values and recommendations for classes with notes indicating where National choice may be made. Therefore the National Standard implementing EN 1991-1-4 should have a National Annex containing 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 for EN 1991-1-4 through clauses:

1.1 (11) Note 1
1.5 (2)

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[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.

4.1 (1)
4.2 (1)P Note 2
4.2 (2)P Notes 1, 2, 3 and 5
4.3.1 (1) Notes 1 and 2
4.3.2 (1)
4.3.2 (2)
4.3.3 (1)
4.3.4 (1)
4.3.5 (1)
4.4 (1) Note 2
4.5 (1) Notes 1 and 2

5.3 (5)

6.1 (1)
6.3.1 (1) Note 3
6.3.2 (1)

7.1.2 (2)
7.1.3 (1)
7.2.1 (1) Note 2
7.2.2 (1)
7.2.2 (2) Note 1
7.2.8 (1)
7.2.9 (2)
7.2.10 (3) Notes 1 and 2
7.4.1 (1)
7.4.3 (2)
7.6 (1) Note 1
7.7 (1) Note 1
7.8 (1)
7.10 (1) Note 1
7.11 (1) Note 2
7.13 (1)
7.13 (2)

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8.1 (1) Notes 1 and 2
8.1 (4)
8.1 (5)
8.2 (1) Note 1
8.3 (1)
8.3.1 (2)
8.3.2 (1)
8.3.3 (1) Note 1
8.3.4 (1)
8.4.2 (1) Notes 1 and 2

A.2 (1)

E.1.3.3 (1)
E.1.5.1 (1) Notes 1 and 2
E.1.5.1 (3)
E.1.5.2.6 (1) Note 1
E.1.5.3 (2) Note 1
E.1.5.3 (4)
E.1.5.3 (6)
E.3 (2)

Section 1 General

1.1 Scope

(1) EN 1991-1-4 gives guidance on the determination of natural wind actions for the structural design of building and civil engineering works for each of the loaded areas under consideration. This includes the whole structure or parts of the structure or elements attached to the structure, e. g. components, cladding units and their fixings, safety and noise barriers.

(2) This Part is applicable to:

– Buildings and civil engineering works with heights up to 200 m. See also (11).

– Bridges having no span greater than 200 m, provided that they satisfy the criteria for dynamic response, see (11) and 8.2.

(3) This part is intended to predict characteristic wind actions on land-based structures, their components and appendages.

(4) Certain aspects necessary to determine wind actions on a structure are dependent on the location and on the availability and quality of meteorological data, the type of terrain, etc. These need to be provided in the National Annex and Annex A, through National choice by notes in the text as indicated. Default values and methods are given in the main text, where the National Annex does not provide information.

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(5) Annex A gives illustrations of the terrain categories and provides rules for the effects of orography including displacement height, roughness change, influence of landscape and influence of neighbouring structures.

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(6) Annex B and C give alternative procedures for calculating the structural factor $c_s c_d$.

(7) Annex D gives $c_s c_d$ factors for different types of structures.

(8) Annex E gives rules for vortex induced response and some guidance on other aeroelastic effects.

(9) Annex F gives dynamic characteristics of structures with linear behaviour

(10) This part does not give guidance on local thermal effects on the characteristic wind, e.g. strong arctic thermal surface inversion or funnelling or tornadoes.

(11) This part does not give guidance on the following aspects:

– wind actions on lattice towers with non-parallel chords

– wind actions on guyed masts and guyed chimneys

– torsional vibrations, e.g. tall buildings with a central core

– bridge deck vibrations from transverse wind turbulence

– cable supported bridges

– vibrations where more than the fundamental mode needs to be considered

NOTE 1 The National Annex may provide guidance on these aspects as non contradictory complementary information.

NOTE 2 For wind actions on guyed masts, guyed chimneys and lattice towers with non-parallel chords, see EN 1993-3-1, Annex A.

NOTE 3 For wind actions on lighting columns, see EN 40.

1.2 Normative references

The following normative documents contain provisions which, through references 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 1990 Eurocode: Basis of structural design

EN 1991-1-3 Eurocode 1: Actions on structures: Part 1-3: Snow loads

EN 1991-1-6 Eurocode 1: Actions on structures: Part 1-6: Actions during execution

EN 1991-2 Eurocode 1: Actions on structures: Part 2: Traffic loads on bridges

EN 1993-3-1 Eurocode 3: Design of steel structures: Part 3-1: Masts and towers

1.3 Assumptions

(1)P The general assumptions given in EN 1990, 1.3 apply.

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1.4 Distinction between Principles and Application Rules

(1)P The rules in EN 1990, 1.4 apply.

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1.5 Design assisted by testing and measurements

(1) In supplement to calculations wind tunnel tests and proven and/or properly validated numerical methods may be used to obtain load and response information, using appropriate models of the structure and of the natural wind.

(2) Load and response information and terrain parameters may be obtained from appropriate full scale data.

NOTE: The National Annex may give guidance on design assisted by testing and measurements.

1.6 Definitions

For the purposes of this European Standard, the definitions given in ISO 2394, ISO 3898 and ISO 8930 and the following apply. Additionally for the purposes of this Standard a basic list of definitions is provided in EN 1990,1.5.

1.6.1
fundamental basic wind velocity
the 10 minute mean wind velocity with an annual risk of being exceeded of 0, 02, irrespective of wind direction, at a height of 10 m above flat open country terrain and accounting for altitude effects (if required)

1.6.2
basic wind velocity
the fundamental basic wind velocity modified to account for the direction of the wind being considered and the season (if required)

1.6.3
mean wind velocity
the basic wind velocity modified to account for the effect of terrain roughness and orography

1.6.4
pressure coefficient
external pressure coefficients give the effect of the wind on the external surfaces of buildings; internal pressure coefficients give the effect of the wind on the internal surfaces of buildings.

The external pressure coefficients are divided into overall coefficients and local coefficients. Local coefficients give the pressure coefficients for loaded areas of 1 m^2 or less e.g. for the design of small elements and fixings; overall coefficients give the pressure coefficients for loaded areas larger than 10 m^2.

Net pressure coefficients give the resulting effect of the wind on a structure, structural element or component per unit area.

1.6.5
force coefficient
force coefficients give the overall effect of the wind on a structure, structural element or component as a whole, including friction, if not specifically excluded

1.6.6
background response factor
the background factor allowing for the lack of full correlation of the pressure on the structure surface

1.6.7
resonance response factor
the resonance response factor allowing for turbulence in resonance with the vibration mode

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1.7 Symbols

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(1) For the purposes of this European standard, the following symbols apply

NOTE The notation used is based on ISO 3898:1999. In this Part the symbol dot in expressions indicates the multiplication sign. This notation has been employed to avoid confusion with functional expressions.

(2) A basic list of notations is provided in EN 1990, 1.6 and the additional notations below are specific to EN 1991-1-4.

Latin upper case letters

A	area
A_{fr}	area swept by the wind
A_{ref}	reference area
B^2	background response part
C	wind load factor for bridges
E	Young's modulus
F_{fr}	resultant friction force
F_j	vortex exciting force at point j of the structure
F_w	resultant wind force
H	height of a topographic feature
I_v	turbulence intensity
K	mode shape factor; shape parameter

K_{iv}	interference factor for vortex shedding
K_{rd}	reduction factor for parapets
K_w	correlation length factor
K_x	non dimensional coefficient
L	length of the span of a bridge deck; turbulent length scale
L_d	actual length of a downwind slope
L_e	effective length of an upwind slope
L_j	correlation length
L_u	actual length of an upwind slope
N	number of cycles caused by vortex shedding
N_g	number of loads for gust response
R^2	resonant response part
Re	Reynolds number
R_h, R_b	aerodynamic admittance
S	wind action
Sc	Scruton number
S_L	non dimensional power spectral density function
St	Strouhal number
W_s	weight of the structural parts contributing to the stiffness of a chimney
W_t	total weight of a chimney

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Latin lower case letters

a_G	factor of galloping instability
a_{IG}	combined stability parameter for interference galloping
b	width of the structure (the length of the surface perpendicular to the wind direction if not otherwise specified)
c_{alt}	altitude factor
c_d	dynamic factor
c_{dir}	directional factor
$c_e(z)$	exposure factor
c_f	force coefficient
$c_{f,o}$	force coefficient of structures or structural elements without free-end flow
$c_{f,l}$	lift force coefficient
c_{fr}	friction coefficient
c_{lat}	aerodynamic exciting coefficient
c_M	moment coefficient
c_p	pressure coefficient
c_{prob}	probability factor
c_r	roughness factor
c_o	orography factor

c_s	size factor
c_{season}	seasonal factor
d	depth of the structure (the length of the surface parallel to the wind direction if not otherwise specified)
e	eccentricity of a force or edge distance
f_L	non dimensional frequency
h	height of the structure
h_{ave}	obstruction height
h_{dis}	displacement height
k	equivalent roughness
k_p	peak factor
k_r	terrain factor
k_Θ	torsional stiffness
l	length of a horizontal structure
m	mass per unit length
m_1	equivalent mass per unit length
n_i	natural frequency of the structure of the mode i
$n_{1,x}$	fundamental frequency of along wind vibration
$n_{1,y}$	fundamental frequency of cross-wind vibration
n_0	ovalling frequency
p	annual probability of exceedence
q_b	reference mean (basic) velocity pressure
q_p	peak velocity pressure
r	radius
s	factor; coordinate
t	averaging time of the reference wind speed, plate thickness
v_{CG}	onset wind velocity for galloping
v_{CIG}	critical wind velocity for interference galloping
v_{crit}	critical wind velocity of vortex shedding
v_{div}	divergence wind velocity
v_m	mean wind velocity
$v_{b,0}$	fundamental value of the basic wind velocity
v_b	basic wind velocity
w	wind pressure
x	horizontal distance of the site from the top of a crest
x-direction	horizontal direction, perpendicular to the span
y-direction	horizontal direction along the span
y_{max}	maximum cross-wind amplitude at critical wind speed
z	height above ground
z_{ave}	average height
z-direction	vertical direction

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