DIN EN 1991-1-4



ICS 91.010.30

Supersedes: see below

Eurocode 1: Actions on structures – Part 1-4: General actions – Wind actions (includes Amendment A1:2010 + Corrigendum AC:2010) English translation of DIN EN 1991-1-4:2010-12

Eurocode 1: Einwirkungen auf Tragwerke -Teil 1-4: Allgemeine Einwirkungen -Windlasten (enthält Änderung A1:2010 + Berichtigung AC:2010) Englische Übersetzung von DIN EN 1991-1-4:2010-12

Eurocode 1: Actions sur les structures -Partie 1-4: Actions générales -Actions du vent (Amendement A1:2010 + Corrigendum AC:2010 inclus) Traduction anglaise de DIN EN 1991-1-4:2010-12

Supersedes DIN EN 1991-1-4:2005-07; together with DIN EN 1991-1-4/NA:2010-12, supersedes DIN 1055-4:2005-03 and DIN 1055-4 Corrigendum 1:2006-03; supersedes DIN EN 1991-1-4 Corrigendum 1:2010-01

Document comprises 151 pages

Translation by DIN-Sprachendienst.

In case of doubt, the German-language original shall be considered authoritative.

No part of this translation may be reproduced without prior permission of DIN Deutsches Institut für lin.de has the exclusive right of s th.de This is a preview. Click here to purchase the full publication. 02 11



A comma is used as the decimal marker.

National foreword

This standard has been prepared by Technical Committee CEN/TC 250 "Structural Eurocodes" (Secretariat: BSI, United Kingdom).

The responsible German body involved in its preparation was the *Normenausschuss Bauwesen* (Building and Civil Engineering Standards Committee), Working Committee NA 005-51-02 AA *Einwirkungen auf Bauten (Sp CEN/TC 250/SC 1).*

This document includes Amendment EN 1991-1-4:2005/A1:2010, approved by CEN on 18 February 2010. In addition, this document includes Corrigendum EN 1991-1-4:2005/AC:2010, approved by CEN on 27 January 2010.

In Germany, this standard is to be applied in conjunction with the National Annex.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. DIN [and/or DKE] shall not be held responsible for identifying any or all such patent rights.

The start and finish of text introduced or altered by amendment or corrigendum is indicated in the text by tags A and AC AC.

Amendments

This standard differs from DIN V ENV 1991-2-4:1996-12 as follows:

- a) the prestandard status has been changed to that of a full standard;
- b) the number of the standard has been changed to DIN EN 1991-1-4;
- c) the comments received from the national standards bodies have been taken into account and the text of the standard has been completely revised.

Compared with DIN EN 1991-1-4:2005-07, DIN EN 1991-1-4 Corrigendum 1:2010-01, DIN 1055-4:2005-03 and DIN 1055-4 Corrigendum 1:2006-03, the following corrections have been made:

- a) the standard has been based on European design rules;
- b) superseding notes have been corrected;
- c) this standard is the consolidated version of the previous 2005 edition with Amendment A1:2010 and Corrigendum AC:2010;
- d) further subclauses have been added to the list indicating where national choice may be made;
- e) Subclauses 7.2.3(2), 7.2.3(4), 7.2.4(1), 7.2.4(3), 7.2.5(1), 7.2.5(3), 7.2.6(1), 7.2.6(3), 7.2.7(4) and 7.9.2(2) have been replaced by new subclauses;
- f) Subclause 7.2.3 (5) has been deleted;
- g) the titles of Tables 7.2, 7.3a, 7.3b, 7.4a, 7.4b and 7.5 have been changed and some tables have been moved from the main text to notes;

- h) in Table 7.14, the first column, second line has been deleted;
- i) national specifications of DIN 1055-4 have been adopted.

Previous editions

DIN 1055-4: 1938xxx-06, 1977-05, 1986-08, 2005-03 DIN 1055-4/A1: 1987-06 DIN 1055-4 Corrigendum 1: 2006-03 Supplement to DIN 1055-4: 1939-06, 1941-02 DIN EN 1991-1-4: 2005-07 DIN EN 1991-1-4 Corrigendum 1: 2010-01 DIN V ENV 1991-2-4: 1996-12 - This page is intentionally blank -

EUROPEAN STANDARD NORME EUROPÉENNE EUROPÄISCHE NORM

EN 1991-1-4

April 2005

+ A1 + AC

April 2010 January 2010

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

EN 1991-1-4:2005 was approved by CEN on 2004-06-04, Amendment A1:2010 on 2010-02-18 and Corrigendum AC:2010 on 2010-01-27.

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 Management Centre or to any CEN member.

The European Standards exist 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 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, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.



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

Management Centre: Avenue Marnix 17, B-1000 Brussels

© 2010 CEN All rights of exploitation in any form and by any means reserved worldwide for CEN national Members.

Ref. No. EN 1991-1-4:2005 + A1:2010 + AC:2010 E

This is a preview. Click here to purchase the full publication.

Contents

5 Foreword to EN 1991-1-4:2005 A Foreword to EN 1991-1-4:2005/A1:2010 5 Section 1 General 10 1.1 Scope 10 **1.2 Normative references** 11 1.3 Assumptions 11 **1.4 Distinction between Principles and Application Rules** 11 1.5 Design assisted by testing and measurements 11 **1.6 Definitions** 11 1.7 Symbols 12 Section 2 **Design situations** 17 Section 3 Modelling of wind actions 18 3.1 Nature 18 3.2 Representations of wind actions 18 3.3 Classification of wind actions 18 3.4 Characteristic values 18 3.5 Models 18 Section 4 Wind velocity and velocity pressure 19 4.1 Basis for calculation 19 4.2 Basic values 19 4.3 Mean wind 20 4.3.1 Variation with height 20 4.3.2 Terrain roughness 20 4.3.3 Terrain orography 22 4.3.4 Large and considerably higher neighbouring structures 22 4.3.5 Closely spaced buildings and obstacles 23 4.4 Wind turbulence 23 23 4.5 Peak velocity pressure Section 5 Wind actions 25 5.1 General 25 5.2 Wind pressure on surfaces 25 5.3 Wind forces 26 29 Section 6 Structural factor c_Scd 6.1 General 29 29 6.2 Determination of c_sc_d 6.3 Detailed procedure 29 6.3.1 Structural factor $c_{s}c_{d}$ 29 6.3.2 Serviceability assessments 31 6.3.3 Wake buffeting 31 Section 7 Pressure and force coefficients 32 7.1 General 32 Choice of aerodynamic coefficient 32 7.1.1 Asymmetric and counteracting pressures and forces 33 7.1.2 7.1.3 Effects of ice and snow 33 7.2 Pressure coefficients for buildings 34 7.2.1 General 34 35 7.2.2 Vertical walls of rectangular plan buildings 7.2.3 Flat roofs 38 7.2.4 Monopitch roofs 41 7.2.5 **Duopitch roofs** 44 7.2.6 **Hipped roofs** 48

Page

DIN EN 1991-1-4:2010-12 EN 1991-1-4:2005 + A1:2010 + AC:2010 (E)

7.2.9 Internal pressure	52		
7.2.10 Pressure on walls or roofs with more than one skin			
7.3 Canopy roofs	55		
7.4 Free-standing walls, parapets, fences and signboards			
7.4.1 Fieldstanding waits and parapets $7.4.2$ Shelter factors for walls and fonces	67 67		
7.4.2 Sinchoards	64		
7.5 Friction coefficients	65		
7.6 Structural elements with rectangular sections	66		
7.7 Structural elements with sharp edged section	68		
7.8 Structural elements with regular polygonal section	68		
7.9 Circular cylinders	70		
7.9.1 External pressure coefficients	/0		
7.3.2 Force coefficients for vertical cylinders in a row arrangement	75		
7.10 Spheres	75		
7.11 Lattice structures and scaffoldings	77		
7.12 Flags	79		
7.13 Effective slenderness λ and end-effect factor ψ_{λ}	81		
Section 8 Wind actions on bridges	83		
8.1 General	83		
8.2 Choice of the response calculation procedure	86		
8.3 Force coefficients	86		
8.3.1 Force coefficients in x-direction (general method)	86		
8.3.2 Force in x-direction – Simplified Method	89		
8.3.3 Wind forces on bridge decks in z-direction	90		
8.4 Bridge niers	91		
8.4.1 Wind directions and design situations	92		
8.4.2 Wind effects on piers	92		
Annex A (informative) Terrain effects	93		
A.1 Illustrations of the upper roughness of each terrain category	93		
A.2 Transition between roughness categories 0, I, II, III and IV	94		
A.3 Numerical calculation of orography coefficients	96		
A.4 Neighbouring structures	101		
A.5 Displacement height	102		
Annex B (informative) Procedure 1 for determining the structural factor cscd	103		
B.1 Wind turbulence	103		
B.2 Structural factor	104		
B.3 Number of loads for dynamic response B.4 Service displacement and accelerations for service ability accessments of a vertical	106		
B.4 Service displacement and accelerations for serviceability assessments of a vertical structure	106		
	100		
Annex C (informative) Procedure 2 for determining the structural factor $c_s c_d$	109		
C.1 Wind turbulence C.2 Structural factor	109		
C.3 Number of loads for dynamic response	110		
C.4 Service displacement and accelerations for serviceability assessments	110		
Annex D (informative) c.c. values for different types of structures	112		
Annex E (informative) Vortex shedding and aeroelastic instabilities	115		
E.1 Vortex snedding	115		
E.1.2 Criteria for vortex shedding	115		
E.1.3 Basic parameters for vortex shedding	116		
E.1.4 Vortex shedding action	119		
E.1.5 Calculation of the cross wind amplitude	119		
E.1.6 Measures against vortex induced vibrations	129		
E.2 Galloping	130		
E.2.1 General	130		

E.2.2 Onset wind velocity	130	
E.2.3 Classical galloping of coupled cylinders	132	
E.3 Interference galloping of two or more free standing cylinders	134	
E.4 Divergence and Flutter		
E.4.1 General	135	
E.4.2 Criteria for plate-like structures	135	
E.4.3 Divergency velocity	135	
Annex F (informative) Dynamic characteristics of structures		
F.1 General		
F.2 Fundamental frequency		
F.3 Fundamental mode shape		
F.4 Equivalent mass		
F.5 Logarithmic decrement of damping		
Bibliography		

Foreword to EN 1991-1-4:2005

This document (EN 1991-1-4:2005) has been prepared by Technical Committee CEN/TC 250 "Structural Eurocodes", 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.

This document supersedes ENV 1991-2-4:1995.

CEN/TC 250 is responsible for all Structural Eurocodes.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

A₁ Foreword to EN 1991-1-4:2005/A1:2010

This document (EN 1991-1-4:2005/A1:2010) has been prepared by Technical Committee CEN/TC 250 "Structural Eurocodes", 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 April 2011, and conflicting national standards shall be withdrawn at the latest by October 2010.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

According to the CEN/CENELEC Internal Regulations, the national standards organizations 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, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the 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 agreement¹ 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
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 ;

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).