

DIN EN 1993-1-1



ICS 91.010.30; 91.080.10

Supersedes: see below

**Eurocode 3: Design of steel structures –
Part 1-1: General rules and rules for buildings
(includes Corrigendum AC:2009)
English translation of DIN EN 1993-1-1:2010-12**

Eurocode 3: Bemessung und Konstruktion von Stahlbauten –
Teil 1-1: Allgemeine Bemessungsregeln und Regeln für den Hochbau
(enthält Berichtigung AC:2009)
Englische Übersetzung von DIN EN 1993-1-1:2010-12

Eurocode 3: Calcul des structures en acier –
Partie 1-1: Règles générales et règles pour les bâtiments
(Corrigendum AC:2009 inclus)
Traduction anglaise de DIN EN 1993-1-1:2010-12

Supersedes DIN EN 1993-1-1:2010-08;
together with DIN EN 1993-1-1/NA:2010-12, DIN EN 1993-1-3:2010-12, DIN EN 1993-1-3/NA:2010-12,
DIN EN 1993-1-5:2010-12, DIN EN 1993-1-5/NA:2010-12, DIN EN 1993-1-8:2010-12,
DIN EN 1993-1-8/NA:2010-12, DIN EN 1993-1-9:2010-12, DIN EN 1993-1-9/NA:2010-12,
DIN EN 1993-1-10:2010-12, DIN EN 1993-1-10/NA:2010-12, DIN EN 1993-1-11:2010-12 and
DIN EN 1993-1-11/NA:2010-12 supersedes DIN 18800-1:2008-11;
together with DIN EN 1993-1-1/NA:2010-12, DIN EN 1993-1-3:2010-12, DIN EN 1993-1-3/NA:2010-12,
DIN EN 1993-1-5:2010-12 and DIN EN 1993-1-5/NA:2010-12 supersedes DIN 18800-2:2008-11;
together with DIN EN 1993-1-1/NA:2010-12, DIN EN 1993-1-8:2010-12, DIN EN 1993-1-8/NA:2010-12,
DIN EN 1993-1-11:2010-12 and DIN EN 1993-1-11/NA:2010-12 supersedes DIN 18801:1983-09;
together with DIN EN 1993-1-1/NA:2010-12, DIN EN 1993-1-8:2010-12 and DIN EN 1993-1-8/NA:2010-12
supersedes DIN 18808:1984-10

Document comprises 95 pages

Translation by DIN-Sprachendienst.

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



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 005-08-16 AA *Tragwerksbemessung* (Sp CEN/TC 250/SC 3).

EN 1993-1-1 was approved by CEN on 16 April 2004.

This European Standard is part of a series of standards dealing with structural design (Eurocodes) which are intended to be used as a “package”. In Guidance Paper L on the application and use of Eurocodes, issued by the EU Commission, reference is made to transitional periods for the introduction of the Eurocodes in the Member states. The transitional periods are given in the Foreword of this standard.

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  .

Amendments

This standard differs from DIN V ENV 1993-1-1:1993-04, DIN V ENV 1993-1-1/A1:2002-05 and DIN V ENV 1993-1-1/A2:2002-05 as follows:

- a) the prestandard status has been changed to that of a full standard;
- b) the standard has been divided up into Parts 1-1, 1-8, 1-9 and 1-10;
- c) the comments received from the national member bodies of CEN have been taken into account and the standard has been completely revised.

Compared with DIN EN 1993-1-1:2005-07 and DIN EN 1993-1-1 Corrigendum 1:2006-05, the following corrections have been made:

- a) the European Corrigendum EN 1993-1-1:2005/AC:2009 and Corrigendum 1:2006-05 have been incorporated.

Compared with DIN EN 1993-1-1:2010-08, DIN 18800-1:2008-11, DIN 18800-2:2008-11, DIN 18801:1983-09 and DIN 18808:1984-10, 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 Corrigendum AC:2009;
- d) the standard has been editorially revised.

Previous editions

DIN 1050: 1934-08, 1937xxxx-07, 1946-10, 1957x-12, 1968-06
DIN 1073: 1928-04, 1931-09, 1941-01, 1974-07
DIN 1079: 1938-01, 1938-11, 1970-09
DIN 4100: 1931-05, 1933-07, 1934xxxx-08, 1956-12, 1968-12
DIN 4101: 1937xxx-07, 1974-07
Supplement to DIN 1073: 1974-07
DIN 18800-1: 1981-03, 1990-11, 2008-11
DIN 18800-1/A1: 1996-02
DIN 4114-1: 1952xx-07
DIN 4114-2: 1952-07, 1953-02
DIN 18800-2: 1990-11, 2008-11
DIN 18800-2/A1: 1996-02
DIN 18801: 1983-09
DIN 18808: 1984-10
DIN V ENV 1993-1-1: 1993-04
DIN V ENV 1993-1-1/A1: 2002-05
DIN V ENV 1993-1-1/A2: 2002-05
DIN EN 1993-1-1: 2005-07
DIN EN 1993-1-1 Corrigendum 1: 2006-05

— This page is intentionally blank —

English version

Eurocode 3: Design of steel structures — Part 1-1: General rules and rules for buildings

Eurocode 3: Calcul des structures en acier — Partie 1-1:
Règles générales et règles pour les bâtiments

Eurocode 3: Bemessung und Konstruktion von
Stahlbauten — Teil 1-1: Allgemeine Bemessungsregeln
und Regeln für den Hochbau

EN 1993-1-1:2005 was approved by CEN on 2004-04-16 and Corrigendum AC:2009 on 2009-04-15.

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

Contents

Page

Foreword	5
1 General	9
1.1 Scope.....	9
1.2 Normative references.....	10
1.3 Assumptions.....	11
1.4 Distinction between principles and application rules	11
1.5 Terms and definitions	11
1.6 Symbols.....	12
1.7 Conventions for member axes.....	20
2 Basis of design.....	22
2.1 Requirements	22
2.1.1 Basic requirements	22
2.1.2 Reliability management.....	22
2.1.3 Design working life, durability and robustness	22
2.2 Principles of limit state design	23
2.3 Basic variables	23
2.3.1 Actions and environmental influences.....	23
2.3.2 Material and product properties.....	23
2.4 Verification by the partial factor method	23
2.4.1 Design values of material properties	23
2.4.2 Design values of geometrical data.....	23
2.4.3 Design resistances.....	24
2.4.4 Verification of static equilibrium (EQU).....	24
2.5 Design assisted by testing.....	24
3 Materials.....	25
3.1 General.....	25
3.2 Structural steel.....	25
3.2.1 Material properties.....	25
3.2.2 Ductility requirements	25
3.2.3 Fracture toughness.....	25
3.2.4 Through-thickness properties	27
3.2.5 Tolerances.....	28
3.2.6 Design values of material coefficients.....	28
3.3 Connecting devices.....	28
3.3.1 Fasteners	28
3.3.2 Welding consumables.....	28
3.4 Other prefabricated products in buildings	28
4 Durability	28
5 Structural analysis.....	29
5.1 Structural modelling for analysis	29
5.1.1 Structural modelling and basic assumptions.....	29

5.1.2	Joint modelling	29
5.1.3	Ground-structure interaction.....	29
5.2	<i>Global analysis</i>	30
5.2.1	Effects of deformed geometry of the structure	30
5.2.2	Structural stability of frames	31
5.3	<i>Imperfections</i>	32
5.3.1	Basis	32
5.3.2	Imperfections for global analysis of frames	33
5.3.3	Imperfection for analysis of bracing systems	36
5.3.4	Member imperfections.....	38
5.4	<i>Methods of analysis considering material non-linearities</i>	38
5.4.1	General	38
5.4.2	Elastic global analysis	39
5.4.3	Plastic global analysis.....	39
5.5	<i>Classification of cross sections</i>	40
5.5.1	Basis	40
5.5.2	Classification	40
5.6	<i>Cross-section requirements for plastic global analysis</i>	41
6	Ultimate limit states	45
6.1	<i>General</i>	45
6.2	<i>Resistance of cross-sections</i>	45
6.2.1	General	45
6.2.2	Section properties	46
6.2.3	Tension	49
6.2.4	Compression	49
6.2.5	Bending moment.....	50
6.2.6	Shear	50
6.2.7	Torsion.....	52
6.2.8	Bending and shear	53
6.2.9	Bending and axial force.....	54
6.2.10	Bending, shear and axial force	56
6.3	<i>Buckling resistance of members</i>	56
6.3.1	Uniform members in compression.....	56
6.3.2	Uniform members in bending.....	60
6.3.3	Uniform members in bending and axial compression	64
6.3.4	General method for lateral and lateral torsional buckling of structural components.....	65
6.3.5	Lateral torsional buckling of members with plastic hinges	67
6.4	<i>Uniform built-up compression members</i>	69
6.4.1	General	69
6.4.2	Laced compression members.....	71
6.4.3	Battened compression members	72
6.4.4	Closely spaced built-up members.....	74
7	Serviceability limit states	75
7.1	<i>General</i>	75
7.2	<i>Serviceability limit states for buildings</i>	75
7.2.1	Vertical deflections.....	75
7.2.2	Horizontal deflections.....	75
7.2.3	Dynamic effects.....	75
Annex A	[informative] – Method 1: Interaction factors k_{ij} for interaction formula in 6.3.3(4)	76

Annex B [informative] – Method 2: Interaction factors k_{ij} for interaction formula in 6.3.3(4)	79
Annex AB [informative] – Additional design provisions	81
Annex BB [informative] – Buckling of components of building structures	82

Foreword

This document (EN 1993-1-1:2005 + AC:2009) 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 November 2005, and conflicting national standards shall be withdrawn at the latest by March 2010.

This document supersedes ENV 1993-1-1:1992.

According to the CEN-CENELEC Internal Regulations, the National Standard Organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, 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 harmonization of technical specifications.

Within this action programme, the Commission took the initiative to establish a set of harmonized 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

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).

Eurocode standards recognize 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 recognize 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 harmonized 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 Documents² referred to in Article 12 of the CPD, although they are of a different nature from harmonized product standard³. 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.

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 hENs and ETAGs/ETAs.

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

- a) give concrete form to the essential requirements by harmonizing 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 harmonized 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.