

**Eurokoodeks 3: Teraskonstruksioonide
projekteerimine. Osa 1-8: Liidete projekteerimine**

**Eurocode 3: Design of steel structures - Part 1-8: Design
of joints**

EESTI STANDARDI EESSÕNA

NATIONAL FOREWORD

See Eesti standard EVS-EN 1993-1-8:2005 sisaldab Euroopa standardi EN 1993-1-8:2005+AC:2005+AC:2009 ingliskeelset teksti.	This Estonian standard EVS-EN 1993-1-8:2005 consists of the English text of the European standard EN 1993-1-8:2005+AC:2005+AC:2009.
Standard on jõustunud sellekohase teate avaldamisega EVS Teatajas.	This standard has been endorsed with a notification published in the official bulletin of the Estonian Centre for Standardisation.
Euroopa standardimisorganisatsioonid on teinud Euroopa standardi rahvuslikele liikmetele kättesaadavaks 11.05.2005.	Date of Availability of the European standard is 11.05.2005.
Standard on kättesaadav Eesti Standardikeskusest.	The standard is available from the Estonian Centre for Standardisation.

Tagasisidet standardi sisu kohta on võimalik edastada, kasutades EVS-i veebilehel asuvat tagasiside vormi või saates e-kirja meiliaadressile standardiosakond@evs.ee.

ICS 91.010.30

Standardite reprodutseerimise ja levitamise õigus kuulub Eesti Standardikeskusele

Andmete paljundamine, taastekitamine, kopeerimine, salvestamine elektroonsesse süsteemi või edastamine ükskõik millises vormis või millisel teel ilma Eesti Standardikeskuse kirjaliku loata on keelatud.

Kui Teil on küsimusi standardite autorikaitse kohta, võtke palun ühendust Eesti Standardikeskusega:
Aru 10, 10317 Tallinn, Eesti; www.evs.ee; telefon 605 5050; e-post info@evs.ee

The right to reproduce and distribute standards belongs to the Estonian Centre for Standardisation

No part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying, without a written permission from the Estonian Centre for Standardisation.

If you have any questions about copyright, please contact Estonian Centre for Standardisation:
Aru 10, 10317 Tallinn, Estonia; www.evs.ee; phone 605 5050; e-mail info@evs.ee

English version

Eurocode 3: Design of steel structures - Part 1-8: Design of joints

Eurocode 3: Calcul des structures en acier - Partie 1-8:
Calcul des assemblages

Eurocode 3: Bemessung und Konstruktion von Stahlbauten
- Teil 1-8: Bemessung von Anschlüssen

This European Standard was approved by CEN on 16 April 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.

CEN members are the national standards bodies of 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.



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

Management Centre: rue de Stassart, 36 B-1050 Brussels

Contents

Page

1	Introduction	8
1.1	Scope	8
1.2	Normative references.....	8
1.3	Distinction between Principles and Application Rules	10
1.4	Terms and definitions	10
1.5	Symbols	13
2	Basis of design	18
2.1	Assumptions	18
2.2	General requirements.....	18
2.3	Applied forces and moments	18
2.4	Resistance of joints.....	18
2.5	Design assumptions	19
2.6	Joints loaded in shear subject to impact, vibration and/or load reversal	19
2.7	Eccentricity at intersections.....	19
3	Connections made with bolts, rivets or pins.....	20
3.1	Bolts, nuts and washers	20
3.1.1	General	20
3.1.2	Preloaded bolts	20
3.2	Rivets.....	20
3.3	Anchor bolts	21
3.4	Categories of bolted connections.....	21
3.4.1	Shear connections	21
3.4.2	Tension connections	21
3.5	Positioning of holes for bolts and rivets	23
3.6	Design resistance of individual fasteners	24
3.6.1	Bolts and rivets	24
3.6.2	Injection bolts	28
3.7	Group of fasteners	29
3.8	Long joints.....	29
3.9	Slip-resistant connections using 8.8 or 10.9 bolts	30
3.9.1	Design Slip resistance.....	30
3.9.2	Combined tension and shear.....	31
3.9.3	Hybrid connections.....	31
3.10	Deductions for fastener holes	31
3.10.1	General	31
3.10.2	Design for block tearing	32
3.10.3	Angles connected by one leg and other unsymmetrically connected members in tension	33
3.10.4	Lug angles	34
3.11	Prying forces.....	34
3.12	Distribution of forces between fasteners at the ultimate limit state.....	34
3.13	Connections made with pins.....	35
3.13.1	General	35
3.13.2	Design of pins.....	35
4	Welded connections	38
4.1	General	38
4.2	Welding consumables.....	38
4.3	Geometry and dimensions	38
4.3.1	Type of weld.....	38
4.3.2	Fillet welds	38
4.3.3	Fillet welds all round	40
4.3.4	Butt welds	40
4.3.5	Plug welds	41

4.3.6	Flare groove welds.....	41
4.4	Welds with packings.....	41
4.5	Design resistance of a fillet weld.....	42
4.5.1	Length of welds.....	42
4.5.2	Effective throat thickness.....	42
4.5.3	Design Resistance of fillet welds.....	42
4.6	Design resistance of fillet welds all round.....	44
4.7	Design resistance of butt welds.....	45
4.7.1	Full penetration butt welds.....	45
4.7.2	Partial penetration butt welds.....	45
4.7.3	T-butt joints.....	45
4.8	Design resistance of plug welds.....	45
4.9	Distribution of forces.....	46
4.10	Connections to unstiffened flanges.....	46
4.11	Long joints.....	48
4.12	Eccentrically loaded single fillet or single-sided partial penetration butt welds.....	48
4.13	Angles connected by one leg.....	48
4.14	Welding in cold-formed zones.....	49
5	Analysis, classification and modelling	50
5.1	Global analysis.....	50
5.1.1	General.....	50
5.1.2	Elastic global analysis.....	50
5.1.3	Rigid-plastic global analysis.....	51
5.1.4	Elastic-plastic global analysis.....	51
5.1.5	Global analysis of lattice girders.....	52
5.2	Classification of joints.....	54
5.2.1	General.....	54
5.2.2	Classification by stiffness.....	54
5.2.3	Classification by strength.....	55
5.3	Modelling of beam-to-column joints.....	56
6	Structural joints connecting H or I sections.....	60
6.1	General.....	60
6.1.1	Basis.....	60
6.1.2	Structural properties.....	60
6.1.3	Basic components of a joint.....	61
6.2	Design Resistance.....	65
6.2.1	Internal forces.....	65
6.2.2	Shear forces.....	65
6.2.3	Bending moments.....	66
6.2.4	Equivalent T-stub in tension.....	67
6.2.5	Equivalent T-stub in compression.....	70
6.2.6	Design Resistance of basic components.....	71
6.2.7	Design moment resistance of beam-to-column joints and splices.....	84
6.2.8	Design resistance of column bases with base plates.....	89
6.3	Rotational stiffness.....	92
6.3.1	Basic model.....	92
6.3.2	Stiffness coefficients for basic joint components.....	94
6.3.3	End-plate joints with two or more bolt-rows in tension.....	97
6.3.4	Column bases.....	98
6.4	Rotation capacity.....	99
6.4.1	General.....	99
6.4.2	Bolted joints.....	100
6.4.3	Welded Joints.....	100
7	Hollow section joints.....	101
7.1	General.....	101

7.1.1	Scope	101
7.1.2	Field of application	101
7.2	Design	103
7.2.1	General	103
7.2.2	Failure modes for hollow section joints	103
7.3	Welds	107
7.3.1	Design resistance	107
7.4	Welded joints between CHS members	108
7.4.1	General	108
7.4.2	Uniplanar joints	108
7.4.3	Multiplanar joints	115
7.5	Welded joints between CHS or RHS brace members and RHS chord members	116
7.5.1	General	116
7.5.2	Uniplanar joints	117
7.5.3	Multiplanar joints	128
7.6	Welded joints between CHS or RHS brace members and I or H section chords	129
7.7	Welded joints between CHS or RHS brace members and channel section chord members	132

Foreword

This European Standard EN 1993, Eurocode 3: Design of steel structures, 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 November 2005, and conflicting National Standards shall be withdrawn at latest by March 2010.

This Eurocode supersedes ENV 1993-1-1.

According to the CEN-CENELEC Internal Regulations, the National Standard Organizations of the following countries are bound to implement these 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.

Background to 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 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
EN 1998	Eurocode 8:	Design of structures for earthquake resistance
EN 1999	Eurocode 9:	Design of aluminium 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).

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 standards³. 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.

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.

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.* snow map,
- the procedure to be used where alternative procedures are given in the Eurocode.

It may contain

- decisions on the application of informative annexes,
- references to non-contradictory complementary information to assist the user to apply the Eurocode.

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

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 harmonized 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 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.

There is a need for consistency between the harmonized technical specifications for construction products and the technical rules for works⁴. 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.

National annex for EN 1993-1-8

This standard gives alternative procedures, values and recommendations with notes indicating where national choices may have to be made. The National Standard implementing EN 1993-1-8 should have a National Annex containing all Nationally Determined Parameters for the design of steel structures to be constructed in the relevant country.

National choice is allowed in EN 1993-1-8 through:

- 2.2(2)
- 1.2.6 (Group 6: Rivets)
- 3.1.1(3)
- 3.4.2(1)
- 5.2.1(2)
- 6.2.7.2(9)

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.

1 Introduction

1.1 Scope

- (1) This part of EN 1993 gives design methods for the design of joints subject to predominantly static loading using steel grades S235, S275, S355 and S460.

1.2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard, only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

1.2.1 Reference Standards, Group 1: Weldable structural steels

EN 10025-1:2004	Hot rolled products of structural steels. General technical delivery conditions
EN 10025-2:2004	Hot rolled products of structural steels. Technical delivery conditions for non-alloy structural steels
EN 10025-3:2004	Hot rolled products of structural steels. Technical delivery conditions for normalized/normalized rolled weldable fine grain structural steels
EN 10025-4:2004	Hot rolled products of structural steels. Technical delivery conditions for thermomechanical rolled weldable fine grain structural steels
EN 10025-5:2004	Hot rolled products of structural steels. Technical delivery conditions for structural steels with improved atmospheric corrosion resistance
EN 10025-6:2004	Hot rolled products of structural steels. Technical delivery conditions for flat products of high yield strength structural steels in quenched and tempered condition

1.2.2 Reference Standards, Group 2: Tolerances, dimensions and technical delivery conditions

EN 10029:1991	Hot rolled steel plates 3 mm thick or above - Tolerances on dimensions, shape and mass
EN 10034:1993	Structural steel I- and H-sections - Tolerances on shape and dimensions
EN 10051:1991	Continuously hot-rolled uncoated plate, sheet and strip of non-alloy and alloy steels - Tolerances on dimensions and shape
EN 10055:1995	Hot rolled steel equal flange tees with radiused root and toes - Dimensions and tolerances on shape and dimensions
EN 10056-1:1995	Structural steel equal and unequal leg angles - Part 1: Dimensions
EN 10056-2:1993	Structural steel equal and unequal leg angles - Part 2: Tolerances on shape and dimensions
EN 10164:1993	Steel products with improved deformation properties perpendicular to the surface of the product - Technical delivery conditions

1.2.3 Reference Standards, Group 3: Structural hollow sections

EN 10219-1:1997	Cold formed welded structural hollow sections of non-alloy and fine grain steels - Part 1: Technical delivery requirements
-----------------	--

EN 10219-2:1997	Cold formed welded structural hollow sections of non-alloy and fine grain steels - Part 2: Tolerances, dimensions and sectional properties
EN 10210-1:1994	Hot finished structural hollow sections of non-alloy and fine grain structural steels - Part 1: Technical delivery requirements
EN 10210-2:1997	Hot finished structural hollow sections of non-alloy and fine grain structural steels - Part 2: Tolerances, dimensions and sectional properties

1.2.4 Reference Standards, Group 4: Bolts, nuts and washers

EN 14399-1:2002	High strength structural bolting for preloading - Part 1 : General Requirements
EN 14399-2:2002	High strength structural bolting for preloading - Part 2 : Suitability Test for preloading
EN 14399-3:2002	High strength structural bolting for preloading - Part 3 : System HR -Hexagon bolt and nut assemblies
EN 14399-4:2002	High strength structural bolting for preloading - Part 4 : System HV -Hexagon bolt and nut assemblies
EN 14399-5:2002	High strength structural bolting for preloading - Part 5 : Plain washers for system HR
EN 14399-6:2002	High strength structural bolting for preloading - Part 6 : Plain chamfered washers for systems HR and HV
EN ISO 898-1:1999	Mechanical properties of fasteners made of carbon steel and alloy steel - Part 1: Bolts, screws and studs (ISO 898-1:1999)
EN 20898-2:1993	Mechanical properties of fasteners - Part 2: Nuts with special proof load values - Coarse thread (ISO 898-2:1992)
EN ISO 2320:1997	Prevailing torque type steel hexagon nuts - Mechanical and performance requirements (ISO 2320:1997)
EN ISO 4014:2000	Hexagon head bolts - Product grades A and B (ISO 4014:1999)
EN ISO 4016:2000	Hexagon head bolts - Product grade C (ISO 4016:1999)
EN ISO 4017:2000	Hexagon head screws - Product grades A and B (ISO 4017:1999)
EN ISO 4018:2000	Hexagon head screws - Product grade C (ISO 4018:1999)
EN ISO 4032:2000	Hexagon nuts, style 1 - Product grades A and B (ISO 4032:1999)
EN ISO 4033:2000	Hexagon nuts, style 2 - Product grades A and B (ISO 4033:1999)
EN ISO 4034:2000	Hexagon nuts - Product grade C (ISO 4034:1999)
EN ISO 7040:1997	Prevailing torque hexagon nuts (with non-metallic insert), style 1 - Property classes 5, 8 and 10
EN ISO 7042:1997	Prevailing torque all-metal hexagon nuts, style 2 - Property classes 5, 8, 10 and 12
EN ISO 7719:1997	Prevailing torque type all-metal hexagon nuts, style 1 - Property classes 5, 8 and 10
ISO 286- 2:1988	ISO system of limits and fits - Part 2: Tables of standard tolerance grades and limit deviations for hole and shafts
ISO 1891:1979	Bolts, screws, nuts and accessories - Terminology and nomenclature - Trilingual edition
EN ISO 7089:2000	Plain washers- Nominal series- Product grade A
EN ISO 7090:2000	Plain washers, chamfered - Normal series - Product grade A
EN ISO 7091:2000	Plain washers - Normal series - Product grade C
EN ISO 10511:1997	Prevailing torque type hexagon thin nuts (with non-metallic insert)
EN ISO 10512:1997	Prevailing torque type hexagon nuts thin nuts, style 1, with metric fine pitch thread - Property classes 6, 8 and 10
EN ISO 10513:1997	Prevailing torque type all-metal hexagon nuts, style 2, with metric fine pitch thread - Property classes 8, 10 and 12

1.2.5 Reference Standards, Group 5: Welding consumable and welding

- EN 12345:1998 Welding-Multilingual terms for welded joints with illustrations. September 1998.
EN ISO 14555:1998 Welding-Arc stud welding of metallic materials. May 1995
EN ISO 13918:1998 Welding-Studs for arc stud welding-January 1997
EN 288-3:1992 Specification and approval of welding procedures for metallic materials. Part 3: Welding procedure tests for arc welding of steels. 1992
EN ISO 5817:2003 Arc-welded joints in steel - Guidance for quality levels for imperfections

1.2.6 Reference Standards, Group 6: Rivets

NOTE: Information may be given in the National Annex.

1.2.7 Reference Standard, Group 7: Execution of steel structures

- EN 1090-2 Requirements for the execution of steel structures

1.3 Distinction between Principles and Application Rules

- (1) The rules in EN 1990 clause 1.4 apply.

1.4 Terms and definitions

- (1) The following terms and definitions apply:

1.4.1

basic component (of a joint)

Part of a joint that makes a contribution to one or more of its structural properties.

1.4.2

connection

Location at which two or more elements meet. For design purposes it is the assembly of the basic components required to represent the behaviour during the transfer of the relevant internal forces and moments at the connection.

1.4.3

connected member

Any member that is joined to a supporting member or element.

1.4.4

joint

Zone where two or more members are interconnected. For design purposes it is the assembly of all the basic components required to represent the behaviour during the transfer of the relevant internal forces and moments between the connected members. A beam-to-column joint consists of a web panel and either one connection (single sided joint configuration) or two connections (double sided joint configuration), see Figure 1.1.

1.4.5

joint configuration

Type or layout of the joint or joints in a zone within which the axes of two or more inter-connected members intersect, see Figure 1.2.

1.4.6

rotational capacity