STANDARDISERINGEN I SVERIGE
SWEDISH INSTITUTE FOR STANDARDS

SVENSK STANDARD SS-ENV 1993-1-5

Handläggande organ	Fastställd	Utgåva	Sida
Byggstandardiseringen, BST	1999-01-05	1	1 (1+35)

Stålkonstruktioner – Dimensionering – Eurocode 3 – Del 1-5: Svetsade plåtbalkar

Eurocode 3: Design of steel structures – Part 1-5: General rules – Supplementary rules for planar plated structures without transverse loading

Den europeiska förstandarden ENV 1993-1-5:1997 gäller som svensk standard och publiceras i form av försöksstandard. Detta dokument innehåller den officiella engelska språkversionen av ENV 1993-1-5:1997.

Nationellt förord

Denna standarddel utgör en del av för närvarande sammanlagt 11 delar för beräkning och dimensionering av stålkonstruktioner av olika typer och material.

Standarden förutsätts användas i kombination med anvisningar, principer och ändringar givna i ett nationellt anpassningsdokument, NAD(S)/SS-ENV 1993-1-5, publicerat av Banverket, Boverket och Vägverket i samarbete.

Det finns för närvarande inga planer på att översätta standarden till svenska.

ICS 91.010.30; 91.080.10

Standarder kan beställas hos SIS som även lämnar allmänna upplysningar om svensk och utländsk standard.
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Prisgrupp Q

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EUROPEAN PRESTANDARD
PRENORME EUROPÉENNE
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ENV 1993-1-5

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ICS 91.010.30; 91.080.10
Descriptors: steel construction, structural steels, metal plates, rules of calculation, mechanical strength, loads: forces

English version

Eurocode 3: Design of steel structures – Part 1-5: General rules – Supplementary rules for planar plated structures without transverse loading

Eurocode 3: Calcul des structures en acier – Partie 1-5: Règles générales – Règles supplémentaires pour les plaques planes, raidies ou non, chargées dans leurs plan

Eurocode 3: Bemessung und Konstruktion von Stahlbauten – Teil 1-5: Allgemeine Bemessungsregeln – Ergänzende Regeln zu ebener Blachfelder ohne Querbelastung

This European Prestandard (ENV) was approved by CEN on 30 June 1997 as a prospective standard for provisional application.

The period of validity of this ENV is limited initially to three years. After two years the members of CEN will be requested to submit their comments, particularly on the question whether the ENV can be converted into a European Standard.

CEN members are required to announce the existence of this ENV in the same way as for an EN and to make the ENV available promptly at national level in an appropriate form. It is permissible to keep conflicting national standards in force (in parallel to the ENV) until the final decision about the possible conversion of the ENV into an EN is reached.

CEN members are the national standards bodies of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

CEN
European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung
Central Secretariat: rue de Stassart 36, B-1050 BRUSSELS

Ref. No. ENV 1993-1-5:1997 E

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Foreword

Objectives of the Eurocodes

(1) The "Structural Eurocodes" comprise a group of standards for the structural and geotechnical design of buildings and civil engineering works.

(2) They cover execution and control only to the extent that is necessary to indicate the quality of the construction products, and the standard of the workmanship, needed to comply with the assumptions of the design rules.

(3) Until the necessary set of harmonised technical specifications for products and for methods of testing their performance is available, some of the Structural Eurocodes cover some of these aspects in informative annexes.

Background to the Eurocode programme

(4) The Commission of the European Communities (CEC) initiated the work of establishing a set of harmonised technical rules for the design of building and civil engineering works which would initially serve as an alternative to the different rules in force in the various member states and would ultimately replace them. These technical rules became known as the "Structural Eurocodes".

(5) In 1990, after consulting their respective member states, the CEC transferred the work of further development, issue and updating of the Structural Eurocodes to CEN, and the EFTA Secretariat agreed to support the CEN work.

(6) CEN Technical Committee CEN/TC 250 is responsible for all Structural Eurocodes.

Eurocode programme

(7) Work is in hand on the following Structural Eurocodes, each generally consisting of a number of parts:

EN 1991 Eurocode 1 Basis of design and 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 provisions for earthquake resistance of structures;

EN 1999 Eurocode 9 Design of aluminium alloy structures.

(8) Separate sub-committees have been formed by CEN/TC 250 for the various Eurocodes listed above.

(9) This Part 1.5 of Eurocode 3 is published by CEN as a European Prestandard (ENV) with an initial life of three years.

(10) This Prestandard is intended for experimental application and for the submission of comments.

(11) After approximately two years CEN members will be invited to submit formal comments to be taken

into account in determining future actions.

(12) Meanwhile feedback and comments on this Prestandard should be sent to the secretariat of CEN/TC250/SC3 at the following address:

BSI Standards
British Standards House
389 Chiswick High Road
London W4 4AL
England

or to your national standards organisation.

National Application Documents (NAD's)

(13) In view of the responsibilities of the authorities in member countries for safety, health and other matters covered by the essential requirements of the Construction Products Directive (CPD), certain safety elements in this ENV have been assigned indicative values which are identified by ☐ ("boxed values"). The authorities in each member country are expected to review the "boxed values" and may substitute alternative definitive values for these safety elements for use in national application.

(14) Some of the supporting European or International Standards might not be available by the time this Prestandard is issued. It is therefore anticipated that a National Application Document (NAD) giving any substitute definitive values for safety elements, referencing compatible supporting standards and providing guidance on the national application of this Prestandard, will be issued by each member country or its Standards Organisation.

(15) It is intended that this Prestandard is used in conjunction with the NAD valid in the country where the building or civil engineering works is located.

Matters specific to this Prestandard

(16) The Parts of ENV 1993 that are currently envisaged are:

ENV 1993-1-1 General rules: General rules and rules for buildings;
ENV 1993-1-2 General rules: Structural fire design;
ENV 1993-1-3 General rules: Supplementary rules for cold formed thin gauge members and sheeting;
ENV 1993-1-4 General rules: Supplementary rules for stainless steels;
ENV 1993-1-5 General rules: Supplementary rules for planar plated structures without transverse loading;
ENV 1993-1-6 General rules: Supplementary rules for the strength and stability of shell structures;
ENV 1993-1-7 General rules: Supplementary rules for the strength and stability of planar plated structures loaded transversely;
ENV 1993-2 Steel bridges;
ENV 1993-3 Towers, masts and chimneys;
ENV 1993-4 Silos, tanks and pipelines;
ENV 1993-5 Piling;
ENV 1993-6 Crane supporting structures;
ENV 1993-7 Marine and maritime structures;
ENV 1993-8 Agricultural structures.

(17) This Part 1.5 of Eurocode 3 has been produced to complement Part 2 by providing the rules for plated structures needed in the design of plate girder and box girder bridges.

(18) Because these rules are not specific to bridges, they have been assembled as a separate document, in a form that is capable of future incorporation with other general rules in Part 1 of Eurocode 3.

1 General

1.1 Scope

(1)P This Part 1.5 of ENV 1993 gives supplementary provisions for the design of plated structures, with or without stiffeners, for use in conjunction with ENV 1993-1-1 (including ENV 1993-1-1/A1) and other Parts of ENV 1993 that refer to it.

(2)P Methods are given for determining the effects of plate buckling and shear lag in I-section plate girders and box girders.

(3)P These methods are also applicable to flat parts of tanks and silos in respect of in-plane effects. The effects of lateral pressure are not covered in this Part 1.5.

(4) The methods given are applicable to class 3 and class 4 cross-sections, as defined in 5.3.2 of ENV 1993-1-1. Class 1 and class 2 cross-sections can be treated in the same way as class 3 cross-sections, but methods utilising their plastic resistance are not included.

(5) When this Part 1.5 is used, it supersedes the corresponding provisions in Section 5 of ENV 1993-1-1 and clause D.5 of ENV 1993-1-1/A1.

1.2 Distinction between principles and application rules

(1)P Depending on the character of the individual paragraphs, a distinction is made between principles and application rules.

(2)P The principles comprise:

- general or definitive statements for which there is no alternative;
- requirements and analytical models for which no alternative is permitted unless specifically stated.

(3) The principles are identified by the letter P following the paragraph number.

(4)P The application rules are generally recognized rules that follow the principles and satisfy their requirements. Alternative design rules different from the application rules given in the Eurocode may be used, provided that it is shown that the alternative rule accords with the relevant principles and has at least the same reliability.

(5) The application rules are identified by a number in brackets, as in this paragraph.

1.3 Normative references

This European Prestandard 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 Prestandard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

ENV 1993 *Eurocode 3: Design of steel structures*:
Part 1.1: *General rules: General rules and rules for buildings*;
Part 2 *Steel Bridges*.

1.4 Definitions

For the purpose of this standard, the following definitions apply:

1.4.1 elastic critical stress: Stress in a component at which the component becomes unstable when using small deflection elastic theory.

1.4.2 gross cross-section: The total cross-sectional area of a member but excluding longitudinal stiffeners that are not continuous, battens and splice material.

1.4.3 effective cross-section: The gross cross-section reduced for the effects of plate buckling and shear lag.

1.4.4 membrane stress: Stress at mid-plane of the plate.

1.4.5 plated structure. A structure that is built up from nominally flat plates which are joined together. The plates may be stiffened or unstiffened.

1.4.6 stiffener: A plate or section attached to a plate with the purpose of preventing buckling of the plate or reinforcing it against local loads. A stiffener is denoted:

-longitudinal if its direction is parallel to that of the member;

-transverse if its axis is perpendicular to that of the member.

1.4.7 stiffened plate : Plate with transverse and/or longitudinal stiffeners.

1.4.8 subpanel: Unstiffened plate surrounded by flanges or stiffeners.

1.5 Symbols

(1) Complementary to those given in ENV 1993-1-1, the following symbols are used:

A_{sl} is the total area of all the longitudinal stiffeners within the flange width b_0, see 3.1(1);

A_{st} is the gross cross sectional area of one transverse stiffener;

A_{eff} is the effective cross-section area, see 2.2.2(2);

b is the width of the plate;

b_w is the clear width between welds;

b_{eff} effective width for elastic shear lag;

F_{Sd} is the design transverse force;

f_{yd} is the design yield strength f_y/γ_{M1} or f_y/γ_{M0} according to ENV 1993-1-1:1992. Further subscript f and w indicate flange and web, respectively;

h_w is the clear web depth between flanges;

L_{eff} is the effective length for resistance to transverse forces, see 4.4.3(1);

$M_{f.Rd}$ is the design plastic moment of resistance of a cross-section consisting of the flanges only;

$M_{pl.Rd}$ is the design plastic moment of resistance of the cross-section (irrespective of cross-section class);

M_{Sd} is the design bending moment;

N_{Sd} is the design axial force;

t is the thickness of the plate;

t_{eff} is the effective thickness for shear buckling, see 4.3.2;

V_{Sd} is the design shear force;

W_{eff} is the effective section modulus, see 2.2.2(3);

ß is the effective width factor for elastic shear lag, see 3.2(2);

η is the relation between resistance in shear and yield strength in tension;

$\gamma_{M,ser}$ is the partial factor for resistance at serviceability states.

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

2 Basis of design

2.1 Modelling for elastic global analysis

(1)P The effects of shear lag and of local buckling on the stiffness shall be taken into account if this significantly influences the global analysis.

(2) The effects of shear lag of flanges in elastic global analysis may be taken into account by the use of an effective width. For simplicity this effective width may be assumed to be uniform over the length of the beam.

(3) For each span of a beam the effective width of flanges should be taken as the lesser of the full width and $L/8$ per side of the web, where L is the span or twice the distance from the support to the end, for a cantilever.

(4) For the global analysis the effect of plate buckling on the stiffness may be ignored in normal plated structures.

(5) If the effective cross-sectional area according to 4.2 of an element in compression is less than 0,5 times the gross cross-sectional area, the reduction of the stiffness due to plate buckling should be considered .

2.2 Verification of cross-sectional resistance

2.2.1 General

(1)P At ultimate limit states the verification of cross-sectional resistance shall take the following effects into account:

a) longitudinal stresses $\sigma_{x,Ed}$ considering shear lag and plate buckling

b) transverse stresses $\sigma_{z,Ed}$ considering their distribution and plate buckling

c) shear stresses τ_{Ed} considering plate buckling

d) combined effects of a), b) and c) acting in the same cross-section where relevant, see 2.2.3.

(2) The verification should in general be performed as follows

$$\eta_1 = \frac{\sigma_{x,Ed}}{f_{yd}} = \frac{N_{Sd}}{f_{yd}A_{eff}} + \frac{M_{Sd} + N_{Sd}e_N}{f_{yd}W_{eff}} \leq 1,0 \qquad (2.1)$$

$$\eta_2 = \frac{\sigma_{z,Ed}}{f_{ywd}} = \frac{F_{Sd}}{f_{ywd}L_{eff}t} \leq 1,0 \qquad (2.2)$$

$$\eta_3 = \frac{\tau_{Ed}}{\chi_w f_{ywd}/\sqrt{3}} = \frac{V_{Sd}}{\chi_w f_{ywd}/\sqrt{3}bt} \leq 1,0 \qquad (2.3)$$

where:

A_{eff} is the effective cross-section area according to 2.2.2(2);

b is the width of the plate (for a web the clear distance between flanges h_w);

e_N is the shift in the position of neutral axis, see 2.2.2(2);

F_{Sd} is the design transverse force;