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**EUROCODE 3: DESIGN OF STEEL  
STRUCTURES - PART 1-6: GENERAL RULES  
- SUPPLEMENTARY RULES FOR THE SHELL  
STRUCTURES**

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EUROPEAN PRESTANDARD  
PRÉNORME EUROPÉENNE  
EUROPÄISCHE VORNORM

**ENV 1993-1-6**

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English version

**Eurocode 3: Design of steel structures - Part 1-6: General rules -  
Supplementary rules for the shell structures**

Eurocode 3: Calcul des structures en acier - Partie 1-6:  
Règles générales - Règles supplémentaires pour la  
résistance et la stabilité des structures en coque

Eurocode 3: Bemessung und Konstruktion von Stahlbauten  
- Teil 1-6: Allgemeine Bemessungsregeln - Ergänzende  
Regeln für Schalenträgerwerke

This European Prestandard (ENV) was approved by CEN on 25 December 1998 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.



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

**Central Secretariat: rue de Stassart, 36 B-1050 Brussels**

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## Foreword

### Objectives of the Eurocode

- (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 harmonized 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 harmonized 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 structures.
- (8) Separate sub-committees have been formed by CEN/TC 250 for the various Eurocodes listed above.
- (9) This Part 1.6 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/TC 250/SC 3 at the following address:

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

or to your national standards organisation.

### **National Application Documents (NADs)**

(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 and rules for buildings;
- ENV 1993-1-2 Supplementary rules for structural fire design;
- ENV 1993-1-3 Supplementary rules for cold formed thin gauge members and sheeting;
- ENV 1993-1-4 Supplementary rules for stainless steels;
- ENV 1993-1-5 Supplementary rules for planar plated structures without transverse loading;
- ENV 1993-1-6 Supplementary rules for shell structures;
- ENV 1993-1-7 Supplementary rules for planar plated structures loaded transversely;
- ENV 1993-2 Steel bridges;
- ENV 1993-3-1 Towers and masts;
- ENV 1993-3-2 Chimneys;
- ENV 1993-4-1 Silos;
- ENV 1993-4-2 Tanks;
- ENV 1993-4-3 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 1.6 of Eurocode 3 complements Parts 3 and 4 by providing the rules for axisymmetric shell structures needed in the design of chimneys, towers, masts, silos, tanks and pipelines.

(18) Because these rules are not specific to chimneys, silos, tanks etc. they are presented as a separate document forming part of ENV 1993-1 General Rules.



# 1 General

## 1.1 Scope

(1)P This Part 1.6 of ENV 1993 applies to the structural design of plated steel structures that have the form of a shell of revolution. It is intended for use in conjunction with ENV 1993-1-1, ENV 1993-1-3, ENV 1993-1-4 and the relevant application parts of ENV 1993, which include:

- Part 3.1 for towers and masts;
- Part 3.2 for chimneys;
- Part 4.1 for silos;
- Part 4.2 for tanks;
- Part 4.3 for pipelines.

(2)P See the relevant parts of ENV 1993 for specific application rules for structural design.

(3)P See the relevant parts of ENV 1991 for general rules on actions, including:

- definition of an action;
- combination of actions;
- partial factors on actions.

(4) This prestandard is intended for use in conjunction with the relevant parts of ENV 1991, which include:

- Part 1 for basis of design;
- Part 2.1 for densities, self-weight and imposed loads;
- Part 2.3 for snow loads;
- Part 2.4 for wind loads;
- Part 2.5 for thermal actions;
- Part 4 for actions on silos and tanks.

(5)P This document defines the characteristic values of the resistance of the structure. For the partial factors for resistance to be used in the verification expressions, see ENV 1993-1-1.

(6)P This Part 1.6 is concerned with the requirements for design against the ultimate limit states of:

- plastic limit;
- cyclic plasticity;
- buckling;
- fatigue.

(7)P Overall equilibrium of the structure (sliding, uplifting, overturning) is not included in this Part 1.6, but is treated in ENV 1993-1-1. Special considerations for specific applications are included in the relevant applications parts of ENV 1993.

(8) The provisions in this Part 1.6 apply to axisymmetric shells and associated circular or annular plates and beam section rings and stringer stiffeners where they form part of the complete structure. The following shell forms are covered: cylinders, cones and spherical caps.

(9) Cylindrical, conical and spherical panels are not explicitly covered by this Part 1.6. However, the provisions can be applicable if the appropriate boundary conditions are duly taken into account.

(10) This prestandard is intended for application to structural engineering steel shell structures. However, its provisions can be applied to other metallic shells provided that the appropriate material properties are duly taken into account.

(11) The provisions of this Part 1.6 are intended to be applied within the temperature range defined in the relevant ENV 1993 application parts. The maximum temperature is restricted so that the influence of creep can be neglected if high temperature creep effects are not covered by the relevant application part.

(12) The provisions in this Part 1.6 apply to structures that satisfy the brittle fracture provisions given in annex C of ENV 1993-2.

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