



NSAI
Standards

Irish Standard
I.S. EN 1993-1-6:2007+NA:2010

Eurocode 3 - Design of steel structures - Part 1-6: Strength and Stability of Shell Structures (Including Irish National Annex)

I.S. EN 1993-1-6:2007+NA:2010

Incorporating amendments/corrigenda issued since publication:

EN 1993-1-6:2007/AC:2009
NA to I.S. EN 1993-1-6:2007

This document replaces:
ENV 1993-1-6:1999

This document is based on:
EN 1993-1-6:2007+NA:2010
ENV 1993-1-6:1999

Published:
28 February, 2007
22 September, 1999

This document was published
under the authority of the NSAI
and comes into effect on:
25 March, 2010

ICS number:
91.010.30
91.080.10

NSAI
1 Swift Square,
Northwood, Santry
Dublin 9

T +353 1 807 3800
F +353 1 807 3838
E standards@nsai.ie
W NSAI.ie

Sales:
T +353 1 857 6730
F +353 1 857 6729
W standards.ie

Údarás um Chaighdeáin Náisiúnta na hÉireann

I.S. EN 1993-1-6:2007

EUROPEAN STANDARD

EN 1993-1-6:2007/AC

NORME EUROPÉENNE

April 2009

EUROPÄISCHE NORM

Avril 2009

April 2009

ICS 91.010.30

English version
Version Française
Deutsche Fassung

Eurocode 3 - Design of steel structures - Part 1-3: General rules -
Supplementary rules for cold-formed members and sheeting

Eurocode 3 - Calcul des structures en acier
- Partie 1-3: Règles générales - Règles
supplémentaires pour les profilés et
plaques formés à froid

Bemessung und Konstruktion von
Stahlbauten - Teil 1-3: Allgemeine Regeln -
Ergänzende Regeln für kaltgeformte
dünnwandige Bauteile und Bleche

This corrigendum becomes effective on 29 April 2009 for incorporation in the three official language versions of the EN.

Ce corrigendum prendra effet le 29 avril 2009 pour incorporation dans les trois versions linguistiques officielles de la EN.

Die Berichtigung tritt am 29. April 2009 zur Einarbeitung in die drei offiziellen Sprachfassungen der EN in Kraft.



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

Management Centre: Avenue Marnix 17, B-1000 Brussels

© 2009 CEN All rights of exploitation in any form and by any means reserved worldwide for CEN national Members.
Tous droits d'exploitation sous quelque forme et de quelque manière que ce soit réservés dans le monde entier aux
membres nationaux du CEN.
Alle Rechte der Verwertung, gleich in welcher Form und in welchem Verfahren, sind weltweit den nationalen Mitgliedern
von CEN vorbehalten.

Ref. No.: EN 1993-1-6:2007/AC:2009 D/E/F

1) Modification to 1.3.5.6

Replace reference to "1.3.4.3" with "1.3.5.3".

2) Modification to 1.3.5.8

Replace reference to "1.3.4.5" with "1.3.5.5".

3) Modification to 1.4

Paragraph "(10)", replace "accidental" with "non-intended".

4) Modification to 2.2.4

Paragraph "(2)", replace "(LS2 and LS4)" with "(LS1 to LS4)".

5) Modification to 2.2.6

Paragraph "(1)", replace "(LS2)" with "(LS2 and LS4)".

6) Modification to 2.2.7

Paragraph "(2)", replace "limit state LS1" with "limit states LS1 and LS3".

7) Modification to 8.4.3

Heading of the Subclause and whole subclause (including in the Titles of "Table[s] 8.2" and "8.3" and of "Figure 8.3", in the elements under this Figure and inside "Table 8.2"), replace all the occurrences of "accidental" with "non-intended".

8) Modification to Annex D

Title of Annex D, delete the word "design".

I.S. EN 1993-1-6:2007

National Foreword

This Irish Standard is the official English language version of EN 1993-1-6:2007, prepared by Technical Committee CEN TC 250 "Structural Eurocodes". This document supersedes ENV 1993-1-6:1999.

This standard forms part of a package of 58 Eurocodes, which covers the basis of structural design, actions (loadings), the main structural materials, geotechnical design and design provisions for earthquakes. The European Commission document – Guidance Paper L – Application and Use of Eurocodes provides guidance on the elaboration, implementation and use of Eurocodes.

Where a normative part of this EN allows for a choice to be made at the national level the range, possible choices are given in the normative text, and a Note will qualify it as a Nationally Determined Parameter (NDP).

To enable EN 1993-1-6 to be used in Ireland the Nationally Determined Parameters will be published in a National Annex after public consultation has taken place.

Until the National Annex is available, publication of this European Standard is solely for education/training purposes and this standard should not be used in project design until the relevant National Annex is available.

Note: For use of this European Standard after publication of the Irish National Annex

I.S. EN 1993-1-6:2007 may now be used in Ireland. The Nationally Determined Parameters, which have been prepared by the NSAI National Eurocode Advisory Committee, are included as an informative annex to the standard.

The National Annex to I.S. EN 1993-1-6:2007 is also available as a separate publication as recommended in Guidance Paper L.

In line with international standards practice the decimal point is shown as a comma (,) throughout this document
--

This page is intentionally left BLANK.

English Version

Eurocode 3 - Design of steel structures - Part 1-6: Strength and Stability of Shell Structures

Eurocode 3 - Calcul des structures en acier - Partie 1-6:
Résistance et stabilité des structures en coque

Eurocode 3 - Bemessung und Konstruktion von
Stahlbauten - Teil 1-6: Festigkeit und Stabilität von Schalen

This European Standard was approved by CEN on 12 June 2006.

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 CEN Management Centre 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 CEN Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, 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: rue de Stassart, 36 B-1050 Brussels

Contents	Page
1. General	4
1.1 Scope	4
1.2 Normative references	5
1.3 Terms and definitions	6
1.4 Symbols	11
1.5 Sign conventions	15
2 Basis of design and modelling	15
2.1 General	15
2.2 Types of analysis	15
2.3 Shell boundary conditions	17
3 Materials and geometry	18
3.1 Material properties	18
3.2 Design values of geometrical data	18
3.3 Geometrical tolerances and geometrical imperfections	18
4 Ultimate limit states in steel shells	19
4.1 Ultimate limit states to be considered	19
4.2 Design concepts for the limit states design of shells	20
5 Stress resultants and stresses in shells	23
5.1 Stress resultants in the shell	23
5.2 Modelling of the shell for analysis	23
5.3 Types of analysis	26
6 Plastic limit state (LS1)	26
6.1 Design values of actions	26
6.2 Stress design	26
6.3 Design by global numerical MNA or GMNA analysis	27
6.4 Direct design	28
7 Cyclic plasticity limit state (LS2)	28
7.1 Design values of actions	28
7.2 Stress design	29
7.3 Design by global numerical MNA or GMNA analysis	29
7.4 Direct design	30
8 Buckling limit state (LS3)	30
8.1 Design values of actions	30
8.2 Special definitions and symbols	30
8.3 Buckling-relevant boundary conditions	31
8.4 Buckling-relevant geometrical tolerances	31
8.5 Stress design	38
8.6 Design by global numerical analysis using MNA and LBA analyses	40
8.7 Design by global numerical analysis using GMNIA analysis	43
9 Fatigue limit state (LS4)	48
9.1 Design values of actions	48
9.2 Stress design	48

9.3	Design by global numerical LA or GNA analysis	49
ANNEX A (normative)		50
Membrane theory stresses in shells		50
A.1	General	50
A.2	Unstiffened cylindrical shells	51
A.3	Unstiffened conical shells	52
A.4	Unstiffened spherical shells	53
ANNEX B (normative)		54
Additional expressions for plastic collapse resistances		54
B.1	General	54
B.2	Unstiffened cylindrical shells	55
B.3	Ring stiffened cylindrical shells	57
B.4	Junctions between shells	59
B.5	Circular plates with axisymmetric boundary conditions	62
ANNEX C (normative)		63
Expressions for linear elastic membrane and bending stresses		63
C.1	General	63
C.2	Clamped base unstiffened cylindrical shells	64
C.3	Pinned base unstiffened cylindrical shells	66
C.4	Internal conditions in unstiffened cylindrical shells	68
C.5	Ring stiffener on cylindrical shell	69
C.6	Circular plates with axisymmetric boundary conditions	71
ANNEX D (normative)		73
Expressions for buckling stress design		73
D.1	Unstiffened cylindrical shells of constant wall thickness	73
D.2	Unstiffened cylindrical shells of stepwise variable wall thickness	83
D.3	Unstiffened lap jointed cylindrical shells	88
D.4	Unstiffened complete and truncated conical shells	90

Foreword

This European Standard EN 1993-1-6, Eurocode 3: Design of steel structures: Part 1-6 Strength and stability of shell 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 August 2007, and conflicting National Standards shall be withdrawn at latest by March 2010.

This Eurocode supersedes ENV 1993-1-6.

According to the CEN-CENELEC Internal Regulations, the National Standard Organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria 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.

National annex for EN 1993-1-6

This standard gives alternative procedures, values and recommendations with notes indicating where national choices may have to be made. Therefore the National Standard implementing EN 1993-1-6 should have a National Annex containing all Nationally Determined Parameters to be used for the design of steel structures to be constructed in the relevant country.

National choice is allowed in EN 1993-1-6 through:

- 3.1.(4)
- 4.1.4 (3)
- 5.2.4 (1)
- 6.3 (5)
- 7.3.1 (1)
- 7.3.2 (1)
- 8.4.2 (3)
- 8.4.3 (2)
- 8.4.3 (4)
- 8.4.4 (4)
- 8.4.5 (1)
- 8.5.2 (2)
- 8.5.2 (4)
- 8.7.2 (7)
- 8.7.2 (16)
- 8.7.2 (18) (2 times)
- 9.2.1 (2)P

1. General

1.1 Scope

(1) EN 1993-1-6 gives basic design rules for plated steel structures that have the form of a shell of revolution.

(2) This Standard is intended for use in conjunction with EN 1993-1-1, EN 1993-1-3, EN 1993-1-4, EN 1993-1-9 and the relevant application parts of EN 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.

(3) This Standard defines the characteristic and design values of the resistance of the structure.

- (4) This Standard is concerned with the requirements for design against the ultimate limit states of:
- plastic limit;
 - cyclic plasticity;
 - buckling;
 - fatigue.
- (5) Overall equilibrium of the structure (sliding, uplifting, overturning) is not included in this Standard, but is treated in EN 1993-1-1. Special considerations for specific applications are included in the relevant application parts of EN 1993.
- (6) The provisions in this Standard apply to axisymmetric shells and associated circular or annular plates and to beam section rings and stringer stiffeners where they form part of the complete structure. General procedures for computer calculations of all shell forms are covered. Detailed expressions for the hand calculation of unstiffened cylinders and cones are given in the Annexes.
- (7) Cylindrical and conical panels are not explicitly covered by this Standard. However, the provisions can be applicable if the appropriate boundary conditions are duly taken into account.
- (8) This Standard is intended for application to steel shell structures. Where no standard exists for shell structures made of other metals, the provisions of this standards may be applied provided that the appropriate material properties are duly taken into account.
- (9) The provisions of this Standard are intended to be applied within the temperature range defined in the relevant EN 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.
- (10) The provisions in this Standard apply to structures that satisfy the brittle fracture provisions given in EN 1993-1-10.
- (11) The provisions of this Standard apply to structural design under actions that can be treated as quasi-static in nature.
- (12) In this Standard, it is assumed that both wind loading and bulk solids flow can, in general, be treated as quasi-static actions.
- (13) Dynamic effects should be taken into account according to the relevant application part of EN 1993, including the consequences for fatigue. However, the stress resultants arising from dynamic behaviour are treated in this part as quasi-static.
- (14) The provisions in this Standard apply to structures that are constructed in accordance with EN 1090-2.
- (15) This Standard does not cover the aspects of leakage.
- (16) This Standard is intended for application to structures within the following limits:
- design metal temperatures within the range -50°C to $+300^{\circ}\text{C}$;
 - radius to thickness ratios within the range 20 to 5000.

NOTE: It should be noted that the stress design rules of this standard may be rather conservative if applied to some geometries and loading conditions for relatively thick-walled shells.

1.2 Normative references

- (1) 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

This is a free preview. Purchase the entire publication at the link below:

[Product Page](#)

-
- [Looking for additional Standards? Visit Intertek Inform Infostore](#)
 - [Learn about LexConnect, All Jurisdictions, Standards referenced in Australian legislation](#)
-