



National Standards Authority of Ireland

IRISH STANDARD

**I.S. EN 1998-6:2005**

ICS 91.120.25

**EUROCODE 8: DESIGN OF STRUCTURES  
FOR EARTHQUAKE RESISTANCE - PART 6:  
TOWERS, MASTS AND CHIMNEYS**

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Údarás um Chaighdeán Náisiúnta na hÉireann



## National Foreword

This Irish Standard is the official English language version of EN 1998-6:2005, prepared by Technical Committee CEN TC 250 "Structural Eurocodes". This document supersedes ENV 1998-3:1996.

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 national level, the range and possible choices are given in the normative text and a Note will qualify it as a Nationally Determined Parameter (NDP). National choice for NDP's is normally established through the publication of a related National Annex for each EN Eurocode part, however such annexes are not deemed necessary where a Eurocode part is not relevant for a Member State.

Following established engineering practice, all of the Republic of Ireland is deemed to be in an area of very low seismicity and as such national annexes are not considered necessary for adopted EN 1998 parts.

In the event that EN 1998-6 is considered for the design and construction of buildings and civil engineering works in the Republic of Ireland, the recommended values for NDP's given in EN 1998-6 should be employed.

In Line with international standards practice the decimal point is shown as a comma (,) throughout this document.
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EUROPEAN STANDARD  
NORME EUROPÉENNE  
EUROPÄISCHE NORM

**EN 1998-6**

June 2005

ICS 91.120.25

Supersedes ENV 1998-3:1996

English version

**Eurocode 8: Design of structures for earthquake resistance -  
Part 6: Towers, masts and chimneys**

Eurocode 8: Calcul des structures pour leur résistance aux  
séismes - Partie 6 : Tours, mâts et cheminées

Eurocode 8: Auslegung von Bauwerken gegen Erdbeben -  
Teil 6: Türme, Maste und Schornsteine

This European Standard was approved by CEN on 25 April 2005.

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.



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COMITÉ EUROPÉEN DE NORMALISATION  
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## FOREWORD

This European Standard EN 1998-6, Eurocode 8: Design of structures for earthquake resistance: Towers, masts and chimneys, has been prepared by Technical Committee CEN/TC 250 “Structural Eurocodes”, the secretariat of which is held by BSI. CEN/TC 250 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 December 2005 and conflicting national standards shall be withdrawn at latest by March 2010.

This document supersedes ENV 1998-3:1996.

According to the CEN-CENELEC Internal Regulations, the National Standard Organisations of the following countries are bound to implement this 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 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 harmonisation of technical specifications.

Within this action programme, the Commission took the initiative to establish a set of harmonised 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 agreement<sup>1</sup> 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: Basis of structural design

EN 1991 Eurocode 1: Actions on structures

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<sup>1</sup> 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).



- 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

Eurocode standards recognise 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 recognise 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 harmonised 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 Documents<sup>2</sup> referred to in Article 12 of the CPD, although they are of a different nature from harmonised product standards<sup>3</sup>. 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.

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<sup>2</sup> 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 harmonised ENs and ETAs/ETAs.

<sup>3</sup> According to Art. 12 of the CPD the interpretative documents shall:

- a) give concrete form to the essential requirements by harmonising 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 harmonised 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.

### **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 also contain

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

### **Links between Eurocodes and harmonised technical specifications (ENs and ETAs) for products**

There is a need for consistency between the harmonised technical specifications for construction products and the technical rules for works<sup>4</sup>. Furthermore, all the information accompanying the CE Marking of the construction products which refer to Eurocodes shall clearly mention which Nationally Determined Parameters have been taken into account.

### **Additional information specific to EN 1998-6**

For the design of structures in seismic regions the provisions of this standard are to be applied in addition to the provisions of the other relevant Eurocodes. In particular, the provisions of the present standard complement those of Eurocode 3, Part 3-1 " Towers and Masts " and Part 3-2 " Chimneys", which do not cover the special requirements for seismic design.

### **National annex for EN 1998-6**

Notes indicate where national choices have to be made. The National Standard implementing EN 1998-6 shall have a National annex containing values for all Nationally Determined Parameters to be used for the design in the country. National choice is required in the following sections.

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<sup>4</sup> 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.

Reference section	Item
1.1(2)	Informative Annexes A, B, C, D, E and F.
3.1(1)	Conditions under which the rotational component of the ground motion should be taken into account.
3.5(2)	The lower bound factor $\beta$ on design spectral values, if site-specific studies have been carried out with particular reference to the long-period content of the seismic action.
4.1(5)P	Importance factors for masts, towers, and chimneys.
4.3.2.1(2)	Detailed conditions, supplementing those in 4.3.2.1(2), for the lateral force method of analysis to be applied.
4.7.2(1)P	Partial factors for materials
4.9(4)	Reduction factor $\nu$ for displacements at damage limitation limit state

## 1 GENERAL

### 1.1 Scope

(1) The scope of Eurocode 8 is defined in EN 1998-1:2004, **1.1.1** and the scope of this Standard is defined in **(2)** to **(4)**. Additional parts of Eurocode 8 are indicated in EN 1998-1:2004, **1.1.3**.

(2) EN 1998-6 establishes requirements, criteria, and rules for the design of tall slender structures: towers, including bell-towers, intake towers, radio and TV-towers, masts, chimneys (including free-standing industrial chimneys) and lighthouses. Additional provisions specific to reinforced concrete and to steel chimneys are given in Sections **5** and **6**, respectively. Additional provisions specific to steel towers and to steel guyed masts are given in Sections **7** and **8**, respectively. Requirements are also given for non-structural elements, such as antennae, the liner material of chimneys and other equipment.

NOTE 1 Informative Annex A provides guidance and information for linear dynamic analysis accounting for rotational components of the ground motion.

NOTE 2 Informative Annex B provides information and guidance on modal damping in modal response spectrum analysis.

NOTE 3 Informative Annex C provides information on soil-structure interaction and guidance for accounting for it in linear dynamic analysis.

NOTE 4 Informative Annex D provides supplementary information and guidance on the number of degrees of freedom and the number of modes of vibration to be taken into account in the analysis.

NOTE 5 Informative Annex E gives information and guidance for the seismic design of Masonry chimneys.

NOTE 6 Informative Annex F gives supplementary information for the seismic performance and design of electrical transmission towers.

(3) The present provisions do not apply to cooling towers and offshore structures.

(4) For towers supporting tanks, EN 1998-4 applies.

### 1.2 Normative References

#### 1.2.1 Use

(1)P 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).

#### 1.2.2 General reference standards

(1) EN 1998-1:2004, **1.2.1** applies.

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