

# *Geregistreeerde Belgische norm*

**NBN EN 1998-3**

1e uitg., oktober 2005

**Normklasse: B 03**

## **Eurocode 8: Ontwerp en berekening van aardbevingsbestendige constructies - Deel 3: Beoordeling en hernieuwing van gebouwen**

Eurocode 8: Calcul des structures pour leur résistance aux séismes - Partie 3: Evaluation et renforcement des bâtiments

Eurocode 8: Design of structures for earthquake resistance - Part 3: Assessment and retrofitting of buildings

### **Toelating tot publicatie: 28 juli 2005**

Vervangt NBN ENV 1998-1-4 (1996) en NBN ENV 1998-1-3 (1995) .

Deze Europese norm EN 1998-3:2005 heeft de status van een Belgische norm.

Deze Europese norm bestaat in drie officiële versies (Duits, Engels, Frans).

Deze norm mag in België slechts samen met zijn nationale bijlage (ANB) worden toegepast. Deze laatste legt hoofdzakelijk de waarden van de parameters vast die op nationaal vlak worden bepaald.

Er is bij het NBN ook een Nederlandstalige versie beschikbaar, die dezelfde status heeft als de officiële versies.

*norme belge  
enregistrée*

**NBN EN 1998-3**

1e éd., octobre 2005

**Indice de classement: B 03**

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**Eurocode 8: Calcul des structures pour leur résistance aux séismes -  
Partie 3: Evaluation et renforcement des bâtiments**

Eurocode 8: Ontwerp en berekening van aardbevingsbestendige constructies - Deel 3: Beoordeling en hernieuwing van gebouwen

Eurocode 8: Design of structures for earthquake resistance - Part 3: Assessment and retrofitting of buildings

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**Autorisation de publication: 28 juillet 2005**

Remplace NBN ENV 1998-1-4 (1996) et NBN ENV 1998-1-3 (1995) .

La présente norme européenne EN 1998-3:2005 a le statut d'une norme belge.

La présente norme européenne existe en trois versions officielles (allemand, anglais, français).

Cette norme ne peut être utilisée en Belgique qu'en combinaison avec son annexe nationale (ANB) qui fixe principalement la valeur des paramètres à déterminer au niveau national.

Une version en néerlandais, ayant le même statut que les versions officielles, est également disponible au NBN.

## Nationaal voorwoord van NBN EN 1998-3:2005

1. De norm NBN EN 1998-3:2005 «Eurocode 8: Ontwerp en berekening van aardbevingsbestendige constructies – Deel 3: Beoordeling en hernieuwing van gebouwen (+AC:2010)» omvat de nationale bijlage NBN EN 1998-3 ANB:2011 met een normatief karakter in België. Hij vervangt vanaf de datum van de publicatie in het Belgische Staatsblad van de bekrachtiging van de norm NBN EN 1998-3 ANB:2011 de volgende normen :

NBN ENV 1998-1-3:1996 «Eurocode 8 - Ontwerpbepalingen voor aardbevingsbeveiligend ontwerpen van draagsystemen - Deel 1-3 : Algemene regels - Welbepaalde regels voor verscheidene bouwstoffen en bouwdelen»

NBN ENV 1998-1-4:1996 «Eurocode 8 – Ontwerpbepalingen voor aardbevingsbeveiligend ontwerpen van draagsystemen – Deel 1-4 : Algemene regels – Versterking en herstel van gebouwen»

2. Aanvullende opmerking van het NBN:  
De verbeteringen begrepen in het corrigendum EN 1998-3:2005/AC:2010 behoren te worden aangebracht in deze Nederlandstalige versie van NBN EN 1998-3:2005

## Avant-propos national à la NBN EN 1998-3:2005

1. La norme NBN EN 1998-3:2005 «Eurocode 8 – Calcul des structures pour leur résistance aux séismes – Partie 3 : Evaluation et renforcement des bâtiments» comprend l'Annexe Nationale NBN EN 1998-3 ANB:2011 qui a un caractère normatif en Belgique. Elle remplace à partir de la date de publication au Moniteur Belge de l'homologation de la norme NBN 1998-3 ANB:2011 les normes suivantes :

NBN ENV 1998-1-3:1995 «Eurocode 8 - Conception et dimensionnement des structures pour la résistance aux séismes - Partie 1-3 : Règles générales - Règles particulières pour divers matériaux et éléments»

NBN ENV 1998-1-4:1996 «Eurocode 8 – Conception et dimensionnement des structures pour la résistance aux séismes – Partie 1-4 : Règles générales – Renforcement et réparation des bâtiments»

2. La version de langue française de l'EN 1998-3 a été rédigée en France par l'AFNOR. En conséquence, on y rencontre certaines expressions d'usage moins courant en Belgique.

Une liste de termes équivalents est donnée ci-après :

Terme de l'EN 1998-3	Terme équivalent en Belgique
poteau client	colonne le maître de l'ouvrage assisté de ses bureaux d'architectes, d'ingénierie et de consultance

3. Note complémentaire du NBN  
Les corrections contenues dans le document EN 1998-3:2005/AC:2010 édité par le CEN en mars 2010 sont à apporter à la version française de la NBN EN 1998-3:2005.

EUROPEAN STANDARD  
NORME EUROPÉENNE  
EUROPÄISCHE NORM

**EN 1998-3**

June 2005

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Supersedes ENV 1998-1-4:1996

English version

**Eurocode 8: Design of structures for earthquake resistance -  
Part 3: Assessment and retrofitting of buildings**

Eurocode 8: Calcul des structures pour leur résistance aux  
séismes - Partie 3: Evaluation et renforcement des  
bâtiments

Eurocode 8: Auslegung von Bauwerken gegen Erdbeben -  
Teil 3: Beurteilung und Ertüchtigung von Gebäuden

This European Standard was approved by CEN on 15 March 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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## Foreword

This European Standard EN 1998-3, Eurocode 8: Design of structures for earthquake resistance: Assessment and Retrofitting of buildings, 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 the latest by March 2010.

This document supersedes ENV 1998-1-4:1996.

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 1980's.

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:

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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 1990 Eurocode: 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

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

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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 hENs and ETAGs/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.

## **EN 1998-3: 2005 (E)**

CEN Technical Committees and/or EOTA Working Groups working on product standards with a view to achieving a 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 (informative).

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 application of informative annexes,
- 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 1998-3**

Although assessment and retrofitting of existing structures for non-seismic actions is not yet covered by the relevant material-dependent Eurocodes, this Part of Eurocode 8 was specifically developed because:

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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.

- For many older structures, seismic resistance was not considered during the original construction, whereas non-seismic actions were catered for, at least by means of traditional construction rules.
- Seismic hazard evaluations in accordance with present knowledge may indicate the need for retrofitting campaigns.
- Damage caused by earthquakes may create the need for major repairs.

Furthermore, since within the philosophy of Eurocode 8 the seismic design of new structures is based on a certain acceptable degree of structural damage in the event of the design earthquake, criteria for seismic assessment (of structures designed in accordance with Eurocode 8 and subsequently damaged) constitute an integral part of the entire process for seismic structural safety.

In seismic retrofitting situations, qualitative verifications for the identification and elimination of major structural defects are very important and should not be discouraged by the quantitative analytical approach proper to this Part of Eurocode 8. Preparation of documents of more qualitative nature is left to the initiative of the National Authorities.

This Standard addresses only the structural aspects of seismic assessment and retrofitting, which may form only one component of a broader strategy for seismic risk mitigation. This Standard will apply once the requirement to assess a particular building has been established. The conditions under which seismic assessment of individual buildings – possibly leading to retrofitting – may be required are beyond the scope of this Standard.

National programmes for seismic risk mitigation through seismic assessment and retrofitting may differentiate between “active” and “passive” seismic assessment and retrofitting programmes. “Active” programmes may require owners of certain categories of buildings to meet specific deadlines for the completion of the seismic assessment and – depending on its outcome – of the retrofitting. The categories of buildings selected to be targeted may depend on seismicity and ground conditions, importance class and occupancy and perceived vulnerability of the building (as influenced by type of material and construction, number of storeys, age of the building with respect to dates of older code enforcement, etc.). “Passive” programmes associate seismic assessment – possibly leading to retrofitting – with other events or activities related to the use of the building and its continuity, such as a change in use that increases occupancy or importance class, remodelling above certain limits (as a percentage of the building area or of the total building value), repair of damage after an earthquake, etc. The choice of the Limit States to be checked, as well as the return periods of the seismic action ascribed to the various Limit States, may depend on the adopted programme for assessment and retrofitting. The relevant requirements may be less stringent in “active” programmes than in “passive” ones; for example, in “passive” programmes triggered by remodelling, the relevant requirements may graduate with the extent and cost of the remodelling work undertaken.

In cases of low seismicity (see EN1998-1, **3.2.1(4)**), this Standard may be adapted to local conditions by appropriate National Annexes.

### **National annex for EN 1998-3**

This standard gives alternative procedures, values and recommendations for classes

**EN 1998-3: 2005 (E)**

with notes indicating where national choices may have to be made. Therefore the National Standard implementing EN 1998-3: 2005 should have a National annex containing all Nationally Determined Parameters to be used for the design of buildings and civil engineering works to be constructed in the relevant country.

National choice is allowed in EN 1998-3: 2005 through clauses:

Reference	Item
1.1(4)	Informative Annexes A, B and C.
2.1(2)P	Number of Limit States to be considered
2.1(3)P	Return period of seismic actions under which the Limit States should not be exceeded.
2.2.1(7)P	Partial factors for materials
3.3.1(4)	Confidence factors
3.4.4(1)	Levels of inspection and testing
4.4.2(1)P	Maximum value of the ratio $\rho_{\max}/\rho_{\min}$
4.4.4.5(2)	Complementary, non-contradictory information on non-linear static analysis procedures that can capture the effects of higher modes.

## 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)**, **(4)** and **(5)**. Additional parts of Eurocode 8 are indicated in EN 1998-1: 2004, **1.1.3**.

(2) The scope of EN 1998-3 is as follows:

- To provide criteria for the evaluation of the seismic performance of existing individual building structures.
- To describe the approach in selecting necessary corrective measures
- To set forth criteria for the design of retrofitting measures (i.e. conception, structural analysis including intervention measures, final dimensioning of structural parts and their connections to existing structural elements).

NOTE For the purposes of this standard, retrofitting covers both the strengthening of undamaged structures and the repair of earthquake damaged structures.

(3) When designing a structural intervention to provide adequate resistance against seismic actions, structural verifications should also be made with respect to non-seismic load combinations.

(4) Reflecting the basic requirements of EN 1998-1: 2004, this Standard covers the seismic assessment and retrofitting of buildings made of the more commonly used structural materials: concrete, steel, and masonry.

NOTE Informative Annexes A, B and C contain additional information related to the assessment of reinforced concrete, steel and composite, and masonry buildings, respectively, and to their upgrading when necessary.

(5) Although the provisions of this Standard are applicable to all categories of buildings, the seismic assessment and retrofitting of monuments and historical buildings often requires different types of provisions and approaches, depending on the nature of the monuments.

(6) Since existing structures:

- (i) reflect the state of knowledge at the time of their construction,
- (ii) possibly contain hidden gross errors,
- (iii) may have been submitted to previous earthquakes or other accidental actions with unknown effects,

structural evaluation and possible structural intervention are typically subjected to a different degree of uncertainty (level of knowledge) than the design of new structures. Different sets of material and structural safety factors are therefore required, as well as different analysis procedures, depending on the completeness and reliability of the information available.