

SVENSK STANDARD

SS-EN 1998-3:2005

Fastställt/Approved: 2005-07-06

Publicerad/Published: 2009-12-14

Utgåva/Edition: 1

Språk/Language: engelska/English

ICS: 91.070.08; 91.120.25

Eurokod 8: Dimensionering av bärverk med avseende på jordbävning – Del 3: Tillståndsbedömning och förbättring av skadade byggnader

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

This preview is downloaded from www.sis.se. Buy the entire standard via <https://www.sis.se/std-40079>

Hitta rätt produkt och ett leveranssätt som passar dig

Standarder

Genom att följa gällande standard både effektiviserar och säkrar du ditt arbete. Många standarder ingår dessutom ofta i paket.

Tjänster

Abonnemang är tjänsten där vi uppdaterar dig med aktuella standarder när förändringar sker på dem du valt att abonnera på.

På så sätt är du säker på att du alltid arbetar efter rätt utgåva.

e-nav är vår online-tjänst som ger dig och dina kollegor tillgång till standarder ni valt att abonnera på dygnet runt. Med e-nav kan samma standard användas av flera personer samtidigt.

Leveranssätt

Du väljer hur du vill ha dina standarder levererade. Vi kan erbjuda dig dem på papper och som pdf.

Andra produkter

Vi har böcker som underlättar arbetet att följa en standard. Med våra böcker får du ökad förståelse för hur standarder ska följas och vilka fördelar den ger dig i ditt arbete. Vi tar fram många egna publikationer och fungerar även som återförsäljare. Det gör att du hos oss kan hitta över 500 unika titlar. Vi har även tekniska rapporter, specifikationer och "workshop agreement".

Matriser är en översikt på standarder och handböcker som bör läsas tillsammans. De finns på sis.se och ger dig en bra bild över hur olika produkter hör ihop.

Standardiseringsprojekt

Du kan påverka innehållet i framtida standarder genom att delta i någon av SIS ca 400 Tekniska Kommittéer.

Find the right product and the type of delivery that suits you

Standards

By complying with current standards, you can make your work more efficient and ensure reliability. Also, several of the standards are often supplied in packages.

Services

Subscription is the service that keeps you up to date with current standards when changes occur in the ones you have chosen to subscribe to. This ensures that you are always working with the right edition.

e-nav is our online service that gives you and your colleagues access to the standards you subscribe to 24 hours a day. With e-nav, the same standards can be used by several people at once.

Type of delivery

You choose how you want your standards delivered. We can supply them both on paper and as PDF files.

Other products

We have books that facilitate standards compliance. They make it easier to understand how compliance works and how this benefits you in your operation. We produce many publications of our own, and also act as retailers. This means that we have more than 500 unique titles for you to choose from. We also have technical reports, specifications and workshop agreements.

Matrices, listed at sis.se, provide an overview of which publications belong together.

Standardisation project

You can influence the content of future standards by taking part in one or other of SIS's 400 or so Technical Committees.

Standarden EN 1998-3:2005 gäller som svensk standard. Europastandarden fastställdes 2005-07-06 som SS-EN 1998-3:2005 och utges nu i engelsk språkversion med den nationella bilagan NA.

The European Standard EN 1998-3:2005 has the status of a Swedish Standard. The European Standard was 2005-07-06 implemented as SS-EN 1998-3:2005 and it is now published in English with the National Annexes NA.

Nationellt förord

Information om Eurokodernas införlivande i det svenska standard- och regelsystemet

Eurokoderna innehåller metoder för att verifiera byggnadsverks och enskilda byggnadsdelars bärförmåga, stadga och beständighet samt deras funktionsduglighet då de utsätts för brand.

De innehåller ett antal parametrar där det enskilda landet får välja - s.k. nationellt valda parametrar (Nationally Determined Parameter), NDP. Det innebär att ländernas föreskrivande myndigheter i sin författning anger vad man väljer. För att underlätta användningen av Eurokoderna nationellt och ge den eftersträlvade transparensen för de internationellt verkande företagen, har man kommit överens om att de nationellt valda parametrarna ska återges i en informativ bilaga till respektive nationellt implementerade Eurokod.

Föreliggande standard innehåller den informativa nationella bilagan NA, som anger de nationella valen.

Bilagan publiceras även i ett separat dokument på engelska.

Översättning till svenska av vissa i EN 1998 förekommande definitioner ges i bilaga NB till EN 1998-delarna 1, 2 och 6,

På SIS hemsida, antingen via www.sis.se eller mer direkt www.eurokoder.se, ges en fyllig information om Eurokoderna. Nyheter annonseras i det elektroniska nyhetsbladet SIS EurokodNytt, som är gratis och beställs på adressen eurokoder@sis.se.

© Copyright/Upphovsrätten till denna produkt tillhör SIS, Swedish Standards Institute, Stockholm, Sverige. Användningen av denna produkt regleras av slutanvändarlicensen som återfinns i denna produkt, se standardens sista sidor.

© Copyright SIS, Swedish Standards Institute, Stockholm, Sweden. All rights reserved. The use of this product is governed by the end-user licence for this product. You will find the licence in the end of this document.

Upplysningar om sakinnehållet i standarden lämnas av SIS, Swedish Standards Institute, telefon 08-555 520 00.

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

Information about the content of the standard is available from the Swedish Standards Institute (SIS), tel +46 8 555 520 00.

Standards may be ordered from SIS Förlag AB, who can also provide general information about Swedish and foreign standards.

SIS Förlag AB, SE 118 80 Stockholm, Sweden. Tel: +46 8 555 523 10. Fax: +46 8 555 523 11.

E-mail: sis.sales@sis.se Internet: www.sis.se

EUROPEAN STANDARD

EN 1998-3

NORME EUROPÉENNE

EUROPÄISCHE NORM

June 2005

ICS 91.120.25

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.



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

Management Centre: rue de Stassart, 36 B-1050 Brussels

SS-EN 1998-3:2005 (E)

Contents	Page
FOREWORD	4
1 GENERAL	9
1.1 SCOPE	9
1.2 NORMATIVE REFERENCES	10
1.2.1 General reference standards	10
1.3 ASSUMPTIONS	10
1.4 DISTINCTION BETWEEN PRINCIPLES AND APPLICATION RULES	10
1.5 DEFINITIONS	10
1.6 SYMBOLS	10
1.6.1 General	10
1.6.2 Symbols used in Annex A	10
1.6.3 Symbols used in Annex B	12
1.7 S.I. UNITS	13
2 PERFORMANCE REQUIREMENTS AND COMPLIANCE CRITERIA	14
2.1 FUNDAMENTAL REQUIREMENTS	14
2.2 COMPLIANCE CRITERIA	15
2.2.1 General	15
2.2.2 Limit State of Near Collapse (NC)	15
2.2.3 Limit State of Significant Damage (SD)	16
2.2.4 Limit State of Damage Limitation (DL)	16
3 INFORMATION FOR STRUCTURAL ASSESSMENT	17
3.1 GENERAL INFORMATION AND HISTORY	17
3.2 REQUIRED INPUT DATA	17
3.3 KNOWLEDGE LEVELS	18
3.3.1 Definition of knowledge levels	18
3.3.2 KL1: Limited knowledge	19
3.3.3 KL2: Normal knowledge	20
3.3.4 KL3: Full knowledge	20
3.4 IDENTIFICATION OF THE KNOWLEDGE LEVEL	21
3.4.1 Geometry	21
3.4.2 Details	22
3.4.3 Materials	22
3.4.4 Definition of the levels of inspection and testing	23
3.5 CONFIDENCE FACTORS	23
4 ASSESSMENT	24
4.1 GENERAL	24
4.2 SEISMIC ACTION AND SEISMIC LOAD COMBINATION	24
4.3 STRUCTURAL MODELLING	24
4.4 METHODS OF ANALYSIS	25
4.4.1 General	25
4.4.2 Lateral force analysis	25
4.4.3 Multi-modal response spectrum analysis	26
4.4.4 Nonlinear static analysis	26
4.4.5 Non-linear time-history analysis	27
4.4.6 q-factor approach	27

4.4.7	Combination of the components of the seismic action	27
4.4.8	Additional measures for masonry infilled structures	28
4.4.9	Combination coefficients for variable actions	28
4.4.10	Importance classes and importance factors	28
4.5	SAFETY VERIFICATIONS	28
4.5.1	Linear methods of analysis (lateral force or modal response spectrumanalysis)	28
4.5.2	Nonlinear methods of analysis (static or dynamic	29
4.5.3	q-factor approach	29
4.6	SUMMARY OF CRITERIA FOR ANALYSIS AND SAFETY VERIFICATIONS	29
5	DECISIONS FOR STRUCTURAL INTERVENTION	31
5.1	CRITERIA FOR A STRUCTURAL INTERVENTION	31
5.1.1	Introduction	31
5.1.2	Technical criteria	31
5.1.3	Type of intervention	31
5.1.4	Non-structural elements	32
5.1.5	Justification of the selected intervention type	32
6	DESIGN OF STRUCTURAL INTERVENTION	34
6.1	RETROFIT DESIGN PROCEDURE	34
	ANNEX A (INFORMATIVE) REINFORCED CONCRETE STRUCTURES	35
	ANNEX B (INFORMATIVE) STEEL AND COMPOSITE STRUCTURES	55
	ANNEX C (INFORMATIVE) MASONRY BUILDINGS	81
	Bilaga NA (informativ) Nationellt valda parametrar m.m. för SS-EN 1998, del 1 – 6	90

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, 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 agreement¹ 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:

¹ 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 Documents² referred to in Article 12 of the CPD, although they are of a different nature from harmonised product standards³. Therefore, technical aspects arising from the Eurocodes work need to be adequately considered by

² 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.

³ 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.

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 works⁴. 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:

⁴ 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