SVENSK STANDARD
SS-EN 1998-1:2004

Fastställd/Approved: 2004-12-10
Publicerad/Published: 2009-03-02
Utgåva/Edition: 1
Språk/Language: engelska/English
ICS: 91.070.08; 91.120.25

Eurokod 8: Dimensionering av bärverk med avseende på jordbävning – Del 1: Allmänna regler, seismisk påverkan och regler för byggnader

Eurocode 8: Design of structures for earthquake resistance – Part 1: General rules, seismic actions and rules for buildings

SWEDISH STANDARDS INSTITUTE

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 1998-1:2004 gäller som svensk standard. Europastandarden fastställdes 2004-12-10 som SS-EN 1998-1:2004 och utges nu i engelsk språkversion med de nationella bilagorna NA och NB.

The European Standard EN 1998-1:2004 has the status of a Swedish Standard. The European Standard was 2004-12-10 implemented as SS-EN 1998-1:2004 and it is now published in English with the National Annexes NA and NB

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 eftersträvade 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.
Standarden innehåller också en nationell bilaga NB, som innehåller en översättning till svenska av definitionerna i standardens avsnitt 1.5.
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.

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

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 1998-1

December 2004

ICS 91.120.25

Supersedes ENV 1998-1-1:1994, ENV 1998-1-2:1994, ENV 1998-1-3:1995

English version

Eurocode 8: Design of structures for earthquake resistance - Part 1: General rules, seismic actions and rules for buildings

Eurocode 8: Calcul des structures pour leur résistance aux séismes - Partie 1: Règles générales, actions sismiques et règles pour les bâtiments

Eurocode 8: Auslegung von Bauwerken gegen Erdbeben - Teil 1: Grundlagen, Erdbebeneinwirkungen und Regeln für Hochbauten

This European Standard was approved by CEN on 23 April 2004.

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

Ref. No. EN 1998-1:2004: E

Contents ..... **Page**

FOREWORD **8**
1 GENERAL **15**
1.1 SCOPE 15
1.1.1 Scope of EN 1998 15
1.1.2 Scope of EN 1998-1 15
1.1.3 Further Parts of EN 1998 16
1.2 NORMATIVE REFERENCES 16
1.2.1 General reference standards 16
1.2.2 Reference Codes and Standards 17
1.3 ASSUMPTIONS 17
1.4 DISTINCTION BETWEEN PRINCIPLES AND APPLICATION RULES 17
1.5 TERMS AND DEFINITIONS 17
1.5.1 Terms common to all Eurocodes 17
1.5.2 Further terms used in EN 1998 17
1.6 SYMBOLS 19
1.6.1 General 19
1.6.2 Further symbols used in Sections 2 and 3 of EN 1998-1 19
1.6.3 Further symbols used in Section 4 of EN 1998-1 20
1.6.4 Further symbols used in Section 5 of EN 1998-1 21
1.6.5 Further symbols used in Section 6 of EN 1998-1 24
1.6.6 Further symbols used in Section 7 of EN 1998-1 25
1.6.7 Further symbols used in Section 8 of EN 1998-1 27
1.6.8 Further symbols used in Section 9 of EN 1998-1 27
1.6.9 Further symbols used in Section 10 of EN 1998-1 28
1.7 S.I. UNITS 28
2 PERFORMANCE REQUIREMENTS AND COMPLIANCE CRITERIA 29
2.1 FUNDAMENTAL REQUIREMENTS 29
2.2 COMPLIANCE CRITERIA 30
2.2.1 General 30
2.2.2 Ultimate limit state 30
2.2.3 Damage limitation state 31
2.2.4 Specific measures 32
2.2.4.1 Design 32
2.2.4.2 Foundations 32
2.2.4.3 Quality system plan 32
3 GROUND CONDITIONS AND SEISMIC ACTION **33**
3.1 GROUND CONDITIONS 33
3.1.2 Identification of ground types 33
3.2 SEISMIC ACTION 35
3.2.1 Seismic zones 35
3.2.2 Basic representation of the seismic action 36
3.2.2.1 General 36
3.2.2.2 Horizontal elastic response spectrum 37
3.2.2.3 Vertical elastic response spectrum 40
3.2.2.4 Design ground displacement 41
3.2.2.5 Design spectrum for elastic analysis 41
3.2.3 Alternative representations of the seismic action 42
3.2.3.1 Time - history representation 42
3.2.3.2 Spatial model of the seismic action 43
3.2.4 Combinations of the seismic action with other actions 44
4 DESIGN OF BUILDINGS **45**
4.1 GENERAL 45
4.1.1 Scope 45
4.2 CHARACTERISTICS OF EARTHQUAKE RESISTANT BUILDINGS 45
4.2.1 Basic principles of conceptual design 45
4.2.1.1 Structural simplicity 45

4.2.1.2 Uniformity, symmetry and redundancy ... 45
4.2.1.3 Bi-directional resistance and stiffness ... 46
4.2.1.4 Torsional resistance and stiffness ... 46
4.2.1.5 Diaphragmatic behaviour at storey level ... 46
4.2.1.6 Adequate foundation ... 47
4.2.2 Primary and secondary seismic members ... 47
4.2.3 Criteria for structural regularity ... 48
4.2.3.1 General ... 48
4.2.3.2 Criteria for regularity in plan ... 49
4.2.3.3 Criteria for regularity in elevation ... 50
4.2.4 Combination coefficients for variable actions ... 52
4.2.5 Importance classes and importance factors ... 52
4.3 STRUCTURAL ANALYSIS ... 53
4.3.1 Modelling ... 53
4.3.2 Accidental torsional effects ... 54
4.3.3 Methods of analysis ... 54
4.3.3.1 General ... 54
4.3.3.2 Lateral force method of analysis ... 56
4.3.3.3 Modal response spectrum analysis ... 59
4.3.3.4 Non-linear methods ... 61
4.3.3.5 Combination of the effects of the components of the seismic action ... 64
4.3.4 Displacement calculation ... 66
4.3.5 Non-structural elements ... 66
4.3.5.1 General ... 66
4.3.5.2 Verification ... 67
4.3.5.3 Importance factors ... 68
4.3.5.4 Behaviour factors ... 68
4.3.6 Additional measures for masonry infilled frames ... 68
4.3.6.1 General ... 68
4.3.6.2 Requirements and criteria ... 69
4.3.6.3 Irregularities due to masonry infills ... 69
4.3.6.4 Damage limitation of infills ... 70
4.4 SAFETY VERIFICATIONS ... 71
4.4.1 General ... 71
4.4.2 Ultimate limit state ... 71
4.4.2.1 General ... 71
4.4.2.2 Resistance condition ... 71
4.4.2.3 Global and local ductility condition ... 72
4.4.2.4 Equilibrium condition ... 74
4.4.2.5 Resistance of horizontal diaphragms ... 74
4.4.2.6 Resistance of foundations ... 74
4.4.2.7 Seismic joint condition ... 75
4.4.3 Damage limitation ... 76
4.4.3.1 General ... 76
4.4.3.2 Limitation of interstorey drift ... 76
5 SPECIFIC RULES FOR CONCRETE BUILDINGS ... 78
5.1 GENERAL ... 78
5.1.1 Scope ... 78
5.1.2 Terms and definitions ... 78
5.2 DESIGN CONCEPTS ... 80
5.2.1 Energy dissipation capacity and ductility classes ... 80
5.2.2 Structural types and behaviour factors ... 81
5.2.2.1 Structural types ... 81
5.2.2.2 Behaviour factors for horizontal seismic actions ... 82
5.2.3 Design criteria ... 84
5.2.3.1 General ... 84
5.2.3.2 Local resistance condition ... 84
5.2.3.3 Capacity design rule ... 84

5.2.3.4 Local ductility condition ... 84
5.2.3.5 Structural redundancy ... 86
5.2.3.6 Secondary seismic members and resistances ... 86
5.2.3.7 Specific additional measures ... 86
5.2.4 Safety verifications ... 87
5.3 DESIGN TO EN 1992-1-1 ... 87
5.3.1 General ... 87
5.3.2 Materials ... 88
5.3.3 Behaviour factor ... 88
5.4 DESIGN FOR DCM ... 88
5.4.1 Geometrical constraints and materials ... 88
5.4.1.1 Material requirements ... 88
5.4.1.2 Geometrical constraints ... 88
5.4.2 Design action effects ... 89
5.4.2.1 General ... 89
5.4.2.2 Beams ... 89
5.4.2.3 Columns ... 91
5.4.2.4 Special provisions for ductile walls ... 92
5.4.2.5 Special provisions for large lightly reinforced walls ... 94
5.4.3 ULS verifications and detailing ... 95
5.4.3.1 Beams ... 95
5.4.3.2 Columns ... 97
5.4.3.3 Beam-column joints ... 100
5.4.3.4 Ductile Walls ... 100
5.4.3.5 Large lightly reinforced walls ... 104
5.5 DESIGN FOR DCH ... 106
5.5.1 Geometrical constraints and materials ... 106
5.5.1.1 Material requirements ... 106
5.5.1.2 Geometrical constraints ... 106
5.5.2 Design action effects ... 107
5.5.2.1 Beams ... 107
5.5.2.2 Columns ... 107
5.5.2.3 Beam-column joints ... 107
5.5.2.4 Ductile Walls ... 108
5.5.3 ULS verifications and detailing ... 109
5.5.3.1 Beams ... 109
5.5.3.2 Columns ... 111
5.5.3.3 Beam-column joints ... 112
5.5.3.4 Ductile Walls ... 114
5.5.3.5 Coupling elements of coupled walls ... 119
5.6 PROVISIONS FOR ANCHORAGES AND SPLICES ... 120
5.6.1 General ... 120
5.6.2 Anchorage of reinforcement ... 120
5.6.2.1 Columns ... 120
5.6.2.2 Beams ... 120
5.6.3 Splicing of bars ... 122
5.7 DESIGN AND DETAILING OF SECONDARY SEISMIC ELEMENTS ... 123
5.8 CONCRETE FOUNDATION ELEMENTS ... 123
5.8.1 Scope ... 123
5.8.2 Tie-beams and foundation beams ... 124
5.8.3 Connections of vertical elements with foundation beams or walls ... 125
5.8.4 Cast-in-place concrete piles and pile caps ... 125
5.9 LOCAL EFFECTS DUE TO MASONRY OR CONCRETE INFILLS ... 126
5.10 PROVISIONS FOR CONCRETE DIAPHRAGMS ... 127
5.11 PRECAST CONCRETE STRUCTURES ... 127
5.11.1 General ... 127
5.11.1.1 Scope and structural types ... 127
5.11.1.2 Evaluation of precast structures ... 128

5.11.1.3 Design criteria ... 129
5.11.1.4 Behaviour factors ... 130
5.11.1.5 Analysis of transient situation ... 130
5.11.2 Connections of precast elements ... 131
5.11.2.1 General provisions ... 131
5.11.2.2 Evaluation of the resistance of connections ... 132
5.11.3 Elements ... 132
5.11.3.1 Beams ... 132
5.11.3.2 Columns ... 132
5.11.3.3 Beam-column joints ... 133
5.11.3.4 Precast large-panel walls ... 133
5.11.3.5 Diaphragms ... 135
6 SPECIFIC RULES FOR STEEL BUILDINGS ... 137
6.1 GENERAL ... 137
6.1.1 Scope ... 137
6.1.2 Design concepts ... 137
6.1.3 Safety verifications ... 138
6.2 MATERIALS ... 138
6.3 STRUCTURAL TYPES AND BEHAVIOUR FACTORS ... 140
6.3.1 Structural types ... 140
6.3.2 Behaviour factors ... 143
6.4 STRUCTURAL ANALYSIS ... 144
6.5 DESIGN CRITERIA AND DETAILING RULES FOR DISSIPATIVE STRUCTURAL BEHAVIOUR COMMON TO ALL STRUCTURAL TYPES ... 144
6.5.1 General ... 144
6.5.2 Design criteria for dissipative structures ... 144
6.5.3 Design rules for dissipative elements in compression or bending ... 145
6.5.4 Design rules for parts or elements in tension ... 145
6.5.5 Design rules for connections in dissipative zones ... 145
6.6 DESIGN AND DETAILING RULES FOR MOMENT RESISTING FRAMES ... 146
6.6.1 Design criteria ... 146
6.6.2 Beams ... 146
6.6.3 Columns ... 147
6.6.4 Beam to column connections ... 149
6.7 DESIGN AND DETAILING RULES FOR FRAMES WITH CONCENTRIC BRACINGS ... 150
6.7.1 Design criteria ... 150
6.7.2 Analysis ... 151
6.7.3 Diagonal members ... 152
6.7.4 Beams and columns ... 152
6.8 DESIGN AND DETAILING RULES FOR FRAMES WITH ECCENTRIC BRACINGS ... 153
6.8.1 Design criteria ... 153
6.8.2 Seismic links ... 154
6.8.3 Members not containing seismic links ... 157
6.8.4 Connections of the seismic links ... 158
6.9 DESIGN RULES FOR INVERTED PENDULUM STRUCTURES ... 158
6.10 DESIGN RULES FOR STEEL STRUCTURES WITH CONCRETE CORES OR CONCRETE WALLS AND FOR MOMENT RESISTING FRAMES COMBINED WITH CONCENTRIC BRACINGS OR INFILLS ... 159
6.10.1 Structures with concrete cores or concrete walls ... 159
6.10.2 Moment resisting frames combined with concentric bracings ... 159
6.10.3 Moment resisting frames combined with infills ... 159
6.11 CONTROL OF DESIGN AND CONSTRUCTION ... 159
7 SPECIFIC RULES FOR COMPOSITE STEEL – CONCRETE BUILDINGS ... 161
7.1 GENERAL ... 161
7.1.1 Scope ... 161
7.1.2 Design concepts ... 161
7.1.3 Safety verifications ... 162
7.2 MATERIALS ... 163
7.2.1 Concrete ... 163

7.2.2 Reinforcing steel ... 163
7.2.3 Structural steel ... 163
7.3 STRUCTURAL TYPES AND BEHAVIOUR FACTORS ... 163
7.3.1 Structural types ... 163
7.3.2 Behaviour factors ... 165
7.4 STRUCTURAL ANALYSIS ... 165
7.4.1 Scope ... 165
7.4.2 Stiffness of sections ... 166
7.5 DESIGN CRITERIA AND DETAILING RULES FOR DISSIPATIVE STRUCTURAL BEHAVIOUR COMMON TO ALL STRUCTURAL TYPES ... 166
7.5.1 General ... 166
7.5.2 Design criteria for dissipative structures ... 166
7.5.3 Plastic resistance of dissipative zones ... 167
7.5.4 Detailing rules for composite connections in dissipative zones ... 167
7.6 RULES FOR MEMBERS ... 170
7.6.1 General ... 170
7.6.2 Steel beams composite with slab ... 172
7.6.3 Effective width of slab ... 174
7.6.4 Fully encased composite columns ... 176
7.6.5 Partially-encased members ... 178
7.6.6 Filled Composite Columns ... 179
7.7 DESIGN AND DETAILING RULES FOR MOMENT FRAMES ... 179
7.7.1 Specific criteria ... 179
7.7.2 Analysis ... 180
7.7.3 Rules for beams and columns ... 180
7.7.4 Beam to column connections ... 181
7.7.5 Condition for disregarding the composite character of beams with slab. ... 181
7.8 DESIGN AND DETAILING RULES FOR COMPOSITE CONCENTRICALLY BRACED FRAMES ... 181
7.8.1 Specific criteria ... 181
7.8.2 Analysis ... 181
7.8.3 Diagonal members ... 181
7.8.4 Beams and columns ... 181
7.9 DESIGN AND DETAILING RULES FOR COMPOSITE ECCENTRICALLY BRACED FRAMES ... 181
7.9.1 Specific criteria ... 181
7.9.2 Analysis ... 182
7.9.3 Links ... 182
7.9.4 Members not containing seismic links ... 183
7.10 DESIGN AND DETAILING RULES FOR STRUCTURAL SYSTEMS MADE OF REINFORCED CONCRETE SHEAR WALLS COMPOSITE WITH STRUCTURAL STEEL ELEMENTS ... 183
7.10.1 Specific criteria ... 183
7.10.2 Analysis ... 185
7.10.3 Detailing rules for composite walls of ductility class DCM ... 185
7.10.4 Detailing rules for coupling beams of ductility class DCM ... 186
7.10.5 Additional detailing rules for ductility class DCH ... 186
7.11 DESIGN AND DETAILING RULES FOR COMPOSITE STEEL PLATE SHEAR WALLS ... 186
7.11.1 Specific criteria ... 186
7.11.2 Analysis ... 187
7.11.3 Detailing rules ... 187
7.12 CONTROL OF DESIGN AND CONSTRUCTION ... 187
8 SPECIFIC RULES FOR TIMBER BUILDINGS ... 188
8.1 GENERAL ... 188
8.1.1 Scope ... 188
8.1.2 Definitions ... 188
8.1.3 Design concepts ... 188
8.2 MATERIALS AND PROPERTIES OF DISSIPATIVE ZONES ... 189
8.3 DUCTILITY CLASSES AND BEHAVIOUR FACTORS ... 190
8.4 STRUCTURAL ANALYSIS ... 191
8.5 DETAILING RULES ... 191

8.5.1 General ... 191
8.5.2 Detailing rules for connections ... 192
8.5.3 Detailing rules for horizontal diaphragms ... 192
8.6 SAFETY VERIFICATIONS ... 192
8.7 CONTROL OF DESIGN AND CONSTRUCTION ... 193
9 SPECIFIC RULES FOR MASONRY BUILDINGS ... 194
9.1 SCOPE ... 194
9.2 MATERIALS AND BONDING PATTERNS ... 194
9.2.1 Types of masonry units ... 194
9.2.2 Minimum strength of masonry units ... 194
9.2.3 Mortar ... 194
9.2.4 Masonry bond ... 194
9.3 TYPES OF CONSTRUCTION AND BEHAVIOUR FACTORS ... 195
9.4 STRUCTURAL ANALYSIS ... 196
9.5 DESIGN CRITERIA AND CONSTRUCTION RULES ... 197
9.5.1 General ... 197
9.5.2 Additional requirements for unreinforced masonry satisfying EN 1998-1 ... 198
9.5.3 Additional requirements for confined masonry ... 198
9.5.4 Additional requirements for reinforced masonry ... 199
9.6 SAFETY VERIFICATION ... 200
9.7 RULES FOR “SIMPLE MASONRY BUILDINGS” ... 200
9.7.1 General ... 200
9.7.2 Rules ... 200
10 BASE ISOLATION ... 203
10.1 SCOPE ... 203
10.2 DEFINITIONS ... 203
10.3 FUNDAMENTAL REQUIREMENTS ... 204
10.4 COMPLIANCE CRITERIA ... 205
10.5 GENERAL DESIGN PROVISIONS ... 205
10.5.1 General provisions concerning the devices ... 205
10.5.2 Control of undesirable movements ... 206
10.5.3 Control of differential seismic ground motions ... 206
10.5.4 Control of displacements relative to surrounding ground and constructions ... 206
10.5.5 Conceptual design of base isolated buildings ... 206
10.6 SEISMIC ACTION ... 207
10.7 BEHAVIOUR FACTOR ... 207
10.8 PROPERTIES OF THE ISOLATION SYSTEM ... 207
10.9 STRUCTURAL ANALYSIS ... 208
10.9.1 General ... 208
10.9.2 Equivalent linear analysis ... 208
10.9.3 Simplified linear analysis ... 209
10.9.4 Modal simplified linear analysis ... 211
10.9.5 Time-history analysis ... 211
10.9.6 Non structural elements ... 211
10.10 SAFETY VERIFICATIONS AT ULTIMATE LIMIT STATE ... 211
ANNEX A (INFORMATIVE) ELASTIC DISPLACEMENT RESPONSE SPECTRUM ... 213
ANNEX B (INFORMATIVE) DETERMINATION OF THE TARGET DISPLACEMENT FOR NONLINEAR STATIC (PUSHOVER) ANALYSIS ... 215
ANNEX C (NORMATIVE) DESIGN OF THE SLAB OF STEEL-CONCRETE COMPOSITE BEAMS AT BEAMCOLUMN JOINTS IN MOMENT RESISTING FRAMES ... 219
Bilaga NA (informativ) Nationellt valda parametrar m.m. för SS-EN 1998, del 1 – 6 ... 230
Bilaga NB (informativ) Översättning av definitionerna i avsnitt 1.5.2 ... 232

Foreword

This European Standard EN 1998-1, Eurocode 8: Design of structures for earthquake resistance: General rules, seismic actions and rules for 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 June 2005, and conflicting national standards shall be withdrawn at latest by March 2010.

This document supersedes ENV 1998-1-1:1994, ENV 1998-1-2:1994 and ENV 1998-1-3:1995.

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[1] 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).

[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).

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

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[2] referred to in Article 12 of the CPD, although they are of a different nature from harmonised product standards[3]. 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 works[4]. 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 1998-1

The scope of EN 1998 is defined in **1.1.1** and the scope of this Part of EN 1998 is defined in **1.1.2**. Additional Parts of EN 1998 are listed in **1.1.3**.

[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.

EN 1998-1 was developed from the merger of ENV 1998-1-1:1994, ENV 1998-1-2:1994 and ENV 1998-1-3:1995. As mentioned in **1.1.1**, attention must be paid to the fact that for the design of structures in seismic regions the provisions of EN 1998 are to be applied in addition to the provisions of the other relevant EN 1990 to EN 1997 and EN 1999.

One fundamental issue in EN 1998-1 is the definition of the seismic action. Given the wide difference of seismic hazard and seismo-genetic characteristics in the various member countries, the seismic action is herein defined in general terms. The definition allows various Nationally Determined Parameters (NDP) which should be confirmed or modified in the National Annexes.

It is however considered that, by the use of a common basic model for the representation of the seismic action, an important step is taken in EN 1998-1 in terms of Code harmonisation.

EN 1998-1 contains in its section related to masonry buildings specific provisions which simplify the design of "simple masonry buildings".

National annex for EN 1998-1

This standard gives alternative procedures, values and recommendations for classes with notes indicating where national choices may be made. Therefore the National Standard implementing EN 1998-1 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 1998-1:2004 through clauses:

Reference	Item
1.1.2(7)	Informative Annexes A and B.
2.1(1)P	Reference return period T_{NCR} of seismic action for the no-collapse requirement (or, equivalently, reference probability of exceedance in 50 years, P_{NCR}).
2.1(1)P	Reference return period T_{DLR} of seismic action for the damage limitation requirement. (or, equivalently, reference probability of exceedance in 10 years, P_{DLR}).
3.1.1(4)	Conditions under which ground investigations additional to those necessary for design for non-seismic actions may be omitted and default ground classification may be used.
3.1.2(1)	Ground classification scheme accounting for deep geology, including values of parameters S, T_B, T_C and T_D defining horizontal and vertical elastic response spectra in accordance with **3.2.2.2** and **3.2.2.3**.
3.2.1(1), (2),(3)	Seismic zone maps and reference ground accelerations therein.
3.2.1(4)	Governing parameter (identification and value) for threshold of low seismicity .

3.2.1(5)	Governing parameter (identification and value) for threshold of very low seismicity .
3.2.2.1(4), 3.2.2.2(1)P	Parameters S, T_B, T_C, T_D defining shape of horizontal elastic response spectra.
3.2.2.3(1)P	Parameters a_{vg} T_B, T_C, T_D defining shape of vertical elastic response spectra.
3.2.2.5(4)P	Lower bound factor β on design spectral values.
4.2.3.2(8)	Reference to definitions of centre of stiffness and of torsional radius in multi-storey buildings meeting or not conditions (a) and (b) of **4.2.3.2(8)**
4.2.4(2)P	Values of φ for buildings.
4.2.5(5)P	Importance factor γ_I for buildings.
4.3.3.1 (4)	Decision on whether nonlinear methods of analysis may be applied for the design of non-base-isolated buildings. Reference to information on member deformation capacities and the associated partial factors for the Ultimate Limit State for design or evaluation on the basis of nonlinear analysis methods.
4.3.3.1 (8)	Threshold value of importance factor, γ_I, relating to the permitted use of analysis with two planar models.
4.4.2.5 (2).	Overstrength factor γ_{Rd} for diaphragms.
4.4.3.2 (2)	Reduction factor ν for displacements at damage limitation limit state
5.2.1(5)	Geographical limitations on use of ductility classes for concrete buildings.
5.2.2.2(10)	q_o-value for concrete buildings subjected to special Quality System Plan.
5.2.4(1), (3)	Material partial factors for concrete buildings in the seismic design situation.
5.4.3.5.2(1)	Minimum web reinforcement of large lightly reinforced concrete walls
5.8.2(3)	Minimum cross-sectional dimensions of concrete foundation beams.
5.8.2(4)	Minimum thickness and reinforcement ratio of concrete foundation slabs.
5.8.2(5)	Minimum reinforcement ratio of concrete foundation beams.
5.11.1.3.2(3)	Ductility class of precast wall panel systems.
5.11.1.4	q-factors of precast systems.
5.11.1.5(2)	Seismic action during erection of precast structures.
5.11.3.4(7)e	Minimum longitudinal steel in grouted connections of large panel

	walls.
6.1.2(1)	Upper limit of q for low-dissipative structural behaviour concept; limitations on structural behaviour concept; geographical limitations on use of ductility classes for steel buildings.
6.1.3(1)	Material partial factors for steel buildings in the seismic design situation.
6.2(3)	Overstrength factor for capacity design of steel buildings.
6.2 (7)	Information as to how EN 1993-1-10:2004 may be used in the seismic design situation
6.5.5(7)	Reference to complementary rules on acceptable connection design
6.7.4(2)	Residual post-buckling resistance of compression diagonals in steel frames with *V*-bracings.
7.1.2(1)	Upper limit of q for low-dissipative structural behaviour concept; limitations on structural behaviour concept; geographical limitations on use of ductility classes for composite steel-concrete buildings.
7.1.3(1), (3)	Material partial factors for composite steel-concrete buildings in the seismic design situation.
7.1.3(4)	Overstrength factor for capacity design of composite steel-concrete buildings
7.7.2(4)	Stiffness reduction factor for concrete part of a composite steel-concrete column section
8.3(1)	Ductility class for timber buildings.
9.2.1(1)	Type of masonry units with sufficient robustness.
9.2.2(1)	Minimum strength of masonry units.
9.2.3(1)	Minimum strength of mortar in masonry buildings.
9.2.4(1)	Alternative classes for perpend joints in masonry
9.3(2)	Conditions for use of unreinforced masonry satisfying provisions of EN 1996 alone.
9.3(2)	Minimum effective thickness of unreinforced masonry walls satisfying provisions of EN 1996 alone.
9.3(3)	Maximum value of ground acceleration for the use of unreinforced masonry satisfying provisions of EN. 1998-1
9.3(4), Table 9.1	q-factor values in masonry buildings.
9.3(4), Table 9.1	q-factors for buildings with masonry systems which provide enhanced ductility.
9.5.1(5)	Geometric requirements for masonry shear walls.
9.6(3)	Material partial factors in masonry buildings in the seismic design situation.

9.7.2(1)	Maximum number of storeys and minimum area of shear walls of “simple masonry building”.
9.7.2(2)b	Minimum aspect ratio in plan of “simple masonry buildings”.
9.7.2(2)c	Maximum floor area of recesses in plan for “simple masonry buildings”.
9.7.2(5)	Maximum difference in mass and wall area between adjacent storeys of “simple masonry buildings”.
10.3(2)P	Magnification factor on seismic displacements for isolation devices.

1 GENERAL

1.1 Scope

1.1.1 Scope of EN 1998

(1)P EN 1998 applies to the design and construction of buildings and civil engineering works in seismic regions. Its purpose is to ensure that in the event of earthquakes:

– human lives are protected;

– damage is limited; and

– structures important for civil protection remain operational.

NOTE The random nature of the seismic events and the limited resources available to counter their effects are such as to make the attainment of these goals only partially possible and only measurable in probabilistic terms. The extent of the protection that can be provided to different categories of buildings, which is only measurable in probabilistic terms, is a matter of optimal allocation of resources and is therefore expected to vary from country to country, depending on the relative importance of the seismic risk with respect to risks of other origin and on the global economic resources.

(2)P Special structures, such as nuclear power plants, offshore structures and large dams, are beyond the scope of EN 1998.

(3)P EN 1998 contains only those provisions that, in addition to the provisions of the other relevant Eurocodes, must be observed for the design of structures in seismic regions. It complements in this respect the other Eurocodes.

(4) EN 1998 is subdivided into various separate Parts (see **1.1.2** and **1.1.3**).

1.1.2 Scope of EN 1998-1

(1) EN 1998-1 applies to the design of buildings and civil engineering works in seismic regions. It is subdivided in 10 Sections, some of which are specifically devoted to the design of buildings.

(2) Section **2** of EN 1998-1 contains the basic performance requirements and compliance criteria applicable to buildings and civil engineering works in seismic regions.

(3) Section **3** of EN 1998-1 gives the rules for the representation of seismic actions and for their combination with other actions. Certain types of structures, dealt with in EN 1998-2 to EN 1998-6, need complementing rules which are given in those Parts.

(4) Section **4** of EN 1998-1 contains general design rules relevant specifically to buildings.

(5) Sections **5** to **9** of EN 1998-1 contain specific rules for various structural materials and elements, relevant specifically to buildings as follows: