SLOVENSKI STANDARD

SIST EN 1998-5:2005

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SIST ENV 1998-5:1995+D1:1995

Evrokod 8 - Projektiranje potresnoodpornih konstrukcij - 5. del: Temelji, oporne konstrukcije in geotehniļ ni vidiki

Eurocode 8: Design of structures for earthquake resistance Part 5: Foundations, retaining structures and geotechnical aspects

Eurocode 8: Auslegung von Bauwerken gegen Erdbeben - Teil 5: Gründungen, Stützbauwerke und geotechnische Aspekte

Eurocode 8: Calcul des structures pour leur résistance aux séismes Partie 5: Fondations, ouvrages de soutenement et aspects géotechniques

Ta slovenski standard je istoveten z: **EN 1998-5:2004**

ICS:

91.010.30	Tehniļ ni vidiki	Technical aspects
91.120.25	Zaģļ ita pred potresi in vibracijami	Seismic and vibration protection

SIST EN 1998-5:2005 **en**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 1998-5

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English version

Eurocode 8: Design of structures for earthquake resistance Part 5: Foundations, retaining structures and geotechnical aspects

Eurocode 8: Calcul des structures pour leur résistance aux séismes Partie 5: Fondations, ouvrages de soutènement et aspects géotechniques

Eurocode 8: Auslegung von Bauwerken gegen Erdbeben Teil 5: Gründungen, Stützbauwerke und geotechnische Aspekte

This European Standard was approved by CEN on 16 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.

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EUROPÄISCHES KOMITEE FÜR NORMUNG

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Contents

Foreword

This European Standard EN 1998–5, Eurocode 8: Design of structures for earthquake resistance: Foundations, retaining structures and geotechnical aspects, 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 May 2005, and conflicting national standards shall be withdrawn at the latest by March 2010.

This document supersedes ENV 1998–5:1994.

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 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.

[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 harmonised ENs 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.

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.

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 1998-5

The scope of Eurocode 8 is defined in EN 1998-1:2004, **1.1.1** and the scope of this Part of Eurocode 8 is defined in **1.1**. Additional Parts of Eurocode 8 are listed in EN 1998-1:2004, **1.1.3**.

[4] see Art.3.3 and Art.12 of the CPD, as well as 4.2, 4.3.1, 4.3.2 and 5.2 of ID 1.

EN 1998-5:2004 is intended for use by:

- clients (e.g. for the formulation of their specific requirements on reliability levels and durability) ;
- designers and constructors ;
- relevant authorities.

For the design of structures in seismic regions the provisions of this European Standard are to be applied in addition to the provisions of the other relevant parts of Eurocode 8 and the other relevant Eurocodes. In particular, the provisions of this European Standard complement those of EN 1997-1:2004, which do not cover the special requirements of seismic design.

Owing to the combination of uncertainties in seismic actions and ground material properties, Part 5 may not cover in detail every possible design situation and its proper use may require specialised engineering judgement and experience.

National annex for EN 1998-5

This standard gives alternative procedures, values and recommendations for classes with notes indicating where national choices may have to be made. Therefore the National Standard implementing EN 1998-5 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 1998-5:2004 through clauses:

Reference	Item
1.1 (4)	Informative Annexes A, C, D and F
3.1 (3)	Partial factors for material properties
4.1.4 (11)	Upper stress limit for susceptibility to liquefaction
5.2 (2)c)	Reduction of peak ground acceleration with depth from ground surface

1 GENERAL

1.1 Scope

(1)P This Part of Eurocode 8 establishes the requirements, criteria, and rules for the siting and foundation soil of structures for earthquake resistance. It covers the design of different foundation systems, the design of earth retaining structures and soil-structure interaction under seismic actions. As such it complements Eurocode 7 which does not cover the special requirements of seismic design.

(2)P The provisions of Part 5 apply to buildings (EN 1998-1), bridges (EN 1998-2), towers, masts and chimneys (EN 1998-6), silos, tanks and pipelines (EN 1998-4).

(3)P Specialised design requirements for the foundations of certain types of structures, when necessary, shall be found in the relevant Parts of Eurocode 8.

(4) Annex B of this Eurocode provides empirical charts for simplified evaluation of liquefaction potential, while Annex E gives a simplified procedure for seismic analysis of retaining structures.

NOTE 1 Informative Annex A provides information on topographic amplification factors.

NOTE 2 Informative Annex C provides information on the static stiffness of piles.

NOTE 3 Informative Annex D provides information on dynamic soil-structure interaction.

NOTE 4 Informative Annex F provides information on the seismic bearing capacity of shallow foundations.

1.2 Normative references

(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).

1.2.1 General reference standards

EN 1990 Eurocode - Basis of structural design

EN 1997-1 Eurocode 7 - Geotechnical design – Part 1: General rules

EN 1997-2 Eurocode 7 - Geotechnical design – Part 2: Ground investigation and testing

EN 1998-1 Eurocode 8 - Design of structures for earthquake resistance – Part 1: General rules, seismic actions and rules for buildings

EN 1998-2 Eurocode 8 - Design of structures for earthquake resistance – Part 2: Bridges

EN 1998-4 Eurocode 8 - Design of structures for earthquake resistance – Part 4: Silos, tanks and pipelines

EN 1998-6 Eurocode 8 - Design of structures for earthquake resistance – Part 6: Towers, masts and chimneys

1.3 Assumptions

(1)P The general assumptions of EN 1990:2002, **1.3** apply.

1.4 Distinction between principles and applications rules

(1)P The rules of EN 1990:2002, **1.4** apply.

1.5 Terms and definitions

1.5.1 Terms common to all Eurocodes

(1)P The terms and definitions given in EN 1990:2002, **1.5** apply.

(2)P EN 1998-1:2004, **1.5.1** applies for terms common to all Eurocodes.

1.5.2 Additional terms used in the present standard

(1)P The definition of ground found in EN 1997-1:2004, **1.5.2** applies while that of other geotechnical terms specifically related to earthquakes, such as liquefaction, are given in the text.

(2) For the purposes of this standard the terms defined in EN 1998-1:2004, **1.5.2** apply.

1.6 Symbols

(1) For the purposes of this European Standard the following symbols apply. All symbols used in Part 5 are defined in the text when they first occur, for ease of use. In addition, a list of the symbols is given below. Some symbols occurring only in the annexes are defined therein:

E_d Design action effect

E_{pd} Lateral resistance on the side of footing due to passive earth pressure

ER Energy ratio in Standard Penetration Test (SPT)

F_H Design seismic horizontal inertia force

F_V Design seismic vertical inertia force

F_{Rd} Design shear resistance between horizontal base of footing and the ground

G Shear modulus

G_{max} Average shear modulus at small strain

L_e Distance of anchors from wall under dynamic conditions

L_s Distance of anchors from wall under static conditions

M_{Ed} Design action in terms of moments

$N_1(60)$ SPT blowcount value normalised for overburden effects and for energy ratio

N_{Ed} Design normal force on the horizontal base

N_{SPT} Standard Penetration Test (SPT) blowcount value

PI Plasticity Index of soil

R_d Design resistance of the soil

S Soil factor defined in EN 1998-1:2004, **3.2.2.2**

S_T Topography amplification factor

V_{Ed} Design horizontal shear force

W Weight of sliding mass

a_g Design ground acceleration on type A ground ($a_g = \gamma_I \, a_{gR}$)

a_{gR} Reference peak ground acceleration on type A ground

a_{vg} Design ground acceleration in the vertical direction

c' Cohesion of soil in terms of effective stress

c_u Undrained shear strength of soil

d Pile diameter

d_r Displacement of retaining walls

g Acceleration of gravity

k_h Horizontal seismic coefficient

k_v Vertical seismic coefficient

q_u Unconfined compressive strength

r Factor for the calculation of the horizontal seismic coefficient (Table 7.1)

v_s Velocity of shear wave propagation

$v_{s,max}$ Average v_s value at small strain ($< 10^{-5}$)

α Ratio of the design ground acceleration on type A ground, a_g, to the acceleration of gravity g

γ Unit weight of soil

γ_d Dry unit weight of soil

γ_I Importance factor

γ_M Partial factor for material property

γ_{Rd} Model partial factor

γ_w Unit weight of water

δ Friction angle between the ground and the footing or retaining wall

ϕ' Angle of shearing resistance in terms of effective stress

ρ Unit mass

σ_{vo} Total overburden pressure, same as total vertical stress

σ'_{vo} Effective overburden pressure, same as effective vertical stress

$\tau_{cy,u}$ Cyclic undrained shear strength of soil

τ_e Seismic shear stress

1.7 S.I. Units

(1)P S.I. Units shall be used in accordance with ISO 1000.

(2) In addition the units recommended in EN 1998-1:2004, **1.7** apply.

NOTE For geotechnical calculations, reference should be made to EN 1997-1:2004, **1.6** (2).