SLOVENSKI STANDARD
oSIST prEN 1998-1-1:2022

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Evrokod 8 - Projektiranje potresnoodpornih konstrukcij - 1-1. del: Splošna pravila in potresni vpliv

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

Eurocode 8 - Auslegung von Bauwerken gegen Erdbeben - Teil 1-1: Grundlagen und Erdbebeneinwirkung

Eurocode 8 - Calcul des structures pour leur résistance aux séismes - Partie 1-1 : Règles générales et action sismique

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English Version

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

Eurocode 8 - Calcul des structures pour leur résistance aux séismes - Partie 1-1 : Règles générales et action sismique

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This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 250.

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Recipients of this draft are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

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

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European foreword

This document (prEN 1998-1-1:2022) 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 and has been assigned responsibility for structural and geotechnical design matters by CEN.

This document will supersede EN 1998-1:2004.

The first generation of EN Eurocodes was published between 2002 and 2007. This document forms part of the second generation of the Eurocodes, which have been prepared under Mandate M/515 issued to CEN by the European Commission and the European Free Trade Association.

The Eurocodes have been drafted to be used in conjunction with relevant execution, material, product and test standards, and to identify requirements for execution, materials, products and testing that are relied upon by the Eurocodes.

The Eurocodes recognize the responsibility of each Member State and have safeguarded their right to determine values related to regulatory safety matters at national level through the use of National Annexes.

0 Introduction

0.1 Introduction to the Eurocodes

The Structural Eurocodes comprise the following standards generally consisting of a number of Parts:

— EN 1990 Eurocode: Basis of structural and geotechnical 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

— New parts are under development, e.g. Eurocode for design of structural glass

The Eurocodes are intended for use by designers, clients, manufacturers, constructors, relevant authorities (in exercising their duties in accordance with national or international regulations), educators, software developers, and committees drafting standards for related product, testing and execution standards.

NOTE Some aspects of design are most appropriately specified by relevant authorities or, where not specified, can be agreed on a project-specific basis between relevant parties such as designers and clients. The Eurocodes identify such aspects making explicit reference to relevant authorities and relevant parties.

0.2 Introduction to EN 1998 Eurocode 8

The scope of EN 1998 is to define the rules for the seismic design of new buildings and engineering works and the assessment and retrofit of existing ones, including geotechnical aspects, as well as temporary structures.

NOTE This standard also covers the verification of structures in the seismic situation during construction, when required.

Attention should be paid to the fact that, for the design of structures in seismic regions, the provisions of EN 1998 should be applied in addition to the relevant provisions of EN 1990 to EN 1997 and EN 1999. In particular, EN 1998 should be applied to structures of consequence classes CC1, CC2 and CC3, as defined in prEN 1990:2021, 4.3. Structures of consequence class CC4 are not fully covered by the Eurocodes but may be required to follow EN 1998, or parts of it, by the relevant Authorities.

By nature, perfect protection (a null seismic risk) against earthquakes is not feasible in practice, in particular because the knowledge of the hazard itself is characterized by a significant uncertainty. Therefore, in Eurocode 8, the seismic action is represented in a conventional form, proportional in amplitude to earthquakes likely to occur at a given location and representative of their frequency content. This representation is not the prediction of a particular seismic movement, and such a movement could give rise to more severe effects than those of the seismic action considered, inflicting damage greater than the one described by the Limit States contemplated in this Standard.

Not only the seismic action cannot be predicted but, in addition, it should be recognized that engineering methods are not perfectly predictive when considering the effects of this specific action, under which structures are assumed to respond in the non-linear regime. Such uncertainties are taken into account according to the general framework of EN 1990, with a residual risk of underestimation of their effects.

Further Parts of EN 1998 include, in addition to prEN 1998-1-1, the following:

— prEN 1998-1-2 contains specific provisions relevant to buildings;

— EN 1998-2 contains specific provisions relevant to bridges;

— EN 1998-3 contains provisions for the seismic assessment and retrofitting of existing buildings and bridges;

— EN 1998-4 contains specific provisions relevant to silos, tanks, pipelines, towers, masts and chimneys;

— EN 1998-5 contains specific provisions relevant to foundations, retaining structures and geotechnical aspects.

0.3 Introduction to prEN 1998-1-1

prEN 1998-1-1 contains general requirements for all types of structures for earthquake resistant design, including definition of the seismic action and the description of the methods of analysis and verification, in general terms.

Nevertheless, the definition of the seismic action allows adaptation to a local specific seismic context through Nationally Determined Parameters (NDP) defined by the National Authorities or in the National Annex or through a site-specific description.

prEN 1998-1-1 is subdivided in seven clauses and includes the following annexes, where Annexes B to E and G are normative and Annexes A and F are informative:

— Annex A: European hazard maps;

— Annex B: Alternative identification of site categories;

— Annex C: Site-specific elastic response spectra;

— Annex D: Criteria for selection and scaling of input motions;

— Annex E: Determination of target displacement and limit-state spectral acceleration by using a non-linear response-history analysis of an equivalent SDOF model;

— Annex F: Simplified reliability-based verification format;

— Annex G: Design of fastenings to concrete in the seismic design situation.

0.4 Verbal forms used in the Eurocodes

The verb “shall” expresses a requirement strictly to be followed and from which no deviation is permitted in order to comply with the Eurocodes.

The verb “should” expresses a highly recommended choice or course of action. Subject to national regulation and/or any relevant contractual provisions, alternative approaches could be used/adopted where technically justified.

The verb “may" expresses a course of action permissible within the limits of the Eurocodes.

The verb “can" expresses possibility and capability; it is used for statements of fact and clarification of concepts.

0.5 National annex for prEN 1998-1-1

National choice is allowed in this document where explicitly stated within notes. National choice includes the selection of values for Nationally Determined Parameters (NDPs).

The national standard implementing prEN 1998-1-1 can have a National Annex containing all national choices to be used for the design of buildings and civil engineering works to be constructed in the relevant country.

When no national choice is given, the default choice given in this document is to be used.

When no national choice is made and no default is given in this document, the choice can be specified by a relevant authority or, where not specified, agreed for a specific project by appropriate parties.

National choice is allowed in prEN 1998-1-1 through notes to the following:

1.1(1)	4.1(6)	4.1(8)	4.5.1(2)
5.2.1(1)	5.2.1(3)	5.2.1(4)	5.2.1(5)
5.2.2.2(2)	5.2.2.2(9)	5.2.2.5(2)	F.3(1)
G.4(1)			

National choice is allowed in prEN 1998-1-1 on the application of the following informative annexes:

Annex A	Annex F

The National Annex can contain, directly or by reference, non-contradictory complementary information for ease of implementation, provided it does not alter any provisions of the Eurocodes.

1 Scope

1.1 Scope of prEN 1998-1-1

(1) This document is applicable to the design and verification of buildings and other structures in seismic regions. It gives general rules relevant to all types of structures, with the exception of special structures.

NOTE Special structures belong to consequence class CC4, which is not fully covered by the Eurocodes. The categories of structures of consequence class CC4 where EN 1998, or parts of it, apply in a country can be provided by the relevant Authorities or can be found in the National Annex.

(2) This document provides basic performance requirements and compliance criteria applicable to buildings and civil engineering works in seismic regions.

(3) This document gives rules for the representation of seismic actions and the description of the design seismic situations. Certain types of structures, dealt with in other parts of EN 1998, need supplementary rules which are given in those relevant Parts.

(4) This document contains general methods for structural analysis and verification under seismic actions, including base-isolated structures and structures with distributed dissipative systems.

(5) This document 1 contains rules for modelling and verification of ultimate strengths and deformations.

1.2 Assumptions

(1) The general assumptions of prEN 1990:2021, 1.2, are supplemented as given in (2) to (6).

(2) It is assumed that no change in the structure and in the masses carried by the structure will take place during the construction phase or during the subsequent life of the structure with respect to the design unless proper justification and verification is provided. This applies to ancillary elements as well (see 3.1.2). Due to the specific nature of the seismic response, this applies even in the case of changes that lead to an increase of the structural resistance.

(3) The design documents are assumed to indicate the sizes, the details and the properties of the materials of the structural members. If appropriate, the design documents are also assumed to include the properties of special devices to be used and the distances between structural and ancillary elements. The necessary quality control provisions are assumed to be specified.

(4) Members of special structural importance requiring special checking during construction are assumed to be identified on the design documents. In this case, the verification methods to be used are also assumed to be specified.

(5) In case of high seismic action class (4.1.1(4)), formal quality system plans, covering design, construction, and use, additional to the control procedures prescribed in the other relevant Eurocodes, are assumed to be specified.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE See the Bibliography for a list of other documents cited that are not normative references, including those referenced as recommendations (i.e. in 'should' clauses), permissions ('may' clauses), possibilities ('can' clauses), and in notes.

prEN 1990:2021, *Basis of structural and geotechnical design*

EN 1998 (all parts), *Eurocode 8: Design of structures for earthquake resistance*

ISO 80000, *Quantities and units*

3 Terms, definitions and symbols

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 1990 and the following apply.

3.1.1

ancillary element

architectural, mechanical or electrical element, system and component which, whether due to lack of strength or to the way it is connected to the structure, is not considered in seismic design as load carrying element but may be the cause of risk to persons or to the structure in case of earthquake

3.1.2

antiseismic devices

devices which contribute to modify the seismic response of a structure by isolating it, by dissipating energy or by creating permanent or temporary restraints via rigid connections

Note 1 to entry: The devices considered in EN 1998 are those covered in EN 1337 (all parts) and EN 15129.

3.1.3

bearings

devices that support vertical loads and do not modify the natural period of the structure nor its dissipating energy

3.1.4

behaviour factor

factor used for design purposes to reduce the forces obtained from a linear analysis, to account for the overstrength as well as for the non-linear response of a structure, associated with the material, the structural system and the design procedures

3.1.5

capacity design method

design method in which members of the structural system are chosen and suitably designed and detailed for energy dissipation under severe deformations while all other structural members are provided with sufficient strength so that the chosen means of energy dissipation can be maintained

3.1.6

design displacement (of the isolation system in a principal direction)

maximum horizontal displacement at the effective stiffness centre between the top of the substructure and the bottom of the superstructure, occurring in the design seismic situation

3.1.7

displacement-based approach

design method that explicitly accounts for the strength and deformation capacity of the structure, in most cases considering its non-linear response and uses verifications in terms of displacements or deformations

Note 1 to entry: In EN 1998, the displacement-based approach is implemented in the form of a non-linear static procedure based on a pushover analysis.

3.1.8

dissipative structure

structure which can dissipate energy by means of ductile hysteretic behaviour and/or by other mechanisms

3.1.9

dissipative zones

predetermined parts of a dissipative structure where the dissipative capabilities are mainly located

Note 1 to entry: These are also called critical regions.

3.1.10

dynamically independent unit

structure or part of a structure which is directly subjected to the ground motion and whose response is not affected by the response of adjacent units or structures

3.1.11

effective damping (of the isolation system in a principal direction)

value of the viscous damping that corresponds to the energy dissipated by the isolation system during cyclic response at the design displacement

3.1.12

effective period (of the isolation system in a principal direction)

fundamental period, in the direction considered, of a single degree of freedom system having the mass of the superstructure and stiffness equal to the effective stiffness of the isolation system

3.1.13

effective stiffness (of the isolation system in a principal direction)

ratio of the value of the total horizontal force transferred through the isolation interface when the design displacement takes place in the same direction, to the absolute value of that design displacement (see 3.1.7). This corresponds to the secant stiffness associated to the design displacement.

Note 1 to entry: The effective stiffness is generally obtained by iterative dynamic analysis.

3.1.14

effective stiffness centre of the isolation system

stiffness centre calculated at the upper face of the isolation interface, i.e. including the flexibility of the isolators and of the substructure(s)

Note 1 to entry: In buildings, tanks and similar structures, the flexibility of the substructure may often be neglected in the determination of this point, which then coincides with the stiffness centre of the isolators.

3.1.15

energy dissipation device

disposable element of the energy dissipation system that dissipates energy caused by relative motion of each end of the device and does not form part of the main structural system

3.1.16

energy dissipation system

collection of structural members that includes all the energy dissipation devices and all structural members required to transfer the forces from the energy dissipation devices to the main structural system and to the base of the structure. It includes also all pins, bolts, gusset plates, brace extensions and other components required to connect the energy dissipation devices to other elements of the structure.

3.1.17

force-based approach

force-based method of design which employs a linear analysis that implicitly accounts for the overstrength and the non-linear response through a behaviour factor and verifications in terms of forces. In EN 1998 it is implemented in the form of a static lateral force method or a dynamic response spectrum method.

3.1.18

full isolation

the superstructure is fully isolated if, in the seismic design situation, it remains within the elastic range. Otherwise, the superstructure is partially isolated.

3.1.19

isolation system

collection of isolators used for providing seismic isolation, which are arranged within the isolation interface

Note 1 to entry: These are usually located below the main mass of the structure.

3.1.20

isolators

devices constituting the isolation system

Note 1 to entry: The devices considered in EN 1998-1-1 consist of laminated elastomeric bearings, elastoplastic devices, viscous or friction dampers, sliders with a spherical surface and other devices the behaviour of which conforms to 6.8.2.4.

3.1.21

main structural system

in structures equipped with energy dissipation systems, collection of primary and secondary seismic members and their connections designed and detailed to maintain support of the gravity loading when subjected to the displacements caused by the most unfavourable seismic design condition

Note 1 to entry: The primary seismic members of the main structural system form part of the seismic action resisting system. They provide strength and stiffness. They can also contribute to dissipation of energy through inelastic response.

Note 2 to entry: The main structural system and the energy dissipation system may have common structural members.

3.1.22

non-dissipative structure

structure designed for a seismic design situation solely relying on the linear elastic material behaviour

3.1.23

performance factor

factor that accounts concurrently for the consequence class of a structure and the limit state under consideration

3.1.24

primary structure

set of structural members which can resist seismic action on their own

3.1.25

primary seismic member

structural member considered as part of the primary structure, modelled in the analysis for the seismic design situation and fully designed and detailed for earthquake resistance in accordance with the corresponding rules of EN 1998

3.1.26

reduced spectrum

spectrum that is derived from the elastic response spectrum by applying a behaviour factor, to be used in the framework of the force-based approach

3.1.27

reference seismic action

seismic action associated to the Significant Damage limit state for consequence class CC2

3.1.28

resistant structural member

structural member the resistance of which is not lower than the action effects in the seismic design situation

3.1.29

resistance

resistance of a structural member is the (generalized) force or (generalized) deformation it can sustain without exceeding a prescribed limit state