



SLOVENSKI STANDARD

oSIST prEN 1998-3:2023

01-december-2023

Nadomešča:
SIST EN 1998-3:2005

Evrokod 8 - Projektiranje potresnoodpornih konstrukcij – 3. del: Ocena in prenova stavb in mostov

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

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

Eurocode 8 - Calcul des structures pour leur résistance au séisme - Part 3: Evaluation et renforcement des bâtiments et des ponts

Ta slovenski standard je istoveten z: **prEN 1998-3**

<https://standards.iteh.ai/catalog/standards/sist/6fc3cd0c-5e16-446a-af79-e725b8bc9c75/osist-pren-1998-3-2023>

ICS:

91.010.30	Tehnični vidiki	Technical aspects
91.120.25	Zaščita pred potresi in vibracijami	Seismic and vibration protection

oSIST prEN 1998-3:2023

en,fr,de

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

DRAFT
prEN 1998-3

September 2023

ICS 91.120.25

Will supersede EN 1998-3:2005

English Version

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

Eurocode 8 - Calcul des structures pour leur résistance au séisme - Part 3: Evaluation et renforcement des bâtiments et des ponts

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

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

If this draft becomes a European Standard, 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.

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COMITÉ EUROPÉEN DE NORMALISATION
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European foreword

This document (prEN 1998-3:2023) 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 is currently submitted to the CEN Enquiry.

This document will supersede EN 1998-3:2005.

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.

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prEN 1998-3:2023 (E)**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 (all parts)

EN 1998 (all parts) defines 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 EN 1990:2023, 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, namely 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.

EN 1998 is subdivided in various parts:

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

EN 1998-1-2, Eurocode 8 — Design of structures for earthquake resistance – Part 1-2: Buildings;

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

EN 1998-3, Eurocode 8 — Design of structures for earthquake resistance – Part 3: Assessment and retrofitting of buildings and bridges:

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

EN 1998-5, Eurocode 8 — Design of structures for earthquake resistance – Part 5: Geotechnical aspects, foundations, retaining and underground structures

0.3 Introduction to prEN 1998-3

prEN 1998-3 was developed because:

- For many existing 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 risk evaluations in accordance with present knowledge may indicate the need for retrofitting campaigns;
- Damage caused by earthquakes may create the need for major repairs, associated with large costs.

Seismic risk mitigation policies may differentiate between “active” and “passive” seismic assessment and retrofitting programmes.

- “Active” programmes may require owners of certain categories of structures to meet specific deadlines for the completion of the seismic assessment and – depending on its outcome – of the retrofitting. The categories of structures selected to be targeted may depend on the associated seismic risk, which depends on hazard, site conditions and vulnerability, and/or on the consequence class and occupancy, or, finally on the perceived vulnerability of the structure (as influenced by type of material and construction, size, age of the structure and contemporary design code, etc.);
- “Passive” programmes associate seismic assessment – possibly leading to retrofitting – with other events or activities related to the use of the structure and its continuity, such as a change in use that increases occupancy or consequence class, remodelling above certain limits (as a percentage of the area or of the total value of the structure), repair of damage after an earthquake, etc.

Therefore, this standard only provides technical clauses. The choice to apply it to a certain type of structure depends on the choice of the Authority concerned or the Project Owner, depending on the risk mitigation approach considered.

The choice of the Limit States to be verified, 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 depend on the cost of the retrofitting works to be undertaken, in relation with the final accepted risks. In “passive” programmes triggered by remodelling, the relevant requirements may graduate with the extent and cost of the remodelling work undertaken.

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Unlike new structures, where the mechanical and physical properties of the materials can be prescribed at the time of the project, existing structures can only be partially known, depending on the reconnaissance carried out and the methods of investigation applied. Therefore, the assumed properties for the analysis of these structures are tainted by uncertainties, all the more important as the knowledge resulting from the survey is limited. The conclusions of the assessment, and of the eventual retrofitting design, consequently suffer from inherent uncertainty and there remains a low probability of failure, even when the provisions of this standard have been met.

This standard addresses only the structural aspects of seismic assessment and retrofitting, which may correspond to a single component of a broader strategy for seismic risk mitigation. The conditions under which seismic assessment of individual buildings or bridges – possibly leading to retrofitting – may be required are beyond the scope of this standard. This standard will apply once the requirement to assess a particular structure has been established, in the situation where this structure is dynamically independent of the neighbouring ones. This standard may be applied also when the structure is connected to other structures not explicitly modelled, provided that the structural interaction may be neglected, or it is considered in the model through equivalent constraints and/or added masses.

In cases of low seismic action class (see prEN 1998-1-1:2022, 4.1(4)), this standard may be adapted to local conditions by appropriate National Annexes. The concept of risk-based assessment may be adopted in this context, in particular by countries in low seismicity areas.

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.

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 1998-3

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

The national standard implementing prEN 1998-3 can have a National Annex containing all national choices to be used for the assessment and retrofitting of buildings and bridges to be constructed in the relevant country.

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

When no national choice is made and no default is given in this standard, 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 1998-3 through notes to the following clauses:

4.1(2)	4.1(3)	4.2.2(8)	5.4.4(1)
8.2.4.1(2)	8.6.4.3(10)	10.2.1(3)	A.3(2)

National choice is also allowed in prEN 1998-3 on the application of the following informative annexes:

Annex A

Annex B

Annex C

Annex D

Annex E

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.

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prEN 1998-3:2023 (E)

1 Scope

1.1 Scope of prEN 1998-3

(1) This document is applicable to the assessment and retrofitting of buildings and bridges in seismic regions, namely as given in a) to c):

- a) To provide criteria for the assessment of the seismic performance of existing individual buildings and bridges;
- b) To describe the procedure to be followed in selecting necessary corrective measures;
- c) To set forth criteria for the design of retrofitting measures (i.e. design, structural analysis including intervention measures, final dimensioning of structural parts and their connections to existing structural members).

NOTE 1 For the purposes of this standard, retrofitting covers both the seismic upgrading (e.g. strengthening or adding a passive system) of undamaged structures and the repair and possible upgrading of earthquake-damaged structures.

NOTE 2 Annex E gives flowcharts for the application of this standard.

(2) Unless specifically stated, prEN 1998-1-1 and prEN 1998-5 apply.

(3) Reflecting the performance requirements of prEN 1998-1-1:2022, 4.1, this standard covers the seismic assessment and retrofitting of buildings and bridges made of the more commonly used structural materials: concrete, steel and composite, timber and masonry.

NOTE Annexes B, C and D contain additional guidance related to the assessment of reinforced concrete, timber and masonry structures, respectively, and to their retrofitting when necessary.

(4) This standard is intended for the assessment of individual structures, to decide on the need for structural intervention and to design the retrofitting measures that may be necessary. It is not intended for the vulnerability assessment of populations or groups of structures in seismic risk evaluations for various purposes (e.g. for determining insurance risk, for setting risk mitigation priorities, etc.).

(5) This standard provides (in its material-specific Clauses 8 to 11) criteria for the verification of the more common retrofitting techniques currently in use.

(6) This document gives specific rules for the assessment and retrofitting relevant to existing buildings and bridges of consequence classes CC1, CC2 and CC3, as defined in EN 1990:2023, 4.3.

(7) Although the provisions of this standard are applicable to all common categories of buildings and bridges, the seismic assessment and retrofitting of monuments and heritage structures often requires different types of provisions and approaches, depending on the nature of the monuments.

1.2 Assumptions

(1) The assumptions of prEN 1998-1-1:2022, 1.2, are assumed to be applied.

(2) The provisions of this standard assume that the data collection and tests are performed by experienced personnel and that the engineer responsible for the assessment, the possible design of the retrofitting and the execution of work has appropriate experience of the type of structures being upgraded or repaired.

(3) Inspection procedures, checklists and other data-collection procedures should be documented and filed and should be referred to in the assessment/design documents.