



# Overview of Eurocode 8

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# Structural Eurocodes

- EN1990 Eurocode: ***Basis of structural design***
- EN1991 Eurocode 1: ***Actions on structures***
- EN1992 Eurocode 2: ***Design of concrete structures***
- EN1993 Eurocode 3: ***Design of steel structures***
- EN1994 Eurocode 4: ***Design of composite steel and concrete structures***
- EN1995 Eurocode 5: ***Design of timber structures***
- EN1996 Eurocode 6: ***Design of masonry structures***
- EN1997 Eurocode 7: ***Geotechnical design***
- EN1998 Eurocode 8: ***Design of structures for earthquake resistance***
- EN1999 Eurocode 9: ***Design of aluminium structures***

# Nationally Determined Parameters

*Parameters which are **left open** in the Eurocodes for national choice (**NDPs** - Nationally Determined Parameters):*

- **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.

To be defined in the National Annexes

# Eurocode 8 - Design of structures for earthquake resistance

- **EN1998-1: General rules, seismic actions and rules for buildings**
- **EN1998-2: Bridges**
- **EN1998-3: Assessment and retrofitting of buildings**
- **EN1998-4: Silos, tanks and pipelines**
- **EN1998-5: Foundations, retaining structures and geotechnical aspects**
- **EN1998-6: Towers, masts and chimneys**

# EN1998-1: General rules, seismic actions and rules for buildings

EN1998-1 to be applied in combination with other Eurocodes

EUROPEAN STANDARD

**EN 1998-1**

NORME EUROPÉENNE

EUROPÄISCHE NORM

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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

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# EN1998-1: General rules, seismic actions and rules for buildings

## Contents of EN 1998-1

- **General**
- **Performance requirements and compliance criteria**
- **Ground conditions and seismic action**
- **Design of buildings**
- **Specific rules for:**
  - Concrete buildings
  - Steel buildings
  - Composite Steel-Concrete buildings
  - Timber buildings
  - Masonry buildings
- **Base isolation**

# Nationally Determined Parameters

## Nationally Determined Parameters (NDPs) in EN 1998-1:

General aspects and definition of the seismic action:	11
Modelling, analysis and design of buildings:	7
Concrete buildings:	11
Steel buildings:	6
Composite buildings:	4
Timber buildings:	1
Masonry buildings:	15
Base isolation:	1
<b>TOTAL</b>	<b>56</b>

# Objectives

## Objectives of seismic design according to Eurocode 8

### In the event of earthquakes:

**Human lives are protected**

**Damage is limited**

**Structures important for civil protection  
remain operational**

**Special structures – Nuclear Power Plants, Offshore  
structures, Large Dams – outside the scope of EN 1998**



# Fundamental requirements

## No-collapse requirement:

**Withstand the design seismic action without local or global collapse**

**Retain structural integrity and residual load bearing capacity after the event**

Requirement related to the protection of life under a rare event through the prevention of local or global collapse.

After the event a structure may be economically unrecoverable but should ensure safe evacuation protection against aftershocks

Requirement associated with the **Ultimate Limit State (ULS)** in the framework of the Eurocodes

# Fundamental requirements

## No-collapse requirement:

For ordinary structures this requirement should be met for a **reference seismic action** with 10 % probability of exceedance in 50 years (recommended value) i.e. with **475 years Return Period**

# Fundamental requirements

## Damage limitation requirement:

**Withstand a more frequent seismic action without damage**

**Avoid limitations of use with high costs**

Requirement related to the reduction of economic losses in frequent earthquakes (structural and non-structural).

The structure should not have permanent deformations and its elements should retain its original strength and stiffness with no need for structural repair. Non-structural damages repairable economically.

Requirement associated with the **Serviceability Limit State** (SLS) in the framework of the Eurocodes

# Fundamental requirements

## Damage limitation requirement:

For ordinary structures this requirement should be met for a **seismic action** with 10 % probability of exceedance in 10 years (recommended value) i.e. with **95 years Return Period**

# Reliability differentiation

**Target reliability of requirement depending on consequences of failure**

**Classify the structures into importance classes**

**Assign a higher or lower return period to the design seismic action**

In operational terms multiply the **reference seismic action** by the **importance factor  $\gamma_I$**

# Importance classes for buildings

## Importance classes for buildings

EN 1998-1:2004 (E)

**Table 4.3 Importance classes for buildings**

Importance class	Buildings
I	Buildings of minor importance for public safety, e.g. agricultural buildings, etc.
II	Ordinary buildings, not belonging in the other categories.
III	Buildings whose seismic resistance is of importance in view of the consequences associated with a collapse, e.g. schools, assembly halls, cultural institutions etc.
IV	Buildings whose integrity during earthquakes is of vital importance for civil protection, e.g. hospitals, fire stations, power plants, etc.

NOTE Importance classes I, II and III or IV correspond roughly to consequences classes CC1, CC2 and CC3, respectively, defined in EN 1990:2002, Annex B.

# Importance factor and return period

At most sites the annual **rate of exceedance**,  $H(a_{gR})$ , of the reference peak ground acceleration  $a_{gR}$  may be taken to vary with  $a_{gR}$  as:

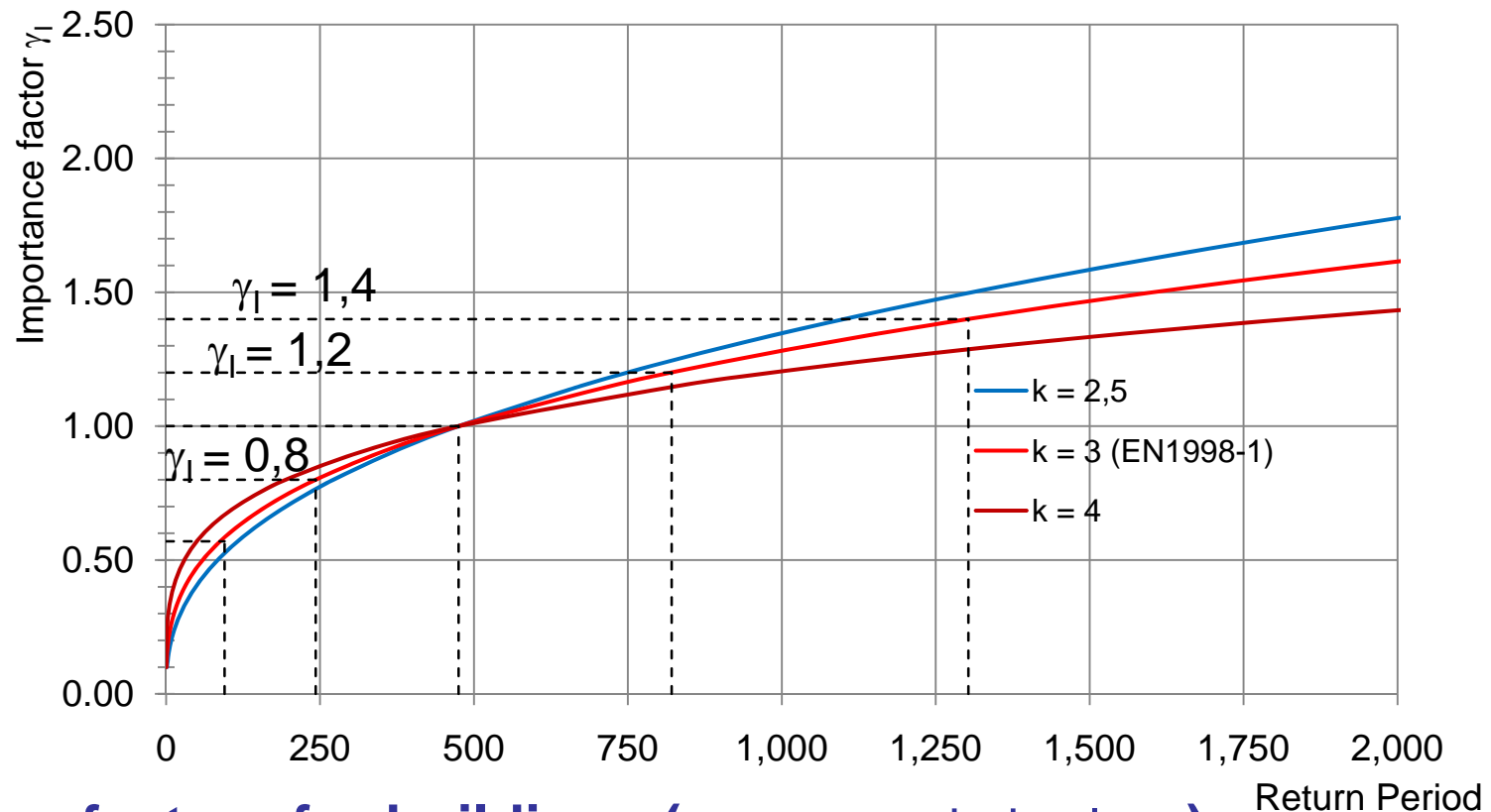
$$H(a_{gR}) \sim k_0 a_{gR}^{-k}$$

with the value of the **exponent k** depending on seismicity, but being generally **of the order of 3**.

If the seismic action is defined in terms of the reference peak ground acceleration  $a_{gR}$ , the value of the **importance factor**  $\gamma_I$  multiplying the reference seismic action to achieve the same probability of exceedance in  $T_L$  years as in the  $T_{LR}$  years for which the reference seismic action is defined, may be computed as

$$\gamma_I \sim (T_{LR}/T_L)^{-1/k}.$$

# Importance factor and return period



**Importance factors for buildings (recommended values):**

**$\gamma_I = 0,8$  (I); 1,0 (II); 1,2 (III) and 1,4 (IV)**

**Reduction factor (recommended values) to account for the lower return period for damage limitation verification:**

**$\nu = 0,4$  (III and IV) or 0,5 (I and II)**



# Compliance criteria

## Ultimate limit state (ULS)

*The **resistance and energy-dissipation capacity** to be assigned to the structure are related to the **extent to which its non-linear response** is to be exploited*

*In operational terms **such balance** between resistance and energy-dissipation capacity is characterised by the **values of the behaviour factor  $q$**  and the associated **ductility classes***

# Compliance criteria

## Ultimate limit state (ULS)

*As a limiting case, for the design of structures classified as **low-dissipative**, no account is taken of any hysteretic energy dissipation and the **behaviour factor** may not be taken, in general, as being greater than the value of **1,5 considered to account for overstrengths***

*For **dissipative structures** the **behaviour factor** is taken as being **greater** than this limiting values, **accounting for the hysteretic energy dissipation** that mainly occurs in specifically designed zones, called **dissipative zones** or **critical regions***

# Compliance criteria

## Design verifications

### Ultimate limit state (ULS)

**Resistance and Energy dissipation capacity**

**Ductility classes and Behaviour factor values**

**Overturning and sliding stability check**

**Resistance of foundation elements and soil**

**Second order effects**

**Non detrimental effect of non structural elements**

Simplified checks for **low seismicity** cases ( $a_g < 0,08$  g)

No application of EN 1998 for **very low seismicity** cases ( $a_g < 0,04$  g)

# Compliance criteria

## Design verifications

### Damage limitation state (DLS/SLS)

**Deformation limits (Maximum interstorey drift due to the “frequent” earthquake):**

- **0,5 %** for **brittle** non structural elements **attached** to the structure
- **0,75 %** for **ductile** non structural elements **attached** to the structure
- **1,0 %** for non structural elements **not interfering** with the structure

**Sufficient stiffness of the structure for the operability of vital services and equipment**

**DLS may control the design in many cases**

# Compliance criteria

## Design verifications

Take Specific Measures intended to reduce the uncertainty and promote a good behaviour of the structure, even under seismic actions more severe than the design seismic action

Implicitly equivalent to the satisfaction of a third performance requirement:

***Prevention of global collapse under a very rare event (1.500 to 2.000 years return period).***

Denoted **Near Collapse (NC) Limit State in EN 1998-3**, very close to the actual collapse of the structure and corresponds to the full exploitation of the deformation capacity of the structural elements

# Compliance criteria

## Specific measures

**Simple and regular forms (plan and elevation)**

**Control the hierarchy of resistances and sequence of failure modes (**capacity design**)**

**Avoid brittle failures**

**Control the behaviour of critical regions (**detailing**)**

**Use adequate structural model (soil deformability and non structural elements if appropriate)**

In zones of **high seismicity** formal **Quality Plan for Design, Construction and Use** is recommended