EUROCODES

EN 1998

Design of structures for earthquake resistance

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EUROCODE Conference I Berlin I 24 May 2023

2023 EUROCODE DIBt

Contents

Eurocode 8 in the frame of the Eurocode set

Consequence classes

1st GENERATION IMPORTANCE CLASSES

PART 1	PART 2
I	I
II	II
III	III
IV	

2nd GENERATION CONSEQUENCE CLASSES (EC0)

CC1
CC2
CC3a
CC3b

Seismic situation & limit states

- **Homogenisation of Limit States definition through all parts with better consistency with EN1990 (ULS and SLS)**
- **Verification of Operational (OP) limit state**

1st GENERATION

PARTS 1 & 2	PART 3
	NEAR COLLAPSE
NO COLLAPSE	SIGNIFICANT DAMAGE
DAMAGE LIMITATION	DAMAGE LIMITATION

2nd GENERATION

	Limit state
ULS	NEAR COLLAPSE (NC)
	SIGNIFICANT DAMAGE (SD)
SLS	DAMAGE LIMITATION (DL)
	OPERABILITY (OP)

- **At least one ULS verification is mandatory (safety of the structure)**
- **Choice of SLS to be verified is up to the NA or the contract**

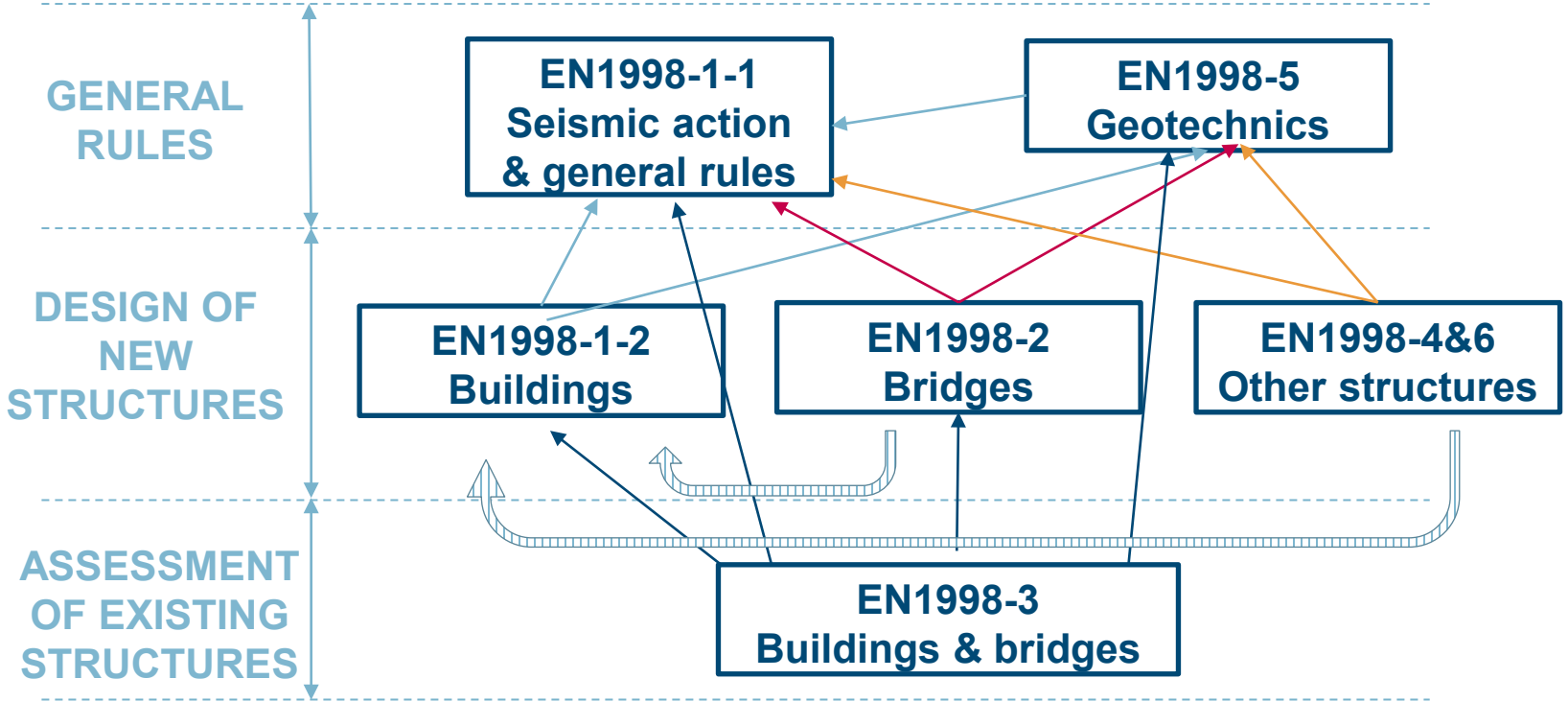
Reduction of NDPs

Case of Eurocode 8 (evaluation)

	1st generation	2nd generation
EC8-1 general /EC8-1-1	18	13
EC8-1 materials /EC8-1-2	39	18
EC8-2	29	5
EC8-3	8	8
EC8-4+6	10+7	3
EC8-5	4	8
TOTAL	115	55

Organisation and concepts of EN1998

Restructuration of EN 1998 in three levels



Performance requirements

Objectives to be met with an appropriate degree of reliability:

- human lives are protected
- damage is limited
- facilities important for civil protection remain operational

Design verification principles for new structures:

- verification of SD limit state mandatory
- ensure deformation capacity and cumulative energy dissipation capacity
- avoid brittle failure or the premature formation of unstable mechanisms

Safety choices for buildings (NDPs)

Return periods in years				
Limit state (LS)	Consequence class			
	CC1	CC2	CC3-a	CC3-b
NC	800	1600	2500	5000
SD	250	475	800	1600
DL	50	60	60	100

10% of exceedance in 50y

Performance factors				
Limit state (LS)	Consequence class (IC)			
	CC1	CC2	CC3-a	CC3-b
NC	1,2	1,5	1,8	2,2
SD	0,8	1	1,2	1,5
DL	0,4	0,5	0,5	0,6

Global safety choice: seismicity index

- **Seismicity index**

$S_d = \delta F_\alpha F_T S_{\alpha,475}$

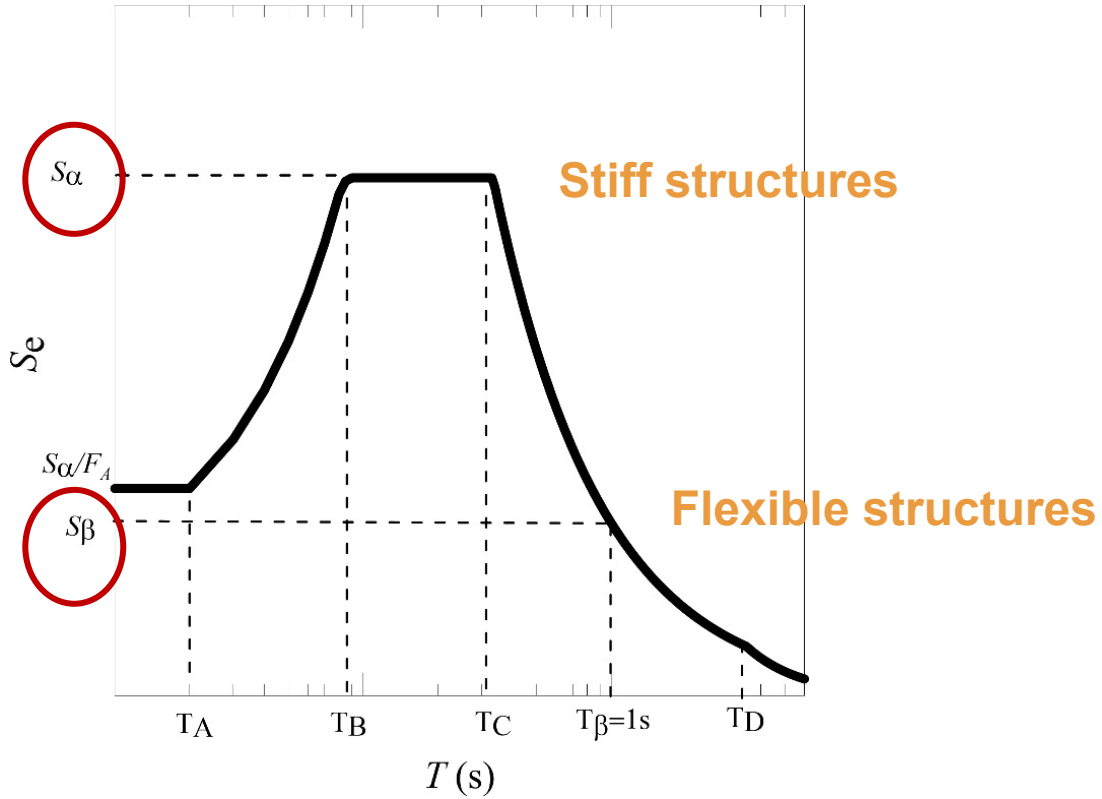
Seismic action

Can depend on the Consequence Class of the structure (NDP)

- **Ranges of S_δ values for seismic action classes**

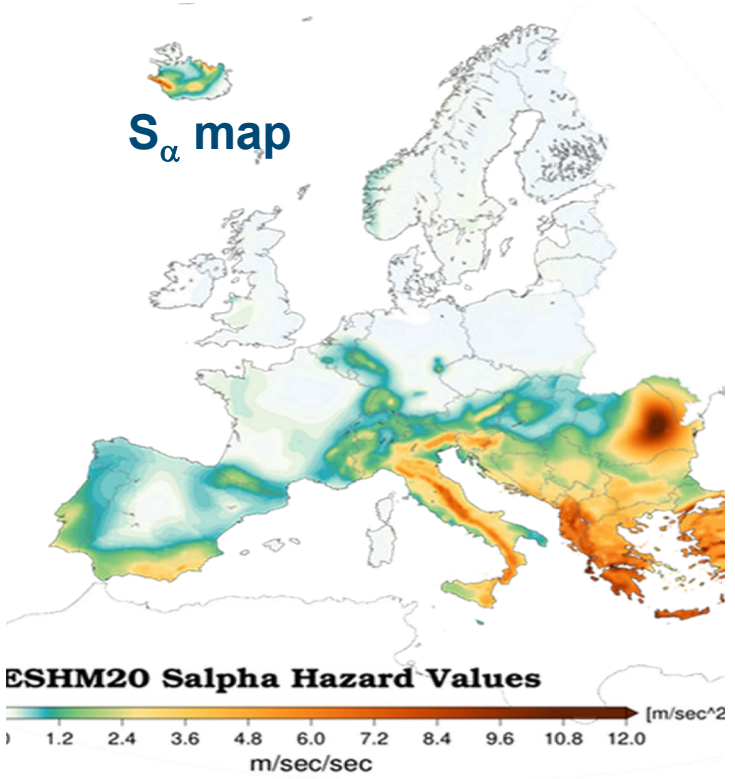
Seismic action class	Range of seismic action index S_δ (m/s²)
Very low	$S_\delta < 1{,}30$ m/s²
Low	$1{,}30$ m/s² $\leq S_\delta < 3{,}25$ m/s²
Moderate	$3{,}25$ m/s² $\leq S_\delta < 6{,}50$ m/s²
High	$S_\delta \geq 6{,}50$ m/s²

New definition of elastic spectrum



New definition of ductility classes

Linear elastic design, force approach (q = 1)	
DC1	Overstrength capacity (q = 1,5)
DC2	Overstrength capacity, local deformation capacity and local energy dissipation capacity
DC3	Ability of the structure to form a global plastic mechanism at SD limit state



Principle of design in the post-elastic domain

Ensure controlled post-elastic behaviour of the entire structure

- ✓ **Locate plastic zones in areas chosen for a good global behaviour**
- ✓ **Eliminate possible brittle failures and instabilities**

⇨ **Capacity design**

Improve ductility of plastic zones (capability of plastic deformation)

⇨ **Size of sections and geometry**

⇨ **Detailing**

⇨ **Two necessary compromises:**

- ✓ **between strength and ductility**
- ✓ **cost versus risk**

Ease of use and flexibility

- **DC2 simpler than DCM**
- **DC3 intermediate to DCM and DCH, simpler than DCH**
- **Existing rules more detailed for easier practice**
- **Simpler approach for choice of partial factors**
- **But important additional content which makes access less direct**

- **Eurocode 8 not for very low seismicity**
- **Simpler rules may be adopted in case of low seismicity (national choice)**
- **Many openings to NCCI for local production (eg masonry)**
- **Removal of most of ”shall”**
- **Extensive use of “may”**

New features in EN 1998

Key changes to EN 1998

- **Homogenisation of seismic zones definition**
- **Simplification of the global safety choice (for Members) through seismic action classes (NDP)**
- **Resistance partial factors γ_{Rd} unified based on a single fractile of the resistance distribution - gives a consistent way to derive the partial factors (NDP)**
- **Better definition of site classification introducing the depth of the bedrock formation**
- **Redefinition of the elastic response spectrum using two parameters instead of a_g**
- **Spatial model of the seismic action**
- **Better control of drift and 2nd order effects**

New content included in scope of EN 1998

- **Verification of Operational (OP) limit state**
- **Development of the displacement-based approach and verification rules**
- **Structures equipped with antiseismic devices**
- **Soil structure interaction**
- **Ancillary elements and floor response spectra**
- **Flat slab systems (buildings)**
- **Infilled frames and claddings (buildings)**
- **Aluminium structures in part 1-2 (buildings)**
- **Bridges in part 3 (existing structures)**
- **Timber structures in part 2 (bridges) and part 3 (assessment of existing structures)**

Presented by

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