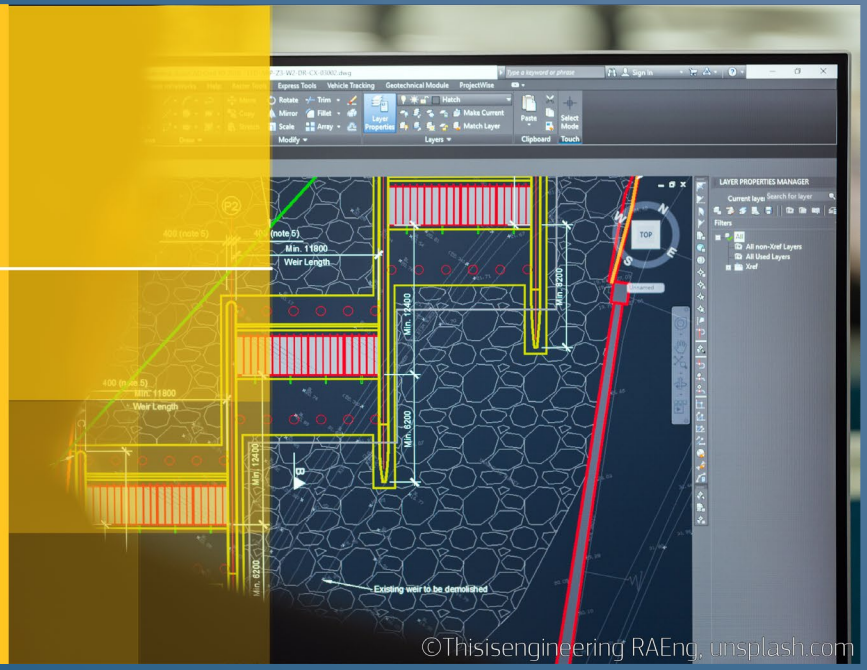
EUROCODES

EN 1990

Basis of structural design



Paolo Formichi

EUROCODE Conference I Berlin I 24 May 2023

2023 EUROCODE DIBt

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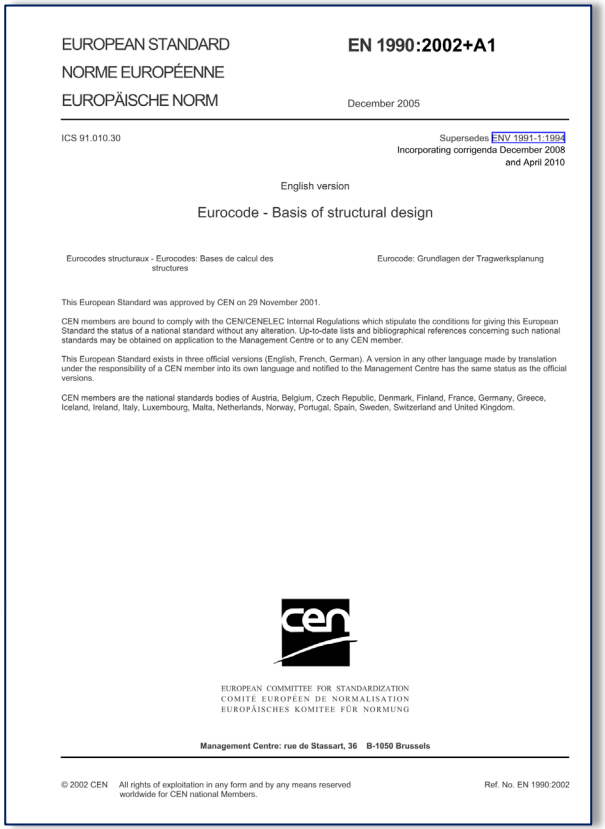
   - EN1990-1 Eurocode - Basis of structural and geotechnical design, Part 1: New structures
   - EN1990-2 Eurocode - Basis of structural and geotechnical design, Part 2: Assessment of existing structures

Contents

EN1990 Key dates



EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 1990:2002+A1

December 2005

ICS 91.010.30

Supersedes ENV 1991-1:1994
Incorporating corrigenda December 2008 and April 2010

English version

Eurocode - Basis of structural design

Eurocodes structuraux - Eurocodes: Bases de calcul des structures

Eurocode: Grundlagen der Tragwerksplanung

This European Standard was approved by CEN on 29 November 2001.

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 Management Centre 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 Management Centre has the same status as the official versions.

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

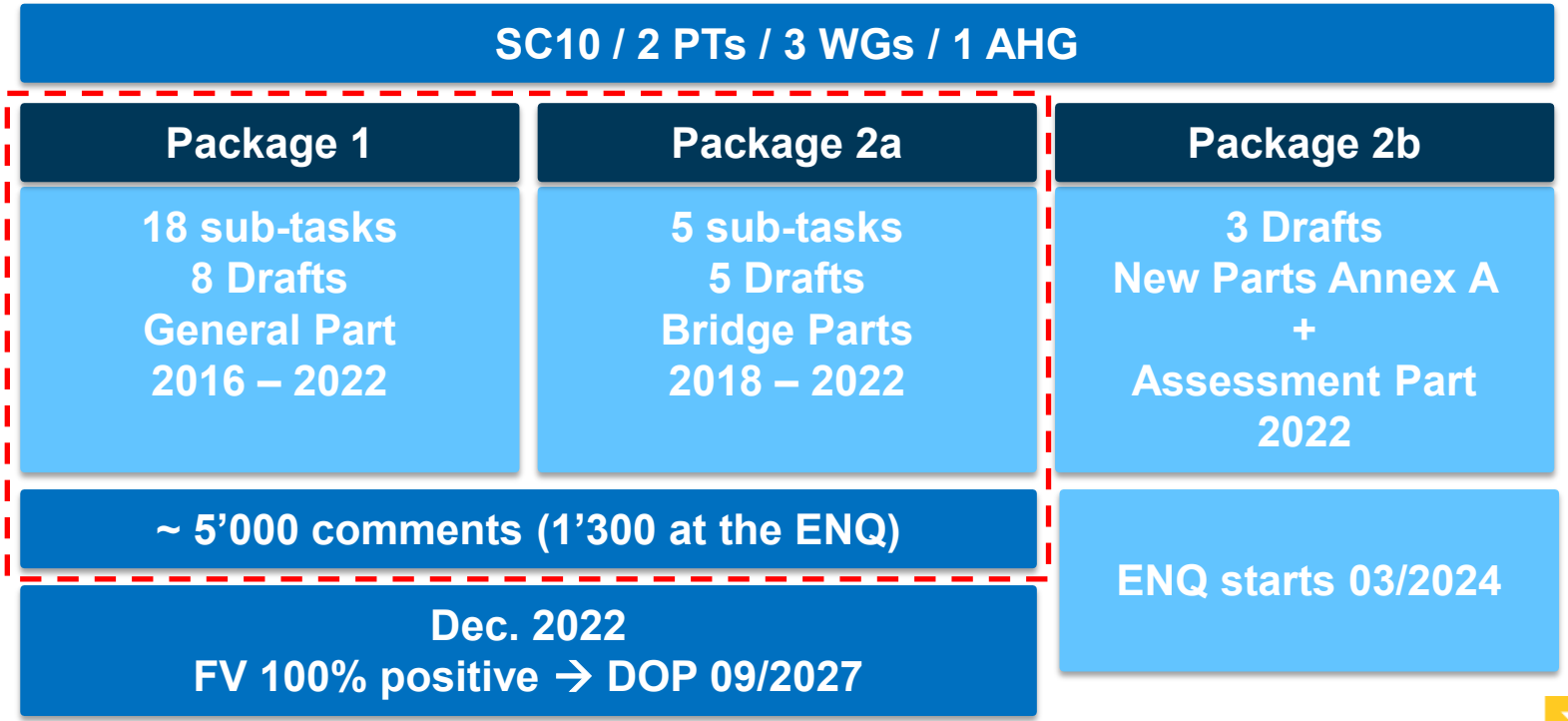
Management Centre: rue de Stassart, 36 B-1050 Brussels

Ref. No. EN 1990:2002

2002	Publication of EN1990 main text + Annexes (except A2)
2005	A1, including Annex A2 (BoD for Bridges)
2007	end of **5 years enquiry**, establishment of an Expert Group, active under TC250, CEN/TC agrees to the formation of an Expert Group to prepare the **first revision of EN 1990**.

- **Short term** corrigenda revision by April 2010
- Report providing suggestions for **medium/long term technical revision**

EN1990's revision under M/515



EN1990's revision under M/515

1st Generation	2nd Generation
EN1990:2002 +A1	EN1990-1 New Structures
	EN1990-2 Assessment of Existing Structures

EN1990's revision under M/515

Normative | Informative

EN1990-1 New Structures

Main Text

Annex A.1 Buildings
Annex A.2 Bridges
Annex A.3 Towers and Masts
Annex A.4 Silos and Tanks
Annex A.5 Cranes supporting Structures
Annex A.6 Coastal Structures

Operational Normative Annexes

Annex B Technical management measures for design and execution
Annex C Reliability analysis and code calibration
Annex D Design assisted by testing
Annex E "Robustness"
Annex F Rain-flow and reservoir counting methods

Specialist informative Annexes

Annex G Basis of design for bearings
Annex H Verifications concerning vibration of footbridges due to pedestrian traffic

Bridge specific

EN1990's revision under M/515

Normative | Informative

EN1990-2 Assessment of Existing Structures

Main Text

1. Introduction
2. Scope
3. Normative References
4. Basic Requirements
5. General Rules
6. Assessment scope and objectives
7. Assessment approach
8. Basic Variables and Updating
9. Structural modelling, updating and analysis
10. Verification using quantitative assessment methods
11. Verification using qualitative assessment methods
12. Interventions

Annex A Additional guidance on assessment of existing structures

Contents

Focus on key revision aspects – EN1990-1

EN1990-1 Eurocode — Basis of structural and geotechnical design — New structures

Focus on key revision aspects – EN1990-1

Consequence Classes

Table 4.1 (NDP) — Qualification of consequence classes

Consequence class	Indicative qualification of consequences	
	Loss of human life or personal injury[a]	Economic, social or environmental consequences[a]
CC4 – Highest	Extreme	Huge
CC3 – High	High	Very great
CC2 – Normal	Medium	Considerable
CC1 – Low	Low	Small
CC0 – Lowest	Very low	Insignificant

[a] The consequence class is chosen based on the more severe of these two columns.

Generally valid for all types of structures

Notes to 4.3 (1) [extract]

NOTE 2 **The provisions in Eurocodes cover design rules for structures classified as CC1 to CC3**.

NOTE 3 The provisions in the Eurocodes **do not entirely cover** design rules needed for structures classified as **CC4**. For these structures, additional provisions to those given in the Eurocodes can be needed.

NOTE 4 Annex A gives examples of the classification of structures into consequence classes.

NOTE 6 The consequence class can be used to determine the management measures to achieve the intended structural reliability, see Annex B for further guidance.

4.3 (3) For consequence class **CC0**, either the Eurocodes or **alternative provisions** may be used

Focus on key revision aspects – EN1990-1

Robustness

3.1.2.32
robustness
ability of a structure to withstand unforeseen adverse events without being damaged to an extent disproportionate to the original cause

4.4 Robustness

(1) A structure should be designed to have an adequate level of robustness so that during its design service life it will not be damaged by unforeseen adverse events to an extent disproportionate to the original cause.

NOTE 1 Progressive collapse is an example of a damage that is disproportionate to the original cause.

NOTE 2 For most structures, design in accordance with the Eurocodes is assumed to provide an adequate level of robustness without the need for any additional design measures to enhance structural robustness.

(2) Design measures to enhance structural robustness should be applied when specified by the relevant authority or, where not specified, as agreed for a specific project by the relevant parties.

NOTE 1 Guidance on additional design measures to enhance structural robustness for buildings and bridges is given in Annex E.

NOTE 2 Further guidance can be given in the National Annex.

Annex E

Focus on key revision aspects – EN1990-1

Robustness

Table E.1 —Design for identified accidental actions and design strategies for enhanced robustness

Design for accidental actions (EN 1991 (all parts)) Explicit design of the structure (e.g. against explosion, impact)		**Design for enhanced robustness (EN 1990)** Strategies based on limiting the extent of damage		
Design structure to resist the action	Prevent or reduce the action e.g. protective measures, control of events	Alternative load paths either providing sufficient ductility, resistance and deformation capacity and redundancy, or applying prescriptive design rules	Key members i.e. designing selected members to resist notional action(s)	Segmentation i.e. separation into distinct parts

Focus on key revision aspects – EN1990-1

Sustainability

4.7 Sustainability

(1) The structure should be designed to limit its adverse impact on non-renewable environmental resources, on society, and on economy during its entire life cycle, as specified by the relevant authority or, where not specified, as agreed for a specific project by the relevant parties.

NOTE 1 The adverse impact of a structure on its environment, on society, and on economy can be minimized by for example appropriate choice of construction process and environmentally compatible building materials, including their manufacture, design solutions, durability, recyclability, and reusability.

NOTE 2 Supplementary requirements to account for sustainability in the design can be given in the National Annex.

Focus on key revision aspects – EN1990-1

Quality management

4.8 Quality Management

(1) <RCM> Appropriate quality management measures should be implemented to provide a structure that corresponds to the design requirements and assumptions.

(2) <RCM> The following quality management measures should be implemented:

— organizational procedures in design, execution, use, and maintenance;

— controls at the stages of design, detailing, execution, use, and maintenance.

NOTE See Annex B and the other Eurocodes for guidance on appropriate quality management measures.

Annex B

Focus on key revision aspects – EN1990-1

Quality management

"Framework Annex"

4 Levels

Annex B
(informative)

Technical management measures for design and execution

B.2 Scope and field of application

(1) This Informative Annex provides a framework for technical management measures for

DQL
DCL
- design quality,
- design checking,

EXC
IL
- execution quality,
- inspection during execution,

so that the intended level of structural reliability of a structure (or part of structure) that fulfils the provisions specified in the Eurocodes is achieved and the assumptions given in 1.2 are satisfied.

NOTE 1 The implementation of this Informative Annex depends on the legal system in force in each country. This Annex is provided as guidance to the writers of National Annexes that can enable a consistent approach to this subject.

NOTE 2 The National Annex can differentiate between technical management measures for the structures covered in the different parts of Annex A.

Focus on key revision aspects – EN1990-1

Quality management

B.4(1) The term 'quality', as used within the design and execution process for structures, deals with the use of adequate technical knowledge and its correct application to achieve the required mechanical resistance, stability, serviceability, and durability of a structure.

Table B.4 (NDP) — Minimum design quality level, design check level, execution class and inspection level for different consequence classes

Consequence class	Minimum design quality level (DQL)	Minimum design check level (DCL)	Minimum execution class (EXC)	Minimum inspection level (IL)
CC3	DQL3	DCL3	See relevant execution standards[a]	IL3
CC2	DQL2	DCL2		IL2
CC1	DQL1	DCL1		IL1

[a] Relevant execution standards might not be available for all materials, see B.6(2).

Focus on key revision aspects – EN1990-1

Annex A.1 Buildings

Table A.1.8 (NDP) — Partial factors on actions and effects for verification cases VC1 to VC4 for persistent and transient (fundamental) design situations

Action or effect				Partial factors γ_F and γ_E for verification cases				
Type	**Group**	**Symbol**	**Resulting effect**	**Structural resistance**[a]	**Static equilibrium and uplift**[b]		**Geotechnical design**	
Verification case				**VC1**[a]	**VC2(a)**[b]	**VC2(b)**[b]	**VC3**[c]	**VC4**[d]
Permanent action (G_k)	All[f]	γ_G	unfavourable /destabilizing	$1{,}35k_F$	$1{,}35k_F$	1,0	1,0	G_k is not factored
	Water[l]	γ_{Gw}		$1{,}2k_F$	$1{,}2k_F$	1,0	1,0	
	All[f]	$\gamma_{G,stb}$	stabilizing[g]	not used	1,15[e]	1,0	not used	
	Water[l]	$\gamma_{Gw,stb}$			1,0[e]	1,0		
	All	$\gamma_{G,fav}$	favourable[h]	1,0	1,0	1,0	1,0	
Prestressing (P_k)		γ_P[k]						
Variable action (Q_k)	All[f]	γ_Q	unfavourable	$1{,}5k_F$	$1{,}5k_F$	$1{,}5k_F$	1,3	$\gamma_{Q,red}$[j]
	Water[l]	γ_{Qw}		$1{,}35k_F$	$1{,}35k_F$	$1{,}35k_F$	1,15	1,0
	All	$\gamma_{Q,fav}$	favourable	0				
Effects of actions (E)		γ_E	unfavourable	γ_E is not applied				$1{,}35k_F$
		$\gamma_{E,fav}$	favourable					1,0

[a] Verification case VC1 is used both for structural and geotechnical design. Formula (8.4) is used for VC1.

[b] Verification case VC2 is used for the combined verification of strength and static equilibrium, when the structure is sensitive to variations in permanent action arising from a single-source. Values of γ_F are taken from VC2(a) or VC2(b), whichever gives the less favourable outcome. See 8.3.3.1(5). Formula (8.4) is used for VC2.

[c] Verification case VC3 is typically used for the design of slopes and embankments, spread foundations, and gravity retaining structures. See the relevant part of EN 1997 for details. Formula (8.4) is used for VC3.

[d] Verification case VC4 is typically used for the design of transversally loaded piles and embedded retaining walls and (in some countries) gravity retaining structures. See EN 1997 (all parts) for details. Formula (8.5) is used for VC4.

[e] The values of $\gamma_{G,stb}$ = 1,15 and 1,0 are based on $\gamma_{G,inf}$ = 1,35 ρ and 1,2 ρ with ρ = 0,85.

[f] Applied to all actions except water actions.

[g] Applied to the stabilizing part of an action originating from a single source.

[h] Applied to actions whose entire effect is favourable and independent of the unfavourable action.

[j] $\gamma_{Q,red} = \gamma_{Q,1} / \gamma_{G,1}$ where $\gamma_{Q,1}$ = corresponding value of γ_Q from VC1 and $\gamma_{G,1}$ = corresponding value of γ_G from VC1.

[k] For the definition of γ_P where γ_P is materially dependent, see other relevant Eurocodes.

[l] For water actions induced by waves and currents, see Clause A.6.

Focus on key revision aspects – EN1990-1

A.1.8 Serviceability criteria for buildings

A.1.8.1 General

(1) Serviceability criteria should be specified for each building project in accordance with 5.4.

NOTE 1 Serviceability criteria for buildings can include, for example, floor deflection and stiffness; differential settlements; storey sway or/and building sway; roof deflection and stiffness; vibration frequency and amplitude/acceleration; and concrete crack width.

NOTE 2 Limiting values can be defined in the National Annex.

NOTE 3 Design values of serviceability criteria for non-industrial buildings, expressed independently of structural materials, are defined in A.1.8.2 for deformations. Industrial buildings include storage buildings.

NOTE 4 Design values of serviceability criteria for geotechnical structures are given in A.1.8.4.

(2) Depending on specific characteristics of the structural system and its material, other limiting values may be specified and agreed by the relevant parties involved in the design.

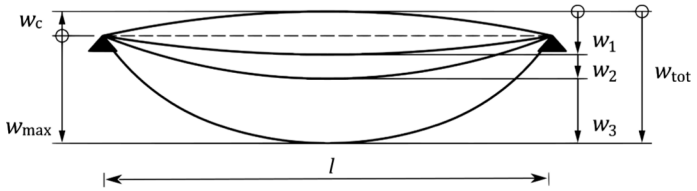
Vertical and Horizontal deformations

Vibrations

Limiting foundation movements

Focus on key revision aspects – EN1990-1

Vertical deflections



NDP

Table A.1.10 (NDP) — Suggested maximum vertical deflections for non-industrial buildings

Serviceability criteria	Limiting damage to elements other than structural[a]	Comfort of users	Appearance
Combination of actions to be considered	Characteristic combination Formula (8.29)	Frequent combination Formula (8.30)	Quasi-permanent combination Formula (8.31)
Not accessible roof	Roofing rigid roofing: $w_2+w_3 \le l/250$ resilient roofing: $w_2+w_3 \le l/125$ Ceiling plastered ceiling: $w_2+w_3 \le l/350$ false ceiling: $w_2+w_3 \le l/250$	$w_2+w_3 \le l/300$	$w_1+w_2-w_c \le l/250$
Floor, accessible roof	Internal partition walls not reinforced: — partitions of brittle material or non-flexible: $w_2+w_3 \le l/500$ — partitions of non-brittle materials: $w_{max} \le l/400$ reinforced walls: $w_2+w_3 \le l/350$ removable walls: $w_2+w_3 \le l/250$ Flooring: — tiles rigidly fixed: $w_2+w_3 \le l/500$ — small tiles[b] or deflection not fully transmitted: $w_2+w_3 \le l/350$ — resilient flooring: $w_2+w_3 \le l/250$ Ceiling: plastered ceiling: $w_2+w_3 \le l/350$ false ceiling: $w_2+w_3 \le l/250$	$w_2+w_3 \le l/300$	$w_1+w_2-w_c \le l/250$
Structural frames	Windows: — no loose joints (no clearance between glass and frame): $w_2+w_3 \le l/1000$ — with loose joints: $w_2+w_3 \le l/350$		

[a] l = span (or, for cantilever, twice the length); w_1, w_2, w_3, w_{max} are defined in Figure A.1.1.

[b] Small tiles: sides less than 10 cm.

Focus on key revision aspects – EN1990-1

Limiting foundation movements

Burland & Wroth's (1975) terms for describing foundation movement:

- settlement, s
- **differential settlement, δs**
- rotation, θ
- angular strain, α
- relative deflection, Δ
- deflection ratio, Δ /L
- **tilt, ω**
- **relative rotation (angular distortion), β**

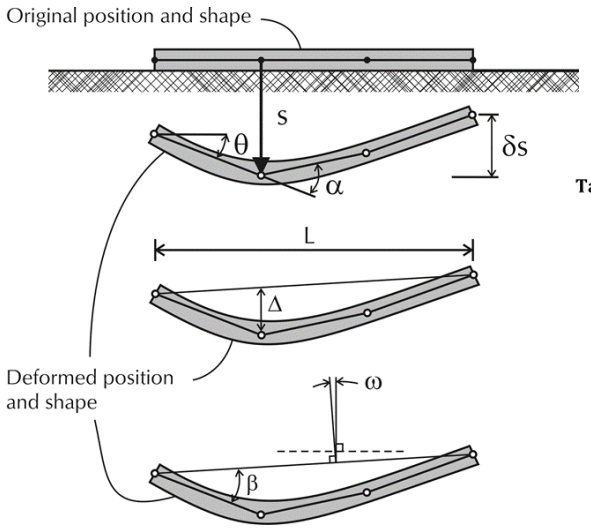


Table A.1.12 —Classification of structural sensitivity to foundation movement

Structural sensitivity class	Description of sensitivity
SSC5	Highest
SSC4	High
SSC3	Normal
SSC2	Low
SSC1	Lowest

Focus on key revision aspects – EN1990-1

Annex C
(informative)

Reliability analysis and code calibration

C.3 Basis for reliability analysis and partial factor design

NSBs & Users

C.4 Approach for calibration of design values

NSBs

Focus on key revision aspects – EN1990-1

Table C.3 (NDP) — Target values for reliability index β for different consequence classes (for persistent and transient (fundamental) and fatigue design situations in ULS) relevant to structures in the scope of Clauses A.1 and A.2

Consequence class[a]	1-year reference period β	50-year reference period	
		β	$P_{f,50}$
CC3	5,2	4,3	$\sim 10^{-5}$
CC2	4,7	3,8	$\sim 10^{-4}$
CC1	4,2	3,3	$\sim 10^{-3}$

[a] Regarding CC0 and CC4, see also 4.3(2) and 4.3(3).

NDP

Focus on key revision aspects – EN1990-1

1. Introduction
2. Principles of structural reliability
3. The Eurocode semi-probabilistic verification method
4. Assessment of Existing Structures
5. Guideline for probabilistic and risk-based decision making
6. Recommendations

Annexes

A: Statistical properties loads, materials etc.

B: Illustrations / examples

Contents

Focus on key revision aspects – EN1990-2

1 Scope

1.1 Scope of prEN 1990-2

(1) This document provides provisions for the assessment of existing structures, including geotechnical structures, and the general principles for interventions, to be used in conjunction with prEN1990-1.

NOTE This document is based on the general requirements and principles of structural reliability provided in prEN 1990-1.

(2) Unless otherwise specified, prEN 1990-1 applies.

(3) This document covers general principles regarding actions for assessment, complementing EN 1991 (all parts).

NOTE Provisions for seismic actions due to earthquake are provided in EN 1998-3.

Focus on key revision aspects – EN1990-2

3 Terms, definitions and symbols

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in prEN 1990-1 and the following apply.

3.1.1
existing structure
any structure that physically (materially) exists

3.1.2
heritage structure
existing structure that has been recognized by the relevant authorities for its historical, cultural or societal value

3.1.3
assessment of an existing structure
verification of the reliability of an existing structure

Focus on key revision aspects – EN1990-2

5 General rules

(1) Clause 4 to Clause 12 shall apply only to existing structures.

NOTE Additional conditions for existing structures to which Clause 4 to Clause 12 apply can be given in the National Annex.

NDP

(3) The assessment of an existing structure should be carried out using quantitative assessment methods, as specified in this standard and in the other Eurocodes, where relevant.

(4) Qualitative assessment methods may be used for assessment for an existing structure together with or in place of quantitative assessment methods where conditions of use are met.

NOTE 1 Minimum conditions for or restrictions on the use of qualitative assessment methods can be given in the National Annex.

NDP

NOTE 2 Qualitative assessment methods can be used to assist the definition of the assessment scope and objectives.

(5) Additional criteria for the use of qualitative assessment methods should be as specified by the relevant authority or, where not specified, as agreed for a specific project by the relevant parties.

Focus on key revision aspects – EN1990-2

4 Basic requirements

(1) The assessment of an existing structure shall verify that the structure fulfils the specified requirements in the remaining service life.

NOTE 1 The basic requirements for an existing structure can be different from the basic requirements applicable for a new structure.

NOTE 2 Minimum requirements for the verification where the structure includes new and existing parts can be given in the National Annex.

Focus on key revision aspects – EN1990-2

10 Verification using quantitative assessment methods

10.1 General

(1) The verification of existing structures should be carried out using the partial factor method.

(2) The following verification methods may be used in addition to the partial factor method:

— reliability-based method;

— risk-informed method.

NOTE 1 Restrictions on the use of the reliability-based method and the risk-informed method for the assessment of an existing structure can be given in the National Annex.

NDP

NOTE 2 See C.3.1 for guidance on the applicability and criteria for use of the reliability-based method and the risk-informed method.

NOTE 3 Further guidance is given in prEN 1990:2023, Annex C.

NOTE 4 For geotechnical structures, verification by testing or using the observational method can be relevant. See EN 1997 (all parts).

Focus on key revision aspects – EN1990-2

The assessment of a structure should be carried out following a **stepwise process** with increasing levels of detail and accuracy

Preliminary stage of assessment

Detailed stage of assessment

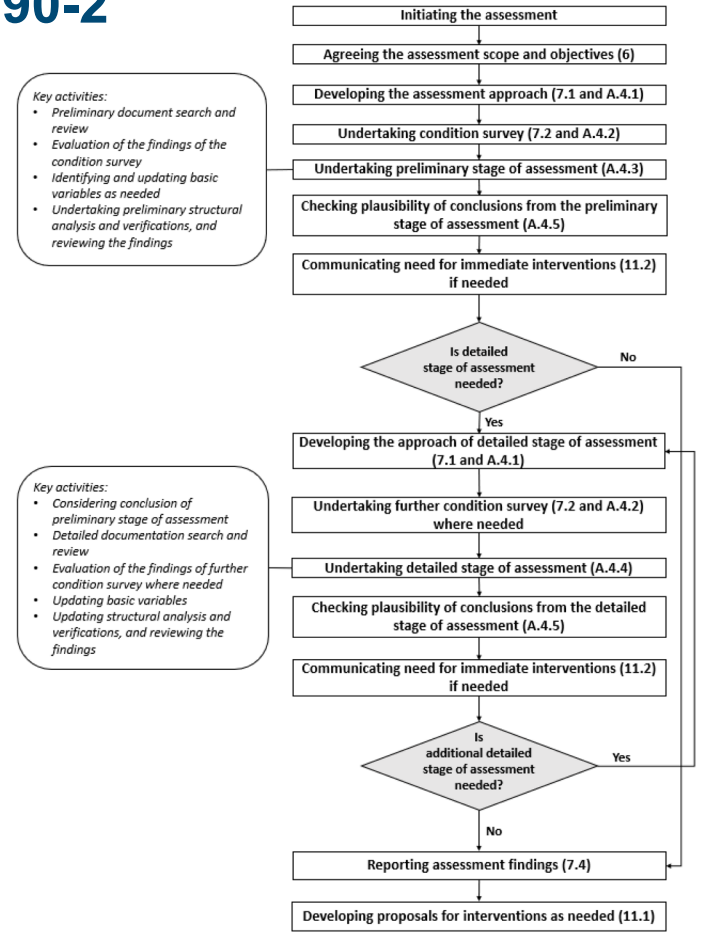


Figure A.1 — Indicative assessment process

Focus on key revision aspects – EN1990-2

12 Interventions

12.1 General

(1) Proposals for intervention should be developed if the degree of reliability or performance required for an existing structure or a part of an existing structure is not achieved.

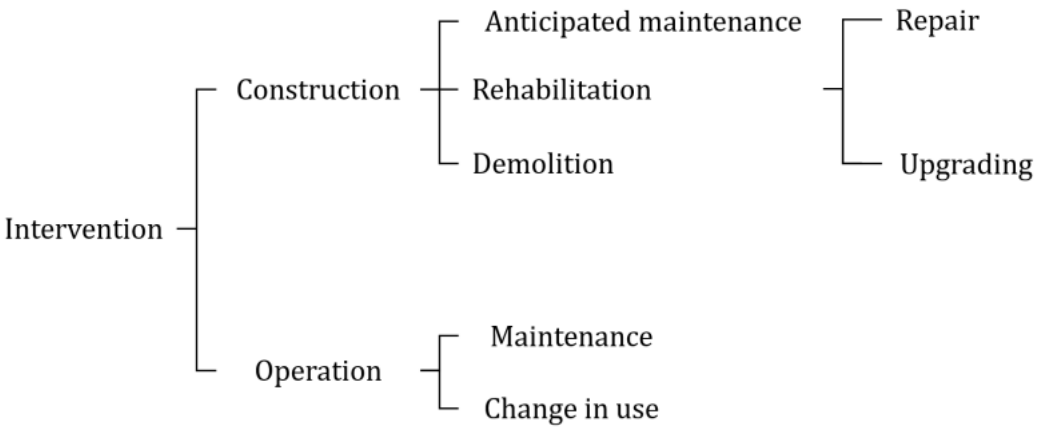


Figure 12.1 — Intervention types

Thank you for your attention

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