EN 1990-2 ‘Eurocode — Basis of structural and geotechnical design — Part 2: Assessment of existing structures’

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EUROCODES

EUROCODES
EN 1990
Basis of structural design

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Agenda

General	• Short history of assessment standard • Structure of EN 1990-2 • Definition of “Existing Structure”
Key aspects and benefits	• Reliability level • Assessment process • Methods of Assessments • Basic variables and Updating
Example	• Assessment of an existing floor beam
Concluding remarks	

EN 1990-2: General

Short history : form Limassol to EN 1990-2

Resolution 242 (CEN/TC 250, Limassol, 15/16th October 2007)

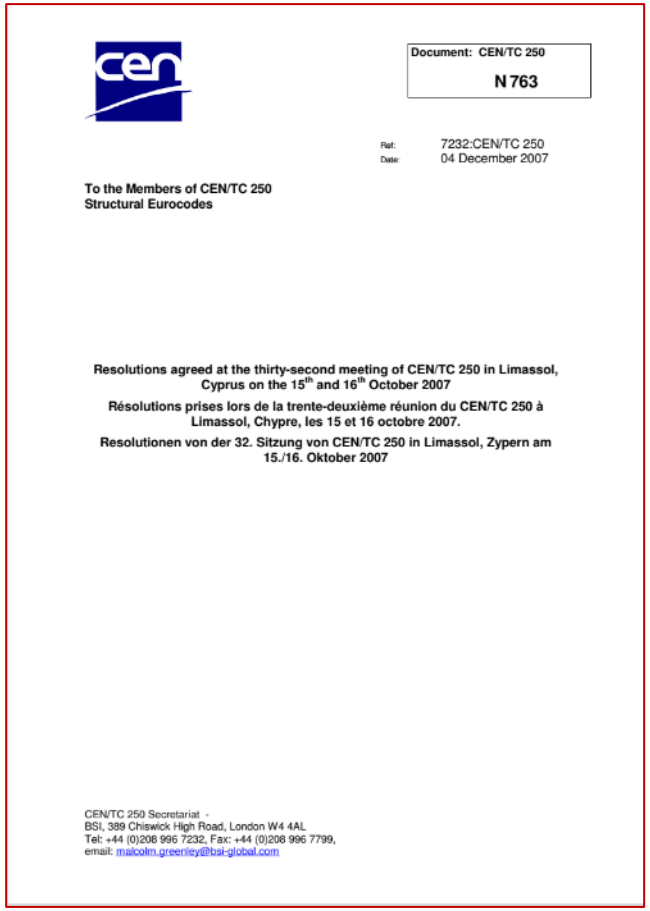
Subject: Assessment of existing structures

CEN/TC 250 decides to include the possibility of work on the Assessment of Existing Structures in the CEN/TC 250 strategy plan for the further development of the Eurocodes.

The strategy plan, prepared by the Chairman's Advisory Panel (Assessment) with the help of JRC, should include the following:

- a list of working items for supplements to EN 1990, EN 1991.
- recommendations as to the extent to which EN 1992 – EN 1999 also need to contain sections on Assessment of Existing Structures.
- consideration about whether the additions will apply to both bridges and building structures or be applied separately.
- the possible need for a Horizontal Group to oversee the work.

The resolution was agreed by unanimity.



Document: CEN/TC 250
N 763

Ref: 7232:CEN/TC 250
Date: 04 December 2007

To the Members of CEN/TC 250
Structural Eurocodes

Resolutions agreed at the thirty-second meeting of CEN/TC 250 in Limassol, Cyprus on the 15th and 16th October 2007

Résolutions prises lors de la trente-deuxième réunion du CEN/TC 250 à Limassol, Chypre, les 15 et 16 octobre 2007.

Resolutionen von der 32. Sitzung von CEN/TC 250 in Limassol, Zypern am 15./16. Oktober 2007

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email: malcolm.greenley@bsi-global.com

EN 1990-2: General

Short history : form Limassol to EN 1990-2

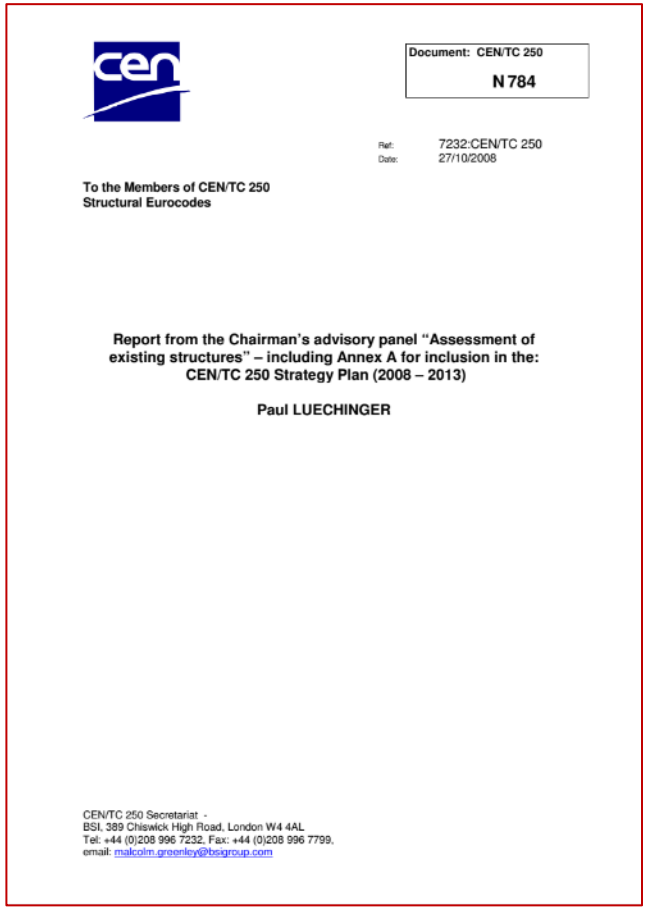
The works shall be performed in several steps:

Step 0: Preparation of a "European guidance" giving a unified European approach and published as "JRC-Scientific and Technical Report".

Step 1: Agreement of CEN/TC250 to apply for a CEN-Working item for preparing a CEN-document on the basis of the "JRC-Scientific and technical report" and final preparation of the appropriate CEN-document.

Such a CEN-document could be a CEN-TR (Technical Report) or CEN-TS (Technical Specification).

Step 2: Decision of CEN/TC250 whether to start a process converting the CEN TR or CEN TS into EN Eurocodes or parts added to the existing EN Eurocodes.



Document: CEN/TC 250
N 784

Ref: 7232:CEN/TC 250
Date: 27/10/2008

To the Members of CEN/TC 250
Structural Eurocodes

Report from the Chairman's advisory panel "Assessment of existing structures" – including Annex A for inclusion in the: CEN/TC 250 Strategy Plan (2008 – 2013)

Paul LUECHINGER

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EN 1990-2: General

Short history : form Limassol to EN 1990-2

Step 0: JRC Science and Policy Report

New European Technical Rules for the Assessment and Retrofitting of Existing Structures

published in March 2015

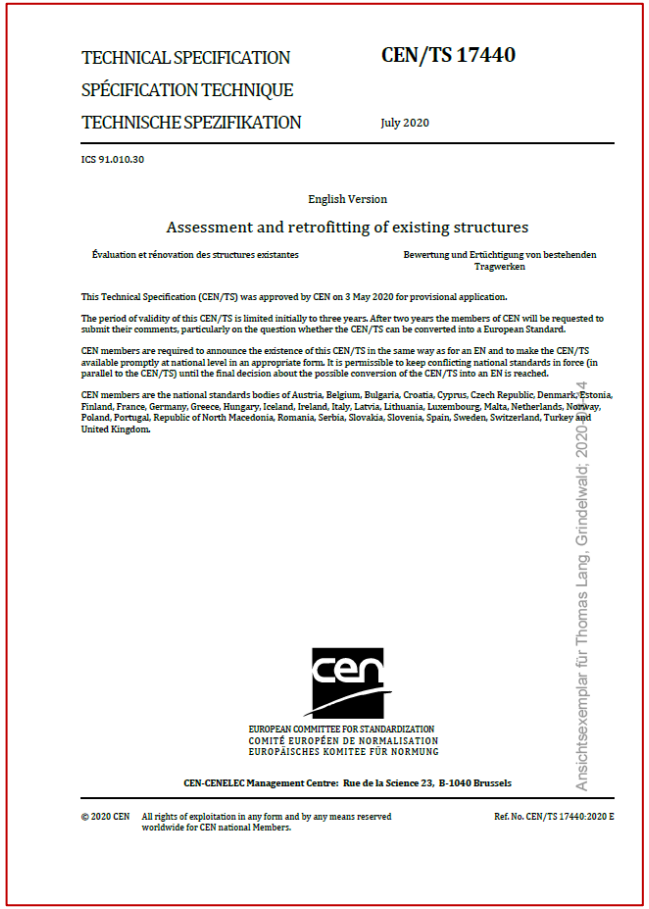
EN 1990-2: General

Short history : form Limassol to EN 1990-2

Step 1: Technical Specification

CEN/TS 17440 Assessment and retrofitting of existing structures

published in July 2020



TECHNICAL SPECIFICATION **CEN/TS 17440**

SPÉCIFICATION TECHNIQUE

TECHNISCHE SPEZIFIKATION July 2020

ICS 91.010.30

English Version

Assessment and retrofitting of existing structures

Évaluation et rénovation des structures existantes

Bewertung und Ertüchtigung von bestehenden Tragwerken

This Technical Specification (CEN/TS) was approved by CEN on 3 May 2020 for provisional application.

The period of validity of this CEN/TS is limited initially to three years. After two years the members of CEN will be requested to submit their comments, particularly on the question whether the CEN/TS can be converted into a European Standard.

CEN members are required to announce the existence of this CEN/TS in the same way as for an EN and to make the CEN/TS available promptly at national level in an appropriate form. It is permissible to keep conflicting national standards in force (in parallel to the CEN/TS) until the final decision about the possible conversion of the CEN/TS into an EN is reached.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom.

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

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

Ref. No. CEN/TS 17440:2020 E

EN 1990-2: General

Short history : form Limassol to EN 1990-2

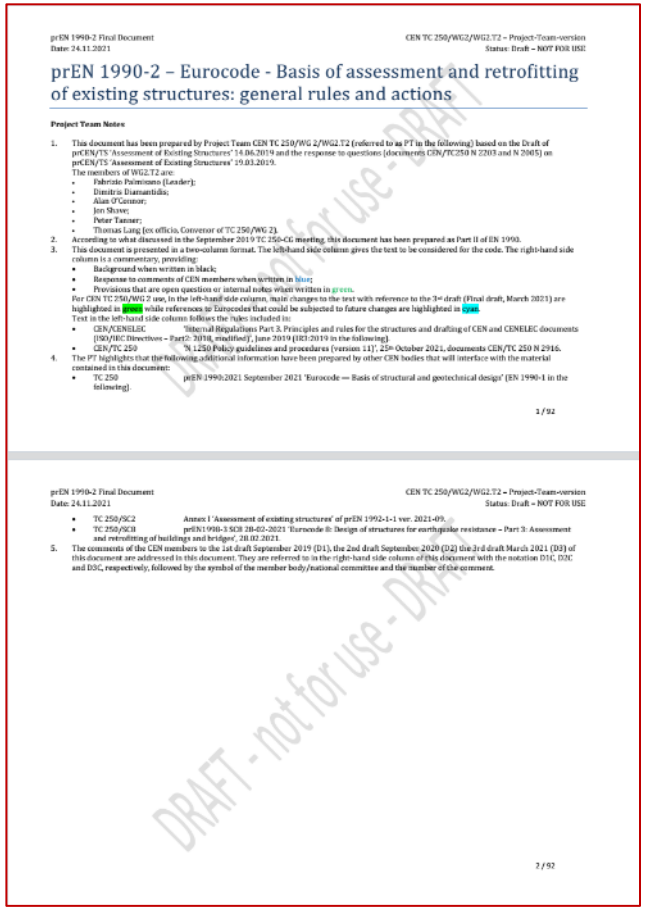
Step 2: Conversion of TS into EN

Step 2-1: work as part of mandate M/515 Phase 4

Final Document of Project Team WG2.T2

prEN 1990-2 – Eurocode – Basis assessment and retrofitting of existing structures: general rules and actions

delivered to TC 250 by end of November 2021


prEN 1990-2 Final Document
Date: 24.11.2021
CEN TC 250/WG2/WG2.T2 – Project-Team-version
Status: Draft – NOT FOR USE

prEN 1990-2 – Eurocode - Basis of assessment and retrofitting of existing structures: general rules and actions

Project Team Notes

1. This document has been prepared by Project Team CEN TC 250/WG 2/WG2.T2 (referred to as PT in the following) based on the Draft of prCEN/TS 'Assessment of Existing Structures' 14.06.2019 and the response to questions (documents CEN/TC250 N 2203 and N 2045) on prCEN/TS 'Assessment of Existing Structures' 19.03.2019.
The members of WG2.T2 are:
   - Fabrizio Palmisano (Leader);
   - Dimitris Diamantidis;
   - Alan O'Connor;
   - Jon Shave;
   - Peter Tanner;
   - Thomas Lang (ex officio, Convenor of TC 250/WG 2).
2. According to what discussed in the September 2019 TC 250-CG meeting, this document has been prepared as Part II of EN 1990.
3. This document is presented in a two-column format. The left-hand side column gives the text to be considered for the code. The right-hand side column is a commentary, providing:
   - Background when written in black;
   - Response to comments of CEN members when written in blue;
   - Provisions that are open question or internal notes when written in green.

For CEN TC 250/WG 2 use, in the left-hand side column, main changes to the text with reference to the 3rd draft (Final draft, March 2021) are highlighted in green, while references to Eurocodes that could be subjected to future changes are highlighted in cyan.
Text in the left-hand side column follows the rules included in:
   - CEN/CENELEC 'Internal Regulations Part 3. Principles and rules for the structures and drafting of CEN and CENELEC documents [ISO/IEC Directives – Part2: 2018, modified]', June 2019 (IR3:2019 in the following).
   - CEN/TC 250 'N 1250 Policy guidelines and procedures (version 11)', 25th October 2021, documents CEN/TC 250 N 2916.
4. The PT highlights that the following additional information have been prepared by other CEN bodies that will interface with the material contained in this document:
   - TC 250 prEN 1990:2021 September 2021 'Eurocode — Basis of structural and geotechnical design' (EN 1990-1 in the following)

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prEN 1990-2 Final Document
Date: 24.11.2021
CEN TC 250/WG2/WG2.T2 – Project-Team-version
Status: Draft – NOT FOR USE

   - TC 250/SC2 Annex I 'Assessment of existing structures' of prEN 1992-1-1 ver. 2021-09.
   - TC 250/SC8 prEN1990-1 SC8 28-02-2021 'Eurocode 8: Design of structures for earthquake resistance – Part 3: Assessment and retrofitting of buildings and bridges', 28.02.2021.
5. The comments of the CEN members to the 1st draft September 2019 (D1), the 2nd draft September 2020 (D2) the 3rd draft March 2021 (D3) of this document are addressed in this document. They are referred to in the right-hand side column of this document with the notation D1C, D2C and D3C, respectively, followed by the symbol of the member body/national committee and the number of the comment.

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EN 1990-2: General

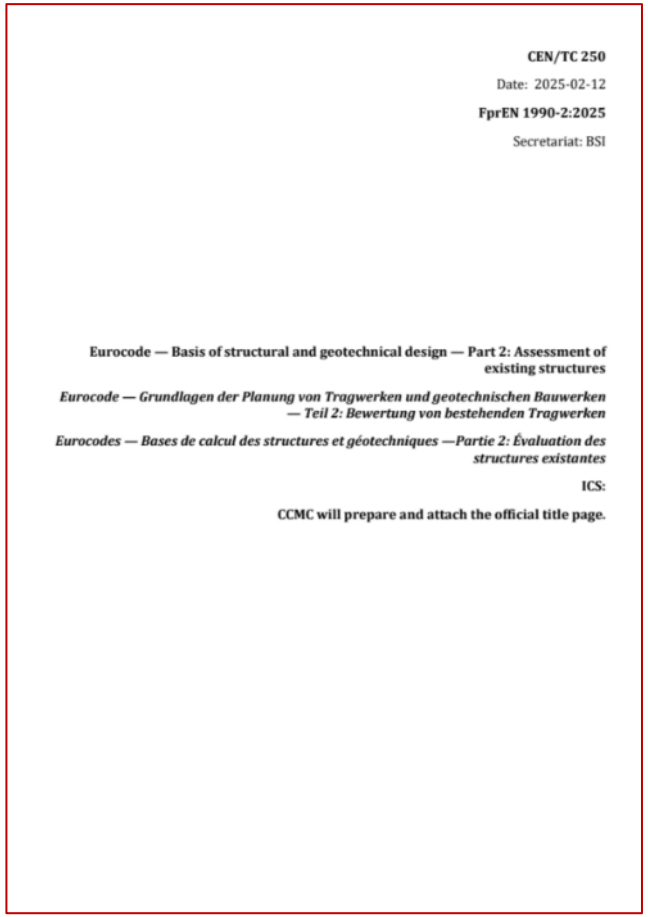
Short history : form Limassol to EN 1990-2

Step 2: Conversion of TS into EN
Step 2-2: work of SC 10/WG 4

Formal Vote Draft

FprEN 1990-2 – Eurocode – Basis of structural and geotechnical design –
Part 2: Assessment of existing structures

delivered to TC 250 by mid of February 2025 for preparation of Formal Vote (October – November 2025)



CEN/TC 250

Date: 2025-02-12

FprEN 1990-2:2025

Secretariat: BSI

Eurocode — Basis of structural and geotechnical design — Part 2: Assessment of existing structures

Eurocode — Grundlagen der Planung von Tragwerken und geotechnischen Bauwerken — Teil 2: Bewertung von bestehenden Tragwerken

Eurocodes — Bases de calcul des structures et géotechniques —Partie 2: Évaluation des structures existantes

ICS:

CCMC will prepare and attach the official title page.

EN 1990-2: General

Structure of EN 1990-2

Options for publication of provisions on existing structures:

- OPTION 1: Add one new (normative) Annex to EN 1990
- OPTION 2: Add one new clause in the main part of EN 1990 and new informative annex(es)
- OPTION 3: Modify existing and add new clauses in the main part of EN 1990 and new informative annex(es)
- OPTION 4: Add a new part to EN 1990

EN 1990-2: General

Structure of EN 1990-2

Options for publication of provisions on existing structures:

- Final choice was OPTION 4: add new part: EN 1990-2
- Making EN 1990 to EN 1990-1
- mirroring as much as possible the structure of EN 1990-1 including all the annexes
- EN 1990-1 is the starting point for design of new structures
- EN 1990-2 is the starting point for assessment of existing structures
- Referencing from EN 1990-2 to EN 1990-1 wherever possible to avoid repetitions

EN 1990-2: General

Definition of « existing structure »

1 Scope

1.1 Scope of EN 1990-2

(1) This document provides provisions to cover the assessment of existing structures, including geotechnical structures, and the general principles for interventions.

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

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

EN 1990-2: General

Definition of « existing structure »

Structure is considered an existing structure from the moment of the notice of completion until the moment of demolition

Any structure in use or abandoned; it does not include structures under construction or recently erected. These shall be considered new structures up to its final reception, or end of warranty period, and therefore this document does not apply (instead EN 1990-1 applies)

An existing structure is assumed to be a structure which is already in use and for which an approval of use has been issued

A structure should not be considered “an existing structure” until it has actually “performed as a structure”, before that it still is “a structure in the being”

EN 1990-2: General

Definition of « existing structure »

Need for an **NDP** either in the scope or in the definition?

EN 1990-2: General

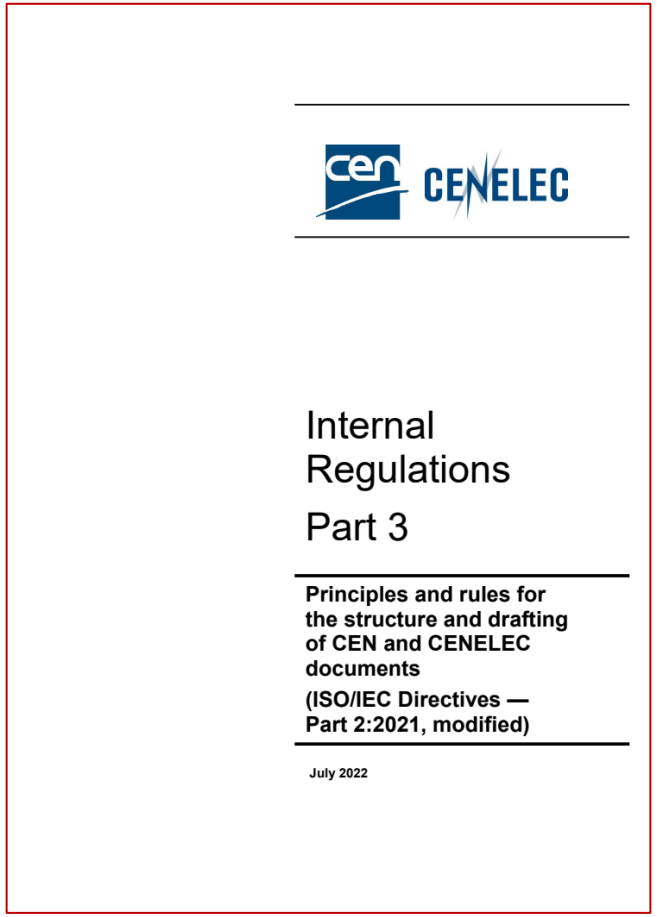
Definition of « existing structure »

Need for an **NDP** either in the scope or in the definition?

According to the CEN rules

- neither the **Scope**
- nor **Terms and Definition**

can include NDPs.



EN 1990-2: General

Definition of « existing structure »

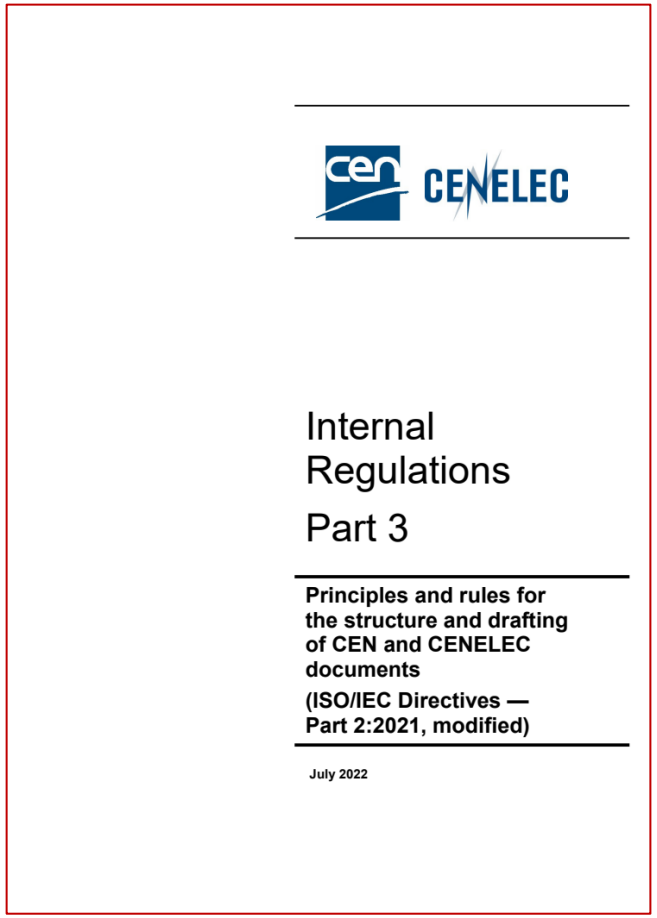
Need for an **NDP** either in the scope or in the definition?

According to the CEN rules

- neither the **Scope**
- nor **Terms and Definition**

can include NDPs.

Having an NDP in the scope would mean that a Member State could change the scope of a standard, which is not acceptable. Similarly changing a definition.



EN 1990-2: General

Definition of « existing structure »

EN 1990:2023

3.1.1.2
structure
part of the construction works that provides stability, resistance, and rigidity, to meet the safety, serviceability and durability requirements

Note 1 to entry: This definition includes structures that comprise one member or a combination of connected members.

FprEN 1990-2:2025

3.1.1
existing structure
structure that physically (materially) exists

Note 1 to entry: For further information on existing structures, see 4.1(2), Note 1.

EN 1990-2: General

Definition of « existing structure »

FprEN 1990-2:2025

4 General rules

4.1 Basic requirements

(1) The assumptions given in 1.2 and in the other Eurocodes shall be met.

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

NOTE 1 Additional conditions for existing structures to which this document applies can be given in the National Annex.

Agenda

General

- Short history of assessment standard
- Structure of EN 1990-2
- Definition of “Existing Structure”

Key aspects and benefits

- Reliability level
- Assessment process
- Methods of Assessments
- Basic variables and Updating

Example

- Assessment of an existing floor beam

Concluding remarks

EN 1990-2: Key aspects and benefits

Reliability level (according to 4.2(3) Note 2 and C.3(2))

4.2 Structural reliability

(…)

(3) The choice of an appropriate level of reliability for the structure should take into account the following:

(…)

NOTE 2 Reliability levels for the assessment of existing structures can be taken as the reliability levels given in EN 1990-1 for new structures unless different levels are specified in the National Annex.

EN 1990-2: Key aspects and benefits

Reliability levels (according to 4.2(3) Note 2 and C.3(2))

C.3 Reliability analysis and code calibration

(…)

(2) Reliability targets for existing structures may differ from the ones of new structures.

NOTE 1 EN 1990:2023, Table C.3 (NDP) can be used, unless the National Annex gives different values.

EN 1990-2: Key aspects and benefits

Assessment process (according to 5.1.1 and Annex I.3)

5 Principles of assessment

5.1 General

5.1.1 Assessment process

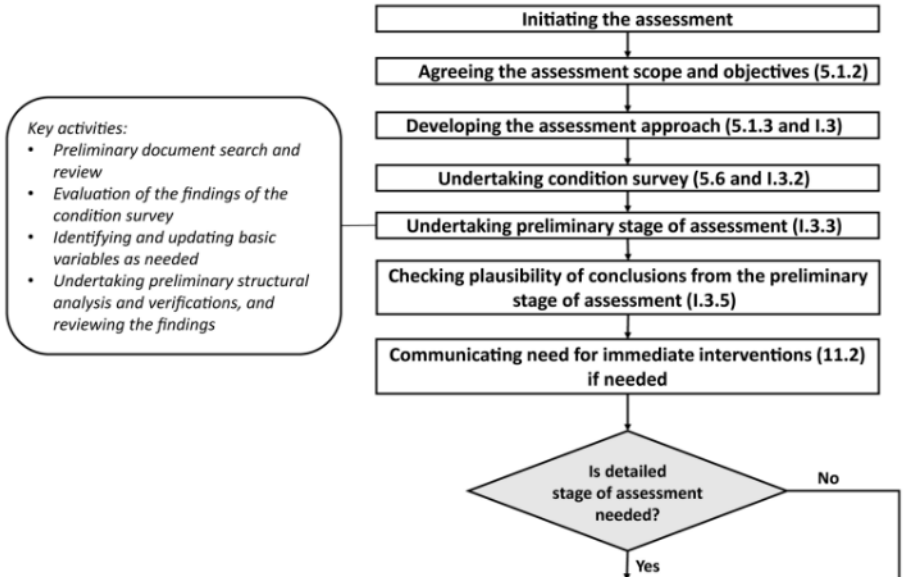
(1) The assessment of a structure may be carried out following a stepwise process with increasing levels of detail and accuracy.

NOTE 1 A stepwise process can include preliminary and detailed stages in order to optimize the overall level of effort required for the assessment.

NOTE 2 Guidance on the assessment process is provided in Clause I.3.

EN 1990-2: Key aspects and benefits

Assessment process
(according to 5.1.1 and Annex I.3)



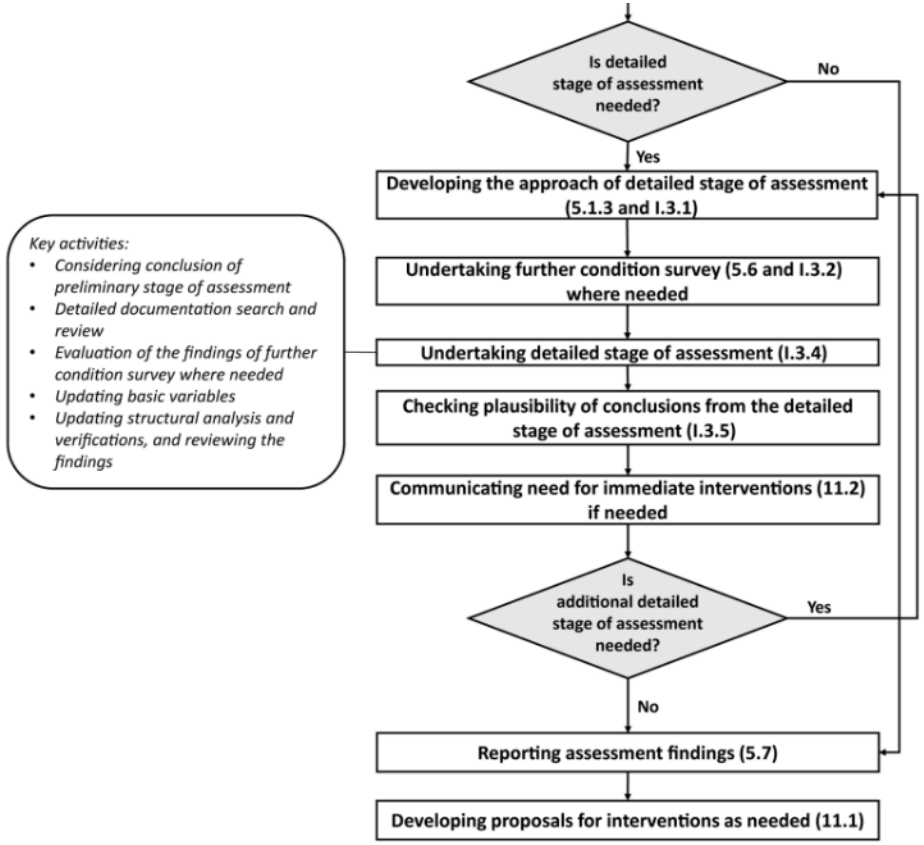


Figure I.1 — Indicative assessment process

EN 1990-2: Key aspects and benefits

Methods of assessment (according to 5.1.4)

5.1.4 Method of assessment

(1) The assessment of an existing structure should be carried out using quantitative assessment methods, as specified in this document.

(2) Qualitative assessment methods may be used together with quantitative assessment methods unless otherwise specified.

NOTE 1 The National Annex can specify minimum conditions for or restrictions on the use of qualitative assessment methods alone, in place of quantitative assessment methods.

EN 1990-2: Key aspects and benefits

Methods of assessment (according to 5.1.4)

5.1.4 Method of assessment

(…)

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

NOTE The National Annex can identify structures where other methods can be used.

EN 1990-2: Key aspects and benefits

Methods of assessment (according to 5.1.4)

5.1.4 Method of assessment

(,,,)

(5) The following quantitative 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.

EN 1990-2: Key aspects and benefits

Basic variables and Updating (according to 6.1.1.1 and Annex I.4)

6.1 Basic variables for assessment

6.1.1 General

6.1.1.1 Prior information and updating

(1) The basic variables needed for an assessment should include:

— actions and environmental influences;

— materials, products and ground properties;

— geometrical properties (including structural detailing).

EN 1990-2: Key aspects and benefits

Basic variables and Updating (according to 6.1.1.1 and Annex I.4.1)

(…)

(2) Prior information for the values for basic variables related to geometrical, material and product properties may be based on:

— original design documents, construction records, documentation on previous assessments and interventions, if applicable;

— the codes and standards and/or related background information from the time of design and construction, including those from the time of previous interventions, if applicable;

— the manufacturers' data and product literature.

(3) If new information becomes available, relevant data should be re-evaluated and, if needed, updated, taking into account the uncertain prior information.

NOTE Guidance on updating procedures is provided in I.4.2.

EN 1990-2: Key aspects and benefits

Updating of Structural models (according to 7)

(…)

(2) Structural models should be based on the actual conditions of the existing structure.

(3) Prior information related to the structural system may be based on, if applicable:

— original design documents;

— construction records;

— documentation on previous assessments and interventions.

(4) Information on the structural system should be updated if prior information is:

— not sufficient for the assessment; or

— not considered to be sufficiently reliable.

Agenda

General

- Short history of assessment standard
- Structure of EN 1990-2
- Definition of “Existing Structure”

Key aspects and benefits

- Reliability level
- Assessment process
- Methods of Assessments
- Basic variables and Updating

Example

- Assessment of an existing floor beam

Concluding remarks

EN 1990-2: Example

Assessment of an existing floor beam (as per EN 1990-2)

(based on CEN/TC 250/WG 2/WG2.T2 Background document to prEN 1990-2 ver. November 2021, Section D by P. Tanner and C. Lara)

References are made to FprEN 1990-2:2025 (E)

Input parameters (assessment scope and objectives (5.1.2)):

- transformation of an industrial building from the 1940's into a cultural centre
- 6 m span length, simply supported reinforced concrete beams
- 5 m centre to centre distance between beams
- new lightweight floors will be installed, supported by the existing main beams
- Self weight of reinforced concrete g_c = 25 kN/m^3 (6.1.2.2)
- Permanent load g_k = 2 kN/m² (self-weight, partition walls, etc) (6.1.2.2)
- Imposed load q_k = 4 kN/m^2 (area with fixed seating) (6.1.2.3)

EN 1990-2: Example

Assessment of an existing floor beam (as per EN 1990-2)

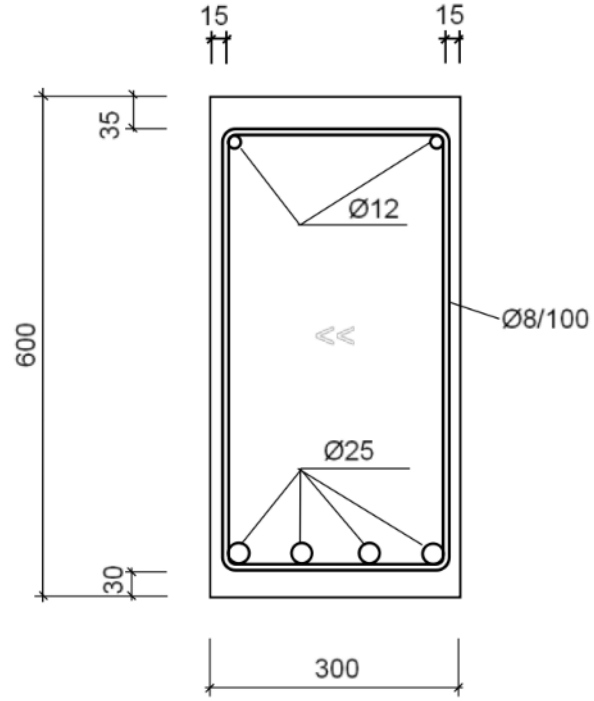
Input parameters:

Condition survey (5.6) of Floor beam shows:

- Overall and cross-sectional dimensions corresponds to nominal values
- Deviations are equivalent to today's tolerances
- No deterioration of rebars

Further assumptions:

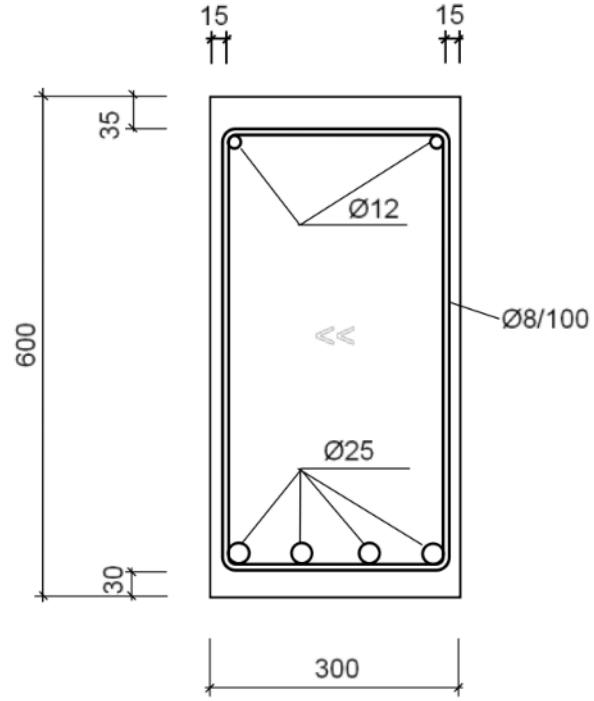
- Consequence class 2 (A.1.3)
- Remaining service life of 50 years (A.1.4)
- Verification of ULS: bending moment only according to the partial factor method (5.1.2(2))



EN 1990-2: Example

Assessment of an existing floor beam (as per EN 1990-2)

Verification of ULS (Bending moment at mid span) (8.3):



$\mathbf{M_{Ed} \leq M_{Rd}}$

$M_{Ed} = \gamma_G \cdot M_{Gc} + \gamma_G \cdot M_{Gk} + \gamma_Q \cdot M_{Qk}$

With
$\gamma_G = 1{,}35$ and $\gamma_Q = 1{,}5$ (A.1.7)
and
$M_{Gc} = 0{,}6m \cdot 0{,}3m \cdot 25{,}0kN/m^3 \cdot (6{,}0m)^2/8 = 20{,}3kNm$
$M_{Gk} = 5{,}0m \cdot 2{,}0kN/m^2 \cdot (6{,}0m)^2/8 = 45{,}0kNm$
$M_{Qk} = 5{,}0m \cdot 4{,}0kN/m^2 \cdot (6{,}0m)^2/8 = 90.0kNm$

$\mathbf{M_{Ed}} = 1{,}35 \cdot 20{,}3kNm + 1{,}35 \cdot 45{,}0kNm + 1{,}5 \cdot 90{,}0kNm$ **= 223,1kNm**

EN 1990-2: Example

Assessment of an existing floor beam (as per EN 1990-2)

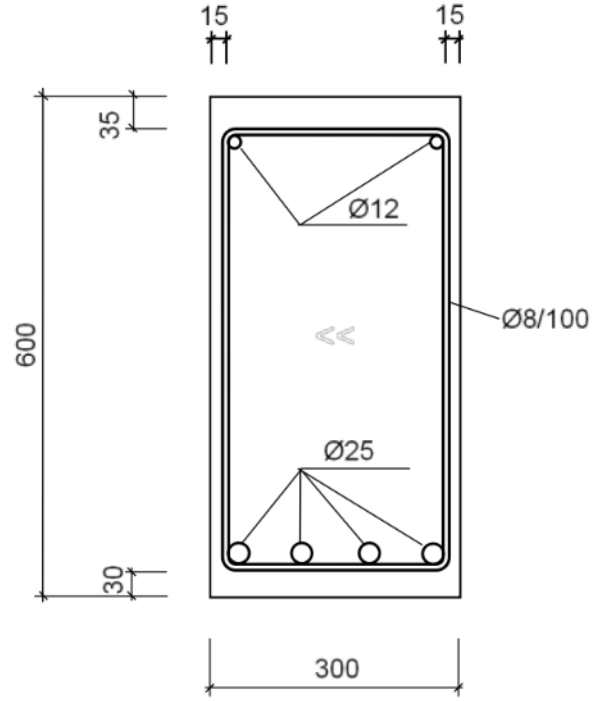
Verification of ULS (Bending moment at mid span) (8.3):

$\mathbf{M_{Ed} \leq M_{Rd}}$

Approximation of bending resistance $M_{Rd} = 1/\gamma_S \cdot f_{yk} \cdot A_s \cdot 0{,}9 \cdot d$

With
$d = 600mm - 30mm - 8mm - 25mm/2 = 550mm$
$A_s = 4 \cdot \pi \cdot (25mm)^2/4 = 1963mm^2$

$M_{Rd} = 1/\gamma_S \cdot f_{yk} \cdot 1963mm^2 \cdot 0{,}9 \cdot 550mm = 1/\gamma_S \cdot f_{yk} \cdot 0{,}97 \cdot 10^{-6}$ kNm



EN 1990-2: Example

Assessment of an existing floor beam (as per EN 1990-2)

Preliminary stage of assessment (I.3.3)

Using fixed partial factor and characteristic value according to prior information for yield strength as follows:

γ_S = 1,15 (EN 1992-1-1:2025, Table 4.3)

f_{yk} = 180 N/mm^2 (according to prior information)

M_{Rd} = $1/\gamma_S \cdot f_{yk} \cdot 0{,}97 \cdot 10^{-6}$kNm = $1/1{,}15 \cdot 180$N/mm$^2 \cdot 0{,}97 \cdot 10^{-6}$ = **151,8kNm < M_{Ed} = 223,1kNm**

Recommendation: a **detailed assessment** according to 5.1.1 and Annex I.3 should be carried out!

EN 1990-2: Example

Assessment of an existing floor beam (as per EN 1990-2)

Detailed stage of assessment (I.3.4)

- no operational restrictions are planned for the remaining service life. Thus, no updating for action variables is carried out, neither for permanent actions nor for imposed loads.
- further structural investigations are carried out to update the material properties for the detailed assessment: tensile tests performed on samples of rebars taken from main beams. However, following the owner's condition to minimize destructive material testing, only one sample could be extracted.
- Tensile tests are conducted on four steel specimens fabricated from a single sample, extracted from one 25 mm diameter reinforcing bar.

- The following values are measured for the reinforcing steel yield strength:
  f_y = {312; 301; 308; 306} N/mm^2

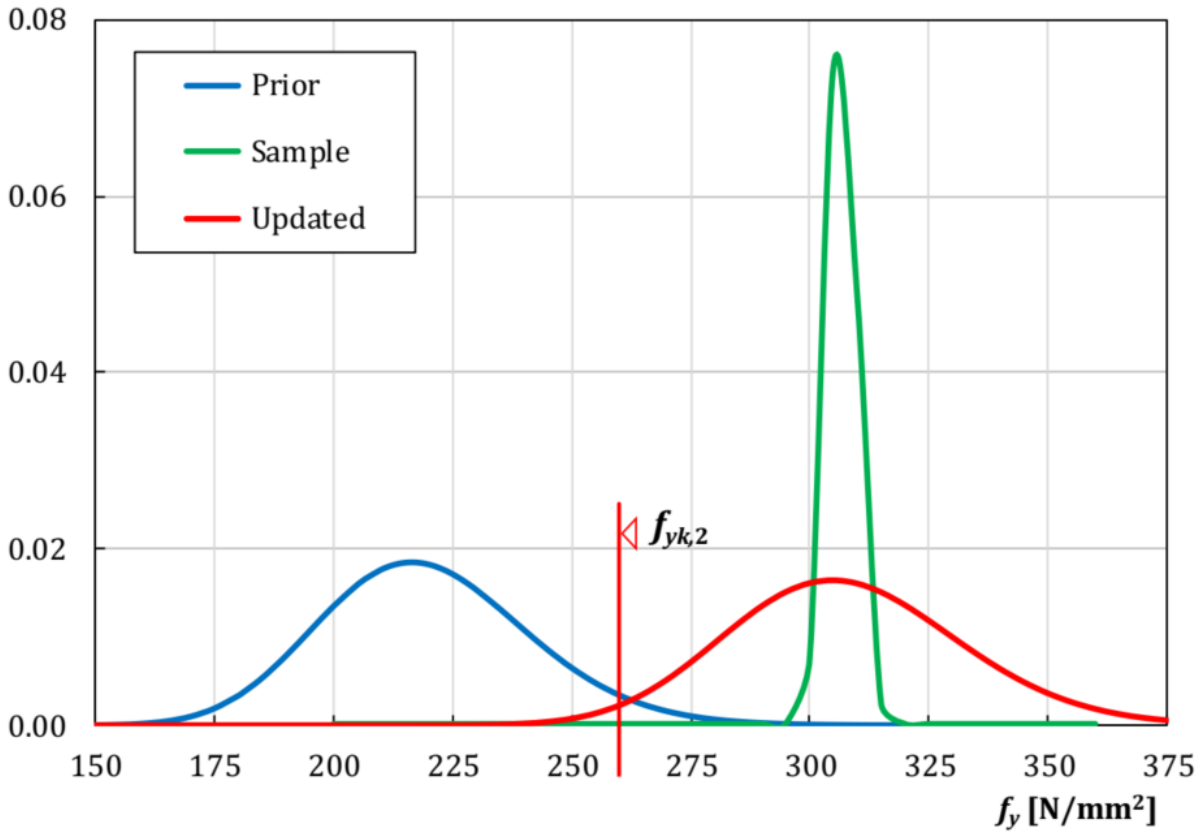
EN 1990-2: Example

Assessment of an existing floor beam (as per EN 1990-2)

Detailed stage of assessment (I.3.4)

Sample parameters for f_y (D.7.2)
Number of test n = 4
f_{ym} = 307 N/mm^2
V_{fy} = 0,01
f_{yk} = 299 N/mm^2

Updated parameters for f_{y2} (I.4.2):
Distribution Lognormal
f_{yk2} = 260 N/mm^2
V_{fy2} = 0,08
m_{fy2}/f_{yk2} = 1,18



EN 1990-2: Example

Assessment of an existing floor beam (as per EN 1990-2)

Detailed stage of assessment (I.3.4)

Adjustment of γ_S according to C.4.4.2 and using formula C.18: $f_{yd} \approx m_{fy} \cdot e^{(-\alpha_{fy} \cdot \beta \cdot V_{fy})}$

With $\gamma_S = f_{yk}/f_{yd} \approx 1/(m_{fy}/f_{yk}) \cdot e^{(\alpha_{fy} \cdot \beta \cdot V_{fy})}$ and $\alpha_{fy} = 0{,}8$ and $\beta = 3{,}8$

$\gamma_{S2} = 1/(m_{ys2}/f_{sk2}) \cdot e^{(\alpha_{fy} \cdot \beta \cdot V_{fy2})} = 1/1{,}18 \cdot e^{(0.8 \cdot 3{,}8 \cdot 0{,}08)} = 1{,}08$

$M_{Rd} = 1/\gamma_{S2} \cdot f_{yk2} \cdot 0{,}97 \cdot 10^{-6}$kNm = 1/1,08·260N/mm^2·0,97·10^{-6} = 233,3kNm > M_{Ed} = 223,1kNm

Recommendation: **No additional assessment stage is needed** regarding bending failure!

Agenda

General

- Short history of assessment standard
- Structure of EN 1990-2
- Definition of “Existing Structure”

Key aspects and benefits

- Reliability level
- Assessment process
- Basic Variables and Updating
- Methods of Assessments

Example

- Assessment of an existing floor beam

Concluding remarks

EN 1990-2: Concluding remarks

- After 20 years of hard work, we will finally get a European Standard for basis of assessment of existing structures
- Further work will be needed mainly on the material specific side to come to fully consistent set of standards for assessment and retrofitting of existing structures
- TC 250 is ready to do this work within the material specific Subcommittees coordinated by the newly created **Horizontal Group "Assessment and Retrofitting"** (TC 250/HG A&R)

Thank you!

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