Overview of the Evolution of EN1992: Design of concrete structures

17 December 2021

Structure of this slide deck

- → General overview of the evolution of EN 1992
- → Specific overview of the evolution of EN 1992 parts:
  - *EN 1992-1-1 General rules – Rules for buildings, bridges and civil engineering structures (merged current parts -1-1, -2 and -3)*
  - *EN 1992-1-2 General rules – Structural fire design*

General overview of the Evolution of EN1992: Design of concrete structures

17 December 2021

Agenda – Evolution of EN 1992

- → Key changes to EN 1992
- → New content included in the scope of EN 1992
- → How ease of use has been enhanced

The following slides provide a general overview of the evolution of EN 1992. Complementary slides provide greater details for individual Eurocode Parts.

Key changes to EN 1992

- → *Design rules which are based on physical models avoiding member specific rules, sufficiently comprehensive for existing structures but simplified for new construction*
- → *Commonly used design provisions are given in the main text, special design provisions which are used for less common structures or members are given in Annexes*
- → *Simple fatigue verification for all types of structures is given in Clause 10; detailed fatigue verification is given in Annex E; bridge specific fatigue verification provisions are given in Annex K*

Key changes to EN 1992

→ *Introducing new performance based provisions for concrete structures facilitating increased use of new types of cements and concretes (green concretes) and thus permitting improved sustainability of new concrete structures*

New content included in scope of EN 1992

- *Assessment of existing structures*
- *Strengthening with CFRP materials*
- *New materials and products: FRP reinforcement; steel fibre reinforced concrete structures; recycled aggregate concrete structures; stainless steel reinforcement*
- *New methods of anchoring reinforcement: Headed bars, U-loop bars, post-installed bars*

How ease of use has been enhanced

- *Provided extended list of terms and definitions and list of symbols*
- *Removed rules of little practical use and alternative application rules*
- *Start design provisions with a simple check whether verification is required at all before going into simplified and then comprehensive verification rules adapted to the specific task*
- *Unified design provisions for complete range of concrete strength avoiding duplicate rules for grades up to 50MPa and grades above 50MPa*

Overview of the Evolution of EN1992-1-1: General rules, rules for buildings, bridges and civil engineering structures

17 December 2021

Agenda – Evolution of EN 1992-1-1: General rules, rules for buildings, bridges and civil engineering structures

- Key changes to EN 1992-1-1
- New content included in the scope of EN 1992-1-1
- How ease of use has been enhanced

Key changes to EN 1992-1-1

→ *Provisions for improved sustainability of concrete structures:*

- Permitting reference age for concrete strength to be chosen up to 91 days to benefit from slow strength development of "green concretes"

- Introducing Exposure Resistance Concept for durability assessment of concretes, suitable for common and new types of concrete such as "green concretes"

- Introducing provisions for recycled aggregates concrete

- Introducing provisions for assessment of existing structures

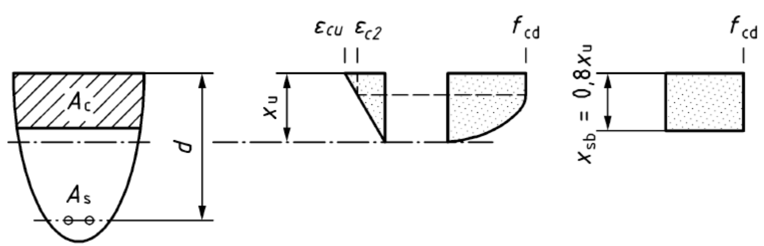
- Introducing provisions for adaptation of partial material factors for improved quality control and/or improved knowledge

Key changes to EN 1992-1-1

- → *Design rules which are based on physical models avoiding member specific rules, sufficiently comprehensive for existing structures but simplified for new construction*
- → *Commonly used design provisions are given in the main text, special design provisions which are used for less common structures or members are given in Annexes*
- → *Simple fatigue verification for all types of structures is given in Clause 10; detailed fatigue verification is given in Annex E; bridge specific fatigue verification provisions are given in Annex K*

Key changes to EN 1992-1-1

- *Integration of bridge provisions from current EN 1992-2:2005 into future EN 1992-1-1, with few bridge specific rules given in Annex K*
- *Integration of containment structures provisions from current EN 1992-3:2006 into future EN 1992-1-1, Annex D (cracking due to restraint) and Annex H (water tightness)*
- *Re-defined effective concrete strength f_{cd} such as to avoid different design provisions for grades up to 50MPa and for grades above 50MPa, and to simplify assumptions for strain and stress distributions in concrete compression zone*



$$\varepsilon_{c2} = 0{,}002$$

$$\varepsilon_{cu} = 0{,}0035$$

New content included in scope of EN 1992-1-1

- *Assessment of existing structures*
- *Strengthening with CFRP materials*
- *New materials and products: FRP reinforcement; steel fibre reinforced concrete structures; recycled aggregate concrete structures; stainless steel reinforcement*

New content included in scope of EN 1992-1-1

- *Requirements assumed in design provisions and for specification of materials in Annex C serve as interface to product standards*
- *Safety format for non-linear analysis procedures*
- *Design of membrane-, shell- and slab type members*
- *Durability design with performance-based approach for consideration of new types of cement and concrete (e.g. green concretes)*
- *Coverage of new methods of anchoring reinforcing steel (U-bar, headed bar, post-installed bar)*
- *Strength of confined concrete*

How ease of use has been enhanced

- *Collected all partial action and material factors in easy to read table form in Clause 4*
- *Kept only material properties needed for common design in Clause 5; properties for detailed design or less commonly used materials and requirements for products moved to Annex*
- *Removed 122 NDPs and added 51 new NDPs (new items)*
- *Reduced volume of text corresponding to current version of EN 1992-1-1, EN 1992-2 and EN 1992-3 by 35%*
- *Provided comprehensive background document on design provisions*

How ease of use has been enhanced

- *Shear and punching shear strength: comprehensive design model and formulae for detailed verification of new members without and with shear reinforcement; amendments for existing structures not complying with detailing rules of new construction; simplification of comprehensive model for quick check whether shear or punching needs detailed verification at all*
- *Anchorage and lap length: tabulated data for anchorage length of bars stressed to design yield strength as a function of concrete strength; detailed formula for verification of anchorage and lap length as a function of stress in reinforcement, concrete strength, cover, confinement, bends/hooks, etc.*

How ease of use has been enhanced

→ *Collected detailing rules for members in easy to read and compact table format*

	Description	Symbol	Requirement
1	Minimum longitudinal reinforcement, in those parts of the section where tension may occur	$A_{s,min}$	12.2(2), see also 12.2(3), 12.2(6)
2	Minimum shear and transverse torsional reinforcement, when required. Minimum torsion reinforcement should be provided to the full perimeter including features not counted part of the thin walled section.	$\rho_{w,min}$	12.2(4)
3	Minimum bottom reinforcement at inner supports taking account of unforeseen effects at supports		0,25 $A_{s,req\ span}$
4	Maximum longitudinal spacing of shear assemblies/stirrups[a]	$s_{max,l}$	0,75d (1 + cotα)
5	Maximum longitudinal spacing of bent-up bars[a]	$s_{max,bu}$	0,6d (1 + cotα)
6	Maximum transverse spacing of shear legs[a]	$s_{max,tr}$	0,75d ≤ 600 mm
7	Minimum ratio of shear reinforcement in the form of stirrups with respect to the required reinforcement ratio (taking account of unforeseen effect's e.g. compatibility torsion)	$\rho_{w,stir}$	$\geq 0{,}5\rho_{w,req}$
8	Minimum ratio of torsion reinforcement in the form of closed stirrups with respect to the required reinforcement ratio	$\rho_{w,stir}$	$\geq 0{,}2\rho_{w,req}$
9	Maximum spacing for torsion assemblies/stirrups (u defined in 8.3.2(2)).	$s_{max,stir}$	$u/8 \leq \min\{b; h\}$
10	Minimum area and spacing of longitudinal surface reinforcement in beams with downstand ≥ 600 mm to avoid coarse cracks in SLS.	$A_{s,web}$ $s_{max,l,surf}$	9.2.2(6) 300 mm
11	Minimum transverse reinforcement in flanges (those part of flanges where tension in the transverse direction may occur)	$A_{st,min}$	12.2(2) see 8.2.5, Figure 8.13

[a] These spacings are consistent with the shear model in 8.2.3. Where alternative models are used alternative spacings may be required.

Overview of the Evolution of EN1992-1-2: General – Structural fire design

17 December 2021

Agenda – Evolution of EN 1992-1-2: General – Structural fire design

- → Key changes to EN 1992-1-2
- → New content included in the scope of EN 1992-1-2
- → How ease of use has been enhanced

Key changes to EN 1992-1-2

- → *Harmonised structure / table of contents of EN 1992-1-2 with other fire parts*
- → *Amended and improved simplified design methods*
- → *Ensured consistency between tabulated design data, simplified and advanced design methods*

New content included in scope of EN 1992-1-2

- → *Properties of steel fibre reinforced concrete at high temperature*
- → *Properties of recycled aggregate concrete at high temperature*
- → *Specific rules for avoiding / controlling spalling*
- → *Simplified analytical formulae for determination of temperature profiles in members*

How ease of use has been enhanced

- → *Reduced number of alternative application rules*
- → *Clarified use and scope of tabulated data*
- → *Included simplified analytical formulae for determination of temperature profiles in members*
- → *Removed 14 NDPs and added 2 new NDP*
- → *Reduced volume of text corresponding to current version of EN 1992-1-2 by about 30%*
- → *Provided comprehensive background document on design provisions*