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SECOND-GENERATION EUROCODE 2: STRUCTURAL REORGANISATION, NEW DESIGN MODELS AND PRACTICAL IMPLICATIONS

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Abstract

The second generation of Eurocode 2 was published as EN 1992-1-1:2023 after systematic review and technical development under Mandate M/515. This paper provides a standards-based overview of the transition from EN 1992-1-1:2004, focusing on document structure, sustainability, durability, shear and punching, serviceability and reinforcement detailing. The revised document integrates rules for buildings, bridges and civil-engineering structures, permits later concrete-strength reference ages, introduces exposure resistance classes and uses more physically based resistance models. The benefits, additional information demands and implementation issues are discussed without reproducing detailed design formulae or project-specific calculations.

***Keywords**: Eurocode 2, concrete structures, second-generation Eurocodes, durability, shear resistance*

1. INTRODUCTION

The first generation of EN 1992 established a common European basis for plain, reinforced and prestressed concrete design. Two decades of application also exposed fragmentation between rules for buildings, bridges and containment structures, extensive empirical formulations, limited treatment of newer materials and an essentially prescriptive route to durability [1,3]. Meanwhile, research improved understanding of size effect, shear cracking, serviceability and in-situ material properties.

Mandate M/515 combined maintenance of the established rules with targeted development. The ambitions were easier use, fewer Nationally Determined Parameters, more consistent physical models, wider scope and improved support for sustainable construction [3,4]. Drafts commonly referred to as prEN or FprEN became the published EN 1992-1-1:2023 [2]; the limit-state philosophy remains, but the architecture and many verification routes changed.

This review identifies the principal changes and their practical meaning at a deliberately general level. Detailed formula-by-formula comparison, reliability calibration, deterioration modelling and project-specific examples are outside its scope and remain suitable topics for subsequent research.

2. DEVELOPMENT AND STRUCTURE OF EN 1992-1-1:2023

2.1. Scale and reorganisation

Figure 1 illustrates the structural change. EN 1992-1-1:2004 contained 12 main sections and 10 annexes. The second-generation Part 1-1 is organized into 15 sections and 19 annexes and incorporates substantial content formerly placed in the separate bridge and containment parts [2,5]. Consequently, the core design family is reduced from four parts to two, while Part 1-1 becomes a broader reference for buildings, bridges and other civil-engineering works.

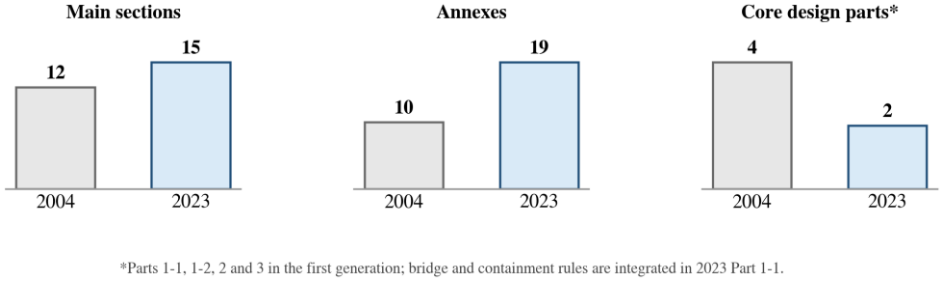


Figure 1. *Reorganisation of the core Eurocode 2 design documents (based on [1,2,5])*

2.2. Extended scope and practical orientation

The annex system accommodates topics that were absent or dispersed in the first generation: restrained early-age cracking, non-linear analysis, watertightness, assessment of existing structures, CFRP strengthening, steel-fibre-reinforced concrete, recycled aggregate concrete, stainless reinforcement and embedded FRP [3,5]. Bridge provisions are concentrated in a normative annex, and detailing rules are reorganized into compact member-oriented provisions.

The intention is to make common cases direct while retaining advanced routes for less usual situations. This hierarchy can reduce dependence on non-conflicting complementary information, but it also requires careful identification of normative versus informative annexes and all National Annex choices. Table 1 summarises the most visible changes and their likely design consequences.

Table 1. *Selected changes and practical implications of EN 1992-1-1:2023*

Aspect	EN 1992-1-1:2004	EN 1992-1-1:2023	Practical implication
Structure and scope	Separate parts for buildings, bridges and containment structures; 10 annexes in Part 1-1	Buildings, bridges and civil-engineering structures integrated; 19 annexes	Fewer core documents, but a much larger Part 1-1 and more cross-referencing.
Concrete strength	Reference strength normally at 28 days	Project-specified reference age may be selected from 28 to 91 days	Slow-strength-gain binders can be used more rationally when specified and controlled.

Aspect	EN 1992-1-1:2004	EN 1992-1-1:2023	Practical implication
Durability	Predominantly prescriptive cover and material-quality approach	Exposure resistance classes combine exposure, service life, cover and concrete performance	Moves towards performance-based durability and closer coordination with EN 206.
Shear and punching	Mainly empirical/semi-empirical resistance expressions	CSCT-based models explicitly reflect size, deformation and control-section effects	A more physical and consistent basis, with new variables and recalibration needs.
Crack control	Established spacing/width model with recognised scatter	Refined surface-crack model; simplified verification moved to an informative annex	Potentially better prediction, but the detailed route is more involved.
Anchorage and laps	Bond-based design length with several correction coefficients	Reorganised physical model including size and non-linear stress effects; new anchorage forms	Detailing is broadened and tied more clearly to model assumptions and robustness.
New materials/systems	Limited direct coverage of innovative reinforcement and strengthening	Annexes address CFRP strengthening, SFRC, recycled aggregate concrete, stainless steel and embedded FRP	Less dependence on separate guidance, subject to National Annex and product provisions.

3. SUSTAINABILITY, MATERIALS AND DURABILITY

3.1. Reference age and material scope

EN 1992-1-1:2023 permits the reference age for concrete compressive strength to be specified between 28 and 91 days [2,3]. The change does not automatically qualify a low-carbon concrete, but it prevents the 28-day convention from penalising mixtures with slower strength development. Concrete strength classes extend to fck = 100 MPa, reinforcement to fyk = 700 MPa and prestressing strand to fpk = 2060 MPa [5].

A brittleness factor is introduced in the design compressive strength to address the non-proportional translation of specimen strength into member resistance, particularly for higher-strength concrete [3,5]. This separates a physical member effect from the material partial factor and provides a common concept across bending, shear and punching calculations.

3.2. Exposure resistance classes

The principal conceptual change in durability is the exposure resistance class (ERC). Environmental exposure class, design service life, cover, execution and concrete resistance are treated as linked design variables rather than as a one-way prescriptive checklist. Figure 2 presents two equivalent decision routes: a chosen cover leads to a required ERC, or a selected ERC leads to the required cover [2,5,6].

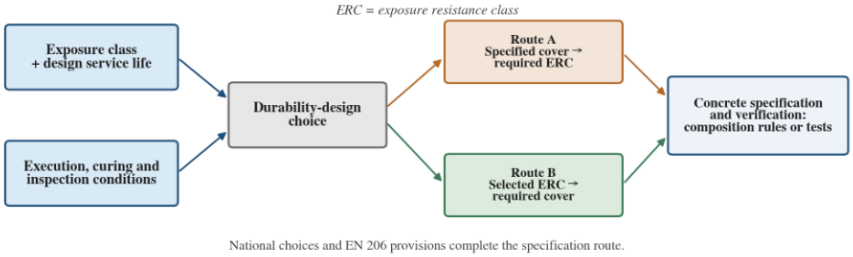


Figure 2. *Conceptual durability-design route using exposure resistance classes (author's synthesis based on [2,5,6])*

For established concretes, conformity may still rely on deemed-to-satisfy composition rules; for new or less familiar binders, performance tests can demonstrate the required resistance [5,6]. The approach creates a clearer path for innovation, but its effectiveness depends on coordination with EN 206, execution control and nationally selected parameters.

4. STRUCTURAL MODELS, SERVICEABILITY AND DETAILING

4.1. Shear and punching

A central technical revision concerns members without shear reinforcement. The 2004 expression did not represent size effect adequately, did not explicitly include shear slenderness and could be overly conservative under tensile axial force while producing unfavourable trends for slender beams [3]. The new formulation is derived from Critical Shear Crack Theory (CSCT) and is expressed as a closed-form design route. Figure 3 outlines the information flow without reproducing the normative equations.

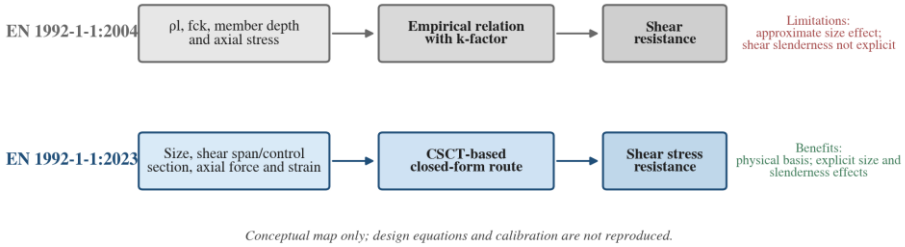


Figure 3. *Conceptual evolution of shear resistance without shear reinforcement (based on [3,5,7])*

The same mechanical family underpins punching provisions for slabs without shear reinforcement, while a compression-field approach remains for members with shear reinforcement. Action effects are presented consistently as stresses and control sections are more explicitly defined [3,5].

4.2. Serviceability and reinforcement detailing

The refined crack-width formulation incorporates cover, bond conditions, stress distribution and the location at which surface crack width is verified. Its calibration reduces scatter, although the detailed procedure is more demanding; simplified control is retained in an informative annex [3,5]. Deflection rules include a simplified model based on linear-elastic analysis and a refined interpolation route.

Anchorage and lap provisions are restructured around updated physical models calibrated against expanded test databases. Size effect and the non-linear influence of reinforcement stress are included, and explicit routes are added for headed bars, U-bar loops and post-installed reinforcement [3,5]. These provisions link detailing, robustness and the validity of resistance models more transparently than before.

5. IMPLEMENTATION AND CONCLUSION

EN 1992-1-1:2023 is evolutionary in philosophy but extensive in content. It addresses fragmented scope, prescriptive durability, empirical limitations of shear and punching models, scatter in crack prediction and gaps in the treatment of innovative materials. Its strength is a more consistent link between physical behaviour, material evidence, execution and verification.

The transition is not a clause-number substitution. National Annexes, EN 206 coordination, software updates, training and transparent records of the selected approximation level are necessary. The broader framework may improve sustainability and reduce unnecessary conservatism, but quantitative comparisons of safety, material consumption, time-dependent reliability and existing-structure assessment require dedicated studies and are intentionally left outside this overview.

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REFERENCES

[1] CEN, EN 1992-1-1:2004, Eurocode 2: Design of concrete structures – Part 1-1: General rules and rules for buildings, Brussels, 2004.
[2] CEN, EN 1992-1-1:2023, Eurocode 2: Design of concrete structures – Part 1-1: General rules and rules for buildings, bridges and civil engineering structures, Brussels, 2023.
[3] A. Pérez Caldentey, EN 1992 ‘Eurocode 2: Design of concrete structures’, The second-generation Eurocodes: key changes and benefits through design examples, online workshop, 3–5 June 2025.
[4] European Commission, Joint Research Centre, Second generation of the Eurocodes: what is new?, Eurocodes: Building the Future, online (accessed 12 August 2026).

[5] J.M. Arrieta, J. Rodríguez, H.R. Ganz, The Origins and Some Highlights on the New Proposal for Eurocode 2, Hormigón y Acero 74(299–300) (2023) 7–18, doi:10.33586/hya.2023.3115.
[6] C. Andrade, D. Izquierdo, Durability and cover depth provisions in next Eurocode 2: background modelling and calculations, Hormigón y Acero 74(299–300) (2023), doi:10.33586/hya.2023.3102.
[7] P. Miguel, M.A. Fernández, J. Hegger, M. Schmidt, Shear resistance of members without shear reinforcement in presence of compressive axial forces in the next Eurocode 2, Hormigón y Acero 74(299–300) (2023), doi:10.33586/hya.2023.3112.