The 57th International October Conference on Mining and Metallurgy
05 - 07 October 2026, Bor Lake, Serbia
https://ioc.irmbor.co.rs

DOI: 10.5937/IOC26459Z Original Scientific Paper-Civil Engineering

SECOND-GENERATION EUROCODE 4: CHANGES INEN 1994-1-1:2026 AND DESIGN IMPLICATIONS

Miloš Živanović[1a], Ivan Stojičić[1b], Nikola Miljković[1c], Nikola Jovanović[1d], Miloš Marković[1e], Jelena Đorđević[1f]

[1]Mining and Metallurgy Institute Bor, Alberta Ajnštajna 1, 19210 Bor, Serbia

[1a] milos.zivanovic@irmbor.co.rs, https://orcid.org/0009-0006-3331-4294
[1b] ivan.stojicic@irmbor.co.rs, https://orcid.org/0009-0005-0571-1172
[1c] nikola.miljkovic@irmbor.co.rs, https://orcid.org/0009-0009-2372-3942
[1d] nikola.jovanovic@irmbor.co.rs, https://orcid.org/0009-0008-0982-2576
[1e] milos.markovic@irmbor.co.rs, https://orcid.org/0009-0007-8392-0636
[1f] jelena.djordjevic@irmbor.co.rs, https://orcid.org/0000-0001-5406-0074

Abstract

The second generation of Eurocode 4 was published in 2026 after systematic review and technical development under Mandate M/515. This paper provides a standards-based comparison of EN 1994-1-1:2004 and EN 1994-1-1:2026, focusing on document structure, material scope, composite-beam design, shear connection, composite slabs, and construction systems newly covered by annexes. The revised document introduces strain-limited design, connector ductility categories, refined partial shear-connection rules, harmonized test procedures, and provisions for web openings, shallow floors, modern profiled sheeting, and precast slabs. Practical benefits, additional verification demands, and transition issues are discussed.

***Keywords**: Eurocode 4, composite structures, second-generation Eurocodes, shear connection, design standards*

1. INTRODUCTION

Eurocode 4 couples structural steel, concrete, reinforcement and shear connection and therefore relies on consistent rules in EN 1992 and EN 1993. The first-generation EN 1994-1-1 provided a common European basis for composite building design for about two decades [1]. Its systematic review exposed uneven alignment with adjacent Eurocodes, rules calibrated for a narrow range of members and products, and limited coverage of construction forms already common in practice.

Mandate M/515 combined maintenance from user comments with targeted development. Its objectives were greater harmonisation, easier use, less reliance on national supplementary guidance and inclusion of new systems [3,4]. EN 1994-1-1:2026 [2] retains the established limit-state framework but substantially reorganises and extends its application rules.

This standards-based review identifies the principal changes and their practical meaning. Experimental validation, statistical calibration and optimisation of individual resistance models are outside its scope.

2. DEVELOPMENT AND STRUCTURE OF EN 1994-1-1:2026

2.1. Scale and reorganisation

Figure 1 illustrates the scale of revision. The 2004 document had nine sections, three informative annexes, 19 Nationally Determined Parameters (NDPs) and 118 pages. The 2026 edition has 11 sections, five normative and five informative annexes, 18 NDPs and 227 pages [3]. The increase partly reflects general provisions transferred from EN 1994-2 and therefore represents centralisation and wider scope, not only additional calculation complexity.

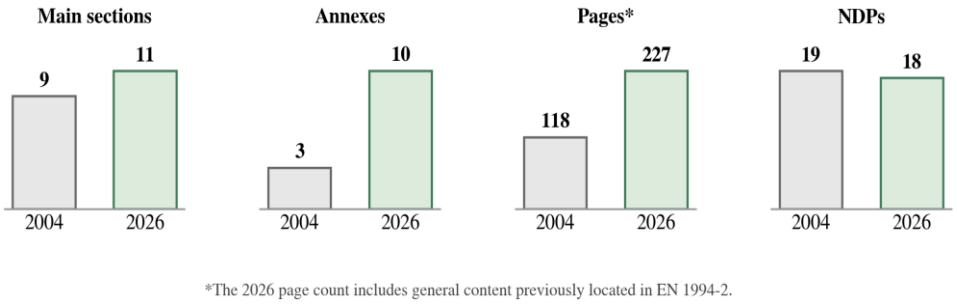


Figure 1. *Structural expansion of EN 1994-1-1 (data from [3])*

2.2. Technical scope and annex architecture

The second-generation Eurocode 4 family comprises three core EN parts and Technical Specifications for steel-concrete structures, composite dowels and high-performance composite columns [3]. In Part 1-1, ten annexes separate mandatory procedures from complementary options (Figure 2). Normative annexes cover standard tests, web openings, stud-induced splitting, studs in tension and shallow floors; informative annexes address joint stiffness, shrinkage, stiff slabs above openings, open-trough sheeting and precast slabs [2,5].

The structure reduces reliance on non-conflicting complementary information for common systems. However, a National Annex can modify the use of an informative annex, so designers must check both the European text and national choices. Table 1 condenses the main differences and consequences.

Table 1. *Selected changes and practical implications of EN 1994-1-1:2026*

Aspect	EN 1994-1-1:2004	EN 1994-1-1:2026	Practical implication
Structure	9 sections; 3 informative annexes	11 sections; 5 normative and 5 informative annexes	More topics are codified; navigation and cross-referencing become more important.
Materials and flexure	Plastic design within familiar material ranges; limitation when the plastic neutral axis is deep	Explicit strain-limited route and clearer material-method compatibility	Higher strengths can be used more rationally when deformation is checked.
Connector ductility	Binary distinction; ductile behaviour linked mainly to $\delta uk \geq 6$ mm	Categories D1, D2 and D3 use elastic slip and slip-capacity criteria	The redistribution capacity assumed by the beam model is stated more transparently.
Partial shear connection	Simplified limits derived for a restricted range of beams and assumptions	Rules reflect utilisation, construction sequence and connector category; slip may be verified	A broader but more input-dependent design route is available.
Profiled sheeting	Reduction factors traceable to decking common in the 1980s	Retained equations have a narrower scope; Annex G covers other open-trough cases	Modern profiles receive a more defensible design pathway.
Testing	Standard push tests in an informative annex	Normative Annex B standardises test set-up and evaluation	Product evidence should be more comparable across laboratories.
Additional systems	No unified rules for several common floor and beam forms	Annexes cover web openings, shallow floors and precast slabs	Less reliance on non-conflicting complementary information and national guidance.

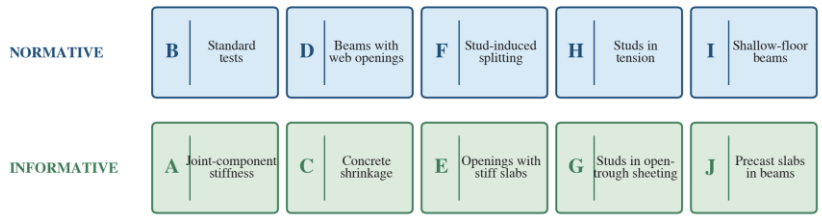


Figure 2. *Annex architecture of EN 1994-1-1:2026 (author's synthesis based on [2,3,5])*

3. KEY TECHNICAL CHANGES AND PRACTICAL IMPLICATIONS

3.1. Materials and cross-section resistance

Harmonisation with EN 1992-1-1 and EN 1993-1-1 now links material range to design method. Plastic resistance and plastic global analysis are limited to C20/25–C70/85, LC20/22–LC60/66, reinforcement up to B500 in relevant members and structural steel with nominal yield strength up to 460 MPa [3]. Broader ranges permitted by EN 1992 and EN 1993 remain available for elastic or strain-limited methods.

A notable improvement is strain-limited design when the plastic neutral axis lies deeper than 15% of the member depth. The former restriction safeguarded against insufficient strain development in high-strength steel; the new route checks deformation compatibility more directly. It may avoid a coarse reduction in bending resistance, but requires explicit analysis and material assumptions [3,5].

3.2. Shear connection and partial interaction

The first generation largely associated a ductile connector with characteristic slip capacity δuk of at least 6 mm. EN 1994-1-1:2026 introduces categories D1, D2 and D3 (Figure 3). D2 covers 6 mm ≤ δuk < 10 mm and D3 covers δuk ≥ 10 mm; both also require characteristic elastic slip δek ≤ 2.5 mm. D1 contains connectors that do not fulfil the D2 or D3 conditions. The change separates stiffness from ultimate deformation and clarifies whether connector behaviour supports the redistribution assumed by the beam model [2,3].

Partial shear-connection limits are also revised. Earlier rules were derived from restricted beam configurations and implicit assumptions on utilization, construction sequence and deformation. The new approach accounts for these variables and permits direct comparison of slip demand and capacity. Normative Annex B standardises push-test set-up and evaluation, improving product classification [3,6].

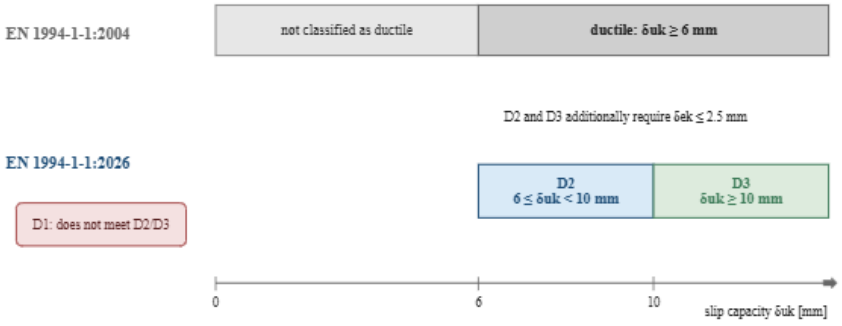


Figure 3. *Conceptual comparison of shear-connector ductility definitions (based on [2,3,5])*

3.3. Profiled sheeting, slabs, columns and new systems

A documented shortcoming concerned stud reduction factors calibrated mainly against decking used in the 1980s, which did not consistently represent modern trapezoidal profiles [3,7]. EN 1994-1-1:2026 retains these equations for a narrower scope, while informative Annex G provides a mechanics-based route for other open-trough cases [8]. National acceptance and suitable product information remain essential.

For composite slabs, a specific vertical-shear method is introduced and the partial-connection approach has a wider role; the m-k route is no longer supported in the main Eurocode. The composite-column general method is clarified. Rules for web openings coordinate with EN 1993-1-13, while annexes bring shallow floors and precast slabs into

a harmonised framework. Technical Specifications address composite dowels and high-performance composite columns [3,5,6].

Implementation involves more than replacing clause numbers. Software must expose method and National Annex choices, product documentation must support connector classification, and engineers need training in the new decision routes. Fewer NDPs signal harmonisation, but the larger set of provisions increases the importance of transparent design records.

4. CONCLUSION

EN 1994-1-1:2026 is an evolutionary revision. It preserves the limit-state basis while correcting narrow decking-rule calibration, binary connector ductility, restrictive partial-interaction limits, unclear test comparability and missing coverage of several systems. Strain-limited design, ductility categories, normative testing and focused annexes better link material behaviour, product evidence and verification.

The benefit is a broader, better-supported framework; the trade-off is more method selection and cross-referencing. Transition depends on National Annexes, updated software and worked examples. Quantitative assessment of model resistance, reliability and parameter sensitivity remains a separate research task and is intentionally outside this review.

ACKNOWLEDGEMENTS

This work was financially supported by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia, as well as the Contract on realization and financing of the scientific research work of the Mining and Metallurgy Institute Bor in 2026, contract number: 451-03-33/2026-03/200052.

REFERENCES

[1] CEN, EN 1994-1-1:2004, Eurocode 4: Design of composite steel and concrete structures – Part 1-1: General rules and rules for buildings, Brussels, 2004.

[2] CEN, EN 1994-1-1:2026, Eurocode 4: Design of composite steel and concrete structures – Part 1-1: General rules and rules for buildings, Brussels, 2026.

[3] European Commission, Joint Research Centre, The second-generation Eurocodes: key changes and benefits through design examples, JRC144386, Publications Office of the European Union, Luxembourg, 2025, doi:10.2760/3056713.

[4] European Commission, Joint Research Centre, Second generation of the Eurocodes: what is new?, Eurocodes: Building the Future, online (accessed 12 August 2026).

[5] R.P. Johnson, S.J. Hicks, Designers' Guide to EN 1994-1-1:2026, 3rd ed., ICE Publishing/Emerald, Leeds, 2025, doi:10.1108/978-1-83662-920-7.

[6] S.J. Hicks, M. Banfi, W. Kurz, F. Hanus, EN 1994 'Eurocode 4: Design of composite steel and concrete structures', JRC Second-generation Eurocodes Workshop, online, 3–5 June 2025.

[7] S.J. Hicks, A.L. Smith, Stud shear connectors in composite beams that support slabs with profiled steel sheeting, Structural Engineering International, 24(2) (2014) 246–253, doi:10.2749/101686614X13830790993122.

[8] V. Vigneri, S.J. Hicks, A. Taras, C. Odenbreit, Design models for predicting the resistance of headed studs in profiled sheeting, Steel and Composite Structures, 42(5) (2022) 633–647, doi:10.12989/scs.2022.42.5.633.