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# EUROPEAN CODE DEVELOPMENTS

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**Abstract** *The second generation of Eurocode 4 has been developed through several project teams that report to CEN TC250 Subcommittee 4 (CEN/TC250/SC4) 'Design of composite steel and concrete structures', which is chaired by Dr Graham Couchman. Given that work on the revised version of Eurocode 4 is nearing completion, this paper presents a selection of the changes that will be included, together with some of the technical challenges that needed to be overcome. Finally, further enhancements that might be considered worthy for inclusion within future editions of this standard are presented.*

## 1 INTRODUCTION

Work on the Eurocodes commenced in 1975 when the European Commission decided on 'an action programme in the field of construction' based on article 95 of the Treaty of Rome, which was aimed at 'the elimination of technical obstacles to trade and harmonisation of technical specifications'. The Commission of European Communities (CEC) published eight European codes, or 'Eurocodes', for the design and execution of buildings and civil engineering structures. From these eight documents, the code for composite steel and concrete structures was published as Eurocode No. 4 in 1985 [1], which was based on the: ECCS Model Code [2]; international studies; together with Eurocode No. 1 (Common unified rules for different types of construction and material), No. 2 (Common unified rules for concrete structures), and No. 3 Common unified rules for steel structures). The European Commission transferred the preparation and the publication of the Eurocodes to the European Committee for Standardization (CEN) in 1989 through a series of mandates, in order to provide them with the status of a European Standard (EN). In the same year, the Construction Products Directive (CPD), was issued which introduced the concept of CE Marking for all construction products permanently incorporated into construction works [3].

Under the direction of Technical Committee CEN/TC250, the Eurocodes were published by CEN in 1992 as European pre-standards (ENV). Due to difficulties in harmonizing all aspects, the ENV Eurocodes included "boxed values" which permitted Member States to choose values for use within their territory through the publication of National Application Documents (NADs). Subcommittee 4 (CEN/TC250/SC4) was responsible for the ENV Eurocode 4, which was published in three Parts *viz*. ENV 1994-1-1 [4], ENV 1994-1-2 [5], and ENV 1994-2 [6]. To avoid repetition of information, and reduce potential ambiguity, values and properties are only given in one Eurocode. Because of this, ENV Eurocode 4 provided extensive cross-referencing to the ENV Eurocode 2 and Eurocode 3.

The EU mandate to CEN required that the content of the final ENs should be limited to the ENV versions modified in response to national comments; this became challenging in the development of the EN

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Eurocode 4 due to changes in Eurocode 2 and Eurocode 3 that had been made to address these comments which, *inter alia*, included increasing the maximum yield strength of structural steel from 355 MPa to 460 MPa. Moreover, from national comments relating to the ease of use of ENV 1994-2 for bridge designers, the Eurocode 4 project team were given permission to repeat the 'general' Part 1-1 rules within Part 2 [7]. For the design of composite steel and concrete structures, the EN Eurocode 4 was published in the following three parts:

- EN 1994-1-1, Part 1-1: General rules and rules for buildings [8].
- EN 1994-1-2, Part 1-2: General rules – Structural fire design [9].
- EN 1994-2, Part 2: General rules and rules for bridges [10].

To enable the EN Eurocodes to be used within a particular territory, National Standards Bodies (NSBs) have published National Annexes (NAs) which contain: Nationally Determined Parameters (NDPs) (values of partial safety factors and classes applicable to that country, country specific data, and values where only a symbol is given in the EN); decisions on the status of informative annexes; and references to non-contradictory complementary information (NCCI). After a coexistence period, the EN Eurocodes replaced the former national standards in 2010 in countries that are members of CEN. The Construction Products Regulation (CPR) [11] replaced the CPD in 2011, which resulted in CE Marking becoming mandatory from 1st July 2013. The above provides a brief overview of the history of Eurocode 4 up to the EN version; a much more comprehensive review of the development from 1970 to 2010 is presented by Johnson [7]. More recently, the Eurocodes were adopted as national standards in Singapore [12], and it is anticipated that other countries may soon be implementing them, such as Hong Kong, Macau, Malaysia, Vietnam, Sri Lanka and Indonesia [13].

Following the publication of Mandate M/515 by the European Commission [14], work on the second generation of the Eurocodes commenced in 2015. Given that the work programme is nearing completion, the revised version of Eurocode 4 will soon become available. This paper presents a selection of the changes that will be included within the second generation of Eurocode 4, Part 1-1 (hereafter referred to as prEN 1994-1-1) [15], as well as highlighting future areas of improvement which may be considered worthy for future revisions.

## 2 SECOND GENERATION OF EUROCODE 4

A response to Mandate M/515 was prepared by CEN/TC250 [16], which set-out an ambitious and detailed work programme where discrete tasks are undertaken under the direction of one of TC250's existing subcommittees, working groups or horizontal groups. The mandate, *inter alia*, requires: extension of the Eurocodes in terms of new materials, products and construction methods; reduction in the number of NDPs (thereby leading to an alignment of safety levels); enhancing 'ease of use' for users; adoption of relevant ISO standards to supplement the Eurocodes (which implicitly recognizes the CEN-ISO Vienna agreement); and incorporation of recent results from scientific and technical associations, together with new research results. The revision can be broadly divided into two activities:

- General revisions and maintenance of the Eurocodes following the receipt of comments from the industry through a "systematic review" undertaken by NSBs.
- Technical enhancements of the Eurocodes within the scope of Mandate M/515.

For cases where there was insufficient agreement to develop a new EN, European Technical Specifications (CEN/TS) are also under development, which will complement and enlarge the suite of Eurocodes. A graphical representation of the structure for the second generation of the Eurocodes is presented in Figure 1.

The CEN/TC 250 work programme has been split into four overlapping phases, as follows:

- Phase 1: 25 Tasks (125 technical experts), 2015-2018
- Phase 2: 22 Tasks (88 technical experts), 2017-2020
- Phase 3 & 4: 26 Tasks (104 technical experts) 2018-2022

Each Task is the responsibility of a Project Team, which consists of a maximum of five or six members. The project team members were selected through a competitive tender and are contracted to the Royal

Netherlands Standardization Institute (NEN), which manages the work programme on behalf of CEN. For Eurocode 4, CEN/TC250/SC4 identified eight tasks within the work programme (see Table 1). At the time of writing, work is nearing completion with the last three project teams shown in Table 1 concluding in February 2022.

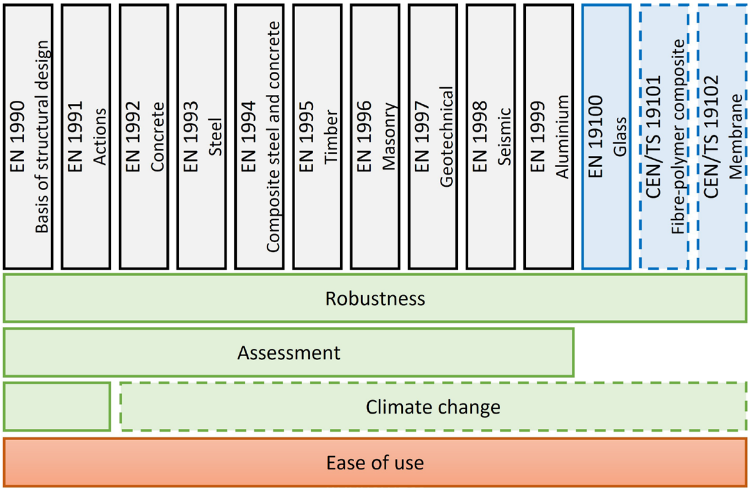


Figure 1. Structure of the second generation of the Eurocodes

Table 1: Tasks relating to Eurocode 4 within the CEN/TC250 work programme[16]

| Project Team | Phase | Tasks |
|---|---|---|
| SC4.T1 | 1 | Development of revisions to EN 1994-1-1, EN 1994-1-2 and EN 1994-2 in response to feedback from industry during the systematic review, including needs for harmonization with EN 1992 and EN 1993. |
| SC4.T2 | 1 | Development of a new annex in EN 1994-1-1 for the design of composite beams with large web openings. |
| SC4.T3 | 1 | Development of revised rules in EN 1994-1-1 for shear connection in the presence of modern forms of profiled sheeting. |
| SC4.T4 | 1 | Development of new rules in EN 1994-1-2 for composite columns (concrete filled tubes) in fire. |
| SC4.T5 | 2 | Development of new rules for EN 1994-1-1 and EN 1994-1-2 covering shallow floor construction, and other flooring types using precast concrete elements. |
| SC4.T6 | 3-4 | Development of revised EN 1994-1-1 |
| SC4.T7 | 3-4 | Development of revised EN 1994-1-2 |
| SC4.T8 | 3-4 | Development of revised EN 1994-2 |

For the design of composite steel and concrete structures, it is anticipated that the second generation of Eurocode 4 will result in the following documents:

1. EN 1994-1-1, Part 1-1: General rules and rules for buildings.
2. EN 1994-1-2, Part 1-2: General – Structural fire design.
3. EN 1994-2, Part 2: Additional rules for bridges.
4. CEN/TS 1994-1-101 Design of composite steel and concrete structures — Design of double and single skin steel concrete composite (SC) structures.
5. CEN/TS 1994-1-102 Design rules for the use of Composite Dowels.
6. CEN/TS 1994-1-103 Design rules for composite columns comprising high performance materials.

As well as the new technical specifications, to reduce repetition and avoid any ambiguity, it has been decided to remove general rules from EN 1994-2 (as reflected in the change in title above) and provide cross-references to EN 1994-1-1; this change is consistent with Eurocode 3 and effectively results in EN 1994-2 becoming an "application part" [17]. Moreover, one of the important revisions to EN 1994-1-2 that was the responsibility of project team SC4.T4 are new rules for concrete filled tubes (CFTs) in fire conditions [18], which have also been implemented within the Australasian design standard AS/NZS 2327 [19]. Although not exhaustive, the following sections present a selection of the changes that will be included within Part 1-1 of Eurocode 4 (prEN 1994-1-1).

## 2.1 Materials

Similar to the earlier project teams that developed the first generation of Eurocode 4, one of the challenges faced by SC4.T6 was harmonisation with the rules given in the second generation of Eurocode 2 (prEN 1992-1-1) and Eurocode 3 (prEN 1993-1-1), which were also under development. For prEN 1992-1-1, the range of concrete strength classes will be between C12/15 and C100/115 for normal concrete, together with LC12/13 and LC80/88 for lightweight concrete; also, reinforcing steel strength classes between B400 and B700 are permitted. For prEN 1993-1-1, structural steel grades between S235 and S700 are supported. However, given the lack of experience of using higher strength materials in composite steel and concrete structures in Europe, the rules in Eurocode 4 will be limited to the following:

- Concrete strength classes between C20/25 and C70/85, together with LC20/22 and LC60/66 with a density not less than 1750 kg/m$^3$.
- When the design method is based on plastic global analysis and plastic resistance:
  - Reinforcing steel strength classes not greater than B500 for continuous composite beams, columns, and slabs.
  - Structural steel with a nominal yield strength not more than $f_y$ = 460 MPa.
- When the design method is based on elastic or strain-limited design principles (see Section 2.6), the full range of reinforcing steel strength classes and structural steel grades permitted in prEN 1992-1-1 and prEN 1993-1-1, respectively may be applied.

Note that the concrete strength class of C70/85 has increased from C60/75 due to push test evidence suggesting that that is no adverse effects on the ductility of headed studs (see Section 2.3). Notwithstanding this, it is anticipated that a larger nominal yield strength for structural steel and higher concrete strength classes will be supported within the forthcoming CEN/TS on composite columns, which is consistent with other international standards and design guides where $f_y \leq 690$ MPa and $f_{ck} \leq 100$ MPa are permitted (see Section 2.10).

## 2.2 Composite beams with web-openings

Over the last 20 years, many long-span composite systems have been developed which permit mechanical services to be integrated within the structural depth of the floor. A common method of achieving this service integration is by means of openings cut within the webs of composite beams using I- or H-sections. The two main configuration of openings that are used are:

- isolated large openings at positions where the interaction between the openings is minimised; and
- regular openings, to form what are sometimes known as 'cellular beams'.

Whilst a draft amendment to the ENV version of Eurocode 3 was prepared in 1998 [20], which covered non-composite beams with web-openings, the committee draft was never published. Improvements to existing industry design guidance on composite beams with web-openings was developed through two major European research programmes [21],[22]. In the UK, this led to a design guide [23] that can be used alongside Eurocode 3 and 4.

From work undertaken by project team SC4.T2 (see Table 1), prEN 1994-1-1 will include a new Annex, which complements the new EN 1993-1-13 [17], and supports the design of composite beams with web-openings in sagging moment regions. For cases where the flexural stiffness of the concrete slab above the hole is significant, supplementary design rules [24] are given in a separate Annex which considers tension in the shear connectors and shear in the concrete.

### 2.3 Headed stud shear connectors embedded in solid concrete slabs and encasements

Internationally, higher strength concrete and a wider range of stud diameters are frequently being supported by composite design standards [19],[25]. Due to a greater body of push test data being available than when the existing Eurocode 4 was developed, several studies have investigated the design resistance of headed stud shear connectors to extend the scope of the current rules, as follows:

- From conducting an EN 1990 reliability analyses based on 101 push tests, Hanswille and Porsch [26] showed that some small modifications should be made the existing Eurocode 4 design model to justify the use of the target value of $\gamma_V = 1.25$ for the existing concrete strength classes of between C20/25 and C60/75, stud diameters of $16 \text{ mm} \leq d \leq 25 \text{ mm}$, and a specified ultimate tensile strength of the stud material of $460 \leq f_u \leq 620$ MPa.
- The database by Hanswille and Porsche was expanded to 242 tests by Hicks [27], who investigated what changes would need to be made to several design models to support the use of higher concrete strengths and larger stud diameters. From analyses according to EN 1990, it was found that by making small modifications to the Eurocode 4 design model, it could be safely extended to include concrete between C12/15 and C90/105, $12.7 \text{ mm} \leq d \leq 31.75 \text{ mm}$, and $400 \leq f_u \leq 500$ MPa (in addition, an enhancement to the Eurocode 4 model according to Döinghaus [28] for classes greater than C50/60 was also proposed). It was also recommended that the design model should be limited to a stud height to diameter ratio of $h_{sc}/d \geq 4$.
- Konrad *et al.* [29] developed a completely new design model. From reliability analyses considering 140 push tests, this design model was validated for concrete between C20/25 and C100/115, $16 \text{ mm} \leq d \leq 25 \text{ mm}$, and a characteristic tensile strength of the stud material $f_{uk} \leq 740$ MPa. It was also recommended that $h_{sc}/d \geq 4$.

The design resistances predicted by Eurocode 4 compared with the above design models are presented graphically in Figure 2.

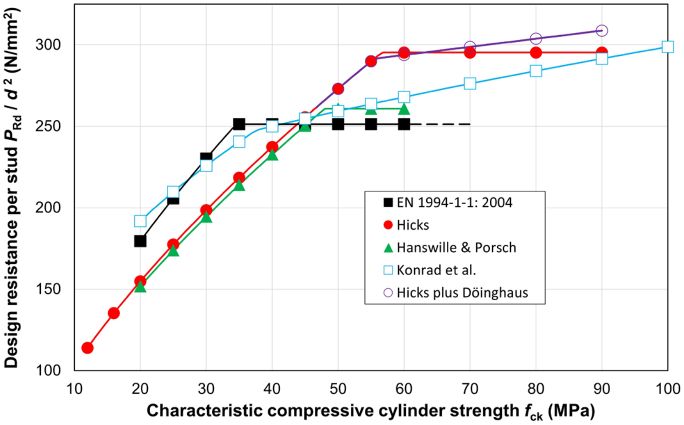


Figure 2. Design resistance of headed studs versus characteristic compressive cylinder strength of concrete with $f_u$ = 450 MPa and $h_{sc}/d \geq 4$ for Eurocode 4 compared with other proposed design models (extension for prEN 1994-1-1 shown dotted).

Due to concerns that the ductility of headed studs may reduce in more modern concretes than those included within the push test databases discussed above [30], coupled with the fact that increasing the design resistance of headed studs might have adverse implications when fatigue is considered, the current rules will be maintained within prEN 1994-1-1. However, the concrete compressive strength will be increased to strength class C70/85 (shown by the dotted line in Figure 2), and the rules limited to $h_{sc}/d \geq 4$. The latter limit is consistent with the requirements in the AISC Specification [31].

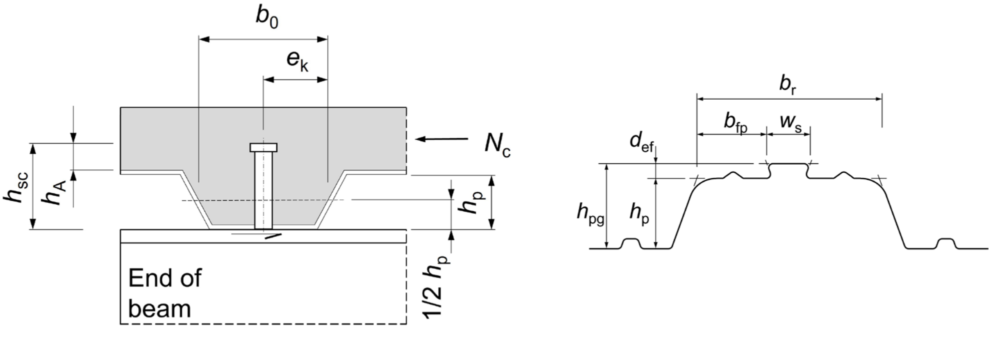
## 2.4 Headed studs used with profiled steel sheeting in buildings

For studs welded within trapezoidal sheeting with the ribs transverse to the supporting beam the current Eurocode 4 provides equations to determine a reduction factor $k_t$, which is applied to the design resistance of a stud embedded in a solid concrete slab (see Section 2.3). The existing reduction factor equations are based on push test data from specimens that used sheeting types which were common in the 1980s. However, more recent research [32],[33] has shown that the reduction factor equations do not perform well for modern trapezoidal profiled steel sheeting. To remedy this situation, two new design models have been proposed for incorporation within Eurocode 4 *viz.*: new reduction factor equations by Konrad *et al.* [29], which need to be used with a new design model for headed studs embedded in solid concrete slabs (see Section 2.3); and a mechanical cantilever model that considers failure of a concrete failure cone in combination with plastic hinges developing within the shank of the stud, which is based on the work by Odenbreit and Nellinger [34] and extended by Vigneri *et al.* [35],[36].

From considering the advantages and disadvantages of the proposed models, it was felt that neither was able to completely replace the existing design rules in Eurocode 4 because they: reduced the current scope; required changes elsewhere (e.g. fatigue); or resulted in different design resistances for long established products that are known to perform well. On this basis, it was decided to retain the existing Eurocode 4 reduction factor equations, but reduce their scope for sheeting with transversely orientated ribs to:

- Trapezoidal sheets with an embedment depth $h_A \geq 2.7d$ and $e_k > 60$mm, where $h_A = (h_{sc}-h_p)$ (see Figure 3(a)).
- Re-entrant sheets with $h_A \geq 2d$.
- Reinforcement placed underneath the head of the stud.
- For trapezoidal sheets with a top re-entrant stiffener, $d_{ef} \leq 15$ mm and $b_{fp} \geq 25$ mm (see Figure 3(b)).

For cases when the above limits are not satisfied, it is proposed that the design resistances may be evaluated through the design model proposed by Vigneri *et al.* [35],[36], which are presented within a new Annex to prEN 1994-1-1.



(a) (b)

Figure 3. (a) Headed stud welded centrally within transversely orientated rib of trapezoidal profiled steel sheeting (b) cross-section of trapezoidal sheeting with top re-entrant stiffener [15].

## 2.5 Minimum degree of shear connection in beams for buildings

The existing Eurocode 4 rules for partial shear connection are based on two independent studies [37],[38]. These studies assumed that, in solid concrete slabs and composite slabs using profiled steel sheets prevalent in the 1980s, the characteristic slip capacity of 19 mm diameter studs was approximately $\delta_{uk}$ =

6 mm. The required slip was determined from numerical analyses of composite beams using various spans, cross-sections, and degrees of shear connection $\eta$. The rules for partial shear connection in Eurocode 4 were limited to situations where the required slip did not exceed 6 mm. Studs were deemed to be "ductile" in those situations.

From full-scale composite beam and companion push tests with trapezoidal sheeting and transversely orientated ribs, it has been found that a characteristic slip capacity of $\delta_{uk}$ = 10 mm can be achieved [32], [33]. Moreover, in practical design of composite beams in buildings, the utilization of the plastic bending resistance $\rho_m$ (= $M_{Ed}$ / [$0.95M_{Rd}(\eta)$]) can be low because the design is often limited by serviceability considerations. Finally, the earlier numerical analyses that formed the basis for the existing Eurocode 4 rules conservatively assumed propped construction, which is unusual in current practice. From a major European research programme [33], numerical analyses have been undertaken to investigate the sensitivity of these variables on the required slip. In the UK, this led to a design guide that can be used alongside Eurocode 4 [39]. From project team SC4.T3, the following changes are proposed within prEN 1994-1-1:

- Two ductility categories for ductile shear connectors are introduced: D2 for $\delta_{uk}$ = 6 mm; and D3 for $\delta_{uk}$ = 10 mm.
- Utilization of the plastic bending resistance of between $0.8 \le \rho_m \le 1.0$.
- Consideration of whether propped or unpropped construction is used which, for the latter, is related to the utilization of the bending resistance of the steel section from the self-weight loads before composite action $M_{a,Ed}$ cf. bending resistance of the composite beam with full shear connection ($\rho_{up} = M_{a,Ed} / M_{pl,Rd}$).

The proposed minimum degree of shear connection rules for composite beams in bending are presented graphically in Figure 4.

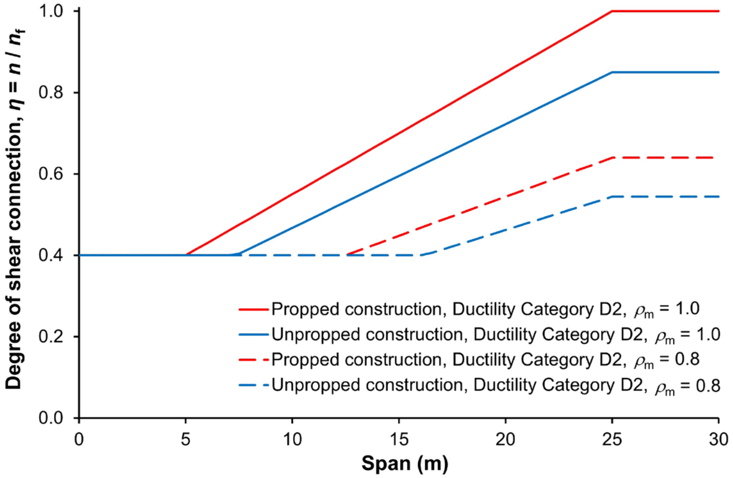


Figure 4. Minimum degree of shear connection versus span for S355 symmetric steel sections, Ductility Category D2 shear connectors and plastic bending resistance utilization of $\rho_m$ = 1.0 or $\rho_m$ = 1.0 (with $\rho_{up}$ = 0.15 for unpropped construction).

## 2.6 Strain limited design of composite beams in bending

For composite beams where the plastic neutral axis is deep within the cross-section (such as may occur in slim floor beams, or for beams when steel grades S420 or S460 are used), the plastic bending resistance can overestimate the actual resistance. In these circumstances, the bending resistance should be evaluated from non-linear theory using the stress-strain relationships of the concrete, structural steel and reinforcement. Given that such a calculation is often impractical in normal design, Schäfer *et al.* [40]

developed a simplified method for evaluating the non-linear bending resistance which will be included in prEN 1994-1-1 with the following scope:

(i) concrete strength class between C20/25 and C50/60;
(ii) ratio of the overall depth of the concrete slab ($h_c + h_{pg}$) to the depth of the steel section $h_a$ is between $0.15 \leq (h_c + h_{pg})/h_a \leq 0.7$, where $h_c$ is the thickness of concrete flange above the ribs of the sheeting;
(iii) the depth of the profiled steel sheeting $h_{pg} \leq 135$ mm;
(iv) the effective width of the concrete flange $b_{eff} \geq 1000$ mm; and
(v) the cross-sectional area of the top flange $A_{ft}$ in relation to the bottom flange area $A_{fb}$ satisfies $A_{ft}/A_{fb} \leq 1.0$.

When conditions (i) to (v) are satisfied, the non-linear bending resistance may be taken to be:

$$M_{Rd} = \beta M_{pl,Rd} \tag{1}$$

where $\beta$ is a reduction factor (which is related to the steel grade and the depth of the plastic neutral axis in relation to the overall depth of the beam, expressed by the ratio $z_{pl}/h$) and $M_{pl,Rd}$ is the design value of the plastic bending resistance of the composite cross-section with full shear connection.

### 2.7 Slim floor beams in buildings

Shallow floor, or slim-floor construction, has become popular throughout Europe as it provides a shallow structural zone, reduced number of beams, and flexibility in the layout of mechanical services. The key feature of slim-floor construction is the steel beams, which are integrated within the floor depth and possess a wide bottom flange to support the floor slabs. The floor slabs, consisting of either precast concrete hollow core slabs or composite slabs with deep profiled steel sheeting, span between the beams in the orthogonal direction. The partial encasement of the steel beams leads to an inherent fire resistance without the application of fire protection materials. Whilst shallow floor solutions have been adopted widely, they have predominantly been developed as proprietary floor systems in the absence of specific design rules given in Eurocode 4. To remedy this situation project team SC4.T5 were responsible for developing generic design rules (see Table 1) [41], which will be included within prEN 1994-1-1.

### 2.8 Composite beams with precast concrete slabs in buildings

A high proportion of multi-storey steel frames use precast concrete floors, which are particularly suited to sectors such as hotels, residential buildings and car parks. The synergy between the use of precast concrete slabs and steel structures is that they both come from a manufacturing technology rather than a site-based activity, and share the quality control, accuracy, and reliability of factory production. Whilst rules on precast slabs were given in Eurocode No. 4 [1], ENV 1994-1-1 [4] and ENV 1994-2 [6], this information is not included in the current version on EN 1994-1-1. In the absence of design rules in Eurocode 4, design guides have been published in the UK [42],[43] which are based on research by Lam [44],[45],[46]. Project team SC4.T5 were responsible for developing rules for prEN 1994-1-1 (see Table 1), which are presented in a companion paper [47].

### 2.9 Composite slabs

Whilst the *m-k* method has been widely used in the design of composite slabs for longitudinal shear, it has been known for some time that there are several shortcomings with the approach [48]; because of these shortcomings, the European industry has generally adopted the partial connection method, which has a much wider scope. To reflect current practice, it is proposed that prEN 1994-1-1 will no longer support the *m*+*k* method [49].

When the vertical shear resistance of composite slabs is considered in the current Eurocode 4, reference is made to the Eurocode 2 rules for slabs without shear reinforcement. From a comprehensive test programme on composite slabs with a wide variety of profiled steel sheeting cross-sections, it has been found that the current design approach is very conservative. To remedy this situation, a new design model for composite slabs has been developed [50], which is proposed to be included in prEN 1994-1-1.

### 2.10 Composite columns using high strength concrete and structural concrete

Internationally, higher strength concrete and structural steel is being introduced in design standards for concrete and steel structures (see Section 2.1). This is recognized in the Australasian composite steel and concrete design standards for buildings and bridges AS/NZS 2327 [19] and AS/NZS 5100.6 [25], where $f_y \leq 690$ MPa and $f_{ck} \leq 100$ MPa are permitted in the design of composite columns. Following the introduction of the Eurocodes in Singapore, a design guide was published [51] that extends the scope of the existing Eurocode 4 simplified design method to concrete strength class C90/105 and S550 steel, which is essentially considered as an NCCI. However, given that it was felt that a broader range of composite columns with high strength materials should be included, prEN 1994-1-1 supports their use through an extension to the general design method [49]. Nevertheless, it is anticipated that simplified design methods will be included in the companion CEN/TS (see Table 1).

More recently, from considering a database of more than 3200 tests [52], structural reliability analyses have been undertaken which investigated the performance of the current simplified design methods for concrete filled tubes (CFTs) given in a variety of international design standards when extended to $f_y = 850$ MPa and $f_{ck} = 185$ MPa. From this investigation [53], it was found that the Eurocode 4 simplified method for CFTs could be extended beyond its current limits, whilst still maintaining the existing reliability index $\beta$ level (see Figure 5).

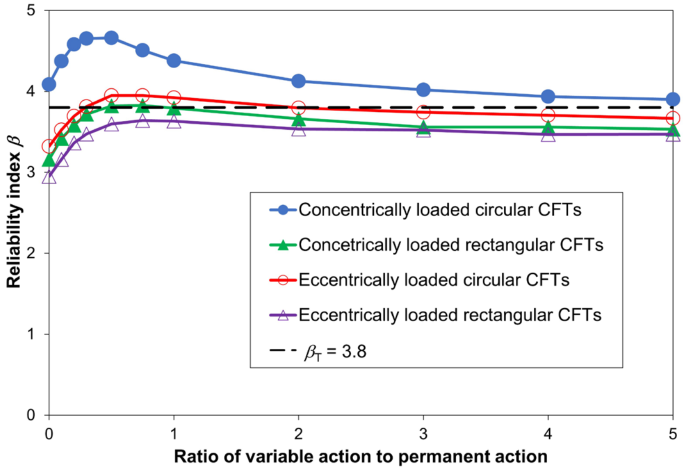


Figure 5. Relationship between reliability index and ratio of variable action to permanent action for simplified design method in existing Eurocode 4 with scope extended to $f_y = 850$ MPa and $f_{ck} = 185$ MPa

## 3 CONCLUSIONS

Following the publication of the first version in 1985, the present paper provides an overview of the development of the current Eurocode 4 before introducing the scope of the Mandate M/515 work programme that commenced in 2015. Focusing on Part 1-1 of Eurocode 4, a selection of the changes that will be included within the second generation of this Eurocode are presented, together with some of the technical challenges that needed to be overcome. Work undertaken within the Phase 4 project teams will be concluded in early 2022, before the CEN Enquiry draft for Eurocode 4 is completed. Due to the CEN process, together with the need to translate the drafts from English, it is anticipated that the complete second generation of the Eurocodes will be published in 2027.

## ACKNOWLEDGEMENTS

The present authors have prepared this paper according to what they consider to be the significant changes to the existing EN 1994-1-1. However, the draft is still being prepared for CEN Enquiry and, because of this, may be subject to change. Any views expressed in this paper may not necessarily reflect those of the other members of CEN/TC250 Subcommittee 4. The first and second author acknowledge with thanks the financial support provided by the European Commission/European Free Trade Association under Grant Agreement SA/CEN/GROW/EFTA/515/2017-08 for Project Team SC4.T6 of the CEN/TC250 work programme.

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