

# Towards a Eurocode for Fibre-Polymer Composite Structures

what has been done,  
*is being done and is still to be done*



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## I. Introduction

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Over the past twenty years, several innovative solutions have confirmed the usefulness of composite structures made of Fibre-Polymer Composite (FPC) structures, both within and outside Europe. The use of profiles, shell structures and sandwich structures made with such composite materials is particularly advantageous for applications in the Civil Engineering field. FPC bearing structures are therefore widely used for the construction of buildings for industrial or residential purposes. FPC usage is also increasingly widespread for civil engineering works. Applications range from lock gates, to entire bridges or bridge decks both for pedestrian and vehicular traffic. Because of their steadily increasing market volume and given the complexity of selection from available materials for FPC structures, it became obvious that it is necessary to develop a standardization document for both the production of FPC structural elements and practical rules for the design and verification of structures to be used for buildings and civil engineering works.

A first generation of Structural Eurocodes for the design of building and civil engineering works is currently in use. These documents have been developed to replace the differing rules previously in force in the various European Member States and thus to establish a set of common technical rules [1]. This first generation did not however comprise an Eurocode for fibre-polymer composite structures (also known as fibre-reinforced polymer (FRP) structures).

In 2010 the European Community (EC) sent the Mandate M/466 to CEN/TC 250 starting the procedure aimed at creating a new generation of structural Eurocodes. The purpose of the Mandate was to initiate the process of further development of the Eurocode system. M/466 requested CEN to provide a programme for standardisation covering:

- *Development of new standards or new parts of existing standards, e.g. a new construction material and corresponding design methods or a new calculation procedure;*
- *Incorporation of new performance requirements and design methods to achieve further harmonisation of the implementation of the existing standards.*

The related business plan (Figure 1) includes a specific document addressed to Fiber-Polymer Composites entrusted to Working Group 4 (WG4). The European Composites Industry Association (EuCIA) is an official member of WG4, in whose activities and meetings it actively participates.

The planned activities should have been developed following a well-defined procedure consisting of three steps:

- **Step 1:** *Preparation and publication of a “Science and Policy Report”, subject to agreement of CEN/TC250.*
- **Step 2:** *After agreement of CEN/TC250, preparation and publication of CEN Technical Specifications (TS, previously known as ENV).*
- **Step 3:** *After a period for trial use and commenting, CEN/TC250 will decide whether the CEN Technical Specifications should be converted into Eurocode Parts.*

The third and last step is expected to be completed until 2024.

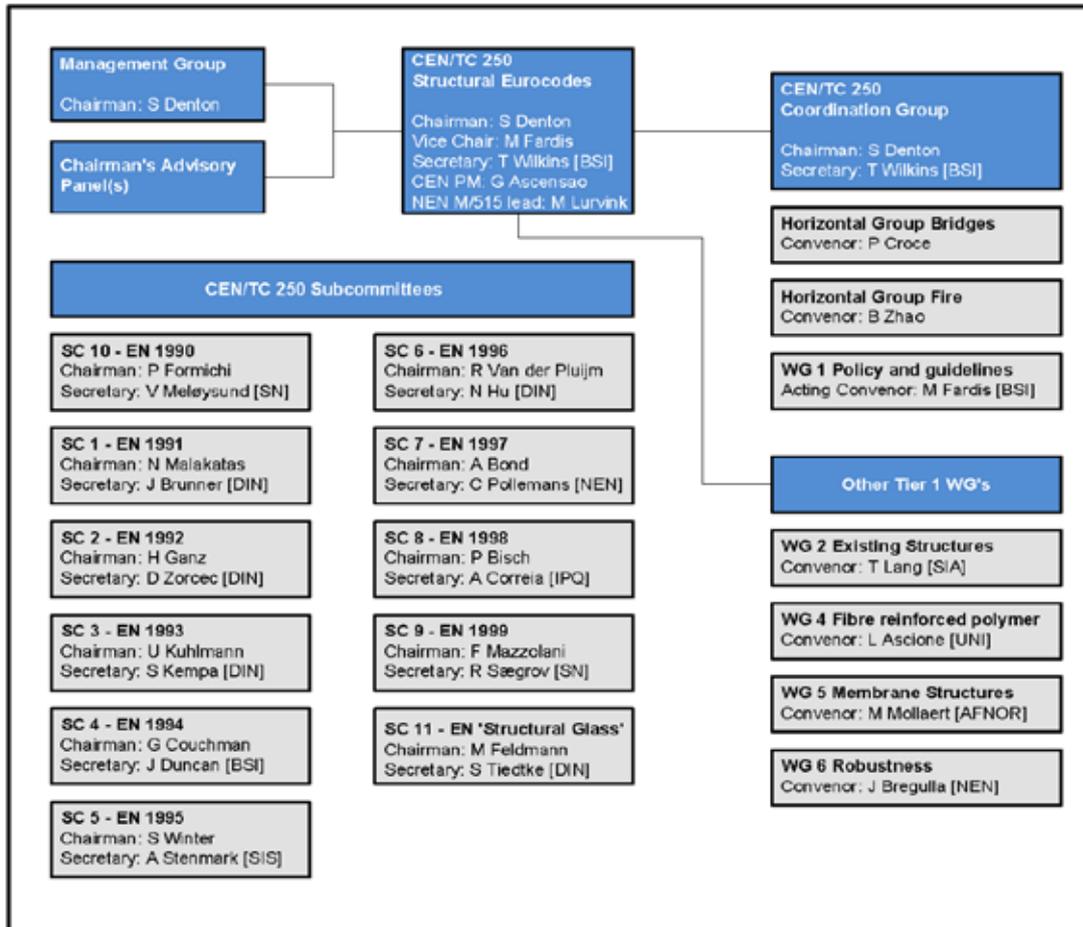


Figure 1: Business Plan of the EC.

## 2. What has already been done: Step 1 and almost all of Step 2

In 2016, after about three years of activity and many meetings, WG4 drew up a proposal of Scientific and Technical Report [2], whose title is Prospect for new guidance in design of FRP (Figure 2a). From January 2016 to July 2016, the Report was subjected to public inquiry by the National Standardizations Bodies (NSB) of EU.

At the end of the inquiry, the Report was revised and resubmitted to CEN/TC 250, which, in July 2017, took the decision to start the adaptation into a CEN Technical Specification (Step 2). The revised version [3] of the Prospect has been published by EuCIA in 2018 (Figure 2b).

Based on this report, the development of a CEN Technical Specification “Design of Fibre-Polymer Composite Structures” was initiated and a Project Team WG4.T2 (PT), associated to WG4, was nominated



Figure 2a: Cover page of the Prospect [2].

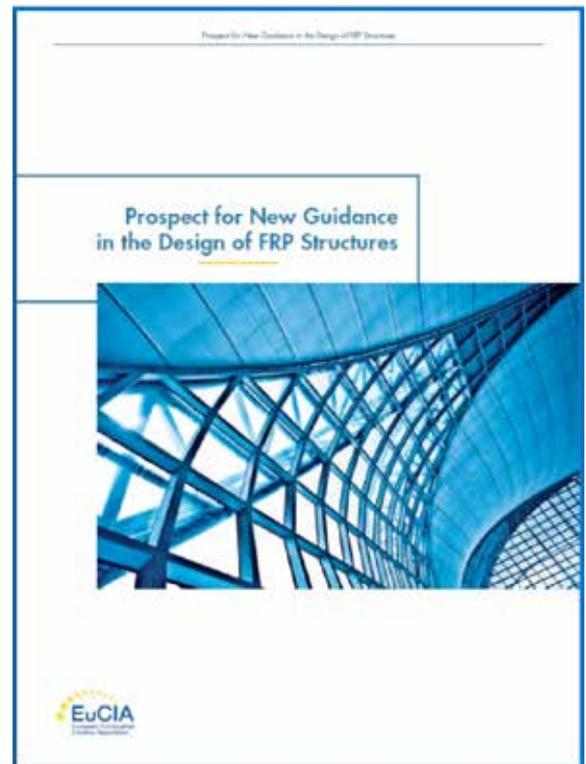


Figure 2b: Cover page of the revised version of the Prospect, published by EuCIA [3]

to prepare this document. The PT members were selected based on a public tender and are:

- *Joao Ramôa Correia (PT Leader)*
- *Thomas Keller*
- *Jan Knippers*
- *Toby Mottram*
- *Carlo Paulotto*
- *José Sena Cruz*

The convenor to WG4 also participated in the works of PT.

The TS represents the second step of the general procedure set by CEN TC 250 towards a new Eurocode. The final draft of this TS was submitted to CEN by PT at the end of April 2021, after three informal inquiries among the NSBs, during which comments were received by PT.

PT members discussed this and provided subsequent and shared drafts until the latest version of the Technical Specification document was released in April 2021 (Figure 3).

The document is organised as a standard Eurocode, and comprises 13 Clauses and 5 Annexes.

The title adopted modifies the material designation from the currently used “fibre-reinforced polymer FRP” to “fibre-polymer composites”, the latter denomination (amongst other things) being in line with the denominations in the other European languages, which all include the term “composites” in an equivalent translation.

The TS applies to the design of buildings, bridges and other civil engineering structures, including permanent and temporary structures, made of Fibre-Polymer Composite materials or combinations of them and other materials (hybrid-FPC structures). The scope includes of Fibre-Polymer Composite laminates, profiles, sandwich panels (including web-core panels), bolted and bonded joints, made of glass, carbon, basalt or aramid fibres, thermoset resins and adhesives, and polymeric foam or balsa wood cores. Fibre-Polymer Composite cables, concrete rebars, strengthening components and honeycomb cores are not covered by the TS.

The TS applies to FPC structures in which the values of the material temperature in members, joints and components, in service conditions, are higher than  $-40^{\circ}\text{C}$  and lower than  $T_g - 20^{\circ}\text{C}$ , where  $T_g$  is the glass transition temperature of the FPC, core and adhesive materials.  $T_g$  is specified as the onset value of the storage modulus decay, obtained from dynamic mechanical analysis (DMA), and should be at least  $60^{\circ}\text{C}$ .

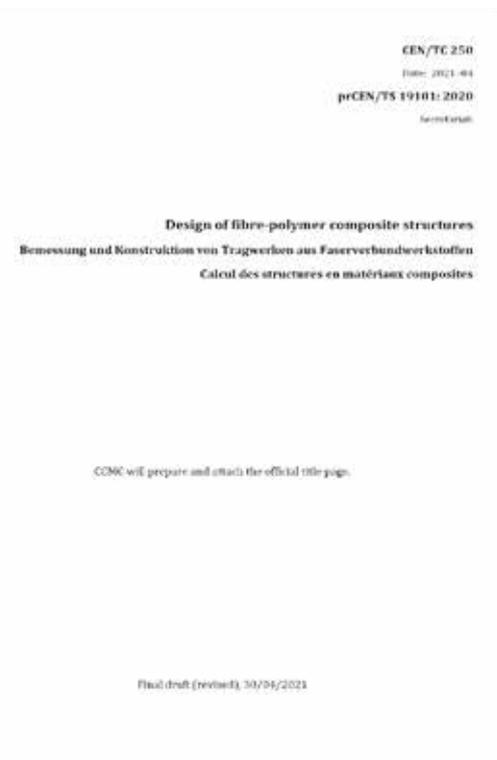


Figure 3: Cover page of the TS.

### 3. What remains to be done: complete Step 2 and perform Step 3

The second step is not yet fully completed. One of the authors of this paper, as convenor at WG4, has to reach the consensus of the members of the Working Group in order to require CEN/TC 250 to proceed for Formal Vote.

Once a positive vote is achieved, the CEN / TC 250 can approve the publication of the TS (Step 2 is concluded).

In accordance with CEN Internal Regulations Part 2, Clause 11.3.1.1, the status of a TS is explained as follows: “A Technical Specification (TS) is a normative document made available by CEN/CENELEC in at least one of the three official languages. A Technical Specification is established by a technical body and approved by the CEN/CENELEC national members in accordance with 11.3.3.2. The Technical Specification is announced and made available at national level, but conflicting national standards may continue to exist.”

The conversion of the TS by CEN TC250, after a period for trial use and commenting, in a new Eurocode will be the third and last step, which is expected to be possibly completed by 2024.

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## 4. Conclusions

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With respect to the first phase Prospect document, besides the editorial changes required by CEN's policy guidelines and procedures, the following main Clauses or Sub-clauses were object of major changes or added:

- i. *Basis of design (regarding partial factors, conversion factors and creep coefficients),*
- ii. *Ultimate limit states of sandwich structures,*
- iii. *Creep rupture,*
- iv. *Fatigue,*
- v. *Adhesive joints and connections,*
- vi. *Detailing*
- vii. *Structural fire design.*

The document is complemented by a Background Document, which provides the background of the paragraphs and justifications for all the decisions that were taken and values selected.

Furthermore, a document comprising design examples will be provided to the designer community.

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## 5. References

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1. CEN/TC 250 Structural Eurocodes: N 1250, "Policy Guidelines and Procedures" Version 9.1, 17 March 2020.
2. L. Ascione, et al. "Prospect for New Guidance in the Design of FRP" EUR 27666, 2016, DOI: 10.2788/22306 (available online at <https://publications.jrc.ec.europa.eu>).
3. L. Ascione, et al. "Prospect for New Guidance in the Design of FRP" Revised version after public inquiry (2018) (available online at <http://www.eucia.eu/>).

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## For more information you may contact

**Luigi Ascione**, Convenor to CEN/TC 250 WG4 and author of the present article  
Università di Salerno (l.ascione@unisa.it)

**Eric Moussiaux**, EuCIA Liaison Officer to CEN/TC 250 WG4  
Exel Composites (eric.moussiaux@exelcomposites.com)

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### **EuCIA AiSBL**

*BluePoint Brussels  
Boulevard A. Reyers 80  
1030 Brussels (Belgium)*

**T. +32 2 706 80 10**  
**[www.eucia.eu](http://www.eucia.eu)**