Status and Future for the Structural Eurocode project *Design of Fibre-Polymer Composite Structures*

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5 September 2024

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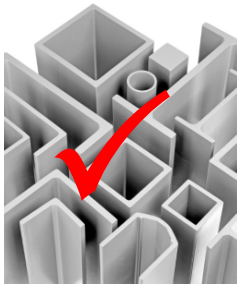
Fibre-Polymer Composite Structures

Reinforcing bars

Strengthening strips and sheets



Profiles

Sandwich panels (web- or homogeneous-core)

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Fibre-Polymer Composite Structures

New construction

Eyecatcher building (5 storeys), Basel, Switzerland

Novartis Pavillion, Switzerland

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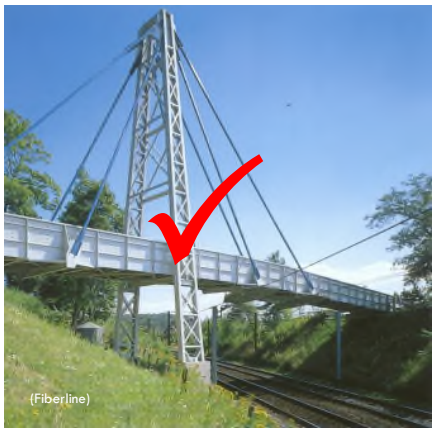
Fibre-Polymer Composite Structures

New construction



Kolding Bridge, Denmark

Friedberg Bridge, Germany

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Fibre-Polymer Composite Structures

Haramain Railway station (Madinah, Saudi Arabia)

Curved panels with GFRP face sheets and PET foam core (lightness, lightning)

Avançon Bridge (Bex, Switzerland), GFRP face sheets and balsa wood core

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Evolution Steps in a Eurocode Project

1. Publication of a Technical and Scientific report (The Prospect);
2. publication of a CEN Technical Specification (referred to as TS, and is for the Current Status);
3. after a period of trial use, conversion of the TS into a Eurocode standard *Design of Fibre-Polymer Composite Structures*, which is for Future Developments.

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Acknowledgements





- Author acknowledges:
  - funding to WG4.T2 from EC Project M515;
  - important and essential scientific and technical support from CEN/TC 250 WG4 *Fibre-Reinforced Polymer Structures* to the drafting of the TS;
  - WG4.T2 and WG4 colleagues: João R. Correia (Leader); Thomas Keller; Jan Knippers; José Sena-Cruz; Carlo Paulotto; and, Luigi Ascione.

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Current Status of Eurocode Project

Step 2: **CEN/TS 19101:2022 *Design of Fibre-Polymer Composite Structures***

Transforming Step 1 Prospect to be with:

- Basic of design (γ_Ms, η_cs and $\phi(t)$s);
- ULS of sandwich panels;
- Creep rupture;
- Fatigue;
- Detailing;
- Adhesive joints and connections;
- Structural fire design;
- National Annex (*UK version with single page NA*).

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Current Status of Eurocode Project

Scope of CEN/TS 19101:2022 is "*for the design of buildings, bridges, and other civil engineering structures, including permanent and temporary structures, made of composite materials or combinations of composite materials and conventional structural materials, in so called hybrid structures*".

Constituents: Fibres – of glass, carbon, aramid and basalt; Thermoset polymers – polyesters, vinylesters and epoxies; Cores - polymeric foams and balsa wood.

Composite processing methods: Include pultrusion, filament winding, hand lay-up, resin transfer moulding (RTM), resin infusion moulding (RIM) and vacuum-assisted resin transfer moulding (VARTM).

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Current Status of Eurocode Project

Content CEN/TS 19101:2022

1. Scope
2. Normative reference
3. Terms, definition and symbols
4. Basic of design
5. Materials
6. Durability
7. Structural analysis
8. Ultimate limit states
9. Serviceability limit states
10. Fatigue
11. Detailing
12. Connections and joints

Annex A (Informative) Creep coefficients

Annex B (Informative) Indicative values of material properties for preliminary design

Annex C (Normative) Buckling of orthotropic laminates and profiles

Annex D (Normative) Structural fire design

Annex E (Informative) Bridge details

National Annex (*optional*)

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Current Status of Eurocode Project

To accompany our TS there will be (and OPEN ACCESS):

- ❑ a **Commentary** covering nearly 400 paragraphs;
- ❑ a set of **Worked Examples** scoping 16 design situations.

Commentary book to be published by Francis & Taylor during November 2024, with Worked Examples book to follow ASAP

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Future Developments Eurocode Project

Pace of progress to be **greater** than presented in FPCC paper. CEN/TC 250 want this Eurocode (*Design of Fibre-Polymer Composite Structures*) to be available with the 2nd generation standards that will be mandatory from 1 April 2028.

Plan is to:

- ❑ transform CEN/TS 19101 into two Eurocode parts; EN 19101-1 General rules and EN 19101-2 Fire;

Feedback comments are welcomed

- ❑ prepare new part EN 19101-3 for Execution, to first appear as a TS.

Drafting support can be welcomed

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Future Developments Eurocode Project

Proposed 10 clauses in Execution part to be:

1. Scope
2. Normative references
3. Terms and definitions
4. Specifications and documentation
5. Constituent products
6. Preparation and assembly
7. Mechanical fastening
8. Erection
9. Geometrical tolerances
10. Inspection, testing and correction.

Drafting team will use prEN 1995-3:2023 *Eurocode 5 — Design of Timber Structures — Part 3: Execution* as a template

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Future Developments Eurocode Project

Current milestones (of TS, Commentary and Worked Examples) provide a "template" to design targeted research projects that will deliver relevant and reliable "test" results to:

- ❑ address gaps in knowledge and understanding;
- ❑ offer higher reliability when calibrating partial factors of resistance (γ_Ms); and
- ❑ setting values of conversion factors η_cs.

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Concluding Remarks

1. What a milestone has been achieved with the publication of the Eurocode CEN Technical Specification (**CEN/TS 19101:2022** ***Design of Fibre-polymer Composite Structures***), and its accompanying publications for Commentary and Worked Examples.
2. All National Standard Bodies requirements were met when transforming '*The Prospect*' into the TS for the current status of this 2nd generation Eurocode project.
3. UK version **PD CEN/TS 19101:2022** is with its NA and can be used to design structures.
4. Future developments are to be an Execution standard (EN 19101-3) and the transformation of the TS in into two standards (EN 19101-1 General rules & EN 19101-2 Fire); planned to available for 1 April 2028.
5. Future development can be targeted research generating test results for analyses that are used to specify γ_M and η_c values, etc.

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Question Time

"*Eurocodes evolution explained*" video series: **https://tinyurl.com/5h9npa25**

New Open Access book: Thomas Keller, *Composites in Structural Engineering and Architecture*, EPFL Press, Lausanne, 2024. **https://www.doi.org/10.55430/6225TKVA01**

Literature database on R and D with Pultruded Fibre Reinforced Polymer Shapes and Systems (3200) - **https://warwick.ac.uk/fac/sci/eng/people/toby_mottram**

Hit me with your Questions?

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