

STN P	Navrhovanie kompozitných konštrukcií s polymérovými vláknami	STN P CEN/TS 19101 73 0041
------------------	---	--

Design of fibre-polymer composite structures

Táto norma obsahuje anglickú verziu európskej normy.
This standard includes the English version of the European Standard.

Táto norma bola oznámená vo Vestníku ÚNMS SR č. 02/23

Táto predbežná slovenská technická norma je určená na overenie. Prípadné pripomienky pošlite do novembra 2024 Úradu pre normalizáciu, metrológiu a skúšobníctvo Slovenskej republiky.

Obsahuje: CEN/TS 19101:2022

136232

TECHNICAL SPECIFICATION
SPÉCIFICATION TECHNIQUE
TECHNISCHE SPEZIFIKATION

CEN/TS 19101

November 2022

ICS 91.010.30

English Version

Design of fibre-polymer composite structures

Calcul des structures en matériaux composites

Bemessung von Tragwerken aus Faserverbund-
Kunststoffen

This Technical Specification (CEN/TS) was approved by CEN on 22 August 2022 for provisional application.

The period of validity of this CEN/TS is limited initially to three years. After two years the members of CEN will be requested to submit their comments, particularly on the question whether the CEN/TS can be converted into a European Standard.

CEN members are required to announce the existence of this CEN/TS in the same way as for an EN and to make the CEN/TS available promptly at national level in an appropriate form. It is permissible to keep conflicting national standards in force (in parallel to the CEN/TS) until the final decision about the possible conversion of the CEN/TS into an EN is reached.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye and United Kingdom.



EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

CEN/TS 19101:2022 (E)

Contents	Page
European foreword	5
0 Introduction	6
1 Scope	7
2 Normative references	9
3 Terms, definitions, symbols and abbreviations	10
3.1 Terms and definitions	10
3.2 Symbols and abbreviations	21
3.3 Symbols for member axes	46
4 Basis of design	50
4.1 General rules	50
4.2 Principles of limit state design	50
4.3 Basic variables	50
4.4 Verification by the partial factor method	52
4.5 Design assisted by testing	61
5 Materials	62
5.1 Glass transition temperature	62
5.2 Composite materials	62
5.3 Core materials	64
5.4 Adhesives	66
6 Durability	67
6.1 General	67
6.2 Environmental conditions	68
6.3 Effects and measures for specific environmental conditions	69
6.4 Effects of combined environmental conditions	72
6.5 Measures for connections and joints	72
7 Structural analysis	73
7.1 Structural modelling for analysis	73
7.2 Global analysis	80
7.3 Imperfections	82
7.4 Methods of analysis	86
8 Ultimate limit states	88
8.1 General	88
8.2 Ultimate limit states of laminates	88
8.3 Ultimate limit states of profiles	96
8.4 Ultimate limit states of sandwich panels	107
8.5 Creep rupture	128
9 Serviceability limit states	131
9.1 General	131
9.2 Deflections	131
9.3 Vibrations	133
9.4 Matrix cracking	134
10 Fatigue	134
10.1 General	134

10.2	Fatigue actions.....	135
10.3	Fatigue verification.....	135
10.4	Fatigue testing.....	136
11	Detailing.....	138
11.1	General.....	138
11.2	Profiles.....	138
11.3	Sandwich panels and member laminates.....	138
11.4	Bolted connections.....	140
11.5	Adhesive connections.....	143
12	Connections and joints.....	143
12.1	General rules.....	143
12.2	Bolted connections.....	144
12.3	Bolted joints.....	163
12.4	Adhesive joints and connections.....	165
12.5	Hybrid joints and connections.....	170
	Annex A (informative) Creep coefficients.....	171
A.1	Use of this annex.....	171
A.2	Scope and field of application.....	171
A.3	Pultruded composite profiles.....	171
A.4	Composite laminates.....	172
A.5	Core materials.....	172
	Annex B (informative) Indicative values of material properties for preliminary design..	174
B.1	Use of this annex.....	174
B.2	Scope and field of application.....	174
B.3	General.....	174
B.4	Fibres.....	174
B.5	Resins.....	175
B.6	Core materials.....	176
B.7	Ply properties.....	178
B.8	Laminate properties.....	188
	Annex C (normative) Buckling of orthotropic laminates and profiles.....	191
C.1	Use of this annex.....	191
C.2	Scope and field of application.....	191
C.3	General.....	191
C.4	Elastic buckling of orthotropic laminates.....	192
C.5	Elastic buckling of profiles.....	196
	Annex D (normative) Structural fire design.....	215
D.1	Use of this annex.....	215
D.2	Scope and field of application.....	215
D.3	Assumptions.....	215

CEN/TS 19101:2022 (E)

D.4	Basis of design	215
D.5	Material properties	220
D.6	Tabulated design data	229
D.7	Simplified design methods	230
D.8	Advanced design methods	230
	Annex E (informative) Bridge details	232
E.1	Use of this annex	232
E.2	Scope and field of application	232
E.3	General	232
E.4	Bridge bearings	232
E.5	Expansion joints	232
E.6	Parapets	234
E.7	Adhesive deck-girder connections	234
E.8	Crash barrier fixations	234
	Bibliography	236

European foreword

This document (CEN/TS 19101:2022) has been prepared by Technical Committee CEN/TC 250 “Structural Eurocodes”, the secretariat of which is held by BSI. CEN/TC 250 is responsible for all Structural Eurocodes and has been assigned responsibility for structural and geotechnical design matters by CEN.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document has been prepared under Mandate M/515 issued to CEN by the European Commission and the European Free Trade Association.

This document has been drafted to be used in conjunction with relevant execution, material, product and test standards, and to identify requirements for execution, materials, products and testing that are relied upon by this document.

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to announce this Technical Specification: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye and the United Kingdom.

CEN/TS 19101:2022 (E)**0 Introduction****0.1 Introduction to CEN/TS 19101**

This document for the design of fibre-polymer composite structures, which was prepared in line with the Eurocodes, is intended for use by designers, clients, manufacturers, constructors, relevant authorities (in exercising their duties in accordance with national or international regulations), educators, software developers, and committees drafting standards for related product, testing and execution standards.

NOTE 1 Some aspects of design are most appropriately specified by relevant authorities or, where not specified, can be agreed on a project-specific basis between relevant parties such as designers and clients. The Eurocodes identify such aspects making explicit reference to relevant authorities and relevant parties.

NOTE 2 Fibre-polymer composites are also commonly referred to as fibre-reinforced polymers (FRP) or as composites.

0.2 Verbal forms used in this Technical Specification

The verb "shall" expresses a requirement strictly to be followed and from which no deviation is permitted in order to comply with the Eurocodes.

The verb "should" expresses a highly recommended choice or course of action. Subject to national regulation and/or any relevant contractual provisions, alternative approaches could be used/adopted where technically justified.

The verb "may" expresses a course of action permissible within the limits of the Eurocodes.

The verb "can" expresses possibility and capability; it is used for statements of fact and clarification of concepts.

0.3 National Annex to CEN/TS 19101

This Technical Specification gives values within notes indicating where national choices can be made. Therefore, a national document implementing CEN/TS 19101 can have a National Annex containing all Nationally Determined Parameters to be used for the assessment of buildings and civil engineering works in the relevant country.

When not given in the National Annex, the national choice will be the default choice specified in the relevant Technical Specification.

The national choice can be specified by a relevant authority.

When no choice is given in the Technical Specification, in the National Annex, or by a relevant authority, the national choice can be agreed for a specific project by appropriate parties.

National choice is allowed in CEN/TS 19101 through the following clauses:

4.3.1.2(4), NOTE 2	4.4.6(1), NOTE	4.4.6(2), NOTE	4.4.6(3), NOTE
4.4.7.1(2), NOTE	4.4.7.1(3), NOTE	8.5(2), NOTE 4	10.3(1), NOTE 1
12.4.5.1(1), NOTE 1	D4.5(1), NOTE		

National choice is allowed in CEN/TS 19101 on the application of the following informative annexes:

Annex A	Annex B	Annex E
---------	---------	---------

The National Annex can contain, directly or by reference, non-contradictory complementary information for ease of implementation, provided it does not alter any provisions of the Eurocodes.

1 Scope

1.1 Scope of CEN/TS 19101

(1) This document applies to the design of buildings, bridges and other civil engineering structures in fibre-polymer composite materials, including permanent and temporary structures. It complies with the principles and requirements for the safety, serviceability and durability of structures, the basis of their design and verification that are given in EN 1990.

NOTE In this document, fibre-polymer composite materials are referred to as composite materials or as composites.

(2) This document is only concerned with the requirements for resistance, serviceability, durability and fire resistance of composite structures.

NOTE 1 Specific requirements concerning seismic design are not considered.

NOTE 2 Other requirements, e.g. concerning thermal or acoustic insulation, are not considered.

(3) This document gives a general basis for the design of composite structures composed of (i) composite members, or (ii) combinations of composite members and members of other materials (hybrid-composite structures), and (iii) the joints between these members.

(4) This document applies to composite structures in which the values of material temperature in members, joints and components in service conditions are (i) higher than -40 °C and (ii) lower than $T_g - 20\text{ °C}$, where T_g is the glass transition temperature of composite, core and adhesive materials, defined according to 5.1(1).

NOTE 1 Composite structures have a temperature-dependent behaviour. The temperature-dependence of the properties of composite, core and adhesive materials is considered through a conversion factor for temperature, η_c , as defined in 4.4.7.2, which depends on the T_g and the maximum material temperature in service conditions (T_s).

NOTE 2 5.1(1) defines requirements for the T_g of composite, core and adhesive materials as a function of the T_s .

(5) This document applies to:

(i) composite members, i.e. profiles and sandwich panels, and

(ii) bolted, bonded and hybrid joints and their connections.

NOTE 1 Profiles and sandwich panels can be applied in structural systems such as beams, columns, frames, trusses, slabs, plates and shells.

NOTE 2 Sandwich panels include homogenous core and web-core panels. In web-core panels, the cells between webs can be filled (e.g. with foam) or remain empty (e.g. panels from pultruded profiles).

NOTE 3 This document does not apply to sandwich panels made of metallic face sheets.

NOTE 4 Built-up members can result from the assembly of two or more profiles, through bolting and/or adhesive bonding.

NOTE 5 The main manufacturing processes of composite members include pultrusion, filament winding, hand layup, resin transfer moulding (RTM), resin infusion moulding (RIM), vacuum-assisted resin transfer moulding (VARTM).

CEN/TS 19101:2022 (E)

NOTE 6 This document does not apply to composite cables or special types of civil engineering works (e.g. pressure vessels, tanks or chemical storage containers).

(6) This document applies to:

(i) the composite components of composite members, i.e. composite plies, composite laminates, sandwich cores and plates or profiles, and

(ii) the components of joints or their connections, i.e. connection plates or profiles (e.g. cleats), bolts, and adhesive layers.

NOTE 1 Composite components are composed of composite materials (i.e. fibres and matrix resins) and core materials. Components of joints and their connections are also composed of composite, steel or adhesive materials.

NOTE 2 The fibre architecture of composite components can comprise a single type of fibres or a hybrid of two or more types of fibres.

NOTE 3 This document does not apply to composite components used for internal reinforcement of concrete structures (composite rebars) or strengthening of existing structures (composite rebars, strips or sheets).

(7) This document applies to composite materials, comprising:

(i) glass, carbon, basalt or aramid fibres, and

(ii) a matrix based on unsaturated polyester, vinylester, epoxy or phenolic thermoset resins.

NOTE This document does not apply to composite materials comprising a matrix based on thermoplastic resins.

(8) This document applies to the core materials (i) polymeric foams, and (ii) balsa wood.

NOTE 1 The core of sandwich panels can be reinforced by composite webs and inserts.

NOTE 2 This document does not apply to honeycomb cores.

(9) This document applies to thermoset adhesives, including epoxy, polyurethane, and acrylic resins.

NOTE This document does not apply to thermoplastic adhesives.

(10) This document applies to other types of fibres, thermoset resins, homogeneous cores and thermoset adhesives than those specified in 1.1(6)-(9), provided that their mechanical and physical properties are obtained from appropriate testing according to Clause 5, and that they are in line with the other relevant clauses of this document.

1.2 Assumptions

(1) The assumptions of EN 1990 apply to this document.

(2) This document is intended to be used in conjunction with EN 1990, EN 1991 (all parts), EN 1997 (all parts), EN 1998 (all parts), ENs, EADs and ETAs for construction products relevant to composite structures.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE See the Bibliography for a list of other documents cited that are not normative references, including those referenced as recommendations (i.e. in 'should' clauses), permissions ('may' clauses), possibilities ('can' clauses), and in notes.

EN 1990:—¹, *Basis of structural and geotechnical design*

EN 1991 (all parts), *Eurocode 1: Actions on structures*

EN 1991-1-2:—², *Eurocode 1: Actions on structures — Part 1-2: General actions — Actions on structures exposed to fire*

EN 1993-1-4, *Eurocode 3: Design of steel structures — Part 1-4: General rules — Supplementary rules for stainless steels*

EN 1993-1-8:—³, *Eurocode 3: Design of steel structures — Part 1-8: Design of joints*

EN 1997 (all parts), *Eurocode 7: Geotechnical design*

EN 1998 (all parts), *Eurocode 8: Design of structures for earthquake resistance*

EN 13706-1, *Reinforced plastics composites — Specifications for pultruded profiles — Part 1: Designation*

EN 13706-2:2002, *Reinforced plastics composites — Specifications for pultruded profiles — Part 2: Methods of test and general requirements*

EN 13706-3, *Reinforced plastics composites — Specifications for pultruded profiles — Part 3: Specific requirements*

EN 16245 (all parts), *Fibre-reinforced plastic composites — Declaration of raw material characteristics*

ISO 6721-11, *Plastics — Determination of dynamic mechanical properties — Part 11: Glass transition temperature*

koniec náhľadu – text ďalej pokračuje v platenej verzii STN

¹ Under preparation. Stage at the time of publication: prEN 1990:2021.

² Under preparation. Stage at the time of publication: prEN 1991-1-2:2021.

³ Under preparation. Stage at the time of publication: prEN 1993-1-8:2021.