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Projektiranje nateznih membranskih konstrukcij

Design of tensioned membrane structures

Bemessung von vorgespannten Membrantragwerken

Conception et calcul des structures en membrane tendue

Ta slovenski standard je istoveten z: **CEN/TS 19102:2023**

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91.080.99 Druge konstrukcije Other structures

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English Version

Design of tensioned membrane structures

Conception et calcul des structures en membrane tendue

Bemessung von vorgespannten Membrantragwerken

This Technical Specification (CEN/TS) was approved by CEN on 24 August 2023 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.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
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European foreword

This document (CEN/TS 19102:2023) 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 Technical Specification has been prepared under Mandate M/515 issued to CEN by the European Commission and the European Free Trade Association.

This Technical Specification 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 the Eurocodes.

Any feedback and questions on this document should be directed to the users’ national standards body. A complete listing of these bodies can be found on the CEN website.

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.

0 Introduction

0.1 Introduction to CEN/TS 19102

This document for the design of tensioned membrane 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 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.

0.2 Verbal forms used in the Eurocodes

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 for CEN/TS 19102

This document gives values within notes indicating where national choices can be made. Therefore, a national document implementing CEN/TS 19102 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 shall 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 19102 through the following clauses:

4.3.1.2(3)	4.4.3.2(1)	8.2.1(3)	8.3.1(3)
9.2.1(1)	9.6.1(3)	C.3	C.4
C.5	C.6		

National choice is allowed in CEN/TS 19102 on the application of the following informative annexes:

Annex A	Annex H

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 19102

(1) This document applies to the design of buildings and structural works, made of structural membrane material. It provides guidance for the design of tensioned membrane structures, either mechanically or pneumatically tensioned at a defined prestress level.

NOTE 1 Membrane materials comprise structural fabrics, coated structural fabrics and foils.

NOTE 2 For elements of tensile surface structures not governed by this Technical Specification (for example made of steel, aluminium, wood or other structural materials), see relevant Eurocode parts.

(2) This document is concerned with the requirements for resistance, serviceability and durability of tensioned membrane structures, as given in EN 1990.

NOTE 1 The safety criteria follow EN 1990 and will consider specific limit states for tensioned membrane structures.

NOTE 2 Specific requirements concerning seismic design are not considered.

(3) Design and verification in this document is based on limit state design in conjunction with the partial factor method.

NOTE Special attention goes to the action of prestress, snow, wind and rain action on membrane structures and the combined effect of wind and rain or snow.

(4) This document covers analysis methodologies appropriate for tensioned membrane structures, from analytical to full numerical simulation methods.

(5) This document considers connections between membrane materials and between membrane materials and others.

(6) This document is applicable for hybrid membrane structures integrating different kinds of load bearing behaviour (tension, compression, bending, inflation…), in a way that the structural membrane shares loadbearing capacity with other structural elements made of different materials.

NOTE The term 'hybrid structure' refers to this combined structural behaviour or use of materials.

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, the EN 1991 series, the EN 1993 series, the EN 1999 series, ENs, EADs and ETAs for construction products relevant to tensioned membrane 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 1990:2023, *Eurocode — Basis of structural and geotechnical design*

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

EN 1993 (all parts), *Eurocode 3 — Design of steel structures*

EN 1999 (all parts), *Eurocode 9 — Design of aluminium structures*

EN ISO 527-1:2019, *Plastics — Determination of tensile properties — Part 1: General principles (ISO 527-1:2019)*

EN ISO 527-3:2018, *Plastics — Determination of tensile properties — Part 3: Test conditions for films and sheets (ISO 527-3:2018)*

EN ISO 1421:2016, *Rubber- or plastics-coated fabrics — Determination of tensile strength and elongation at break (ISO 1421:2016)*

EN ISO 13934-1, *Textiles — Tensile properties of fabrics — Part 1: Determination of maximum force and elongation at maximum force using the strip method (ISO 13934-1)*

3 Terms, definitions and symbols

For the purposes of this document, the terms and definitions given in EN 1990 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1 Terms and definitions

3.1.1
anchor
device used to secure a membrane or cable to a support, usually buried in the ground, so installed as to provide a firm point of attachment for resisting uplift

3.1.2
biaxial
stress state with stress along two orthogonal axes simultaneously

3.1.3
boundary cable
cable at the edge or termination of the membrane

3.1.4
cable
flexible linear or curvilinear element acting in tension

Note 1 to entry: A cable can be a wire rope, strand or web.

3.1.5
cable fitting
any accessory used as an attachment to, or support for, a cable

3.1.6
cable pocket
method of wrapping the membrane around a cable at a boundary condition

3.1.7
clamped connection
connection made by a series of shaped, overlapping plates that are clamped together by bolting

3.1.8
coated fabric
fabric with an adherent layer of polymeric material on one or both sides, the coated product remaining flexible

[SOURCE: ISO 472:2013, 2.152]

3.1.9
compensation
reduction in size of a cutting pattern, so that during installation the panel elongates to achieve an initial nominal prestress

[SOURCE: EN 17117-2:2021, 3.2]

3.1.10
compensation value
amount by which the dimensions of the pattern geometry is reduced by compensation

Note 1 to entry: The compensation value is expressed as a percentage of length in the direction to be compensated.

[SOURCE: EN 17117-2:2021, 3.3]

3.1.11
connection
location at which two or more elements meet, e.g. two structural membrane panels or a structural membrane and the supporting structure; for design purposes, it is the assembly of the basic components required to represent the behaviour during the transfer of the relevant internal forces and moments at the connection

[SOURCE: EN 1993-1-8:—[1], 3.1.3, modified to clarify the possible contribution of the structural membrane]

[1] Under preparation. Stage at the time of publication: FprEN 1993-1-8:2023.

3.1.12
cutting pattern
two-dimensional geometry developed from a pattern to be cut out of an individual piece of membrane

Note 1 to entry: The pattern refers to a seam layout-based subdivision of the three-dimensional surface.

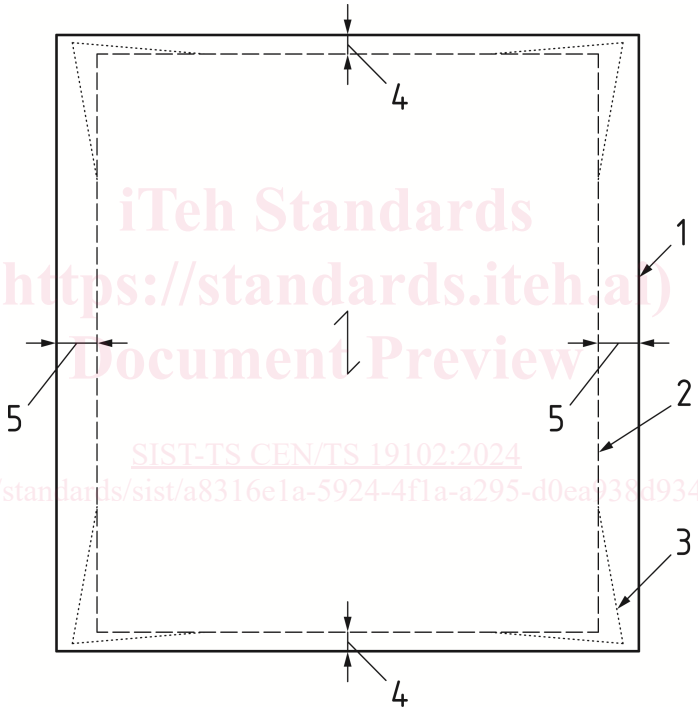
[SOURCE: EN 17117-2:2021, 3.4, modified – "coated fabric" replaced by "membrane"]

3.1.13
decompensation
partial or complete reduction of compensation

Note 1 to entry: Decompensation may be applied to ease the installation process, typically in the vicinity of boundaries.

Note 2 to entry: Typical application of compensation and decompensation to a piece of membrane is depicted in Figure 3.1.

[SOURCE: EN 17117-2:2021, 3.5, modified – "coated fabric" replaced by "membrane" in Note 2 to entry]



Key
1 final geometry when stressed with nominal prestress
2 geometry compensated, unstressed
3 geometry decompensated, unstressed
4 half of the pattern compensation measure in warp
5 half of the pattern compensation measure in fill

Figure 3.1 — Typical application of compensation and decompensation to a piece of membrane

3.1.14
European Technical Product Specification
— European Product Standard (EN),
— or a European Technical Assessment (ETA) based on a European Assessment Document (EAD),
— or a transparent and reproducible assessment that complies with all requirements of the relevant EAD

3.1.15
eyelet
metal ring used to reinforce a small round hole in the membrane for threading a lace, string or rope through

3.1.16
external structure
structural elements of the construction, to which the membrane structure is connected, which carry vertical and horizontal loads from the membrane structure down to the foundations of the construction

Note 1 to entry: The external structure is out of the scope of this document.

3.1.17
extrusion direction
extrusion direction (or machine direction), abbreviated as “ED” (or “MD”), is the direction of extrusion of a foil, corresponding with the longitudinal direction of a rolled-up sheet

3.1.18
fabric
sheet material produced from yarn or roving by a weaving process

3.1.19
fill
weft
all wires running crosswise of the cloth as woven

[SOURCE: ISO 2395:1990, 3.2.22]

3.1.20
foil
film
unsupported film with uniform thickness

[SOURCE: CEN ISO/TS 80004-11:2020, 3.1.4]

Note 1 to entry: Strictly the term foil refers to a metallic membrane. However, it is now the most commonly used term for all isotropic structural plastic membranes including ETFE foils.

3.1.21
form found shape
equilibrium shape of the membrane depending on the geometry of the boundaries and the ratio of prestress in the main structural directions

3.1.22
hem
edge of a membrane panel folded and stitched or welded or both