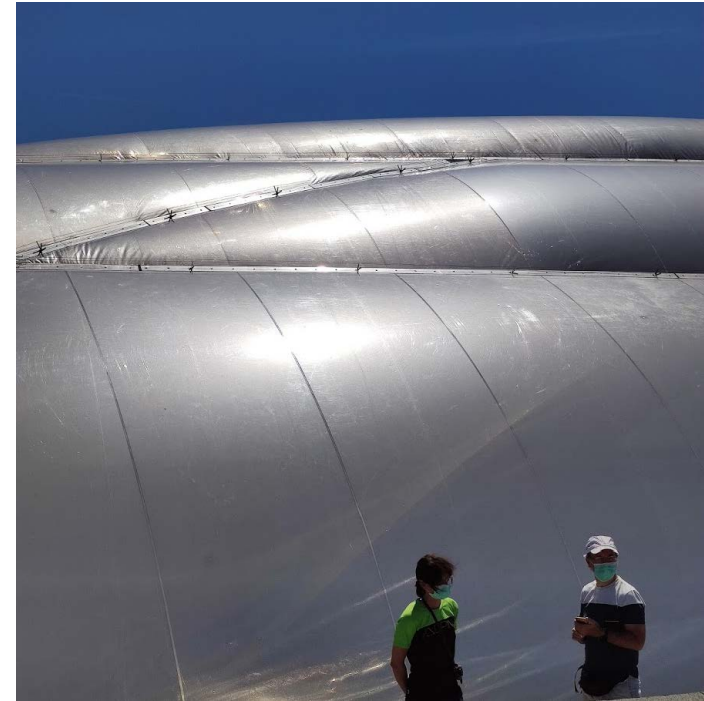




TensiNet & Friends



- **Welcome & introduction** - Bernd Stimpfle
- **WG Sustainability & Comfort** - Carol Monticelli
- **WG Eurocode** - Bernd Stimpfle
- **TensiNet sessions at ABS** – Carol Monticelli & Carl Maywald
- **Announcements** - Bernd Stimpfle
- **Conclusions & questions** - Bernd Stimpfle



Welcome & introduction

Bernd Stimpfle





1999 – 2004

European research project on tensile structures

2004 – 2020

cooperation is continued and TensiNet is founded as a network of experts under the wings of the Vrije Universiteit Brussel

2020 – current

TensiNet became an international non-profit association

Aim

The aim of TensiNet is to enable its members to contribute more effectively, within the scope of their activities, to

- Provide information and advice in the field of tensile membrane buildings;
- Inform about research and other technical studies necessary to support such advice;
- Inform about the application of research findings;
- Improve the quality of tensile membrane buildings;
- Increase the range of architectural applications;
- Get scientific results into practice and
- Stimulate research initiatives.



Members of TensiNet subscribe a Code of Good Practice, encourage and facilitate exchange of information and joint working, in order to increase the quality of tensile architecture.

Objectives

TensiNet is an association or platform for all parties interested in tensioned membrane structures

- supports teaching and training activities
- supports workshop organised by one of its members and provides information about events.
- disseminates information about ongoing research.
- publishes the TensiNews newsletter twice a year.
- organises every three year the TensiNet Symposium.
- publishes reference documents, Working Group publications and proceedings of the TensiNet symposium.
- maintains the website www.tensinet.com, containing a projects database, reference documents, research reports etc
- launched several Working Groups focusing on specific topics



Working Groups

TensiNet discusses specific issues and prepares state of the art documents in the appropriate Working Groups:

- WG analysis & materials
- WG ETFE
- **WG Sustainability & Comfort**
- WG Pneumatic structures
- **WG Specifications & EUROCODE**
- WG Specifications GOOD PRACTICE

TensiNet European
Design Guide for
Tensile Structures
Appendix A5



DESIGN
RECOMMENDATIONS
FOR ETFE FOIL
STRUCTURES

TensiNet ETFE Working Group

WG Sustainability & Comfort

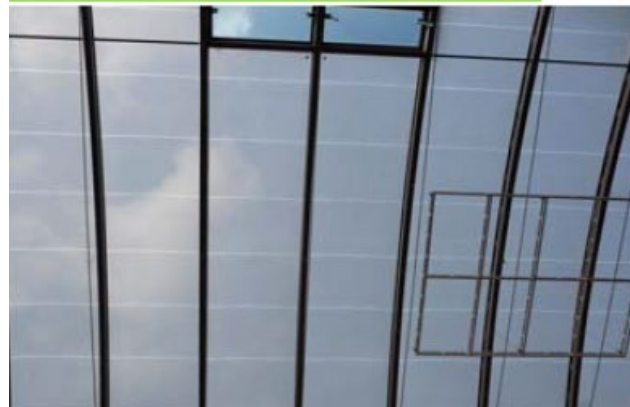
Carol Monticelli

PCR Guidance-Texts for Building-Related Products and Services

From the range of Environmental Product Declarations of Institute Construction and Environment e.V. (IBU)

Part B: Requirements on the EPD for ETFE construction element

www.ibu-epd.com



PCR Guidance-Texts for Building-Related Products and Services

From the range of Environmental Product Declarations of Institute Construction and Environment e.V. (IBU)

Part B: Requirements on the EPD for Technical Textiles

www.ibu-epd.com



Numbers of participants: 24

Topics under discussion:

1. Eco Design Guide: an index proposal to be built together
2. LCA analysis and comparison with other construction materials,
Circularity of membrane architectures
3. A web seminar proposal on the EPDs' histories of the different
Tensinet companies that developed it

3. A internal webinar on the “EPDs’ histories” of the different Tensinet companies that developed it: potentials and limits.

3 internal seminars:

1. 7 May 2021

- Taiyo Europe GmbH - *TAIYO_TensoSky_with_AGC_EP*
- Mehler Technologies - *LCA and EPD approach of PET/PVC Mehler Technologies*

2. 23 June 2021

- Vector Foiltec - new version of the EPD Texlon® - System Vector Foiltec GmbH

3. 21 July 2021

- Serge Ferrari company approach on the LCA and the EPD of PVC membranes
- Maxime Durka of Sioen, so far, introduced the EPD Polyester PVC membrane Sioen

later a PUBLIC SEMINAR and contacts with EPD rulers & organizations



As TensiNet Association, the S&C Working Group discussed about two possible next steps, convenient for the members of the association.

A first hypothesis:

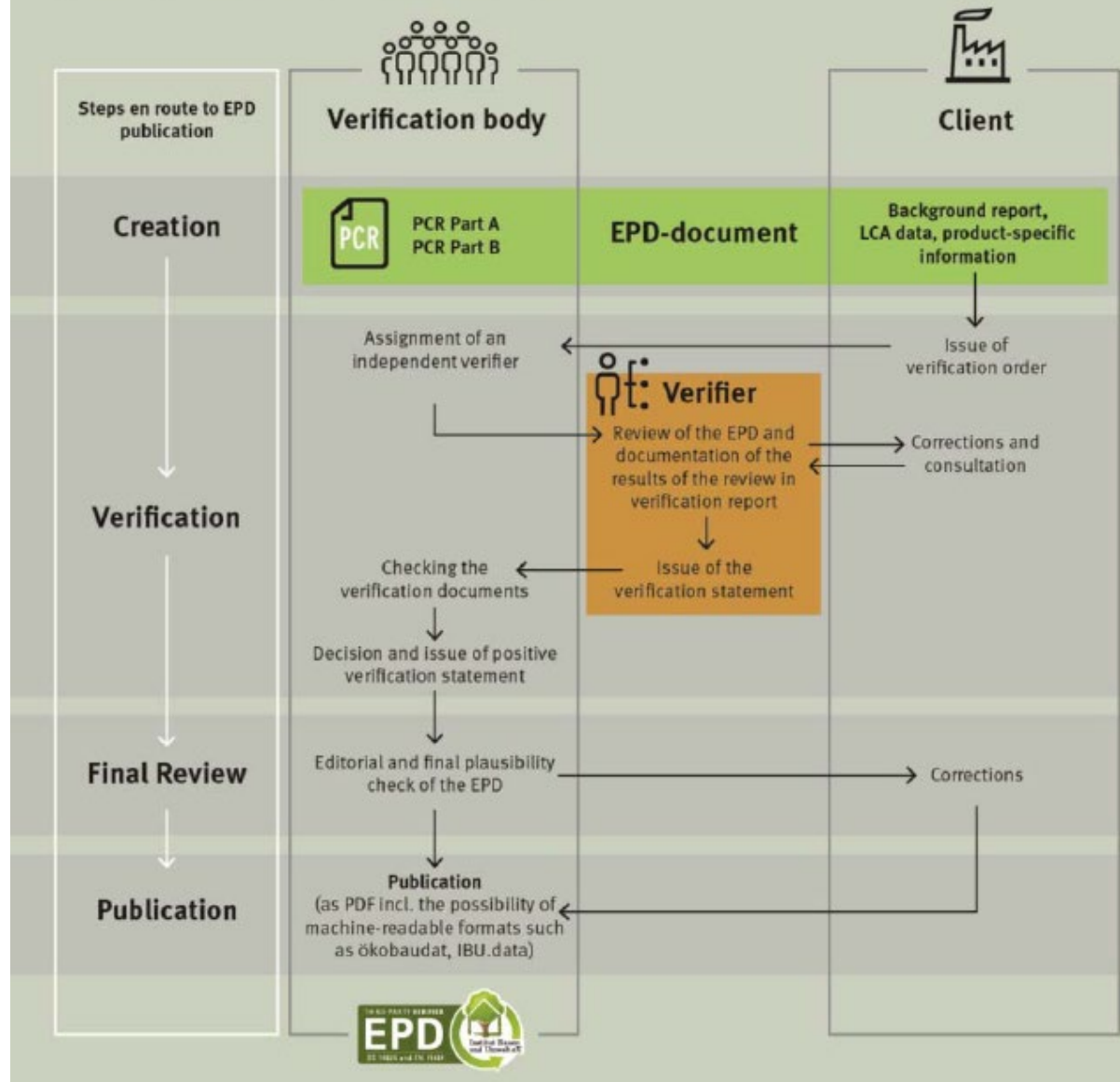
rather than specific EPDs → better to have EPDs based on categories rather than products in order to provide a basic set of data available for customers or suppliers.

The second hypothesis:

A major attention could be focused on the Product Category Rules (PCR), necessary to write and start the EPD process and they could be unified for the MEMBRANES and FOILS products.

Actually the WG S&C is investigating a possible collaboration with the German Institut Bauen und Umwelt e.V., in order to set up the specific category rules and facilitate the EPD process for the TensiNet

The EPD creation process



Emerged interesting topics to be deepen in the next future

Circular economy of membranes for architecture

Bio- based materials for membranes

Need of materials from biomass, no petro based

Need of biodegradable materials at the end of life

Which bio-based material for which application? New fields of application?

WG Eurocode - Technical Specifications document

Marijke Mollaert, Bernd Stimpfle



EUROCODES

prCEN/TS19102:2021-04(E)

Design of membrane structures

CURRENT AIM of the Project Team and WG5: to prepare the CEN TS Design of Membrane Structures

The members of the M/515 Phase Project Team *Membrane Structures* are

Bernd Stimpfle, bernd.stimpfle@form-tl.de

Jean-Christophe Thomas, jean-christophe.thomas@univ-nantes.fr

Jörg Uhlemann, joerg.uhlemann@uni-due.de

Peter Gosling, peter.gosling@newcastle.ac.uk

Ramon Sastre, ramon.sastre@upc.edu

The 3rd of May the Project Team delivered the “final document of the TS” to NEN

Since May 2021 WG5 worked in order to finalise the TS.

August 2022 WG5 shall submit it to CEN for formal vote

TS - prCEN/TS 19102 Design of tensioned membrane structures

| Chapters | responsible within the PT |
|--------------------------------|---------------------------|
| 4. Basis of design | Marijke Mollaert |
| 5. Materials | Jörg Uhlemann |
| 6. Durability | Jörg Uhlemann |
| 7. Structural Analysis | Peter Gosling |
| 8. Ultimate Limit States | Bernd Stimpfle |
| 9. Serviceability Limit States | Bernd Stimpfle |
| 10. Connections | Jörg Uhlemann |
| 11. Execution of membranes | Ramon Sastre |
| Annexes A to H | Jean Christophe Thomas |

TS - prCEN/TS 19102 Design of tensioned membrane structures

Annex A Classification of structural textile membranes

Annex B Procedures for determination of modification factors

Annex C Modification factors

Annex D Test procedures considering crease folds in glass fibre fabrics

Annex E Test procedures to determine foil properties

Annex F Special provisions with regards to fire

Annex G Fire performance of membrane structures exposed to fire

Annex H Execution of membrane structures

Execution of membrane structures

Intensive discussions are still going on, in order to find a consensus about the content of execution

initially in Clause 11; at the moment in Annex H, but with the goal to shift it back to Clause 11

The quality of execution is very important for the safety of membrane structures

Annex H/Clause 11 covers both, foils and (coated) fabrics

Design / Product / Manufacture / Installation are main criteria's to be agreed on.

Execution of membrane structures

What is 'inspection'?

The inspection level / execution level

- Could either refer to the 'historical' performance
- Or could be specified for a specific project/custom made fabric

Innovation should always be possible

External and internal testing are essential topics in order to ensure safe and reliable structures

To assure legitimate content for Clause 11/Annex H new working groups have already been formed

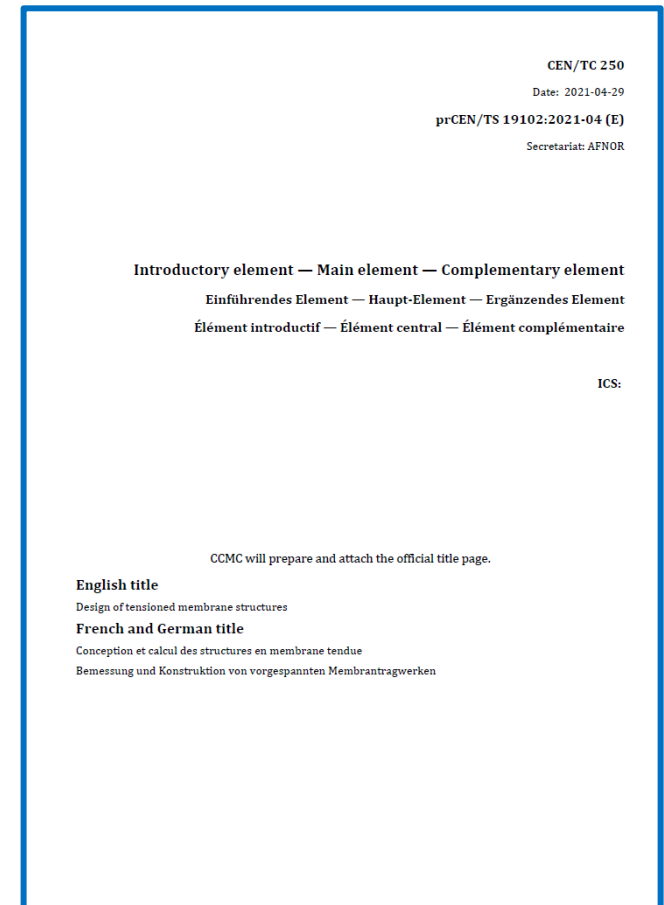
These working groups will continue to discuss Clause 11/Annexe H

The PT and WG5 are sure to conclude before finalising the TS

TS - prCEN/TS 19102 Design of tensioned membrane structures

The current version of the TS WG5.T2_FIN_DOC_prCEN_TS19102.pdf

is uploaded on the TensiNet website
and on the new
'CEN Documents' platform





TensiNet sessions at ABS

Carol Monticelli, Carl Maywald



TensiNet session 1 Friday 22.10.2021 8.30-10.00

Skins from Fabrics and Foils

Chair: Carol Monticelli, POLIMI, Italy

In the session Skins from fabrics and foils **Carol Monticelli** presents the tendencies, challenges, sustainability and life cycle of tensile structures in Europe. Interesting case studies are presented by **Fevzi Dansik** on the Batumi Stadium and by **Gerd Schmid**, who will focus on the new design language for urban architecture. **Allan Hurdle** finds an answer on the question “why limited combustible membranes are important”. **Claudia Lüling** finishes the session by showing results from research about textile based, lightweight construction at Frankfurt University of Applied Sciences

TensiNet session

Skins from Fabrics and Foils

Contemporary tensile structures in Europe: Tendencies, challenges, sustainability and life cycle

Marijke Mollaert, Vrije Universiteit Brussel, Belgium, Carol Monticelli, Politecnico di Milano, Italy, Alessandra Zanelli, Politecnico di Milano, Italy

- Advantages and limits of membranes as construction material
- From cradle to cradle: reuse and recycling
- Assessment of eco-efficiency

Zero
Waste



TensiNet session

Skins from Fabrics and Foils

Batumi Stadium: from design to installation

Fevzi Dansik, Asma Germe Membran Sistemleri Mim., Istanbul, Turkey

- Aesthetical design of a stadium with tensioned fabric
- Implementation steps
- Advantages of tensioned fabric systems



TensiNet session

Skins from Fabrics and Foils

New design language for urban architecture: Bus stations, tram stations, transfer hubs

Gerd Schmid, formTL, Germany

- Increasing mobility requires rethinking of traffic concepts
- Sustainable energy concepts for pneumatic structures
- Special design methods for valuable and lasting solutions





TensiNet session

Skins from Fabrics and Foils

Why limited combustible membranes are important

Allan Hurdle, AKH Services Ltd, Colchester, United Kingdom

- The new Euroclass A2 - Limited combustible membranes
- Fire tests: Euroclass A2, B and E rated membranes
- Related standards and tests - Importance of certificates

TensiNet session

Skins from Fabrics and Foils

Lightweight design with spacer fabrics

Claudia Luelling, University of Applied Sciences, Frankfurt, Germany

- Lightweight design with technical textiles for the building skin
- 3D-textiles in architecture
- FabricFoam: resilient material design with fabric and foam



TensiNet session 2 Friday 22.10.2021 10.45-12.30

Building Membrane Cladding Systems

Chair: Carl Maywald, Vector Foiltec GmbH, Bremen, Germany

The session Building Membrane Cladding Systems starts with a presentation by **Ben Runhaar** on Low haze ETFE film for façade solutions. **Bernd Stimpfle** questioning if technical specifications are needed for building with foils and fabrics. **Carl Maywald** shows ETFE applications along with an outlook on the durability of foils commonly used in tensile architecture. One of today's major functions of tensile building envelopes is highlighted in the presentation of **Monika Rychtáriková** from Leuven University. She talks about researches in the acoustical effects of fabric façades. The insight in engineering ETFE façades is deepened by a presentation of **Felix Surholt**. **Maxime Durka** shows the possibilities of frame-supported membrane structures and **Jürgen Holl** gives an insight in calculating and form finding of tensile structures.

TensiNet session

Building Membrane Cladding Systems

Low haze ETFE film for façade solutions

Ben Runhaar, AGC Chemicals Europe, Amsterdam, Netherlands

- A new ETFE film for façades
- New design and application options
- Case study on the Johan Crujff Arena Amsterdam



Johan Crujff Arena Amsterdam

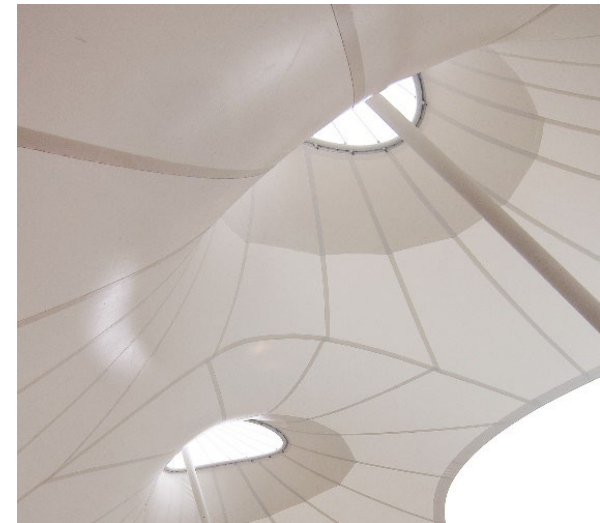
TensiNet session

Building Membrane Cladding Systems

Do we need technical specifications for membrane structures?

Bernd Stimpfle, TensiNet, Germany

- Code of practice in membrane structures
- Harmonised safety levels improve quality
- Transforming a niche into an established building technology



TensiNet session

Building Membrane Cladding Systems

ETFE applications, durability of foils commonly used in tensile architecture

Carl Maywald, Vector Foiltec, Bremen, Germany

- Ageing performance of ETFE foils in architecture
- Longevity of ETFE foil building cladding systems
- Mechanical and optical performance



(c)Mechelen in Beweging

TensiNet session

Building Membrane Cladding Systems

Acoustic benefits of structural skins used as roof or façade construction

Monika Rychtarikova, KU Leuven, Brussels, Belgium

- Long-term and short-term effects of noise on human health
- Acoustic properties of structural skins
- Improvement of indoor and outdoor acoustic comfort



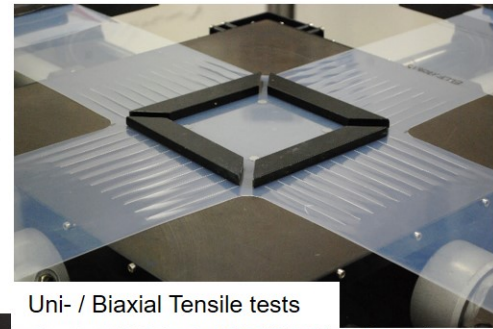
TensiNet session

Building Membrane Cladding Systems

Recent development in European ETFE design

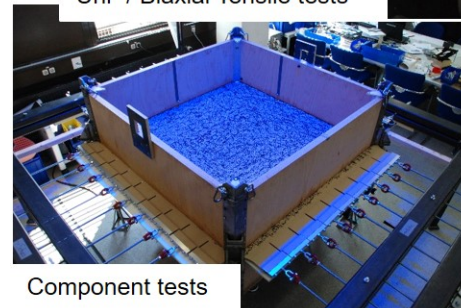
Felix Surholt, Universität Duisburg-Essen, Germany

- Discussion on existing ETFE design methods
- Development of a new design rule for ETFE structures
- Proposals for unified test methods



Uni- / Biaxial Tensile tests

All photos: © UDE/IML



Component tests



Uniaxial weld specimens

TensiNet session

Building Membrane Cladding Systems

Frame-supported membrane structures

Maxime Durka, Sioen, Belgium

- Inspirational projects made with frame-supported membranes
- Fibre-reinforced membranes for frame-supported structures
- Case studies



TensiNet session

Building Membrane Cladding Systems

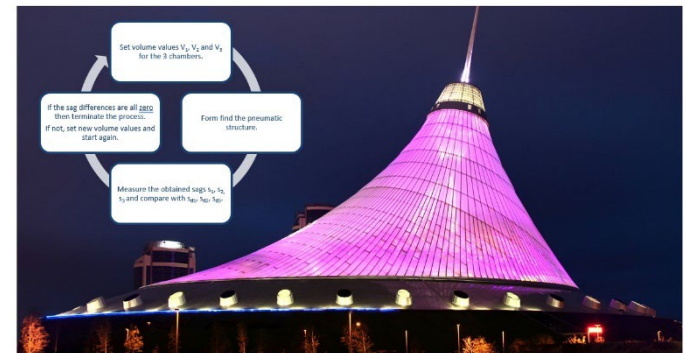
Analytical calculation of membranes and foils for building skins

Jürgen Holl, technet, Stuttgart, Germany

- Complete and accurate structure formulation
- Form finding of mechanically and pneumatically stressed surfaces
- Hybrid structures and their static calculation

Analytical calculation of membranes and foils for building skins

Mass production in a short time → automated calculation





Announcements

Bernd Stimpfle



TensiNet at Techtexsil 2022

Beyond innovation

Performance. Function. Future.

21 - 24/06/2022 at Frankfurt, Germany

**General Assembly 2022
Presentations**





TensiNet Symposium 2023

**Membrane architecture: the seventh established building material.
Designing reliable and sustainable structures for the urban
environment**

June 2023

Nantes University, France



TensiNet Symposium 2023

STRUCTURAL MEMBRANE: contemporary, innovative, adaptive daring and impactful solutions In Jules Verne's hometown, with its focus on innovation and futuristic issues, membrane architecture can provide answers to current problems, especially for ever denser cities and for a world that is always on the move.

TENSIONED MEMBRANE STRUCTURES: the seventh building material Recent advances in the design of membrane structures, development of a Eurocode dedicated to structural membranes: the word membrane must now be part of the daily vocabulary of architects, designers and decision-makers, and the specificities of membrane design must be part of the knowledge of all structural engineers.

STRUCTURAL MEMBRANE: an answer to issues of the 21st century Lightweight design, well-being, environmental impact, energy and acoustic performance, life cycle of materials and structures, end of life of membrane structures: these keywords are part of the current and future construction challenges and are an important message for the younger generations.





Conclusion & questions

Bernd Stimpfle



Thank you and enjoy attending ABS 2021!
Visit our booth and our website www.tensinet.com