TENSILE STRUCTURES
The perfect combination of functionality and aesthetics
Modern technology with proven materials

In addition to the use of form, the selection of the right material is of essential importance to the success of the project. Irrespective of whether its technical textiles (coated or uncoated fabric) or technical plastics (ETFE foils) – when choosing the material, the planned use, service life of the construction as well as later maintenance costs should all be considered. Building regulations, structural requirements and illumination of the covered area are also to be taken into account.

Whatever your requirements, the team from CENO TEC will provide you with the perfect solution from one source.
Technical textiles are characterised by high transparency and flexibility as well as a low surface weight combined with extremely high tensile strength. They are not only a crucial design element, but are a structurally indispensable part of the overall construction thanks to the pre-tensioning applied. When combined with reinforcing features such as cable structures and steel constructions, membranes can be used to create an almost unlimited number of surface shapes.

Thanks to their high tensile strength (five times greater than steel), coated fabrics can be used to create support-free constructions with wide spans. Polyester fabrics are available with either a plastic coating or glass fibre with PTFE (Teflon®) or silicon coating. Due to their high material flexibility, both plastic-coated polyester fabric or high-quality PTFE fabric with a flexible fluoropolymer coating are ideally suited for creating convertible or temporary constructions.

Glass-fibre fabric with a PTFE (Teflon®) coating is particularly noted for its durability, non-combustibility and the fact that it is virtually self-cleaning.

The differences are illustrated in the table on page 7.
A comparison of technical textiles

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>Basic fabric</strong></td>
<td>Polyester</td>
<td>Glass</td>
<td>Glass</td>
<td>PTFE</td>
</tr>
<tr>
<td><strong>Coating material and surface finish</strong></td>
<td>Plastic, Acrylic, Fluoropolymer and PVDF coating</td>
<td>PTFE</td>
<td>PTFE/ETFE foil</td>
<td>Fluoropolymer</td>
</tr>
<tr>
<td><strong>Gesamtgewicht (g/m²)</strong></td>
<td>ca. 800 - 1550</td>
<td>ca. 800 - 1550</td>
<td>ca. 800 - 1550</td>
<td>1080</td>
</tr>
<tr>
<td><strong>Tensile strength (N/5 cm)</strong></td>
<td>3000/5000 – 9800/8300</td>
<td>4200/4100 – 8000/7000</td>
<td>Approx. 4000/5000</td>
<td>4000</td>
</tr>
<tr>
<td><strong>Flex resistance</strong></td>
<td>Good</td>
<td>Adequate</td>
<td>Adequate</td>
<td>Very good</td>
</tr>
<tr>
<td><strong>UV resistance</strong></td>
<td>Good</td>
<td>Very good</td>
<td>Very good</td>
<td>Very good</td>
</tr>
<tr>
<td><strong>Stain resistance</strong></td>
<td>Good</td>
<td>Very good</td>
<td>Very good</td>
<td>Very good</td>
</tr>
<tr>
<td><strong>Translucence</strong></td>
<td>Approx. 5-15%</td>
<td>Approx. 8-15%</td>
<td>Approx. 20-65%</td>
<td>19-38%</td>
</tr>
<tr>
<td><strong>Colour</strong></td>
<td>Standard white, colour selection possible</td>
<td>After bleaching: white - limited colour selection on request</td>
<td>After bleaching: White</td>
<td>White</td>
</tr>
<tr>
<td><strong>Fire classification</strong></td>
<td>DIN 4102 B1 flame retardant</td>
<td>DIN 4102 A2 non-combustible (with reservations)</td>
<td>DIN 4102 B1 flame retardant</td>
<td>EN 13501 B - s1, d0</td>
</tr>
</tbody>
</table>

All advantages at a glance:

- Individual shape and colour
- Low material costs
- Short planning, manufacturing and assembly time
- Support-free roofing for large areas
- Temporary and portable constructions possible
- Enclosed structures possible using thermally insulated and soundproofed, multilayer membrane constructions
- Savings on lighting
- Long lifespan
- Excellent heat protection – high reflectivity
- Excellent resistance to earthquakes
PROJECT EXAMPLES

Translucent construction with technical textiles
In modern architecture, transparent constructions utilising ETFE foils are gaining in importance due to their high translucence and UV resistance. They are used in membrane construction in thicknesses of 0.05 to 0.25 mm. Ideal applications include sectors where the conventional approach would often be to use glass (swimming pools, water parks, atriums, skylights, zoos, greenhouses and palm houses etc.). In addition to optimal daylight conditions, they can also promote plant growth and facilitate natural tanning in enclosed spaces. By partially coating the foils, it is also possible to produce a shading effect.

An overview of the properties and advantages of ETFE structures:

- Especially high light transmitting capacity of approx. 90% in the visible wavelength range (from 400 – 700 nm/UV)
- High UV transmissibility, depending on the material thickness
- Good thermal insulation: U values, depending on the number of foil layers
- G value between 0.10 and 0.85 depending on the design and alignment of the ‘tyres’
- Low weight of foil cushions, thereby facilitating light, intricate substructures
- Very good mechanical properties: High tensile strength/tear resistance and hail resistance
- Flame retardant - ETFE foils burn off without dripping
- Low maintenance costs due to anti-adhesive surface with self-cleaning effect
- Interesting design options offered by printing, e.g. shading without additional construction
- Long service life of at least 25 - 35 years
- Cost savings in comparison with conventional transparent roof constructions
- High recyclability
ETFE foil roofs are individually designed to meet the structural requirements of the building. To achieve a thermal insulation effect, foil cushions with multi-chamber systems are used. 

U values:
- 1.51 W/(m²K)
- 0.78 W/(m²K)

Project-specific verification by a hygrothermal analysis for Düsseldorf/Duisburg.

Structures using multi-layer ETFE foils

As the foils are not fabric-reinforced, ETFE is primarily created in the form of pneumatic cushions in a two or multi-layer design—depending on the desired insulation value. These ‘tires’ maintain their form with permanent air support. The span of the individual cushions can be up to 4.5 metres without requiring any additional supporting structure. However, additional cable net reinforcement allows for considerably larger spans. The air support and controls can be largely automated. Individual concepts enable the optimal design to be developed for every project.

<table>
<thead>
<tr>
<th>ETFE (Ethylene-Tetrafluor-Ethylene)</th>
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</thead>
<tbody>
<tr>
<td>Base material</td>
<td>Fluoropolymer</td>
</tr>
<tr>
<td>Total weight (g/m²)</td>
<td>175 (bei 100 μm)</td>
</tr>
<tr>
<td>Tensile strength (N/mm²)</td>
<td>Longitudinal direction 51-58</td>
</tr>
<tr>
<td></td>
<td>Lateral direction 53</td>
</tr>
<tr>
<td>UV-resistance</td>
<td>very good</td>
</tr>
<tr>
<td>Stain resistance</td>
<td>very good</td>
</tr>
<tr>
<td>Translucence</td>
<td>approx. 90 %</td>
</tr>
<tr>
<td>Colour</td>
<td>highly transparent, printing and dyeing possible</td>
</tr>
<tr>
<td>Fire classification</td>
<td>DIN 4102 B1, Flame retardant: EN 13501-1 / B-s1,d0</td>
</tr>
</tbody>
</table>
PROJECT EXAMPLES

Transparent construction with ETFE foils
Scope

- Expert advice and support in the planning phase
- Provision of the testable statistical calculation
- Creating the design plans
- Prefabrication of the entire structure, the membrane and all accessories while maintaining the highest quality standards
- Delivery free to the construction site
- Complete installation from the top edge of the foundations
- Service and maintenance

In all phases of the membrane construction, from the initial draft to assembly, the experienced Ceno team of architects, engineers and project managers will provide you with advice and practical support.

You will benefit from our comprehensive experience in planning, execution and installation, thereby ensuring that the realisation of your idea doesn’t become an adventure but is a superior, aesthetic structure.
Quality guarantee

Together the Ceno clothing operation in Greven and the Sattler clothing operation in Rudersdorf form a multi-site organisational unit. An experienced and qualified team of approximately 200 employees, state-of-the-art manufacturing and processing technologies in a production facility greater than 14,000 m² in area as well as efficient project and quality management guarantee consistently high quality standards. Since 2004, the entire Group has been certified in accordance with DIN ISO 9001:2000 and DIN ISO 14001:2004.

Other product areas

In addition to textile architecture, Ceno Tec enjoys great success with membrane constructions in many other areas including:

- Flood protection systems
- Mobile noise protection barriers
- Hall cladding
- Biogas storage tanks
- Membrane structures for booth construction and interior architecture (illuminated ceilings, room dividers etc.)