# A Review on Tensile Fabric Materials

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**ABSTRACT**

Nowadays we search the results that are better and options that can sustain more. Results, when combined with new materials and construction techniques, that are lighter, stronger and more flexible, we can achieve more in the field of construction and architecture. Tensile structures can extend architects imagination due to construction lightness unlimited length and flexibility, those are innovative and comparatively new solutions, getting more and more popular. The tensile construction field has grown considerably in the last years and is predicted to grow further. Such structures are becoming bigger and more sophisticated, combining modern tensional construction systems and membrane structures in architecture can give great results thanks to their properties, build ability and physics principles. There is a need for professional to be better informed about the general behaviour, physical aspects, the advantages and disadvantages of using tensile membrane structures in relation to big-scale constructions, as well as small canopies. There are many innovations in membrane materials used for such structure. This Research is dedicated for someone who is interested in innovative, solutions that could be used in practice, and with vital interests in building physics, static design and novel building materials.

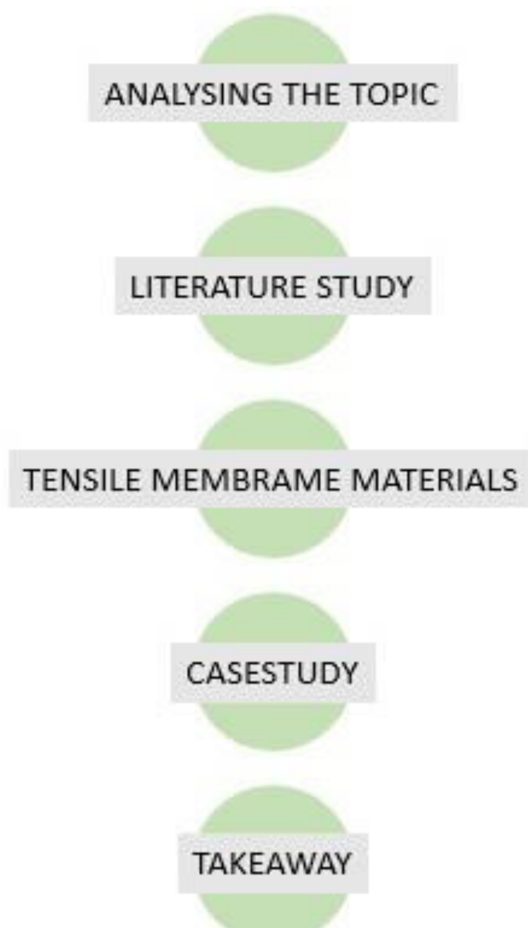
## 1. INTRODUCTION

Tensioned membrane structures (aka tensile fabric structures) are dynamic types of modern architecture that are celebrated for their incredible versatility. From addressing landscape architecture trends to overcoming more traditional challenges, tensioned membrane structures have an incredibly diverse range of applications. The concept behind tensioned membrane structures isn't new. Humans have been using forms of tensioned fabric to create tent structures for centuries, but only in the past few decades have we begun to adapt those principles to create technologically advanced and permanent variations. Today's tensioned membrane structures go far beyond tent designs to include artistic and iconic shade structures, 3D tensile facades, and fabric roof structures that span impressive distances.

Source: https://en.wikiarquitectura.com/building/munich-olympic-stadium/

## 2. METHODOLOGY

This Study is based on qualitative research and empirical quantitative methodologies. Most of the data in the report is provided by articles. Some of the information found in the article is based on interpretation and analysis.




Source: Author

## 3. LITERATURE STUDY

Tensile membrane structures and tensile building envelopes are thin-shell structures. Tensile membranes carry tension with no compression or bending, supported by a lightweight structural system. Made of coated PES, ETFE, PTFE, or PTFE coated fiberglass, the tensile membranes can span large distances and take on a variety of shapes. Most often used for roofs and canopies, tensile structures are capable of creating unique private and public spaces. Tensile structural systems are low-maintenance and provide year-round protection from the elements. Because of their malleability, they are able to complement and not compete with existing architecture and the natural environment. The smooth, reflective surfaces of tensioned membrane structures provide plenty of day lighting, reduce cooling costs and solar gain, and allow the buildings to be more energy efficient. Their innovative forms and inherent efficiencies reduce the amount of materials required to build a structure and the transportation costs, resulting in cost savings. Pavilions, amphitheatres, entertainment venues, museums, hotels, and government and municipal buildings can all realize the benefits of incorporating tensile structures. Tensile structures and tensile building envelopes are easily packaged and transported, so structures can be relocated as needed. Life expectancy can be as much as 45 years

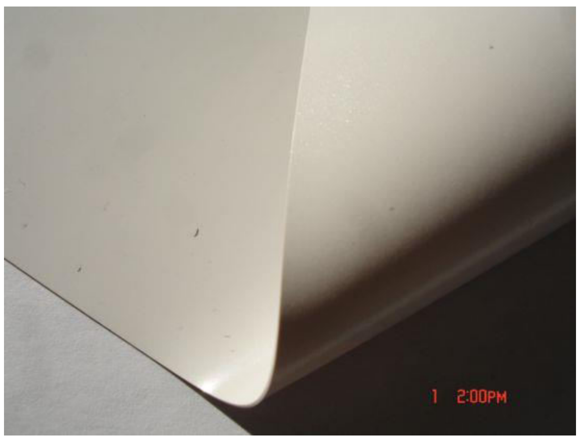
## 4. TENSILE MEMBRANE MATERIALS

One of the key components of a tensile structure is the material used. It determines the aesthetic appeal, durability and has a big influence on costing and maintenance. While deciding on the cover material, main aspects that should be taken under consideration are structure-design and location requirements for the building. Membrane cover types used in tensile architecture vary greatly. At the beginning mostly used fabrics were simple textiles, canvas, woven mats, or fibres. Tensile textile fabrics have a great advantage, are generally easy to make and to stretch. However, the properties, durability and self-cleaning properties of simple textile materials are poor. Its properties will change due to outward movement of the coating mould-increasing agent and ultraviolet effects s that its surface and colour will gradually change overtime.

### 4.1.1 PVC-Polyester Reinforced, coated with PVDF

Nowadays diverse types of membranes are used among them we have PVC, PVDF, Teflon-coated Fiberglas and silicon-coated Fiberglas. One of the newest architectural membrane materials that is proven to be most cost effective and the most prevalent in Tensile Architecture is PVC-Polyester Reinforced, coated with PVDF lacquer on both sides. In general, the service year of a PVC membrane material with coated PVDF surface course is over 25 years, while the service year of PVC membrane material with coated PVDF surface course is 10 to 15 years. In order to improve the durability and self-cleaning of this type of membrane material, a PVF or PVDF surface course can be added to the surface of coating. PVC membrane material is cheap and is can come in various colours. PVC (polyvinyl chlonde) and PVDF (polyvinylidene fluoride) coated polyester fabrics are the most common waterproof membranes. Depending on fabric weight and coating. warranties of up to 15 years are offered making these an extremely attractive long-term solution for any waterproof covered area. Offering good light transmission, they allow diffused natural light to fill the area, eliminating the need of artificial lighting**.**

source: www.archiexpo.com




### 4.1.2 Woven fibreglass coated with polytetrafluoroethylene (PTFE)

As further developments were made in technology, PTFE calmest replace the PVC coated polyester fabric as the material of the membrane structures in Europe. PTFE if an abbreviation for Woven fibreglass coated with polytetrafluoroethylene (PTFE) is a very durable Architectural Fabric available presently in the field PTFE is essentially inert to environmental contaminants, ultra-violet light, has fine resistant properties and a proven lifespan exceeding 30 years. PTFE membrane material has good durability and does not turn yellow or mouldy in due to atmospheric environment. Additionally, rainwater will flow away after forming water drips on the surface as it has good self-cleaning properties. However, PTFE membrane material is more expensive and is stiffer that the substitutes.

source: www.archiexpo.com

### 4.1.3 Ethylene Tetra Fluoro Ethylene (ETFE)

One of the most exciting membrane materials in the design industry Ethylene Tetra Fluoro Ethylene (ETFE) foil has set the construction world alight with the huge range of potential applications. It is the most comonny used membrane building material of the moment, ETFE fall a high translucency fabric which is very economically friendly, practical and show the best properties for big-scale projects. An ETFE root can be formed either by stretching the ETFE into panels, or alternatively by supported membrane by a cable net. If finds use in two different forms, as single ply ETFE and as an alternative, ETFE foil can be used to form ETFE cushions. Single ply ETFE provides minimal insulation but maximum lightness Using inflation units the ETFE cushions provide a lightweight and emulated roof installation and can be manufactured to any shape or stee. For glare reduction, alternatively, by adding additional layers of ETFE foil to a cushion, light transmission and solar gain can be controlled. Multi-layer ETFE cushions can also be constructed. The inflated cushions and single ply ETFE are approximately 1% the weight of glass-this means a significantly reduced amount of structural framework is required which in turn has a substantial cost benefit. Its light weight nature, and very similar appearance to glass, means that it is frequently chosen for new buildings, adopting this material in order to achieve large spans without intermediate steelwork ETFE is often used as an effective replacement for glazing as it transmits up to 5 per cent of natural light and weighs a fraction of the mass and tends to be used to create inside outside connection in a project. As well as being a low flammability material, the ETFE is also self-extinguishing which meat is it is a good option when health and fire safety is a specific concern. The fool itself can also be a engineer to help control and adapt to solar glare, the fol can be printed with a pattern to provide glare reduction, incorporating movable layers and printing. A good example of ETFE material is the Allianz Arena football stadium in Munich, where the inflated cushions are at internally with LED lighting Other major projects around the gibe include the Water Cube Olympic swimming arena in Begging and the Eden Project in Cornwall, which was the first structure to use ETFE cushions

Source: www.Seele.com

### 4.2 Membrane Materials Properties

The acoustic properties of membrane material are similar to its optical qualities and include reverberation and transmission loss properties for the various frequencies of sound waves. Furthermore, the ceiling can collect the reflection of sound waves to impact upon the indoor acoustic environment. Reverberation and sound absorption properties determine the quality of acoustic properties of buildings with membrane structures. Unfortunately, single layer fabric materials have poor acoustic properties and can result in strong echoes and weak sound absorption Corresponding architectural measures need be taken to improve the acoustic environment of buildings with membrane-structure. There is an ongoing study in this field. There is a number of sound-absorption membrane on the market, the lining can lower reverberation and increase sound absorption but at the same time can degrade translucent qualities The thermal insulation performance of buildings with membrane structures can be a challenge, single layer membrane is unlikely to provide a realistic comparison to a traditional construction mater Depending on a type of structure it can be either rather poor, but could be used as a theatre for wrath climate, On the other hand it can be really efficient if it is used as a void membrane with air captured incident, more curtate for cold or mild environment. its layer membrane system can be made to meet thermal insulation requirements for summer and winter, war of 2.708 W/m2K can be achieved, depending on a type of form and structure

### 4.3 Sustainability Features of PTFE

The low-surface free energy of the material creates a surface which is readily cleaned by rainwater. It is also completely immune to UV degradation. This unique combination of inertness, thermal stability and surface properties make Birdair's PTFE-coated fabric membrane ideal for projects requiring superior weather and fire resistance. PTFE fiberglass is additionally Energy Star and Cool Roof Rating Council certified. During scientific tests of its solar properties, it was discovered that PTFE fiberglass membranes reflect as much as 73 percent of the sun's energy while holding just seven percent on its exterior surface. Certain grades of PTFE fiberglass can absorb 14 percent of the sun's energy while allowing 13 percent of natural daylight and seven percent of re-radiated energy (solar heat) to transmit through. The principal element that differentiates PTFE fiberglass membrane from conventional glazing is its advantageous shading coefficient. As lighting levels increase, even cooler climates can realize overall energy savings using PTFE fiberglass membrane. In very warm climates, even low lighting levels make PTFE fiberglass membrane an energy saver versus conventional systems. The savings can be more dramatic when compared with conventional sloped glazing systems.

Source: www.birdair.com Source: www.Seele.com

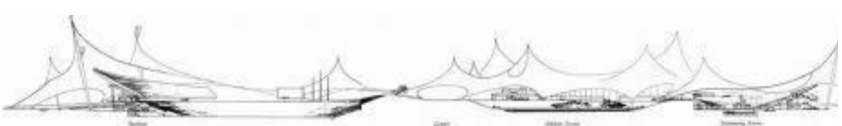
# 5. CASE STUDY

**Munich Olympic Stadium**

- Architect - Günther Behnisch
- Technical Architect - Leonhardt & Andrä
- Structural Engineer - Frei Otto
- Construction Company - Günther Behnisch
- Built in - 1968 - 1972
- Width-68 m, Length-108 m
- Location - Munich, Germany

Section

The first Olympic Games in Germany were held in 1936 in Berlin. For the latter to be held in Munich in 1972, Frei Otto Günther Behnisch and were responsible for teaching the world a new Germany, in a new light. Their goal was to design a structure that emulates the motto of the games: "The Happy Games", "The Happy Games" as a whimsical architectural response to cover the heavy and overbearing shadow left by the Berlin games.



Source: https://en.wikiarquitectura.com/building/munich-olympic-stadium/

Spaces

Besides the buildings covering membrane, a number of volumes also covered by the suspended surface are used as flexible spaces for stands, used during the games or any other event. As the cover system works through the artificial landscape to the Main Stadium, the membrane begins to fade compressed to about the same. The dramatic change in the scales of the deck increases the perception of artificial floating landscape that is formed from soil, to create large open volumes again become integrated into the soil.

Source: https://en.wikiarquitectura.com/building/munich-olympic-stadium/

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# 6. CONCLUSIONS

The study has helped me understand a lot about researched forms of structures and new types of membrane materials available on the market, and I've discovered a lot of fresh facts in this subject that I didn't know about before. Membrane architecture and unique structures will become more widely used in the future. Many textiles are accessible in the field in terms of materials. PVC, PVDF, and Teflon-coated Fiberglas are prominent types of membranes used in tensile structures. PVC and PVDF are less expensive options. It is critical to develop innovative strategies in order to improve cost-related elements and sustainability. New processes and sophisticated materials are hoped to be developed to make membrane structures more robust and architecturally appealing.

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