“Auditorium 1919 Sacmi” - Evaluation of the technological performances in the design phase of the walls and roof subsystem realized with ETFE cushions.

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Abstract

"Auditorium 1919" is a building of high qualitative value both in terms of content and aesthetics, an innovative, eco-friendly auditorium linked to the size of man and his wellbeing signed by the architecture studio A2 studio Gasparri e Ricci Bitti Associated Architects.

EOSS Architettura and Canobbio Textile Engineering dealt with the executive design, construction and installation of the façade and the roof realized with ETFE cushions. During the engineering phase of the aforementioned building components, particular attention has been given to the correct definition of the technological performance requirements like energy optimization, thermal properties, definition of design service life, durability, focus on minimum ordinary maintenance activities.

In this regard, considering the continuous technological progress of technical fabrics for building industry and the methods of application of the same, various operators (fabric producers, research centers, etc…) have been involved. For example, for the definition of the thermal performance of the façade and the roof, necessary to verify the environmental sustainability of the chosen solution, the Politecnico Milano Textile Hub was involved through a computational simulation "Optical and Thermal characterization of a multi-layered ETFE”
1. Introduction

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According to Sacmi 1919 auditorium designers, developing a project with apparently simple shapes but a channeling of attention, where light and architectural volumes merge, giving the structure dynamism and lightness, it was the main challenge "... the quality of the result essentially depended on two elements: transparency and ... absence ". "So we thought about "textile walls ", inspired by the use of this extraordinary material - bubble-like air cushions defined by ETFE fluoropolymer membranes - used in the most modern and famous sports facilities of the world, such as the Allianz Stadium of Munich or the Sea World of Beijing, but also in projects at the forefront of urban furnishing. " Appropriately hooked to the iron structure and " inflated with compressed air, these membranes make it possible to create covered spaces while maintaining the same light as open spaces, with extraordinary performance in terms of resistance to climatic conditions. The result, in terms of aesthetic effect, is a building almost suspended within these "bubbles".

Figure 1: View of the building (photographer Lorenzo Rinella).
A structure where transparency dominates, that polite, never brazen transparency that is well suited to a high-level professional, social and cultural environment: permeable inside, from the outside the “bubbles” play a double effect, sometimes veil, some other mirror. On the other hand, the protagonist is the natural light that intervenes, redefining the rooms according to the time of day, the appearance of the sky, even the mood of the individual visitor. Light and transparent, the bubbles envelop the structure, and allow a dialogue between the volumes that seem to float in them.

The notes given by the architects Gasparri and Ricci Bitti, designers of the auditorium, express the intentions at the base of the project, and more specifically define the architectural and performance characteristics that the building envelope should have guaranteed. The architects Di Fusco and De Rosa, of EOSS Architettura Studio associated, with Canobbio Textile Engineering, engineer Angeleri, took care of the executive design and construction of steel structures and ETFE cushions.

2. Design Development.

Referring to the reported standards and to the requests made by A2 Designers, in the executive design phase of the facades and roofs made with ETFE multi-layer cushions, particular attention was paid to defining the performance requirements of the following technological components that would later define the building envelope:
• etfe cushions
• cushions anchoring system
• metal support structure
• connecting elements with the other surfaces of the building
• arrangements for the passage of technical systems

In this respect, the executive design proceeded together with the verification, at Canobbio manufacturing company, of connection details of metal parts, the technical joints, the pillow detailing, etc. and with the verification at some research laboratories of the performance characteristics of the materials used such as the determination of the thermal transmittance of the ETFE cushions, the latter performed by the Politecnico di Milano through the computational simulation "Optical and thermal characterization of a multilayer ETFE"
Figure 5: Typical cross section view.

Figure 6: Connection detail between stell structure and ETFE pillows
3. Mock-up

The construction of the Mock up of a portion of the façade in a space made available by the client allowed to check definitively with the architects of the A2 Studio, with the client and with the other technicians involved, whether the objective of building an high quality cladding, capable of meeting all the requirements established in the preliminary design phase was achieved.
The result was the design and construction of a building with a very slender metal structure thanks to the lightness of the ETFE, weighing about one percent of the glass while providing the same standard of insulation. The design and construction of a building organization that, according to the principles of "biomimesis", allows the building to be changeable: the cushions depending on the incidence of sunlight are more or less reflective, more or less transparent; it also allows dynamic response to climate stresses: the air cushions, with the right sensors and controls, inflate / deflate depending on the weather conditions of the climate.

4. Some Numbers

Pneumatic Structure is performed with "3 layer pillows" with ETFE films 250µm + 100µm + 250µm. The pillows are stabilized with an internal pressure of 400Pa for the facade, and 400 Pa for the roof, up to 600Pa in case of snow.

It represents the perfect fusion of aesthetics and technique. The façade and part of the cover made of 3-layer ETFE cushions demonstrates its ability to innovate not only the world of architecture, but in terms of technology and design.

Amount of roof cushions = 17x
Amount of facade cushions = 86x
Total cladded area = 1.000 sqm
The objective of the thermal and solar transmittance was:
U value = 1.9 [W/m²k]
g-value = 0.71
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5. Optical and Thermal characterization of a multi-layered ETFE - SACMI

In the project “Auditorium 1919” the thermal performance of the facade was a fundamental issue for the correct evaluation of the environmental sustainability of the solution. Therefore, Politecnico di Milano Textiles hub has been involved to determine the parameters by means of a computational simulation “Optical and Thermal characterization of a multi-layered ETFE – SACMI”. According to the results obtained from the analysis, it has been determined that the 3-layer ETFE cushion solution meets the general given sustainability requirements.

Figure 10: ETFE pillows of the facade

Figure 11: Fritted layed chosen for the top pillows.
Figure 12: Optical and thermal characterization
6. Site Installation

Figure 13: Main supporting structure.

Figure 14: Typical roof corner detail.
Figure 15: Installation of the facade pillows.

Figure 16: Inflated roof ETFE pillows.

Figure 17: Inflated facade ETFE pillows.

Figure 18: View of the complex by night with the effects of the lighting system embedded in the pillows. (Photographer: Lorenzo Rinella).
Figure 17: Inflated facade ETFE pillows.

Figure 18: View of the complex by night with the effects of the lighting system embedded in the pillows (Photographer: Lorenzo Rinella).