Chapter 3
Technical Textiles in Building Facades:
An Exploration of Structural and Aesthetic Potential

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ABSTRACT

Technical textiles have the potential to transform building façade design by uniting structural performance with aesthetic creativity. This chapter investigates the diverse functions of advanced textile materials in contemporary architecture, emphasizing their mechanical properties, environmental adaptability, and visual impact. This analysis assesses the tensile strength, thermal performance, and weather resistance of textiles such as ETFE, PTFE, and composite textiles when used in façade systems. The efficiency and design flexibility of these materials are compared to those of conventional cladding methods. Additionally, it addresses the challenges related to durability, cost, and scalability in practical applications. By analyzing case studies and synthesizing research on potential materials, the chapter provides a comprehensive overview of innovative options, highlights their advantages and limitations, and offers recommendations for future applications of technical textiles in the field.

1. INTRODUCTION

Technical textiles have become a revolutionary type of material in modern architecture, especially when it comes to designing and engineering façades. Their incorporation into architectural practice signifies an increasing focus on sustain-

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able, versatile, and aesthetically groundbreaking solutions for construction related sustainability challenges. As the construction industry throughout the world deals with issues such as energy efficiency, urban retrofitting, and environmental effect, textile-based façades provide a unique way to do things that combines lightness, flexibility, and usefulness (Trencher et al., 2016; Procaccini & Monticelli, 2024). This integration is not just a technological breakthrough; it is also a reaction to urgent structural and ecological needs. It marks a major change in how materials can affect the look and performance of modern structures. In the European Union, buildings account for nearly 40% of total energy consumption and a similar share of carbon emissions (Solis-Guzman et al., 2014). Much of this infrastructure is aging and energy-inefficient, requiring urgent renovation or retrofitting to align with contemporary sustainability standards. Conventional retrofitting approaches, however, are often costly, time-consuming, and disruptive to occupants (Almeida et al., 2025). In contrast, textile-based façades offer a lightweight, non-invasive, and cost-effective solution that can enhance both the energy performance and aesthetic character of buildings, making them particularly well-suited for sustainable retrofitting applications (Iturralde Carrera et al., 2025).

These materials can be engineered to perform multiple architectural functions, including solar shading, thermal regulation, acoustic optimization, and even structural reinforcement (Singh, 2021; Procaccini & Monticelli, 2024; Jalil, 2020). Structurally, technical textiles can be employed in diverse configurations such as tensioned membrane and pneumatic systems that enable complex geometric forms while maintaining lightweight support (Zagubień et al., 2025). They can also be integrated into composites and reinforced mortars to strengthen existing materials like concrete or timber, thereby extending the life of heritage or seismic-prone buildings (Kouris & Triantafillou, 2018; Corradi et al., 2023). Moreover, when incorporated into laminated glass units or double-skin façades, textiles can improve mechanical resilience and thermal regulation while preserving transparency and visual fluidity (Gibilisco et al., 2024; Denz et al., 2021). In safety-focused designs, high-strength textile claddings and blast curtains provide protective barriers against impact, fire, and explosion, adding a critical layer of resilience to modern façades (Bedon & Rajčić, 2019; Houtman, 2015).

Beyond their functional advantages, technical textiles open new aesthetic horizons for architectural expression. Their pliability enables architects to experiment with free-form geometries that are difficult to achieve with rigid materials. The ability to modulate light and transparency allows façades to function as dynamic filters, mediating between interior comfort and exterior appearance. The vast range of available colors, textures, and translucencies facilitates designs that are both contextually responsive and visually engaging. Recent innovations in adaptive and responsive textiles further expand this potential, enabling façades that adjust in real time to