

## Dynamic Facades: A Literature Review on Double-Skin Façade with Lightweight Materials

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**Abstract :** Integrating dynamic facades into contemporary building design is shaping a new era of energy efficiency and user comfort. These innovative facades, often constructed using lightweight construction systems and materials, offer an opportunity to have a responsive and adaptive nature to the dynamic behavior of the outdoor climate. Therefore, in regions characterized by high fluctuations in daily temperatures, the ability to adapt to environmental changes is of paramount importance and a challenge. This paper presents a thorough review of the state of the art on double-skin facades (DSF), focusing on lightweight solutions for the external envelope. Dynamic facades featuring elements like movable shading devices, phase change materials, and advanced control systems have revolutionized the built environment. They offer a promising path for reducing energy consumption while enhancing occupant well-being. Lightweight construction systems are increasingly becoming the choice for the constitution of these facade solutions, offering benefits such as reduced structural loads and reduced construction waste, improving overall sustainability. However, the performance of dynamic facades based on low thermal inertia solutions in climatic contexts with high thermal amplitude is still in need of research since their ability to adapt is traduced in variability/manipulation of the thermal transmittance coefficient (U-value). Emerging technologies can enable such a dynamic thermal behavior through innovative materials, changes in geometry and control to optimize the facade performance. These innovations will allow a facade system to respond to shifting outdoor temperature, relative humidity, wind, and solar radiation conditions, ensuring that energy efficiency and occupant comfort are both met/coupled. This review addresses the potential configuration of double-skin facades, particularly concerning their responsiveness to seasonal variations in temperature, with a specific focus on addressing the challenges posed by winter and summer conditions. Notably, the design of a dynamic facade is significantly shaped by several pivotal factors, including the choice of materials, geometric considerations, and the implementation of effective monitoring systems. Within the realm of double skin facades, various configurations are explored, encompassing exhaust air, supply air, and thermal buffering mechanisms. According to the review places a specific emphasis on the thermal dynamics at play, closely examining the impact of factors such as the color of the facade, the slat angle's dimensions, and the positioning and type of shading devices employed in these innovative architectural structures. This paper will synthesize the current research trends in this field, with the presentation of case studies and technological innovations with a comprehensive understanding of the cutting-edge solutions propelling the evolution of building envelopes in the face of climate change, namely focusing on double-skin lightweight solutions to create sustainable, adaptable, and responsive building envelopes. As indicated in the review, flexible and lightweight systems have broad applicability across all building sectors, and there is a growing recognition that retrofitting existing buildings may emerge as the predominant approach.

**Keywords :** adaptive, control systems, dynamic facades, energy efficiency, responsive, thermal comfort, thermal transmittance

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