VRIJE UNIVERSITEIT BRUSSEL

The faculty of Engineering of the Vrije Universiteit Brussel invites you to attend the public defense leading to the degree of

DOCTOR OF ENGINEERING SCIENCES

of **Zehra Eryuruk**

The public defense will take place on **Monday 21st September 2026 at 4pm** in room **D.2.01** (Building D, VUB Main Campus)

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THE ENVIRONMENTAL PERFORMANCE OF LIGHTWEIGHT MEMBRANE AND FOIL STRUCTURES
FROM MATERIAL ANALYSIS TO BUILDING-SCALE LIFE CYCLE ASSESSMENT

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Abstract of the PhD research

Membrane structures and lightweight building materials offer significant advantages in terms of material efficiency and design flexibility. However, their environmental impact remains a crucial aspect that requires further investigation. This dissertation examines the life cycle assessment (LCA) of various lightweight and conventional construction materials, focusing on their global warming potential (GWP), energy consumption, and overall sustainability.

The research is structured into several case studies covering different scales and applications of lightweight structures. A method is proposed to analyse temporary and reusable membrane structures to assess their potential for circularity and reducing material waste. Small-scale permanent projects are compared with structures made of conventional materials such as metal panels to evaluate their environmental advantages and disadvantages. Large-scale applications, including ETFE cushion systems and air-supported structures, are being studied to quantify the efficiency in terms of material and operational energy consumption.

A key focus of the dissertation is to investigate how technical textiles and foils compare in terms of environmental impact with more conventional materials such as glass, concrete, metals, and wood (both for covering and structural components). Additionally, the study examines the energy demand of inflatable structures, such as air domes and pneumatic enclosures, which, despite their low material footprint, can exhibit significant energy consumption during operation. The research also includes a comparative analysis of façade systems and the influence of different material choices on the overall environmental performance of buildings. By integrating material properties, system configurations, and energy demand, the research provides insights into optimizing lightweight construction for sustainability.

The findings contribute to the development of environmentally conscious design strategies for membrane and lightweight structures. The research results aim to inform architects, engineers, and policymakers about the long-term implications of material choices and guide future developments towards a more sustainable built environment.