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 **Gilles Vandereecken**

The public defense will take place on **Thursday 26th November 2026 at 4pm** in room **D.2.01** (Building D, VUB Main Campus)

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STRETCHING THE PERFORMANCE OF WOVEN BASALT CEMENT COMPOSITES
IMPACT OF CRIMP AND TEXTILE ARCHITECTURE ON SHORT- AND LONG-TERM FLEXURAL PROPERTIES

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Abstract of the PhD research

Concrete is one of the most widely used construction materials, but it usually relies on steel reinforcement to provide sufficient tensile strength. Since steel can rust and thus deteriorate, it must be protected by a thick layer of concrete. This further increases the weight of concrete structures and the amount of material required. An alternative to that is textile-reinforced concrete, in which steel rebars are replaced by grids of strong fibres. As these fibres are less susceptible to corrosion, thinner and lighter structural elements can be produced, reducing material consumption and the environmental impact of construction.

This doctoral research investigates the use of textiles made from basalt, a naturally occurring volcanic rock. Basalt fibres offer promising mechanical properties, but their behaviour when embedded in concrete is not yet fully understood. The aim of this research is to determine how the structure and treatment of these textiles influence the strength, cracking behaviour and long-term performance of the resulting material.

To explore this, different textile configurations were embedded in thin concrete specimens and subjected to bending tests. Attention was given to the waviness of the woven fibres, the use of a protective epoxy treatment, and the differences between two-dimensional and three-dimensional textile reinforcements, in which different textile layers are connected.

The results show that the straightness and the treatment of the fibres strongly influence their ability to reinforce the concrete. Straightening the initially wavy fibres allows them to contribute more effectively when the concrete starts to crack, while applying an epoxy treatment improves their strength and interaction with the surrounding concrete. Combining both approaches leads to significantly better bending performance. Although three-dimensional textiles do not necessarily increase the maximum load that the material can withstand, they improve crack control and offer advantages under long-term loading compared to their two-dimensional counterpart.

The research also examines how the material behaves under repeated or sustained loading and when exposed to harsh environmental conditions. While protective treatments improve resistance to repeated loading and ageing, prolonged exposure to hot water can gradually weaken the basalt reinforcement.

Overall, this research provides a better understanding of how basalt textiles can be used effectively to reinforce concrete. The findings contribute to the development of thinner, lighter and more material-efficient construction elements, while highlighting the importance of protecting the fibres to ensure reliable long-term performance.