

The faculty of Engineering of the Vrije Universiteit Brussel and the Graduate School in Ecole Polytechnique de Bruxelles of the Université Libre de Bruxelles invite you to attend the public defense leading to the degree of

DOCTOR OF ENGINEERING SCIENCES (VUB)

DOCTORAT EN SCIENCES DE L'INGENIEUR ET TECHNOLOGIE (ULB)

of **Ciska Gielis**

The public defense will take place on **Monday 20th October 2025 at 5 pm** in room **D.2.01** (Building D, VUB Main Campus)

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MICROFIBRE-ENHANCED 3D TEXTILE REINFORCED CEMENTITIOUS COMPOSITES (3D TRCs):

INVESTIGATION OF MECHANICAL RESPONSE, CRACK FORMATION, AUTOGENOUS HEALING POTENTIAL AND DURABILITY

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Abstract of the PhD research

This research explores the combination of continuous 3D textile reinforcement and short synthetic microfibres in Textile Reinforced Cementitious (TRC) composites to develop an optimised material with enhanced durability and autogenous healing capabilities.

TRCs are a more resource-efficient alternative to traditional steel-reinforced concrete, enabling the development of more slender and lightweight structural elements. Incorporating three-dimensional (3D) textiles into TRCs further optimises the material, offering considerable advantages compared to equivalent planar (2D) textiles such as more straightforward manufacturing and superior flexural properties. As cement-based materials, however, TRCs remain prone to cracking, which can compromise durability in both new construction and retrofitting applications. To address this, short microfibres are integrated into the cementitious matrix to control crack formation. These fibres provide crack-controlling properties by bridging (micro)cracks and restricting their crack width, resulting in more and narrower cracks. This controlled cracking behaviour not only improves durability but also promotes autogenous healing, the intrinsic property of cementitious materials to close fine cracks in the presence of water.

The presented research investigates the synergetic interaction between knitted alkali-resistant (AR) glass 3D textiles, short polypropylene (PP) or polyvinyl alcohol (PVA) microfibres and the cementitious matrix, evaluating the effect of the reinforcement combination on the material's mechanical properties, cracking behaviour, autogenous healing potential and durability. The research shows the positive effect of the integration of short synthetic microfibres on the 3D TRC's tensile and flexural mechanical properties, as well as its cracking behaviour, resulting in significantly more and narrower cracks, even for limited fibre volume fractions of 1.0 v%. The enhanced crack formation enables notable visual crack closure through autogenous healing, particularly when the material is submerged in water. Though mechanical strength recovery from healing is limited, the visible sealing of cracks and regain in impermeability indicate a promising path towards more durable and sustainable cementitious materials.