Functionalized carbonfiber-based textile reinforcements for textile reinforced concrete

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Abstract: Textile reinforced concrete (TRC) is a promising building material that offers significant advantages, including resource efficiency, corrosion resistance, and innovative design approaches, while maintaining exceptional mechanical properties. Although grid-like carbon fiber non-crimp fabrics (CF-NCF) are widely used in TRC applications, previous studies have highlighted their inherent limitation in pullout behavior [1]. This paper proposes a novel solution to this challenge by introducing grid-like non-crimp fabrics enhanced with carbon fiber tetrahedral-shaped rods (CF-T-Rods) to improve the pullout strength. In addition, integrating textile-based strain sensors provides comprehensive insights into material behavior. The mechanical performance of the developed textile reinforcements is thoroughly investigated through quasistatic tensile testing of TRC specimens. A comprehensive analysis, including parameters such as tensile strength, elongation at break, and energy absorption, is systematically provided, along with data from textile strain sensors.

Keywords: *Smart Concrete, Textile reinforced concrete, textile-based strain sensors, tetrahedral shaped carbonfiber rods.*

Improving the bond performance of CF-NCF within TRC is crucial for enhancing the mechanical behavior and longevity of TRC constructions, particularly in terms of impact resistance. It is advantageous to achieve a balance between sufficient pull-out strength and pull-out behavior to enhance the resilience of the cementitious composite in both quasistatic and impact scenarios. This balance is essential for enhancing the strength of the initial crack and enabling controlled pull-out behavior after crack formation to restrict crack propagation and maintain ductility.
Therefore, this work introduces the systematical textile integration of CF-T-Rods into CF-NCF reinforcements using the tailored fiber placement technology. The manufactured textile reinforcements were functionalized with CF-based strain sensors as proposed in [2]. An overview is depicted in Figure 1, showing the different textile reinforcements with 0 (reference) up to 4 integrated CF-T-Rods. The reinforcements were embedded into a concrete matrix in order to perform quasistatic tensile tests. The mechanical results of the tensile tests are shown in Figure 2.

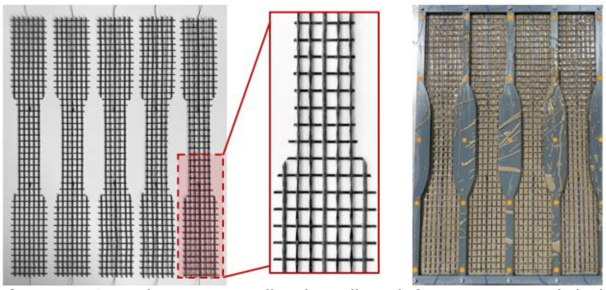

Figure 1 Overview over realized textile reinforcements and their embedment into a concrete matrix

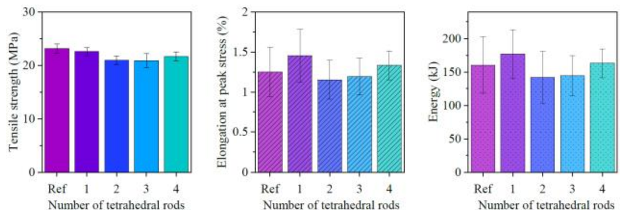

Figure 2 Mechanical results of the tensile tests including tensile strength, elongation at break and absorbed energy for all variants

This work includes an extensive mechanical and optical analysis as well as an evaluation of the measured textile strains. The paper concludes by discussing the potential of this research and identifying areas for further research to drive advancements in the field of TRC.

Acknowledgement: *The authors express their gratitude to the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) for the financial support provided in the framework of the Research Training Group GRK 2250 "Mineral-bonded composites for enhanced structural impact safety", project number 287321140.*

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