STATIK DYNAMIK

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COMPUTATIONAL APPROACHES TO A ROBUST SEGMENTAL LINING DESIGN IN MECHANIZED TUNNELING

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The tunneling industry is undergoing a significant transformation in response to the challenges posed by climate change. The mass production of segments in mechanized tunneling makes the determination of the segment dimensions and reinforcement a crucial factor in the costs and environmental impact of a project. While linings are traditionally constructed using pre-cast reinforced concrete (RC) segments, the use of Steel Fiber Reinforced Concrete (SFRC) offers advantages in terms of durability, production, logistics, and possible material savings.

To investigate the serviceability performance, load-bearing capacity, and ductility of SFRC segments and compare their response to RC segments, a numerical modeling methodology for FRC and RC structures is proposed. The modeling framework utilizes a discrete crack model based on interface elements to predict the structural response and the formation of cracks within segmental linings. The predictive performance of the modeling framework is proven by an extensive validation campaign consisting of experiments related to important SFRC characteristics and tunneling load cases, including two blind simulation competitions. Subsequently, the non-linear fracture response of segments with different reinforcement schemes is evaluated within the framework of a reference tunneling project. Different safety formats are investigated regarding their application on SFRC structures and an uncertainty quantification, assessing the influence of important fiber design parameters, is carried out. Finally, a reliability-based optimization is utilized to design a cost-effective and durable hybrid fiber-reinforced segmental lining with a reduced environmental impact by considering accepted failure probabilities for the ULS and SLS as constraints.

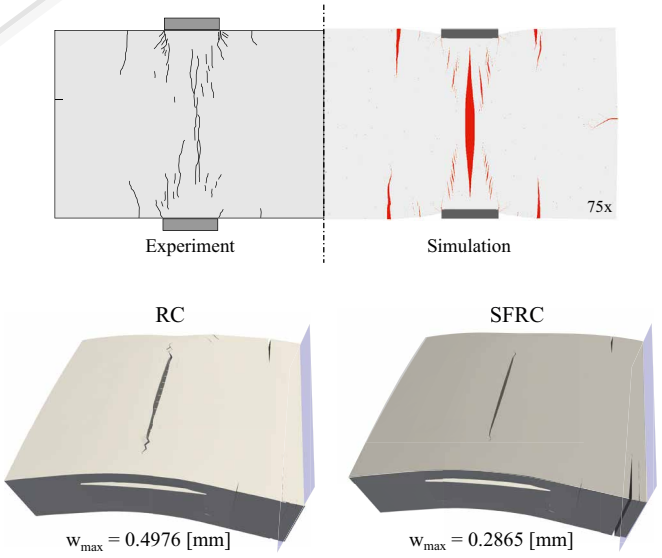

Fig.: Post-cracking response of fiber (SFRC) and conventional reinforced (RC) concrete segments subjected to thrust jack loads.

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