Interaction of normal and shear loads in carbon reinforced slab segments

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Abstract

In recent years, textile reinforced concrete (TRC) has become increasingly important in scientific research. Thin slab segments of TRC in particular show great potential for use in secondary structural systems in bridges or high-rise buildings. However, research has not yet sufficiently investigated all load combinations and some questions remain unanswered in the design process. Especially in restrained structures the interaction of moment, shear, and normal tensile forces might govern the design. To investigate this load combination, a new test setup was developed at the Institute of Structural Concrete of the RWTH Aachen University. A numerical study complements the investigation to extend the database beyond the limited range of experimentally tested parameters. According to the results, the shear resistance decreases with increasing tensile normal force, yet separation cracks have no negative influence.

Keywords: slabs; textile reinforced concrete; shear; tension; experimental investigation; numerical investigation

1 Introduction

In recent decades, numerous damages on steel-reinforced bridge structures have been caused by corrosion of the reinforcement. One way to counteract this issue is the utilization of non-metallic and thus non-corroding reinforcement. Bridge elements reinforced with carbon fiber reinforced polymers (CFRPs) are ideally suited for this purpose due to their superior material properties [1–3]. The depth of concrete cover for such reinforcement is determined solely by ensuring sufficient bond and can typically be minimized compared to conventional steel rebar. This reduction allows for smaller member heights in exposed exterior applications. Whereas steel-reinforced concrete bridge slabs typically require costly protective coatings which call for continuous maintenance, construction with non-metallic reinforced concrete might omit such measures and consequently save maintenance cost throughout the object's life cycle [4].

For a safe and at the same time economical design, a suitable shear design model is required, which is not yet available. The reason for this is the still insufficient research into the shear transfer of slabs with non-metallic reinforcement. In particular, the interaction of tension, shear, and moment has not yet been investigated. While the flexural behavior of carbon concrete has already been extensively studied [5], research in shear behavior is limited to studies without normal force [6, 7] or with compressive normal force [8, 9]. Temperature or shrinkage can lead to a combination of shear and tension in any concrete member. Bracing loads or loads through activation of subordinate slabs in the

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