Textile Reinforced Concrete (TRC) as Torsion Strengthening

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Summary

More and more old buildings must be strengthened. There are various methods by which to improve the torsional resistance of existing reinforced concrete elements. One method entails the use of Textile Reinforced Concrete (TRC). Test results will be used to demonstrate that TRC combined with AR-glass can be used to strengthen the torsional resistance of quadratic reinforced concrete elements. Both, an increase of improved resistance as well as improved serviceability, will be presented. Reduced torque and decreased crack widths are specific results that will be emphasized. An initial approach to determine the torsional resistance of square strengthened concrete components reinforced by TRC (AR-glass) will also be introduced.

Keywords: Textile Reinforced Concrete; TRC; torsion; strengthening; quadratic reinforced concrete; AR-glass.

1. Introduction

The necessity to improve the structural behaviour of existing reinforced concrete elements occurs more and more frequently as a result of building conversions, increases in load scenarios and corrective structural measures (e.g., shoring up walls, etc.). To date, these improvements are largely provided by strengthening through the use of reinforced concrete. The consequence of using such strengthening measures requires reinforcement dimensions and a concrete cover (e.g., corrosion protection) of several centimetres, where by the cross-section and the dead load are drastically enlarged.

Numerous studies by several researchers investigated whether or not textile reinforced concrete can be used to strengthen structural elements, and if so, precisely how this works (Brameshuber [1] / Hegger et al. [2]). Textile reinforced concrete is a composite material with layers that consist of high tensile, fine-grained concrete and textile reinforcing. The small maximum aggregate size of 1mm for the fine-grained concrete matrix allows for minimal layer sizes of about 2mm.

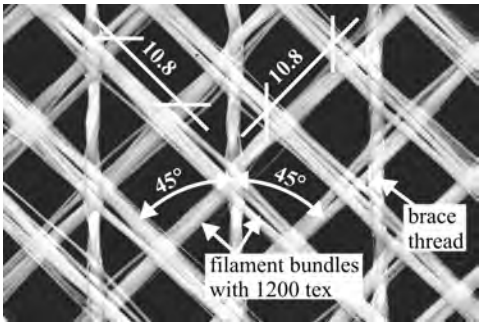

Fig. 1: Textile fabric of the reinforcement

AR-glass or carbon fibers, which were previously converted to textile fabric, are used as fiber material (Fig. 1). Depending on the anticipated load capacity, fabrics with up to four reinforcement directions can be produced. Thus, the reinforcing layer can be systematically strengthened

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while simultaneously optimizing the use of the carrying capacity.

Qualification of the use of TRC in the retrofit of flexural components was already proved by several tests (Brückner et al. [3] and Weiland et al. [4]) and practical uses (Weiland et al. [7]). The reinforcing effect regarding the shear force resistance was demonstrated with beams and T-beams (Brückner et al. [5] and Schladitz et al. [8]).

The improvements of the torsion-bearing strength as well as the mathematical determination of the carrying capacity of TRC strengthened structural elements achieved within the first tests will be shown in the full paper.

2. Experimental investigations and conclusions

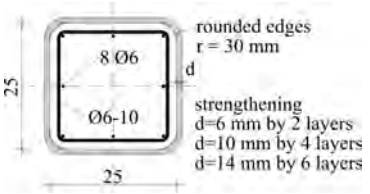

Fig. 2: Arrangement of the strengthening

The experimental investigations included unstrengthened reference structural elements as well as structural elements with varying numbers of layers of textile reinforcement (Fig.2 and Table 1).

A fabric of AR-glass with a mass per unit area of 263 g/m² was used as textile reinforcement (Fig. 7). The rovings used provided a fineness of 1200 tex (that means 1200 g/km length) and were arranged in at ±45°configuration with 10.8 mm spacing.

Table 1. Tested elements

elements	strengthening
1.1 and 1.2	reference without strengthening
2.1 and 2.2	only 10 mm fine grained concrete
3.1 and 3.2	2 layer AR-glass fabric *
4.1 and 4.2	4 layer AR-glass fabric *
5.1 and 5.2	6 layer AR-glass fabric *

* title: NWM-3-003-07-p2 (15%)

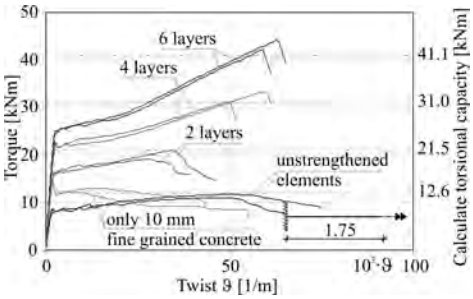

Fig. 3: Torque-twist curve

Components were examined in an experimental rig in which it was possible to measure the torsional load. The two presses in opposite directions with equal loads can almost entirely eliminate shear forces and bending moments.

As the experiments showed, the torsional resistance of the reinforced structural elements was higher than that of the unstrenghtened structural elements. The resistance increased proportionally as the number of textile reinforcement layers grew (Fig. 3). It can be seen that the strengthened structural elements had a noticeably smaller twist at the same load level than that of unstrengthened structural elements.

Test results have shown the possibility of strengthening reinforced concrete elements with TRC. Both the torsional resistance and the serviceability can be improved considerably by the use of textile reinforcement. Comparing calculations display the torsional resistance being able to be investigated by existing strut and tie models. Future analyses will emphasize structural elements having traction strut angles other than 45° as well as units of differing geometric configurations.