Shear Strengthening with Textile Reinforced Concrete

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Summary

A large part of existing bridges in Germany exhibits deficits in the shear capacity under static and cyclic loading according to the current design rules. More structures are expected to demand refurbishment and strengthening within the next years especially due to the current conditions of many older road bridges. Since a reconstruction of the respective bridges is not feasible in many cases, the assessment and development of effective strengthening methods becomes more important. The use of textile reinforced concrete (TRC) offers an innovative alternative to existing strengthening measures by combining the advantages of lightweight glued CFRP-stripes (Carbon Fiber Reinforced Polymer) and additional concrete layers. For the above reasons, full scale tests on strengthened and non-strengthened I-shaped prestressed concrete beams ($h = 0{,}7$ m, $l = 6{,}5$ m) under cyclic shear loading as well as single span reinforced concrete slab strips ($b = 0{,}5$ m, $h = 0{,}28$ m) under static shear loading were carried out at the Institute of Structural Concrete at RWTH Aachen University. The paper presents the test results with regard to the effectiveness, advantages and possible fields of application of this innovative strengthening method.

Keywords: shear; strengthening; bridges; testing; slabs; reinforced concrete; prestressed concrete; textile reinforced concrete; cyclic loading.

1. Introduction

Many bridges in Germany and other European countries were built in the 1960s and ′70s, making assessment, maintenance and refurbishment of the existing infrastructure network more important [1]. The design loads of the traffic load model have been increased several times because of rising traffic loads (Fig. 1). Furthermore, the German design codes for concrete bridges changed increasing the required minimal shear reinforcement ratio and reducing the calculated shear capacity. In this context, the shear capacity of bridge deck slabs in transverse direction and prestressed superstructures in longitudinal direction are of special interest.

Most existing bridge deck slabs were designed according to former codes and built without shear reinforcement. In contrast, the current design codes [2] require shear reinforcement in many cases and the shear capacity of the respective structures is substandard. The shear capacity of many existing bridge superstructures in longitudinal direction was originally determined applying the principal tensile strength criterion according to the German codes for prestressed concrete [3],[4]. The shear check according to the current design code for concrete bridges [2] is based on the more conservative so-called “strut-and-tie model with crack friction” [5]. Hence, more shear reinforcement is now required in the web. Therefore, more structures are expected to be strengthened within the next years also with respect to the current condition of many older road bridges.

Since a replacement of the respective bridges is not possible or reasonable in many cases, the analysis, evaluation and development of efficient strengthening methods become more important.

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