An analytical model to determine the shear capacity of prestressed continuous concrete beams

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Abstract

Structural reassessments of existing older prestressed concrete bridges based on current German standards often uncover substantial deficits in terms of the required shear reinforcement in the main girders in longitudinal direction. This is due to the negligence of the concrete shear capacity that can be determined using the *compressive arch model* as long as plane sections remain plane and only vertical cracks due to bending occur in state II. In case of inclined cracks due to shear plane sections do not remain plane. An *extended compressive arch model* is derived from experimental and numerical investigations that can determine the concrete shear capacity analytically even in case of existing inclined cracks in state II. This model also takes into account that parts of the acting shear forces are covered by the truss model.

Keywords: bridge reassessment; post-tensioned concrete beams; shear resistance; arching effect

1 Introduction

Due to increasing traffic loads, existing road bridges need to be reassessed. These structural reassessments based on the current German standard DIN EN 1992-2 for concrete bridges often uncover substantial deficits in terms of the required shear reinforcement in longitudinal direction for existing older prestressed concrete bridges. In the case of many thousand bridges built in the 1950s and 1960s, the existing and the required shear reinforcement amount can vary by factor 2 to 3 or even exceed these values [1, 2]. As a result of these deficits, many structures are strengthened by cost-intensive measures.

However, these deficits are only partly due to the increases of road traffic load values in current load rules and standards. Most of the deficit is attributed to the evolution of structural shear capacity calculation models. Current models for shear design do not take the shear resistance of the inclined compression force in concrete into account.

Bridge reassessments in Germany are based on a 4-level-approach that is regulated in the recalculation guideline [3]. Reassessments that are executed according to level 1 are based on verification procedures that are similar to design procedures of new bridges. Level 2 bridge reassessments allow doing certain modifications of the verification procedures in order to raise structural resistances moderately. However, in many cases these modifications cannot compensate existing deficits, especially in terms of significant shear deficits.

Level 3 reassessments are based on verification procedures according to level 2 and enable to verify bridge reassessments by means of material properties taken from samples of the existing structure and test loadings.

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