Shear Load Carrying Capacity of Existing Prestressed Concrete Members

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Referees

Recent investigations have shown that an insufficient amount of shear reinforcement (according to current bridge design codes) is a major deficiency in existing older German prestressed post-tensioned concrete bridge structures. In order to ensure a sufficient future safety and usability of these structures, cost and time effective strengthening measures are often carried out. In some cases, bridges even have to be replaced because strengthening is technically and economically not feasible. However, to date no shear failures of German prestressed post-tensioned concrete bridges have been reported. This caused doubts about the accuracy of the models used in the prediction of the available shear load carrying capacity and lead to intensive research about more refined approaches for determining the capacity of existing structures. At the chair of concrete and masonry structures of TUM several research projects related to this topic have been carried out or are still ongoing. The German Structural Assessment Provisions for Existing Road Bridges already took up some of the intermediate research results and feature a slightly modified shear design approach.

Background

Most shear design provisions used for the redesign of existing structures have been derived for reinforced concrete members and were subsequently adapted for prestressed concrete members. However, recent results from the assessment of existing prestressed concrete bridge girders and analytical evaluations as well as numerical simulations of prestressed concrete shear test beams indicate that this approach does not lead take into account all possible load carrying mechanisms observed in prestressed members.
A very conservative estimation of the actual shear capacity can for example be observed in beams with a low amount of shear reinforcement. This is illustrated in Fig. 1. The shear capacity according to DIN-Fachbericht 102 is compared to the actual failure shear force in 119 prestressed concrete beams with stirrups from a test database developed for this thesis. In regions with shear reinforcement ratios $\rho_{sw}$ of less than 1% the actual shear force is up to 5 times the shear force predicted by the design approach. If an existing structure possesses a shear reinforcement ratio in this range, the actual capacity will be strongly underestimated, resulting in unnecessary interventions.

Fig. 1: Prediction accuracy of DIN-Fachbericht 102 shear design approach as a function of geometric shear reinforcement ratio $\rho_{sw}$ for 119 post-tensioned test beams

**Scope of the dissertation**

The dissertation will commence with recalculation of existing prestressed concrete test beams according to several current shear design provisions. The results will be used to identify the need for amendments of these provisions. By means of numerical simulations of selected test beams, including the stochastic nature of geometry and material strength input values, the actual load bearing mechanisms will be illustrated. The findings will be used to propose modified analytical redesign models for an accurate assessment of existing prestressed post-tensioned concrete beams in shear.

**References**


