Abstract

The assessment of the load-bearing capacity of existing concrete structures is, in many cases, performed on the basis of the design models in the current design standards. In these design models, the minimum shear reinforcement ratio, and the maximum spacing of the shear reinforcement, have been introduced to prevent a brittle shear failure. However, many existing concrete structures do not comply with these requirements. In such cases, it is not possible to account for the shear reinforcement when assessing the shear capacity. The development of an accurate shear model that accounts for even small amounts of shear reinforcement is, therefore, a need to suitably evaluate the level of safety and avoid unnecessary strengthening of existing concrete structures and the associated environmental impact.

When assessing the load-bearing capacity of existing concrete bridges, the bridge deck is typically simplified to act as a beam. For reinforced concrete beams without and with small amounts of shear reinforcement, it is well-known that the shear failure is characterised by the development of a critical shear crack. After developing the critical shear crack, the shear capacity is governed by the sum of shear forces carried by each potential shear-transfer action. Therefore, the development of an accurate shear model should account for the shear contribution from each of these shear-transfer actions. This thesis investigates these shear-transfer actions of reinforced concrete beams without and with small amounts of shear reinforcement.

The thesis comprises four large experimental campaigns and the development of analytical formulations designed to evaluate the shear force carried by each potential shear-transfer action. The experimental campaigns consist of a combination of shear tests of beams with and without shear reinforcement and experimental evidence for the developed analytical formulations of shear-transfer actions.

The thesis shows that the developed analytical formulations for the shear contribution from each of these shear-transfer actions can predict the applied load from the measured displacement of the tested beams, with and without shear reinforcement. These shear-transfer action models can then subsequently be combined with a model for the shear behaviour of reinforced concrete beams to evaluate the shear capacity of such beams. Thereby, engineers will be able to accurately predict the shear capacity of concrete beams with and without shear reinforcement, including beams with shear reinforcement that do not comply with the requirements in the current design standards.