Abstract

In solid construction, the transmission of compressive forces between precast elements often takes place via a dry butted joint. One application of this type of connection is found in tunnel construction using segmental lining, where predominantly compressive forces have to be transferred through the longitudinal joint between two segments. As a result of the cross-sectional reduction in the contact area, the longitudinal joint is usually decisive for the load-bearing capacity and thickness of the tunnel segment, respectively. An optimization of the longitudinal joint, therefore, offers high potential for improving the resource efficiency of tunnel structures. Hence, the Institute of Structural Engineering at the TU Wien is researching an optimized reinforcement and design concept.

Since, in the case of the longitudinal joint of tunnel segments, the combination of partial area loading and confinement reinforcement determines the load-bearing behaviour, this work aims to contribute to a better understanding of the two load-bearing mechanisms and, in particular, their interaction. At the beginning of the work, mechanical fundamentals and conceptualities are under exploration. Further on, early and current design models, subsequently used for recalculations, are presented. The further work focuses on the extensive experimental and numerical investigation of a series of tests comprising cylindrical reinforced concrete bodies with partial area loading and different confinement reinforcement.

Within the framework of the experimental investigations, it is possible to identify the influence of the confinement reinforcement on the component behaviour by varying the reinforcement diameters and spacings (resulting in reinforcement ratios of 0–2,5 %). Both an increase in the ultimate load and the deformation capacity can be determined as the reinforcement ratio of the test specimens increases. The extent to which normative design models are suitable for the case under consideration (a load transmission through a tapered cross-section including confinement reinforcement) is examined by comparing the results. The comparison of the calculated ultimate load with the test results shows that the behaviour of the test specimens is not represented appropriately with the current calculation approaches. Due to the relatively strict separation of the modeling concepts for partial area loading and confinement effect, the ultimate load is either significantly underestimated or overestimated. Similarly, the modeling of the test series in ABAQUS yields only partially satisfactory results. The selected modeling strategy, which provides for the use of a (calibrated) material model for the differently reinforced test series, does not allow for a realistic representation of the behaviour of the entire test series. In the numerical simulation of confined components, the deformation behaviour of the interacting model components proves to be very challenging, in particular.

Based on the findings of this work, the adaptation of the modeling strategy or the use of extended input options in ABAQUS shall be examined to enable comprehensive parameter studies for confined members in the future. In addition, the quantification of the ultimate load shares for partially surface-loaded members with confinement reinforcement requires further investigations to allow for developing a combined design model.