STRENGTHENING OF SHORT CORBELS WITH EMBEDDED THROUGH-SECTION REINFORCEMENT

Summary

The subject of the dissertation is strengthening of existing reinforced concrete corbels. The thesis that it is possible to effectively increase the carrying capacity of the corbels with embedded through-section (ETS) rods. Such bars behave similarly to the ones which had been placed before the concrete was put. It may be done by ensuring that the deformations between the materials (steel and concrete) along the entire length of the concrete are the same, which results in better performance than the corbel with reinforcement without bond.

The first part of the paper presents an overview of the available literature on the issues under consideration. Most research works are focused on the use of composite materials (FRP) as strengthening. According to the quoted items, the destruction of such corbels is violent and not signaled which is due to the loss of bonding (debonding). Moreover, almost all works were carried out on previously unloaded elements. This part of the dissertation presents an overview of both code and authors' own methods of determining the load capacity of corbels as well as publications on adhesion of post-installed reinforcement.

The main part of the dissertation is the author's own experimental research. The study covered two categories of corbels: moderately shear slenderness ($a_c/d = 0,5 \div 0,6$) and with short span-to-depth ratios ($a_c/d \approx 0,3$). By the start of the strengthening process, a force equivalent to about half of the ultimate load was applied on each corbel, which was determined on the reference models. All corbels were being strengthened with the load acting at the same time. Threaded rods (M16, class 8.8) were used as additional reinforcement. Some of the corbels were equipped with a steel accessory anchored to the concrete with post-installed screws. During the tests deformations on the reinforcement and the concrete surface were measured and the cracks and their width were recorded. A digital image correlation system (Aramis) was used during one of the test series. On the whole, sixteen corbels were tested: five reference and eleven strengthened ones. Increase of load capacity up to 64% (using embedded through-section rods only) and over 150% for the steel accessory was observed.

The last part of the dissertation contains computational analyses carried out using different methods and the author's own approaches. As a result of these analyzes, it was found that the methods based on the strut-and-tie models correspond very well with the results of the author's own tests for the moderate shear slenderness corbels and the post-installed reinforcement can be treated in the same way as the bars placed before the concrete was put. The situation is different in the case of corbels with short span-to-depth ratios. It has been shown that the existing calculation methods lead to more conservative results if the mechanical reinforcement ratio of the element is smaller. In this case the author of the dissertation proposed his own calculation method which makes the load carrying capacity of the corbel dependent, among other things, on deformations perpendicular to the compressed concrete strut. Due to the different method of destruction the corbel with steel accessory (C – III) was analyzed separately. In that case the ultimate load was determined by the load capacity of anchors.

As a result of the studies and analyses it was found that corbels with moderate and high shear slenderness $a_c/d \geq 0,5$ and low reinforcement ratio can be effectively strengthened by embedded through-section rods. Such reinforcement is less effective for corbels with short span-to-depth ratios $a_c/d \approx 0,3$. The integral part of the work is an attachment with detailed measurement results for each model. These data can be easily used by other researchers for their own analyses.

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