Factor of Transverse Rebar Affecting Crack Behaviors of Concrete Element Subjected to Bending

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Summary

Crack behavior of reinforced concrete (hereinafter RC) member, includes RC-beam and RC-slab, is the one of major parts in design for the serviceability limit state. It has a significant influence on durability and serviceability. However, in the primary factors which affect crack behaviors, influence of transverse rebar was considered and investigated rarely by recent codes and researchers, although its effect is obvious. In order to investigate the influence of transverse rebar, a large number of experimental and theoretical work for RC-slabs subjected to uniaxial, biaxial tension and bending have been performed at the Institute for structural Engineering of the University of the German Armed Forces Munich from 2001. The recent test results, which focus on the influence of transverse rebar on crack behaviours for RC slab-strip, have been described and analysed in this paper. These test results indicate that crack behaviours, in which first and finial crack pattern, crack direction, crack depth and width, would be influenced once the positions of transverse and longitudinal rebar were shifted. Furthermore, other factors of transverse rebar will be performed in the further with the financial support from German Research Foundation (DFG). These results will be regarded as a foundation of further theoretical analysis.

Keywords: Crack behaviours; concrete element; transverse rebar; bending, crack pattern.

1. Introduction

Crack behaviour of RC member subjected to bending is the one of major parts in design for the serviceability limit state. In general, Bond force, reinforcement stress and concrete cover are considered in recent codes sufficiently. However, the influence of transverse reinforcement (here is vertical to the bending direction) which affects crack behaviour as a single variable was considered rarely. In order to achieve a realistic theoretical formulation of crack distances, which considers the influence of transverse reinforcements, a large number of experimental and theoretical investigations of RC-slabs subjected to biaxial tension and bending loading were performed at the Institute for Construction Engineering of the University of the German Armed Forces Munich in last seven years.

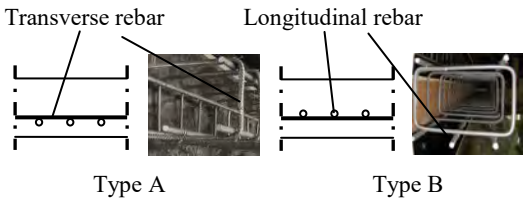


Fig.1 Transverse bar position.

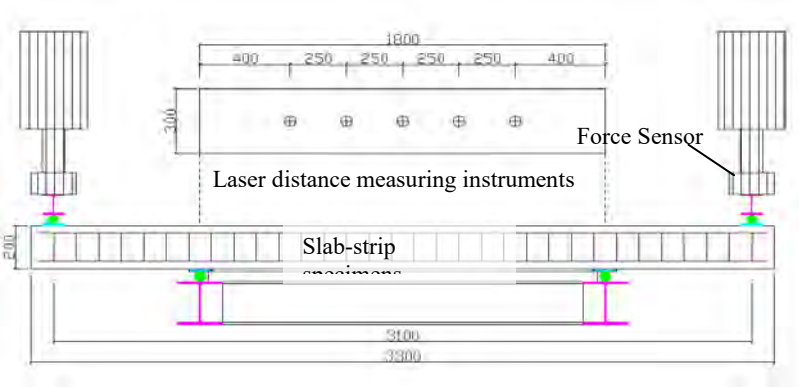
At present, under the financing supports from German Research Foundation (DFG), a new test work for RC member subject to bending have been performing in the following three years, which

https://doi.org/10.2749/222137809796068253

aims to establish a uniform formulation of crack distances considered the effects of transverse reinforcement.

2. Experiment

The RC slab-strip were designated PS01 to PS12. Casting and testing 12 slab-strips were divided into three test group based on different concrete grades (Group 1-Normal concrete C30, Group 2-High strength concrete C10 and Group 3-Light weight concrete LC30).



The slab-strips in each group were differentiated into Type A and Type B from different transverse bar position to longitudinal bar (as shown in Fig. 1). A diagram of the test equipment and the specimen are shown in Fig.2.

Fig. 2: Test setup and instrumentation (unit: mm)

3. Experimental results

The crack pattern under the loading 51kN, which was approximately 85% of the ultimate load, was shown in Fig. 3. Crack patterns characteristic include crack position and direction, cracking timeliness, crack distance and crack width. Crack behaviors of Type B, which were compared with Type B, are summarized as: (a) spread in crack patterns, (b) random in crack direction, (c) dense in crack distances, (d) shallow in crack width and (e) continuity in cracking time. In test of type A, crack positions are affected obviously by the transverse rebar, that's because (a) transverse rebar formed cavities outside of the longitudinal rebar and, cavities became the potential crack with 8mm width; (b) transverse rebar occupied large bond area between concrete and longitudinal rebar, which decreased the effect of bond force. In contrast, the negative effects of transverse rebar are reduced in test of type B. Meanwhile, the active effects of longitudinal rebar are reacted. Crack pattern represent crack uniform distribution and continuous cracking to various direction.

Fig. 3: Influence of Transverse bar position for crack pattern

4. Conclusions and Acknowledgements

As the transverse rebar variable which affects crack behaviours has been considered, RC slab-strips subjected to bending were carried out. Referring to the test results, the transverse rebar positions have influence on crack behaviours. The crack behaviours have been changed along with different transverse positions inside longitudinal rebar, which represented as dense in crack distance and small in crack width and depth. According to the authors' opinion, the capacity of crack resistance of RC slab-strip seems to be improved. Furthermore, based on the test results, the rebar vertical to load direction should be layout inside of longitudinal rebar (opposite side of concrete tension surface), so that the negative effects of transverse rebar could be partly avoided. In the following two years, more variables will be considered and tested including: (a) diameter of rebar, (b) distance to concrete surface, (c) spacing of rebar, (d) angel to longitudinal rebar and (e) concrete grade. After these, concrete slab test and analysis will be carried out. Finally the authors would like to give their acknowledgements to the German Research Foundation for financial support of the ongoing research work reported about in this paper.