STUDY ON THE SHEAR BEHAVIORS OF RC NEW-BEAM AND OLD-SLAB COMPOSITE COMPONENT

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Keywords: Beam-Slab Composite Component, shear connector, shear behaviors; experimental study.

Abstract. In order to study the influences of shear span ratio and stirrup spacing on the shear behaviors of RC beam-slab composite component, static shear experiment of 9 RC beam-slab composite component and 3 beam-slab casting component were made. The results show that the development trend of flexural-shear crack of composite component is associated with both the shear span ratio and the stirrup spacing. The outer shear connector of the composite component produces the diagonal crack which develops and extends to the support and a horizontal crack to the load point is accompanied on the bond face oblique crack. The lower end of the oblique crack extends to the support and the upper end extends to the load point or the off second shear connector. The diagonal crack of beam-slab casting component extends to the load point and the interface of the beam and slab has no horizontal crack.

Introduction

The composite beam has been used in engineering practice for many years. ACI-ASCE Committee 333 proposed “suggestion on composite beam for building design” in the 1960s. By the contrast test between the composite beam and the cast-in-place beam, Guo pointed out that the stress of the composite beam under the secondary load exceeded and must be limited. Based on the I-shape test beam, Kang proposed the computational schema and calculation formula of the failure shear strength of the diagonal compression on the reinforced concrete I-shape beam (including T-shape beam) under concentrated load and the results of calculation were in good agreement with the results of tests.

The shear performance, seismic measures and shear connector design in the combined interface of composite beam are the key to ensure the two part of the concrete before and after casting to work together and have also been concerned about by many scholars so far. A lot of theoretical analyses and experimental studies show that taking appropriate seismic measures in the combined interface can guarantee the composite beams to work together.

Although many scholars at home and abroad have conducted lots of experimental studies and theoretical analyses and put forward relevant design proposals, the stress characteristics of the new-beam and old-slab composite structure based on the practical engineering have not been studied. This paper has studied on the shear behaviors of reinforced concrete beam and slab composite component.

Experiment situation

Considering the influences of the different shear span ratio and the stirrup spacing on the shear behaviors of the composite beam, 9 reinforced concrete beam-slab composite components were made and 3 beam-slab casting components were also made to contrast with the beam-slab composite components. The length of the composite beam was 2000mm, the width was 100mm and the height was 250mm. To ensure that shear failure occurs to the components, 2 grade Ⅲ steel of diameter 16mm and 3 grade Ⅲ steel of diameter 18mm were at the bottom part of beam-end. 2

grade Ⅲ steel of diameter 10mm was used as the handling reinforcement. Grade Ⅲ steel of diameter 6mm was used as stirrup reinforcement and the spacing was 100mm, 125mm and 150mm. The length of the composite slab was 2000mm, the width was 600mm and the thickness was 60mm. Two-layer two-way reinforcement of grade Ⅲ steel of diameter 6mm and spacing 100 was reinforced into the slab to simulate the actual reinforcement situation of the original slab. The thickness of the cover to reinforcement was 10mm. The design intensity level of concrete was c30 and the concrete was fine aggregate and commercial. Cross-sectional reinforcements of the composite components and the casting components are shown in figure 1.

In order to ensure the integrity of the composite beam and slab was fine, the number of shear connector was designed 6. the collocation of the shear connectors took equidistance. The diameter of the concrete open-holes was 90mm. 1grade Ⅲ steel of diameter 10mm was used as the reinforced connection. Schematic view of shear connector collocations of beam-slab composite component is shown in figure 2. the parameters of specimens are shown in table1. the test set-up is shown in figure 3.

a）Beam-Slab Composite Component

b）Beam-Slab casting component

Fig.1 Cross-sectional reinforcements of components

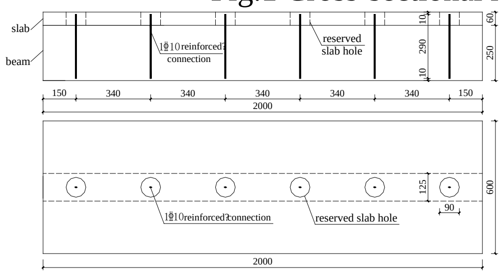


Fig.2 Schematic view of shear connector collocations of Beam-Slab Composite Component

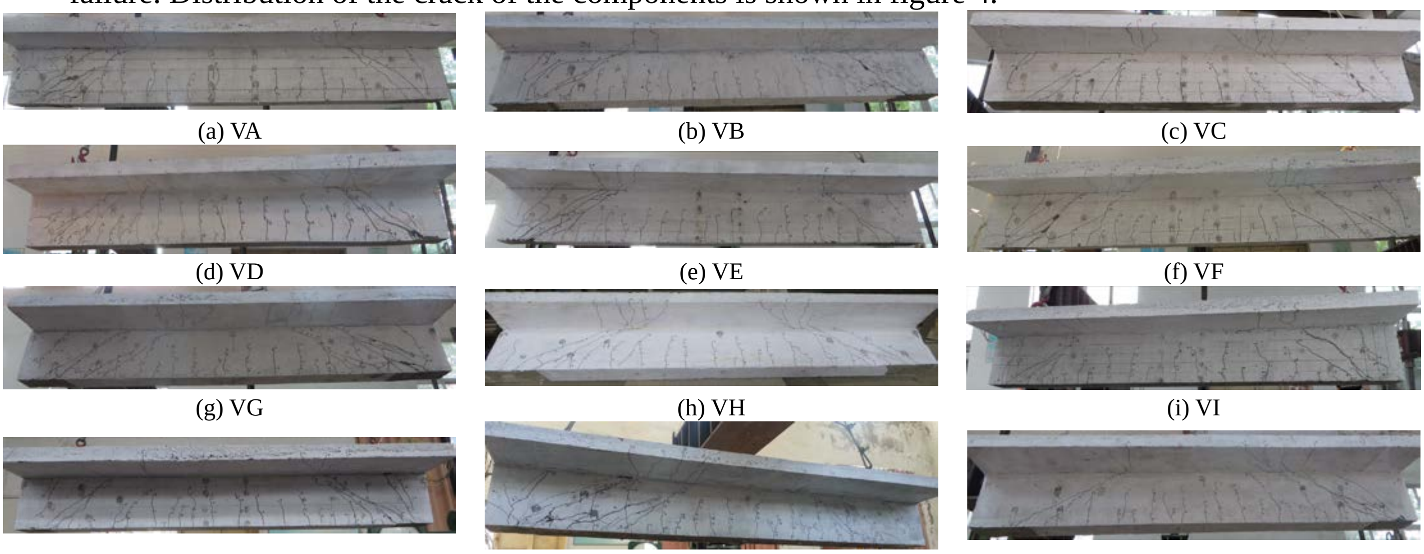
Fig.3 Test set-up

Table1 Parameters of Specimens

Component number	Component type	Number of shear connector	Shear span ratio	stirrup spacing(mm)
VA	composite component	6	1.62	100
VB	composite component	6	1.96	100
VC	composite component	6	2.29	100
VD	casting component	0	1.62	100
VE	composite component	6	1.62	125
VF	composite component	6	1.96	125
VG	composite component	6	2.29	125
VH	casting component	0	1.96	125
VI	composite component	6	1.62	150
VJ	composite component	6	1.96	150
VK	composite component	6	2.29	150
VL	casting component	0	2.29	150

Results and analysis of static test

For composite components, they were in elastic deformation stage at the beginning of loading; with increase load, the first crack was appeared in pure bending section of the tension zone, it was appeared in the beam span nearby for most of the components and under the loading point for individual components, and then several vertical bending cracks were appeared in succession in the pure bending section; with load continued increasing, the first vertical crack in curved shear section of the tension zone was appeared approximately under the second shear connector off the end of the component and several vertical cracks were also appeared between the second shear connector off the end and the end of the shear connector; load constant increasing, the vertical cracks in curved shear section began to extend and develop obliquely, which meant the flexural-shear diagonal crack was appeared; at the same time, the height of bending cracks in the pure bending section was continuously extending, the width was continuously broadening, and became gradually stabilized; in the process of loading, the diagonal crack developing from the end of the shear connector to the support was produced in all of the composite components; horizontal crack was produced in the combined interface, it extended from the end of the composite component or the end of the shear connector to the beam span, and when the horizontal crack reached the point of loading nearby, it extended to the bottom of slab rather than continued to move forward in the combined interface; with the further increase of load, web shearing diagonal crack was appeared in curved shear section, the lower end extended to the support and the upper end extended to the loading point or the second shear connector off the end; after the web shearing diagonal crack extended to the combined interface, it coincided with the horizontal crack; the cracks under the bottom of slab extended to the thickness of the slab horizontally or diagonally and all the cracks were concentrated under the loading point; at last, the concrete of the two sides of the web shearing diagonal crack produced obvious dislocation, the composite component failed and presented the form of shear compression failure. Distribution of the crack of the components is shown in figure 4.



(a) VA (b) VB (c) VC

(d) VD (e) VE (f) VF

(g) VG (h) VH (i) VI

(j) VJ (k) VK (l) VL

Fig.4 Distribution of the crack

Compared the composite component with the casting component whose the shear span ratio and the stirrup spacing were the same, the diagonal cracks of the casting component all extended to the loading point because of no shear connector. Meanwhile, the interface of the beam and the slab did not appear the horizontal crack. The other distribution of the crack of the composite components was comparatively similar with the casting components.

Conclusion

By studying the shear behaviors of 9 reinforced concrete beam-slab composite components and 3 beam-slab casting components, the main conclusions are as follows:

(1) The extension and development trend of the flexural-shear diagonal crack of the composite components was related with both the shear span ratio and the stirrup spacing. When the stirrup spacing was the same, the larger the shear span ratio was, the more the flexural-shear diagonal cracks could extend to the combined interface; when the shear span ratio was the same, the larger the stirrup spacing was, the more the flexural-shear diagonal cracks could extend to the combined interface;

(2) The diagonal crack developing from the end of the shear connector to the support was produced in all composite components. At the same time, the horizontal crack was also produced in the combined interface and extended to the loading point;

(3) When the shear span ratio was 1.62 or 1.96, the upper end of the web shearing diagonal crack extended to the loading point; but when the shear span ratio was 2.29, the upper end extended to the second shear connector off the end;

(4) The diagonal cracks of the casting component all extended to the loading point because of no shear connector. The interface of the beam and the slab did not appear the horizontal crack. The other distribution of the crack of the composite components was comparatively similar with the casting components.

Acknowledgments

The authors appreciate the support of the national natural science foundation of China (51278445, 51578478).

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