Beam-Column Composite Connections

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1. Introduction

Multi-spans continuous bridge, which is designed to provide continuity across the supports, is sometimes integrated as a composite mixed rigid frames with many advantages in the performance of the structure and construction cost saving. Elimination of bearings between beams and piers is a good selection in maintenance works for corrosion of them and in structural performance for seismic. The objective of the study is to provide a basic concept by essential tests for the design of those types of connections such as steel girders and concrete piers.

2. Experimental models and test procedures

Five specimens as shown in Fig.1 were prepared by changing the stud arrangements and flange width, column height and arrangement of the base reinforcements called as U-shape bars at the connection part of the column as shown in Fig.2 and Table 1. H shape beam of 100×200×9×6mm was used as the steel beam, reinforced concrete rectangular column has the cross section of 20cm×24cm and small studs of 35mm height and 6mm diameter were used. The compressive strength and elastic modulus of the concrete were 296kgf/cm^2 and 188000kgf/cm^2, respectively.

The test specimen was set in the test frame top to bottom as shown in Fig.3 and the steel beam was pin-supported. By giving constant vertical load as dead weight of the girders, the column was loaded horizontally at the end of the pier.

3. Experimental results and discussions

In Fig.4, the envelope curves of load-displacement cycle results of every specimen are shown. The curve of specimen A became horizontal at very low load. It seems due to small resistance against the bending moment at the bottom of the column. Even though the column breadth was 20cm, the steel flange breadth was only the half and studs number was only 6. Also, as the stud height was very low, the main crack in the column occurred just over the stud heads. In the specimens C,D and E, the maximum loads went up over 1000kgf due to the increased resistance for tension at the stud arrangement part. In specimen C, the resisting stud number was 5 but the cracked cross section of the column became large. In specimens D and E, due to ten studs, the load carrying capacity increased. In those three specimens, the curves after the maximum loads did not go down so remarkably. It seems to be due to restraint of bending crack opening by the vertical normal force.

The specimen B failed as shear failure because only the column height was short, therefore, the displacement has dropped suddenly from the linear increasing curve.

In Table 2, the maximum loads are listed with the results of the series of H/D=10 of studs. Only the result of specimen A of H/D=5.8 seems to be irregular. By comparing the both series, the results of H/D=10 are larger than the present H/D=5.8. The tendency can be explained by the difference of failure modes, that is, the specimens of H/D=10 failed as reinforced concrete beams because the reinforcements in the column have yielded. On the other hand, the specimens of H/D=5.8, almost specimens have failed by pull out type of studs or pure tension failure of concrete without reinforcement.

Fig.5 is an example of the comparison of stud height. By the long studs, anchoring of reinforcement became sufficient and the reinforcements could resist until yield strength.

Fig.6 is a comparison of load-displacement curves. The analytical result was obtained by FEM analysis of the Common software by MARK. The analytical result is fairly fitting to the experimental results.

4. Concluding remarks

The study will be continued to get more useful data for the design of the connection of steel beam and concrete column. In some cases, studs will be arranged to resist against shearing force. Also, analytical approach will be Carried out to make conventional structural models for the connection parts.

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Table 1 Specimens details

Specimen	Number of studs	Frange width	Length of column	U-bars
Type A	6+6	10cm	80cm	no
Type B	6+6	10cm	50cm	no
Type C	5+5	20cm	80cm	no
Type D	12+12	20cm	80cm	no
Type E	12+12	20cm	80cm	yes

Table 2 Maximum load (kgf)

Specimen	Maximum load	
	Studs (H/D=5.8)	Studs (H/D=10)
Type A	399	977
Type B	1000	1499
Type C	1051	1168
Type D	1211	1439
Type E	1193	1604

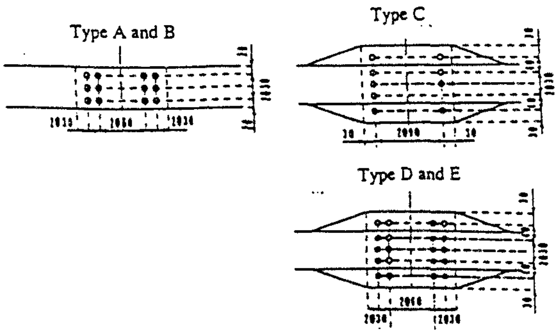

Fig 1 Arrangement of studs

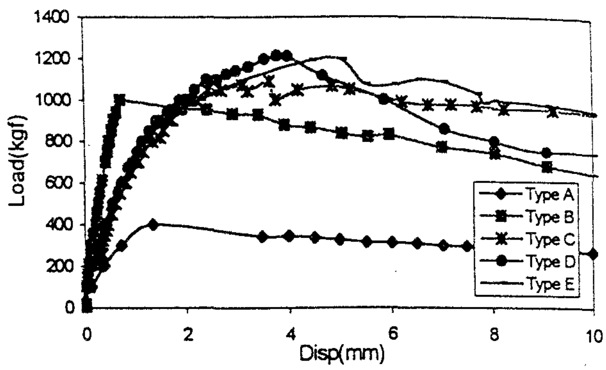

Fig.4 Load-displacement curve of all types

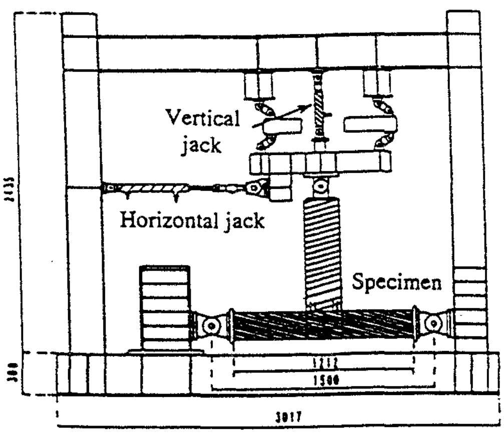

Fig.3 Experiment set up

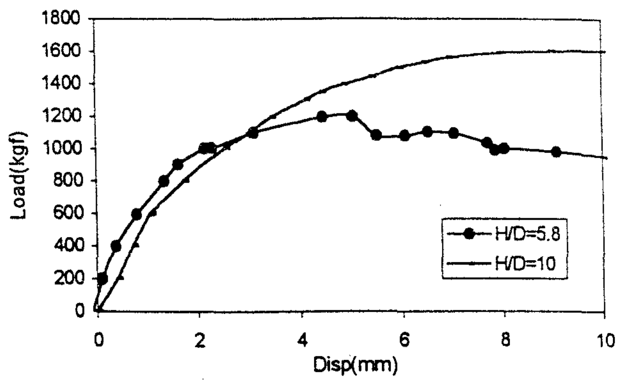

Fig.5 Comparision of displasements by stad's H/D

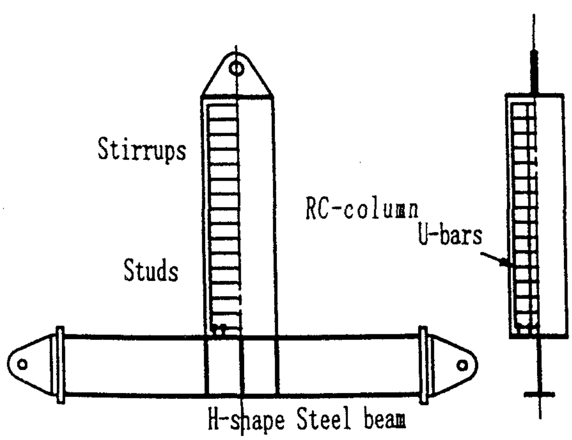

Fig. 2 Typical speci men

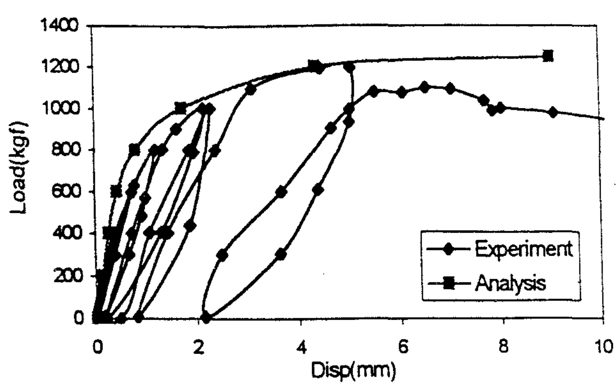

Fig.6 Analytical example for Type E