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Structural Tests and Analyses of H-Shaped Beam-to-Column Connections with Reformed T-stub Components

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Abstract. In steel structures, the connection which a column is combined to a beam is rigid for efficient stress transmission to each component of structures. In analyses and designs of structures, connection parts of structures are assumed to have rigidity that means to make stable rotations and deliver moment at panel points. A pinned style only breaks out rotations. The movement of column-to-beam connections slightly is occurred by bending forces of moment and rotation to connections. This study shows basic connections designed by reformed T-stub, which is closed to semi-rigid connections. It relieves turning forces. In case of four models, specimens are given by variables the length of overhang. Finally some results are verified from this study as follows. 1) The leverage effect of tension connection part does not occur to the given steel structures. 2) Especially TL4 specimen which takes the longest overhang length results in the biggest ultimate strength of all. 3) The semi-rigid parts of unified T-stub connections result in, gradually, restored force situation under acting repeated load.

Keywords: Beam-to-Column, Connection, T-stub, Semi-rigid, Steel structure

1 Introduction

The connections of recent structure, which are being magnified and multiple stories play extremely important roles in the entire structure. Since they directly affect the safety of buildings, there is a need to ensure the safety of structures through proper analysis. In particular, the joint connecting beams with columns should maintain the structural stiffness of the building and stress deliver; it should also demonstrate joint strength and deformation ability from the design stage considering workability. The current design and analysis of the connections of steel-structured buildings in general are assumed to be rigid or pinned. Since the column-beam joint of actual buildings carries binding force on moment delivery and rotation to a certain degree, the reality is that the safety of the frame and economic design

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are being applied to the behavior of actual structures. This study aimed to observe structural behavior and promote the efficiency and applicability of the connections through this test as well as present the basic materials needed to design the semi-rigid beam-column connections. To present basic materials on the design and analysis of a T-stub close to semi-rigid connections, this study integrally joined the connections of the beam-column connections to apply the results to actual behavior and examine the effectiveness of the initial rigidity. If the beam-to-column connections are joined with high-strength bolts, the rigid connection cannot maintain the initial angle due to micro relative displacement between members, On the other hand, pinned connection carries a certain level of moment-resisting force owing to skid resistance;[4)] hence the importance of accurately measuring the relative rotation angle between the beam-column members to identify the correlations of the moment-rotation angle of the connections.

2 Tests of Connections of Unified T-stub

2.1 Test Plans

In this study, connections were made using the unified T-stub, and repeated loading tests were conducted. The study attempted to examine the possibility of creating semi-rigid connections based on the test results by analyzing and examining the moment-rotation angle relations using the unified T-stub and by selecting the initial rigid influence factor. The materials used for tests are shown in Table 1. The tests selected the initial rigid influence factors to check the behavior of the semi-rigid connection as the extension; to identify the behavior of the unified T-stub, the T-stub thickness was fixed at 8mm, and the extension, at 16mm as shown in Table 2. Bolt diameters were set to 16mm~24mm. Based on these variables, tensile and compressive factor tests were conducted to check the load-deflection relations.[5)-8)] The existing improved T-stubs were connected to 2 separated members on the beam flange to share tensile strength and compressive force; if flange buckling occurs to the beam member, each T-stub featuring a different character shares stress. This was the reason obtaining the accurate value of the moment-rotation angle was impossible. Therefore, this test connected the existing separated T-stub into a single body to receive satisfactorily the force of the beam member, enabling accurately checking the value of the moment-rotation angle. The quality of all materials used for tests was SS400. The beam member used H-350×175×7×11, and the column member, H-250×250×9×11. The length of the member was 1.5m beam and 1.2m for column. The test fixed the entire thickness of the improved T-stub at 8mm; the basic manufacturing sizes were as follows: extension of 16mm, bolt interval of 120mm, and bolt diameter of 20mm. The value was analyzed by changing the bolt intervals and diameters. Bolt diameters were 16mm, 20mm, and 24mm. To connect the beam-column members, 8 -F10TM20 high-strength bolts were fastened at standard tensile strength on both sides of the beam flange, and 4 bolts, on the column flange using an auxiliary loading device.

Table 1. Materials

Location	Specification	Material quality
Column	H-250×250×9×11	SS400
Beam	H-350×175×7×11	SS400

Table 2. List of Samples

Sample name	T-stub thickness (mm)	Extension (mm)	Bolt interval (mm)	Bolt diameter (mm)
BD1	8	16	120	16
BD2				20
BD3				24

3 Results of Test and Analyses

BD1～BD3 samples were tested using as variables bolt diameters 16~24mm; the outcome value of the strain gauge in each point and related graphs are presented below. The result showed that the breaking load was 51.73kN as the highest level in the case of BD 3. As for the maximum strain rate of each point of strain gauge, the BD3 sample read No. 11, BD3 sample, No. 13, BD3 sample, No. 14, and BD3 sample, No. 16 as the largest value.

To check the strength of the T-stub used on the connection, compressive and tensile factor tests were conducted covering each sample. The results of the tests are shown in Tables 3, 4, and Figs. 1 and 2.

With regard to the sample that changed bolt diameters, there was significant difference in the initial displacement; as the displacement increased, however, however, there was almost no difference. This was believed to be attributable to the negligible effect of sectional loss resulting from the diameters on the connection strength.

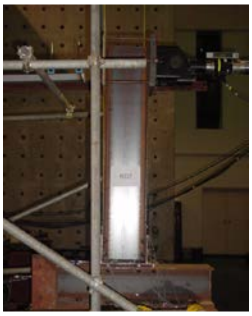

Photo 1. Testing BD samples

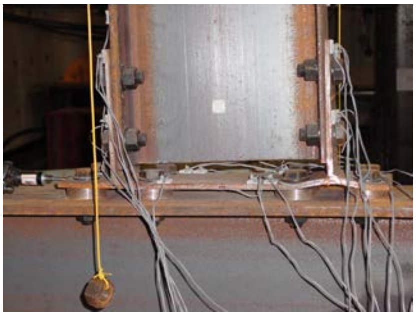

Photo 2. Testing BD samples(strain gauge)

Table 1. Test results of BD sample by strain gauge location

Sample name	Breaking load (kN)	Max. displacement (mm)	Max. moment (kN·cm)	Angle of rotation (rad)
BD1	32.27	51.26	4,840.5	0.1709
BD2	37.72	55.57	5,658	0.1852
BD3	51.73	94.79	7,759.5	0.3160

Table 2. Test results of BD sample by strain gauge location

Sample name	Breaking load (kN)	No. 11 maximum strain rate ($\times 10^{-6}$)	No. 13 maximum strain rate ($\times 10^{-6}$)	No. 14 maximum strain rate ($\times 10^{-6}$)	No. 16 maximum strain rate ($\times 10^{-6}$)
BD1	32.27	334	1,536.9	611.7	349
BD2	37.72	367.8	1,767.7	591.1	740.3
BD3	51.73	1,561.3	3,086	1,073.4	3,337.5

4 Conclusions and Remarks

This study verifies the possibility of connections using a structurally improved T-stub. The beam-to-column connections are joined with the unified T-stub, and simple and repeated loading tests are carried out to measure the structural behaviors of initial rigidities. The following conclusions are represented in this study. In case of tests using to change high-strength bolt diameters, there is no difference to the magnitude of breaking load or strain rate even though the diameters are increased; it is verified that bolt diameters are not important factors for improving the rigidity of connections.

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References

1. KBC2009 Design of Steel Structure, Korean Society of Steel Construction, 2000.
2. M. Lee, “Initial Stiffness Evaluation of T-stub Connection”, Journal of Korean Society of Steel Construction, 18(6), 805-813, 2006.
3. H.B. Lee, H.M. Kim, C.J. Yang and S.S. Park, “A Study on the Strength and Deformation Characteristics of T-stub Connection”, Journal of Architectural Institute of Korea, 16(10), 49-55, 2000.

4. N. Kishi and W.F. Chen, "Moment–rotation relations of semi rigid connections with angles", Journal of Structural Engineering ASCE, 116(7), 1813–1833, 1990.
5. Lynn S. Beedle, "Plastic Design of steel frame", John Wiley&Sons, 1961.
6. R. Bjorhovde, "Classification System for Beam-to-Column Connections", Journal of Structural Engineering, ASCE, 116(11), 1990.
7. R. Bjorhovde, "Connections in Steel Structures". Elsevier Applied Science, London and New York, 1988.
8. W. F. Chen, "Joint Flexibility in Steel Frames". Elsevier Applied Science, London and New York, 161-202, 1987.

