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# Experimental Investigation of Cyclic Behavior of Reformed Rigid Steel Beam-double Column Connections

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**ABSTRACT:** Beam-column connection is one of the most important parts of steel ductile flexural frames, as the performance of frame is depending on connection's flexibility. The rigid steel connections with cover plate are one of the most common connections in Iran. Due to the importance of seismic resistant design, it is necessary to investigate their seismic performance. In this experimental research, three steel connection specimens with 1/2 scale with introduction of new T-shape plate were built based on Iran steel code to evaluate their seismic performance and the specimens were subjected to cyclic loading. The results indicated that specimen designed based on Iran steel code cannot satisfy all of rigid connection criteria, and also, the strength was increased up to 10% and ductility was decreased up to 18% by adding the plates. Plastic hinges were transmitted to flange of beams, and the collapse mechanism of connections were changed due to deleting groove welding, strength and ductility were decreased respectively.

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## 1- Introduction

Due to the high seismic potential of our country Iran, investigate of the seismic performance of steel connections is very important. Also, the use of the double profile was increased during last decade because of restrictions on the production and construction of rolled box sections used in structures with the flexural frame in both direction. Despite the high flexural stiffness on the both directions, one of the most important drawbacks of using these sections is the difficulty of implementation of continuity plates inside the column [1, 2]. The common connections in Iran are constructed using top and bottom plates with groove welding to flange column as shown in Figure 1.

Most of the existing research on double connections in Iran were numerical and analytical investigations, so the new experimental research on this topic can show the real behavior of these connections. The purpose of this research is to investigate the seismic performance of the conventional connections in Iran [3]. Several researchers have conducted valuable experimental works on this issue and compared the results with FEMA code and also Iranian 2800 design code [4, 5].

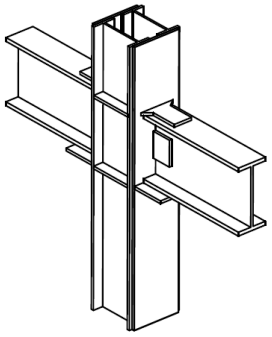

**Figure 1. The common connections in Iran constructed using top and bottom plates with groove welding to column flange**

## 2- Experimental Program

Three specimens were identified as SC1, SC2 and SC5 and were quite similar in terms of specifications. Although adding double plate in the panel zone of specimen SC2 is not necessary according to the design criteria of Iran code, but the panel zone of specimen SC2 was strengthened with double extra plates. The SC5 specimen was designed and built to investigate the effects of the deleting groove welding and the introducing of the new T-shape model of connection. A series of T-shaped plates connected from one side to the column flange and other side to beam flange by the fillet weld was used in specimen SC5. The weak beam- strong column

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criteria was respected in the design of all specimens. The general characteristics of the specimens was shown in Figure 2.

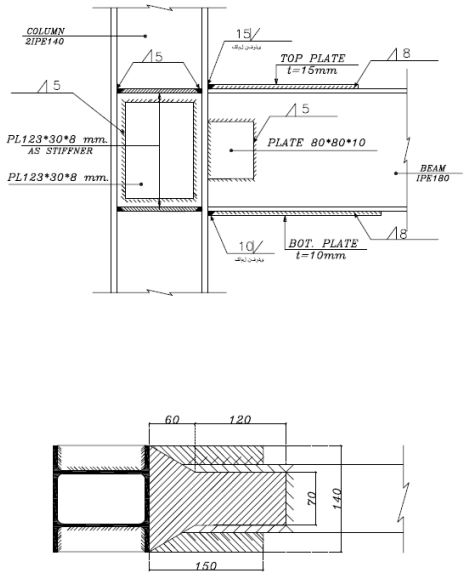


**Figure 2.General characteristics of the specimens**

## 3- Test Setup and Instrumentation

T-shape specimen as representative of corner connections of steel structure was selected as test specimen. It was assumed that the middle pointes of the column and beam in the experimental specimen was similar to the points of inflections in column and beam in flexural frames. Therefore these points were assumed as hinge plastics points. Test setup, the rigid laboratory frame, hydraulic jack (in the experimental tests, two hydraulic jacks had been used with a 250 kN capacity and 20 cm stroke) and also load cell and test specimen is shown in Figure 3. Loading history was based on AISC and ATC24 design codes [6, 7]. Therefore, appropriate ductile behavior of connections under cyclic loading was obtained at some experimental researches [8, 9].

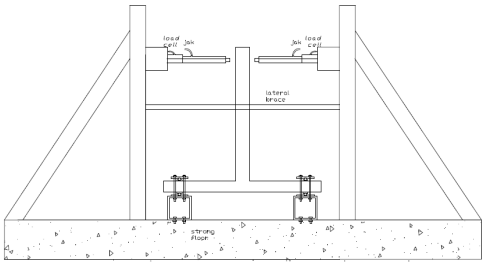


**Figure 3. Test setup**

## 4- Conclusions

The specimen SC1 designed based on the Iranian steel design code regulation and did not satisfy the weak beam-strong column connection criteria. The weak beam-strong column connection (SCC-WB) criteria was satisfied by additional plates within the panel zone and the plastic hinge location was transmitted to beam flange and the necessary ductility in flexural frames was satisfied. The specimen strength was increased up to 10% and ductility was decreased up to 18% by adding the plates to specimen SC2. The weak beam-strong column connection (SCC-WB) criteria was satisfied in both specimens SC2 and SC5 during the loading test and also the plastic hinge was formed an area far form the panel zone. By the way, using the T shape plate and deleting groove weld and replacing it with fillet weld in specimen SC5 led to increasing 21% ultimate strength and decreasing 30% ductility compared to specimen SC2. The general comparison of test specimens (SC1, SC2, SC5) behaviors and their moment-drift curves are shown in Figures 4 and 5.

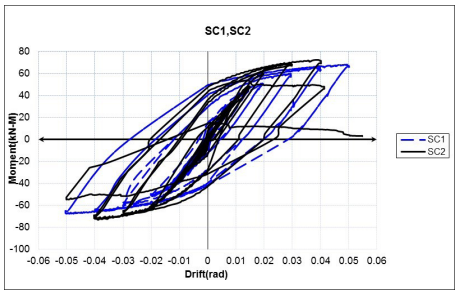


**Figure 4. Hysteresis cycles of specimens SC1 and SC2**

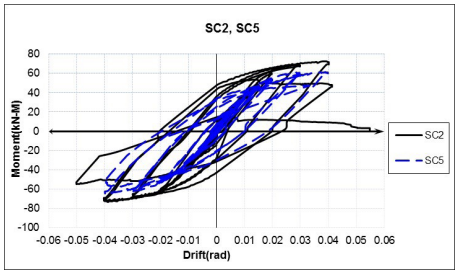


**Figure 5. Moment-drift curves of specimens SC2 and SC5**

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