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EVALUATING A RIGID SEISMIC CONNECTION TO THE MINOR AXIS OF DOUBLE I-SHAPED COLUMNS USING SIDE PLATES

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Providing a gap between beam and column through parallel side plates on two sides of column and substituting fillet welds for groove welds can do significant savings on expenses and welding inspections. Having removed groove welds, side plate connections largely prevent brittle and inflexible behavior in cyclic loads like earthquakes. Although the stiffness, rigidity, ductility, and strength of this connection in case of its major axis have already been evaluated and qualified for using in special moment frames, there have been no published studies into the connection through its minor axis so far. In this paper, the behavior of a beam to column's minor axis connection of a built-up double I-shaped section, which is common in Iran's construction industry, was evaluated, and its stiffness, rigidity, strength, and ductility was calculated. Having verified numerical models with experimental data, six numerical models with various thicknesses of side plates ranging from 12 mm to 20 mm and two beam sections namely IPE300, and 2IPE240 were analyzed via ABAQUS finite element software. Results denoted the satisfactory behavior of these connections, meeting the requirements of AISC and Iran's code in all of the models.

MODEL CHARACTERISTICS

Connection components are introduced in Figure 1 and Table 1. To evaluate the behavior of side-plate connections to minor axis of double I built-up columns (number 5 in Figure 1) of IPE270 section, six numerical models in a one-way sub-assembly ranging from SP1 to SP6 are presented (Rajabi et al., 2013). The beam section (number 4 in Figure 1) used in SP1, SP2, and SP3 was IPE300, and the one for SP4, SP5, and SP6 was 2*IPE240 section. Furthermore, side plates (number 7 in Figure 1) thicknesses were respectively 12, 15, and 20 mm for each series of models, but all shear plates (number 6 in Figure 1) were of the same thickness (8 mm).

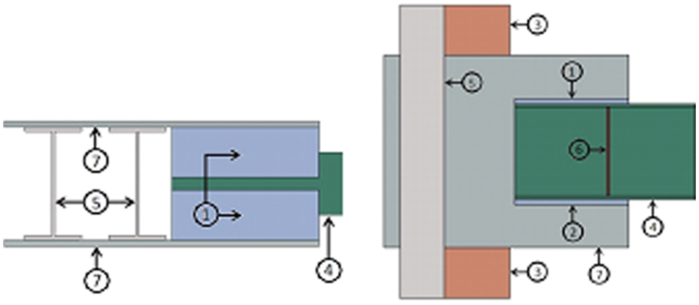

Figure 1. Proposed side plate connection to minor axis of double I-shaped column; Left) Top view; Right) Side view of the models (front side plate was removed).

Table 1. Details of beam to minor axis of column rigid connection using side plates; all dimensions are in cm.

Model name	Top cover plate (1)	Bottom cover plate (2)	Column flange cover plate (3)
SP1-6	2PL35*12*1.5	PL35*27*1.5	4*PL120 *33.5*1.5

STUDY ON THE CONNECTION'S STIFFNESS ACCORDING TO AISC-341(2010)

Stiffness calculations for all models showed that all of them could meet the stiffness criterion of AISC-341(2010) varying from SP1 with stiffness measure of 20.28 to SP3 with 24.81, and SP6 with 21.98. Hence, all of them can be used as fully restrained connections.

CONCLUSIONS

In this study, six full-scale steel models for the rigid connection of beam (IPE300 and 2*IPE240) to web side of column (2*IPE270), through side plates were numerically investigated under AISC cyclic loading in order to evaluate the impacts on restraint percentage, rotational stiffness, connection strength, plastic hinge location, and ductility. Side plate thicknesses were gradually added to and as expected, results indicated that increasing the thickness of side plates could lead to a significant increase in the stiffness of a connection. Based on the results, corresponding analysis and discussion, four main points are to be concluded as follows.

1. None of the models could bear more than 77% restraint according to Iran's connection code (No. 264). Hence, using this configuration for rigid connections cannot be justified; and therefore, they should be used as semi-rigid connections.
2. Stiffness for all models was in qualifying range of AISC, and they could be regarded as fully restrained connections. Moreover, having evaluated the moment-interstory drift angle hysteretic curves, it was found that moments for all models at $\theta = 0.04$ rad were more than $M_{P,beam}$ (plastic moment of beam), satisfying the strength measure of AISC.
3. Results showed that stiffness in these types of connections, i.e. rigid connections of beam to column's web through side plates, is a function of side plate thickness. As an exemplification, the effects of horizontal continuity plates, vertical inner plates, triangular stiffening plates, and increasing the length and thickness of top and bottom cover plates were studied (Rajabi et al., 2013); however, none of them represented a continuous improvement.
4. As shown in findings, using side plate configuration produced more favorable results than traditional cover plates (Rahimi et al., 2011) and haunch plates (Rajabi et al., 2016); providing more feasible operations by removing continuity and vertical plates in panel zone, and less welding and inspection process by replacing groove welds with fillet welds.

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