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EXTENDED ABSTRACT

Investigation of Effect of the Middle Link Beam Construction Imperfection on the Behavior of Connection in Steel Moment Frames

Masoud Hoseinzadeh Asl *, Vahid Ghaffari

Faculty of Civil Engineering, University of Tabriz, Tabriz 5166616471, Iran

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1. Introduction

Geometric imperfections that occur due to the inevitable errors during the fabrication process or erection of structural members, may affect the performance of the steel structure. One of the most common and very efficient shop-welded and field bolted systems is the column-tree moment connection system. Sometimes, in the implementation of the moment-resisting frames with column-tree connections, the middle link beam length after the fabrication does not match with inserted dimension in shop drawing completely and a gap can be seen between the splice plates in beam to beam end-plate bolted splice connection, as shown in Fig. 1. The aim of this study is to investigate the effect of different values of the construction imperfections of the middle link beam length on the behavior of column-tree connections. For this purpose, firstly, the effect of the middle link beam construction imperfection in three steel moment-resisting frames with different stories and bays are considered by using SAP2000 software and the values of internal forces in members are extracted. Secondly, non-linear behavior of three-dimensional models of single-sided beam-to-column connection from these frames are investigated by using ANSYS Workbench finite element software.

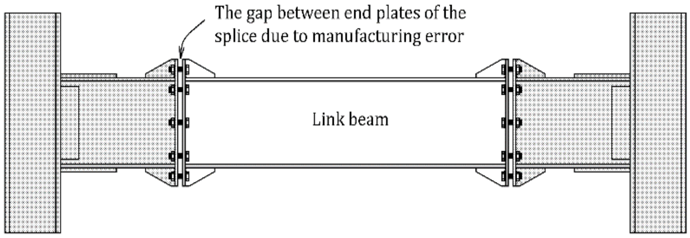

Fig. 1. Fabrication error in column-tree moment frames

In relation to the construction method shown in Fig. 1, various investigations have been carried out. Among them Astane (1997), provided a detailed report on the seismic behavior of column-tree moment connections and also proposed methods for designing them. Several studies have also been carried out in connection with the splice of beams. In an experimental program, Oh, et al. (2014) investigated the effect of weakening of the splice of the beam at a certain distance from the column on the seismic performance of the column-tree moment frames.

* Corresponding Author
E-mail addresses: hoseinzadeh.m@tabrizu.ac.ir (Masood Hoseinzadeh Asl), ghaffari.v1371@gmail.com (Vahid Ghaffari).

2. FEM modeling

The 3D finite element model of splice connection was constructed using ANSYS Workbench software. Fig. 2 shows the finite element model. The geometric properties of the splice are designed according to the proposed process in AISC 358-10 (2015).

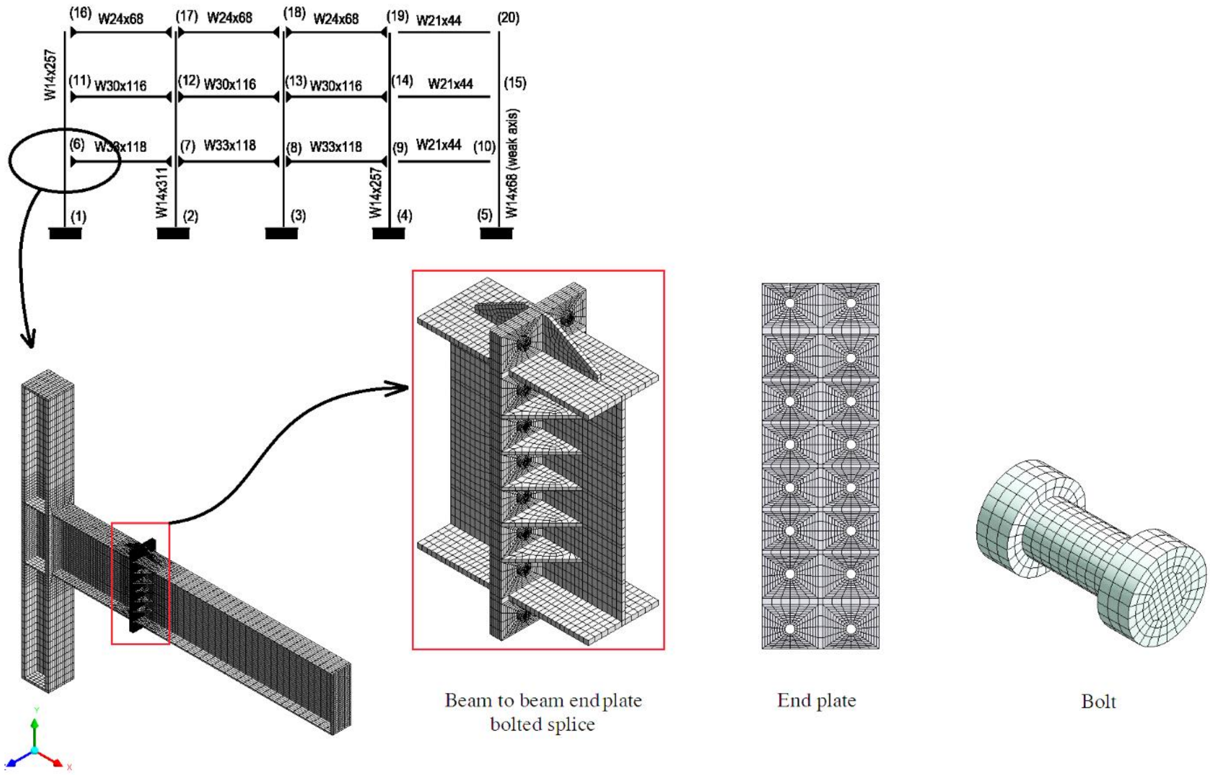

Fig. 2. Finite element model of the end connection

The loading and boundary conditions for all models are the same and is shown in Figure 39. It is assumed that the moment in the middle of the column is equal to zero, and according to Fig. 3, the finite element model is assumed to be pinned at the two ends of the supporting column.

The loading sequences are as following order.

Step 1. In order to simulate the Gap between the ned-plates of the beam splice, thermal loading is used. For this purpose, the negative thermal gradients is applied to the link beam in the model made in the SAP2000 software, which results in reduction of the length of the beam.
Step 2. The axial force generated in the desired beam is extracted from the SAP2000 software.
Step 3. The pre stressing force is applied to the bolts in the finite element model.
Step 4. The axial force obtained from the step 2 is applied to the finite element model, as shown in Fig. 3.

It should be noted that in the analytical models, non-linear properties of materials, geometrical non-linearity and also non-linear behavior of contact between end-plates are taken into account.

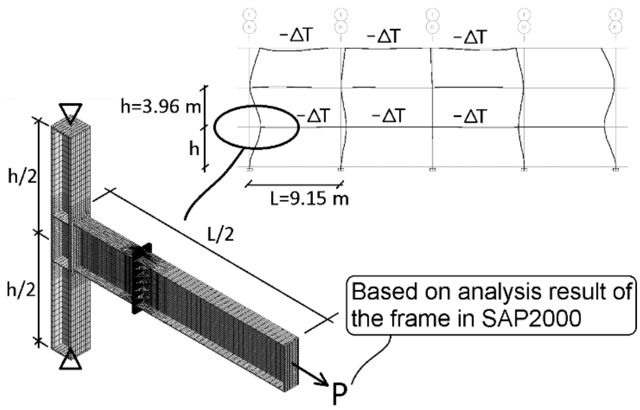

Fig. 3. Boundary condition and loading

3. Conclusions

The results show that in frames, where the columns have higher flexural rigidity, the effect of the middle link beam construction imperfection is considerable and results in significant axial force in the beams. Axial tension caused by construction imperfection with decreasing and also non-uniform distribution of initial contact pressure between the end-plates results in a drop in the frictional shear strength of the beam splice and increases the probability of its premature slip. In this study it was observed that the middle link beam construction imperfection leads to significant stresses in the end-plate stiffeners which connected to the middle link beam.

4. References

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