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Interactions of Column Pyramid Head and Special Prefabricated Steel Connection under Cyclic Loading

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1-introduction

An ideal form is a form whose main members tolerate different combinations of optimal loading. The most important factors in selecting the structural form are the number of stories and non-structural considerations. Connections are one of the most effective parameters on the behavior of structure forms. In this paper, a steel special connection under cyclic loads has been studied. This connection is used in prefabricated steel structures in which all parts such as beams, columns, boxes, braces, doors and windows are manufactured in the factory and then carried to the site and assembled together with bolts. Components of this structural form including box-shaped columns are then connected to the lateral end plate and the pyramidal is perched to the top of this plate. There are box sections at the end of the beams that connect to lateral end plates from above and below. In this form, ceilings can be constructed completely in the factory, then carried to the site and placed on the columns. The implementation of prefabricated ceilings is difficult, especially on the upper floors. In what follows, a new method for faster and easier ceiling assembly has been evaluated. For faster and easier assembly, place a pyramidal section on the connection plate of down floor column such that when the ceilings are to be implemented, the pyramidal section is placed on the short column. Figure 1 indicates the components of connection and implementation process with this pyramidal section.

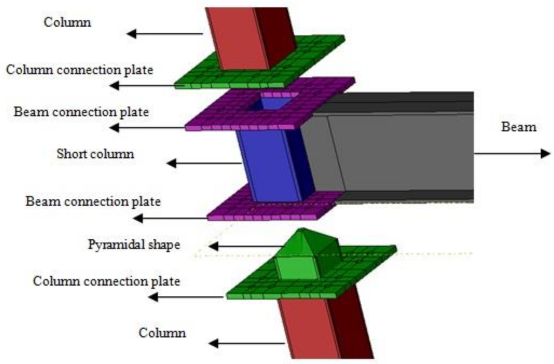

Fig. 1. Components of the proposed connection and implementation process

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2- Modeling

In order to validate the finite element models, the numerical results were first compared with the experimental results of the Specimen from Yang and Kim's reported research study. Figure 2 represents the selected moment

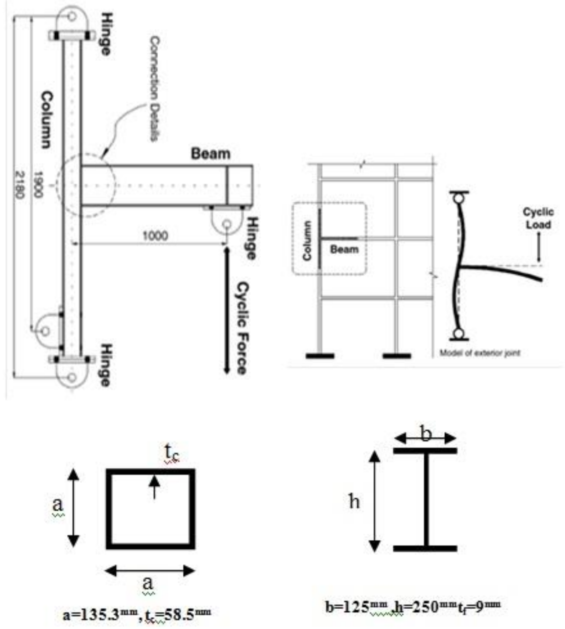

Fig. 2. Model feature and configuration, a: test set-up, b: model of the exterior joint, c: beam section, d: column section

frame, dimensions, the section of beam and columns, and the model of the exterior joint.

The entire components used in this research study including columns, beams, connection plates, stiffeners and boxes are made of SS400 steel. The bolts are also A490. The mechanical properties of all materials are taken from the experimental specimens (Yang and Kim). Modulus of elasticity and the Poisson's ratio for all sections is 200 Gpa and 0.3, respectively. The name and properties of the specimens are presented in Table 1 and Figure 3.

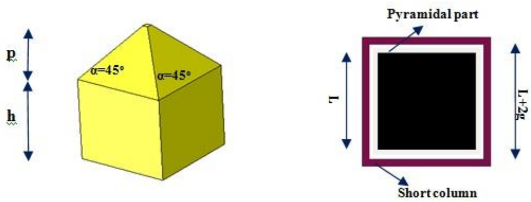

Fig. 3. Specimens parameters

The holes are standard and loading has been done in two steps. In the first step, according to the types and sizes of the bolts, pre-tension force equal to 107 kN was applied to all bolts (Salmon et al.) and in the second step the displacement was applied to the end of the beam according to the experimental set-up and the loading protocol of ATC-24 which is presented in Table 2.

Table 1. Properties of specimens

Specimens	t(mm)	h (mm)	P (mm)	L (mm)	B (mm)	g (mm)
C0	15	-	-	-	-	-
C1h150p50g1	15	150	50	113.3	-	1
C2h150p50g5	15	150	50	105.3	-	5
C3h75p50g1	15	75	50	113.3	-	1
C4h75p50g5	15	75	50	105.3	-	5
C5h75h75p50g1	15	75	50	113.3	-	1
C6h75h75p50g5	15	75	50	105.3	-	5
C7h75p50b230g1	15	75	50	113.3	230	1*

Table 2. Values of displacements applied to the end of the beam (ATC-24)

Step no.	1	2	3	…	6	…	9	10	…	13	14	…	18
Displacement(mm)	±3	±6	±9	…	±18	…	±30	±35	…	±50	±60	…	±100

Figure 4 represents Von Mises stress distribution and Figure 5 represents the force-displacement curve at the end of the beam for C1h150p50g1 specimen have been shown.

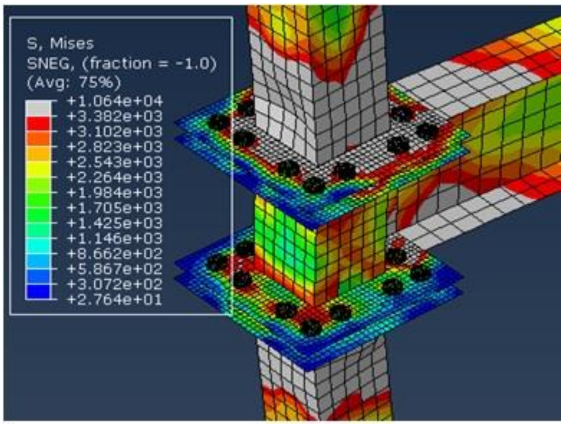

Fig. 4. Contour plot for Von Mises stress distribution in C1h150p50g1 specimen (unit: kg/cm2)

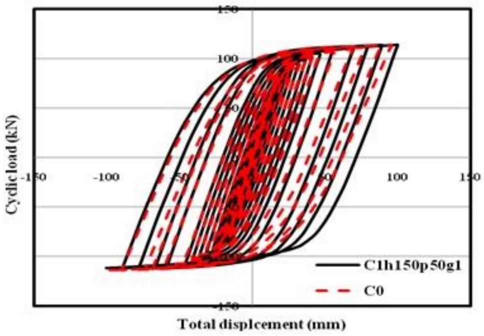

Figure 5. Force-displacement curves for C1h150p50g1 specimens

3- Conclusions

In this paper, the effect of the pyramidal sections on the force-displacement curve of the pre-fabricated steel moment connection under cyclic loads has been investigated. For this purpose, the connection was modeled and analyzed using ABAQUS. The main results of this study can be summarized as follows:

1. All of the specimens can bear 0.01 rad. in the linear region and 0.06 rad. in the nonlinear region. The values presented above indicate that this form has a good ductility and if appropriate amounts are chosen for the plastic moment of the beam, columns, and the short column, this form can be considered as a special moment frame.
2. If appropriate dimensions are not selected for the pyramidal section, when plastic hinge is created in the beam, torsion occurs to the beam and the resistant of the connection decreases
3. In all of the specimens with lateral support, adding a pyramidal section improves the performance of the connection.
4. Adding a pyramidal section on the connection plate causes a decrease in the amount of stress on the connection plate.