Behavior of Octagonal Corner Column-Beam Connection under Cyclic Loads

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Abstract - *The Octagonal concrete filled steel tubular (CFST) sections offer greater efficiency than square and rectangular tubular sections because of their better local-buckling resistance and flat surfaces that allow easier connection compared with circular tubular sections. This paper presents analytical studies on the seismic behavior of steel I-beam to octagonal CFST column assemblies with external diaphragms. Angle of rotation and moment capacities were introduced in the corner and interior octagonal column-beam model and studied analytically using the software ANSYS 16.1. In the analytical study finite element models are developed to predict the hysteretic behavior and the stress distribution. Steel to concrete interfaces are modelled by hard contact with friction. The loading condition is displacement controlled and lateral load is applied on the column by cyclic vertical load on the beam end. The stress distribution of model components, including steel beams, steel tubes and concrete cores are illustrated. The results indicate that failure modes have significant effects on the characteristic of stress distribution.*

Key Words: concrete filled steel tube, Finite element analysis, hysteretic behavior, stress distribution

1. INTRODUCTION

A column in structural engineering is the structural element that transmits, through compression, the weight of the structure above to other structural elements below. In other words, the column is a compression member. Columns are frequently used to support the beams or the arches on which the upper parts of walls or ceilings rest. In the architecture, column refers to such a structural element that also has certain proportional and decorative features. A column might also be a decorative element not needed for the structural purposes. Column is a vertical member in building whose primary function is to support structural load and transfer it through the beams. Upper columns transfers the load to the lower columns and finally to the ground through the footings.

Concrete-filled steel tubular columns are among the most economical and structurally efficient among reinforced and composite members in terms of resistance to high compressive loads. In addition to the steel tube being used as a load-carrying component. It also provides the confinement to concrete core, thereby increases the compressive strength and improves ductility of the concrete. Further, the steel sections can be used as temporary works for fresh concrete so the cost of fabricating formworks can be saved.

The load capacities and stress-strain relationships of octagonal steel tube confined concrete (STCC) stub columns are very close to those of circular STCC, and the reduction of confinement effectiveness due to the change in the cross section shapes from circular to octagonal shape is small in terms of the load capacity. In stub column tests, it was observed that the compact octagonal cross-section showed a similar cross-sectional behaviour in compression comparing with that for circular cross-section and showed a better performance compared to the square cross-section with the same equivalent width.

The objectives of the topics are to improve the buckling strength and axial load performance of octagonal CFST column, to study the effective octagonal column under seismic performance by applying cyclic load and using stiffeners to improve the buckling capacity by different shapes, positions and arrangement

1.1 Modelling

Literature survey is to be done by referring and going through articles and journals published in the related area of the studies to get detail subject knowledge. Model selection and related data collection that will aid in completing the work has to be done, such as validation model detail collection, earth quake data collection etc. Software study is an important step in this project; one should do a software study to get used to the software tools. This helps to eliminate all possible errors that could creep up during modeling and analysis. Then the modeling of validation model. Octagonal column with axial load is modeled for validating. Validation process is an important process which ensures correctness of the end product, this process helps to check product quality obtained from the software. Validation should be done using same software in which project study is being planned. Analysis of the octagonal columns beam connection with varying parameters helps to understand the cyclic performance. Result and discussion is a key step in the project. After conducting analysis, results obtained are carefully studied and reasons for such outputs have to be discussed in detail to understand the obtained output. Conclusions have to be drawn from the obtained result. This should consist of a brief account of the entire project including procedure adopted and result.

2. COLUMNS UNDER CYCLIC LOADING

To study cyclic behavior of octagonal CFST column, a steel beam with 1.3 m length was connected by a diaphragm to the column. The length of the column was taken as 3 m. The beam were connected at the center of the column. First the cyclic behavior studied by changing the slenderness ratios of the column. According to AISC seismic provisions for the special moment frames, the beam column connection shall be capable of sustaining an inter story drift angle of at least 0.04 radians (AISC-2005). From the values 4.000 is taken as drift percentage for the project. The displacement corresponding to 0.04 radians is 52.115 mm. Slenderness ratios of 7.82, 9.116 and 10.93 are taken for the study, because they gives displacement close to 52.115 mm. Hence that column selected for further study.

Table – 1: Cyclic Loadings

Drift Ratio	Displacement (mm)
0.375	4.88
0.5	6.511
0.75	7.7
1	13.02
1.5	19.5
2	26.058
3	39.08
4	52.115
5	65.16
6	78.226

As per FEMA350 cyclic protocol cyclic loading is given at 0.375%, 0.5%, 0.75%, 1%, 1.5%, 2%, 3%, 4%, 5%, and 6% drift ratio.

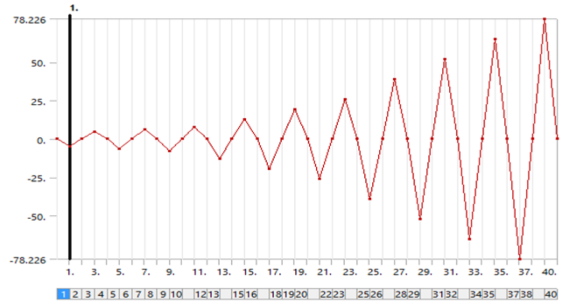


Fig – 1: Cyclic Loading

2.1 By Varying Angle of rotation

In the corner column, the angle was changed and the behavior of column while changing the angle also analysed. The diameter of the column is taken as 302 mm, which is corresponding to l/D ratio 10.93. Fig 2 to 4 shows the models

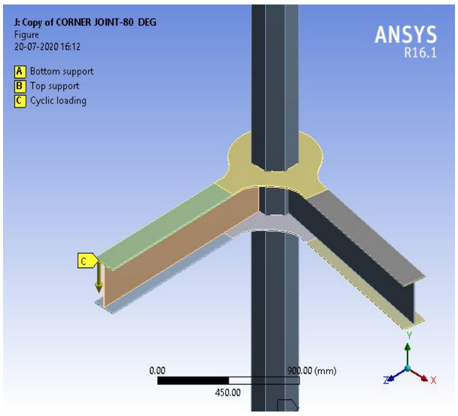


Fig-2: Octagonal Corner Column with angle 80^0 with cyclic loading

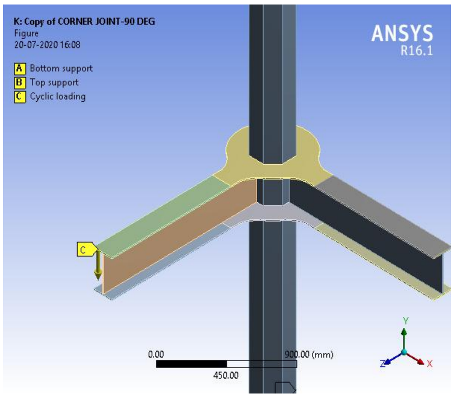


Fig-3: Octagonal Corner Column with angle 90^0 with cyclic loading

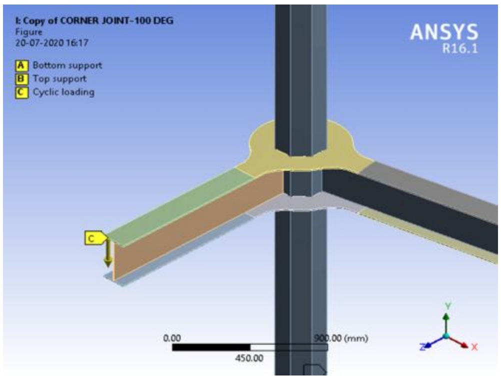


Fig-4: Octagonal Corner Column with angle 100^0 with cyclic loading

3. RESULT AND DISCUSSION

The hysteresis behavior of corner column are shown in fig 5. Equivalent stress of corner column as shown in fig 6 to 8.

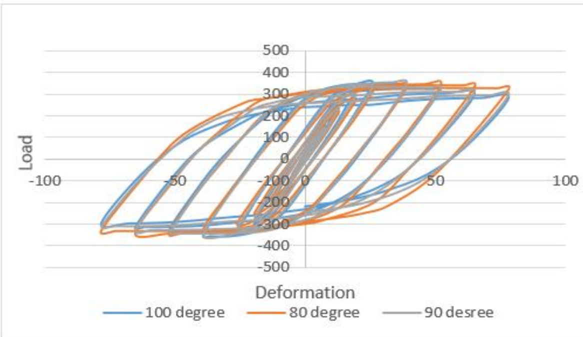
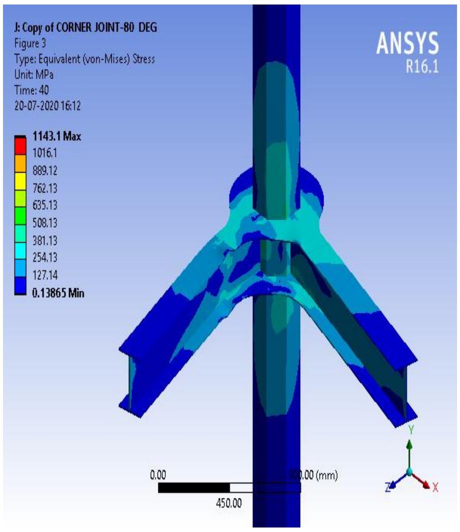
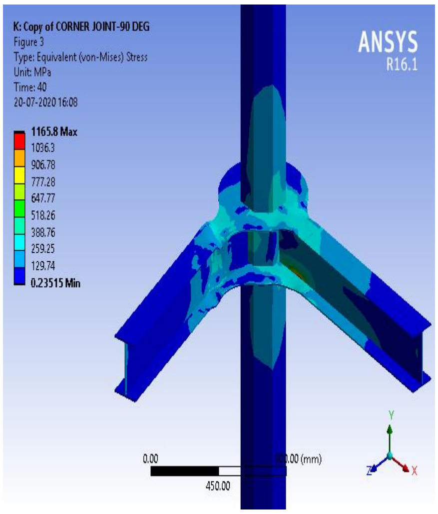


Chart -1: Hysteresis Graph of Corner Column with angles 80^0, 90^0 and 100^0





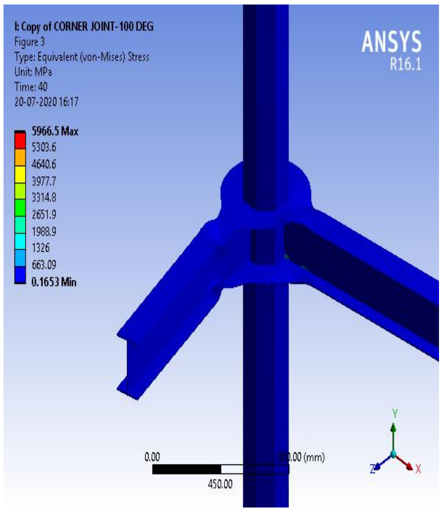


Table – 2: Analysis Results

Angle of rotation (^{0})	Time (s)	Deformation (mm)	Load (kN)	Stress (MPa)
80	31	52.11	345.23	685.27
90	26.85	33.218	354.19	566.84
100	24.81	31.753	358.15	749.72

From the table 2, it is clear that the octagonal column beam connection with 100^0 angle of inclination gives higher load. Which implies that model gives higher moment capacity. But octagonal column beam connection with angle of rotation 80^0 gives greater ductility and time for deformation.

3. CONCLUSIONS

The cyclic behavior of octagonal CFST column beam connection with different angle of rotation was studied. The following conclusions are drawn from the experimental results.

- Octagonal CFST column beam connection with 80^0 gives higher ductile than 90^0 and 100^0
- Octagonal CFST column beam connection with 80^0 gives 36% higher ductile than octagonal CFST column beam connection with 90^0 and 39% higher ductility compared to octagonal CFST column beam connection with 100^0
- Octagonal CFST column beam connection with 100^0 gives 4% higher moment capacity than octagonal CFST column beam connection with 80^0 and 1% higher ductility compared to octagonal CFST column beam connection with 90^0
- Octagonal CFST column beam connection with 80^0 gives more time for deformation

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