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Seismic Analysis of Concrete Filled Steel Tubular Column and H- Steel Beam of Normal and Reduced Beam Sections

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***Abstract*— A beam-column junction is a structural member that is subjected to transverse bending and axial compression at the same time. H Steel beams are beams that are composed of an H-steel core within a precast concrete beam. Advantage of H steel beam is its high bearing capacity compared to RC columns. Concrete Filled Steel Tubular (CFST) structure consists of hollow steel tube filled with plain or reinforced concrete. They are lighter than RC columns and are safer and dependable in seismic regions. The study is to find the seismic analysis of developed joints between H steel beam and CFST column under cyclic loading and to compare the behavior of those joints of CFST tubes with normal and Reduced Beam Section beams (RBS). The result aims to show a significant seismic behavior in RBS section than the normal beam section in terms of load- displacement hysteresis curve.**

***Index Terms*— Concrete Filled Steel Tubular section, Reduced Beam Section**

I. INTRODUCTION

For assuring the safety of structures, it is critical to design and detailing of beam -column junction in order to develop ultimate strength and deformation capabilities. The most popular beam – column joint used in everyday life is Concrete – filled steel tube (CFST) column and H- steel beam junction. CFST column is best known for their performance in load bearing capacity, ductility and energy absorption capacity. Also, it reduces the material and labor cost in the construction.

H – steel beam have stronger cross section than I -beams and lighter than RC beams. The seismic analysis was done through ANSYS workbench software. The type of analysis used for cyclic loading is transient analysis. The design chosen for the CFST column, Normal beam and RBS beam are as per Eurocode 4.

II. ENGINEERING DATA

A. Structural steel (Q345)

i) Density : 7850 kg/m3
ii) Young's Modulus : 1.948x105 MPa
iii) Poisson's ratio : 0.3
iv) Bilinear Isotropic Hardening:

Yield strength: 324MPa, Tangent Modulus: 1.45x109Pa

B. Bolt

i) Density : 7850 kg/m3
ii) Young's Modulus : 2.06x105MPa
iii) Poisson's ratio : 0.3
iv) Bilinear Isotropic Hardening:

Yield strength: 900MPa, Tangent Modulus: 1450MPa
Grade : 10.9 M20

C. Figures

i) Density: 2300kg/m^3
ii) Young's Modulus: 3x1010Pa
iii) Poisson ratio: 0.18
iv) Grade : M40. The Multilinear Isotropic Hardening of M40 is as pert he Table 1.

Table 1: Multilinear Isotropic Hardening

Plastic Strain (1/mm)	Stress (MPa)	Plastic Strain (1/mm)	Stress (MPa)
0	0.5	0.0016	33.218
0.0002	5.3097	0.0018	35.294
0.0004	10.48	0.002	36.923
0.0006	15.385	0.0022	38.15
0.0008	19.917	0.0024	39.024
0.001	24	0.0026	39.594
0.0012	27.586	0.0028	39.905
0.0014	30.567	0.003, 0.0032, 0.0034	40

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III. ANALYSIS SETTINGS

As per the Eurocode 4, the length of steel beam was 1360mm. Height of CFST column was 1000mm. Cross sections of square hollow CFST column and H- shaped steel beam were 250mm x 250mm x 6mm and 300mm x 150mm x6.5mm x 9mm respectively as per the figure 1.

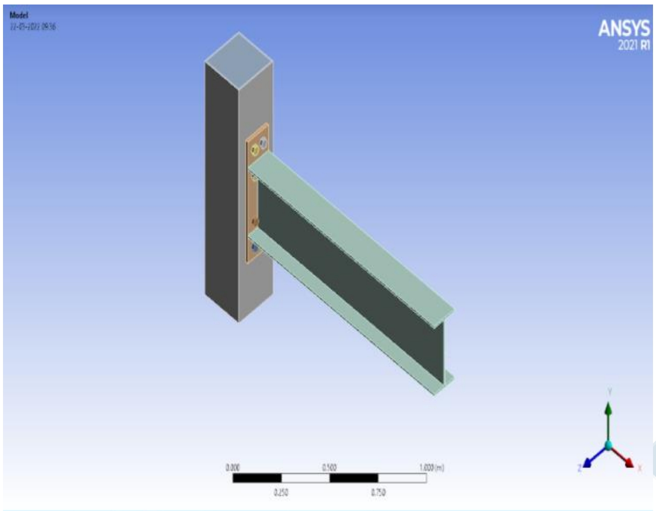

Figure 1: Geometry of the normal structure

For a time step of 32 seconds, Maximum cyclic displacement is 80mm at the beam. A pretensioning force of $1.55x10^5$ N was applied on one end of the bolts. An axial force of 3000kN was applied on the top and remote displacements were distributed on top and bottom sides of columns.

Second beam chosen was Reduced Beam Section (RBS). A radius of 15mm ,30mm, 35mm was inserted in the centre of beam. 372mm was taken on both sides away from the centre of beam. The geometry of RBS beam and CFST column is shown in figure 2.

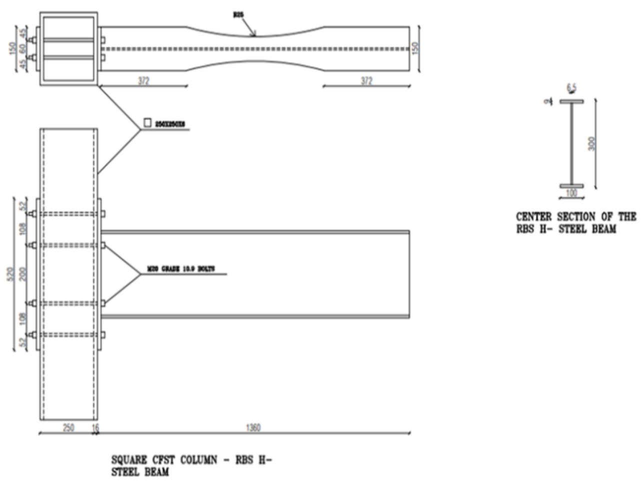

Figure 2: Framework of RBS – CFST structure

IV. RESULTS

The yield stress is the minimum stress where the material starts to deform. The ultimate stress is the maximum stress before the material fails. The failure stress is 0.87 times the ultimate stress where 0.87 is the Factor of Safety (FoS).

The maximum yield displacement attained was 28.46mm from a yield stress of 75.423kN. The ultimate and failure stress were 123.17kN and 104.72kN respectively and the ultimate and failure displacement are 61.6 mm and 51.68mm respectively (figure 4). The total deformation of normal structure is as shown in the figure 3.

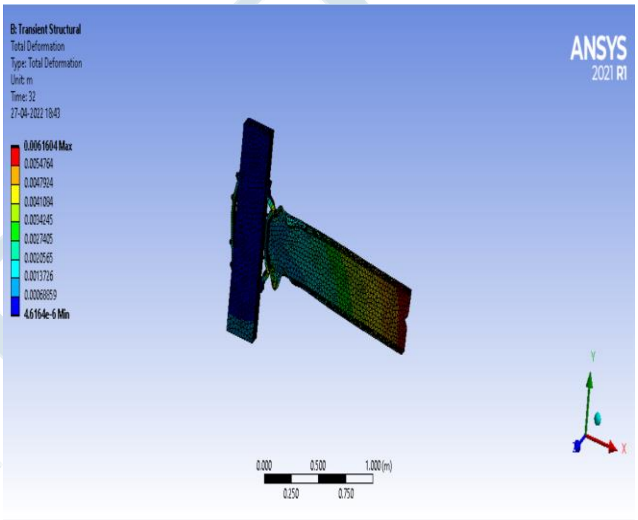

Figure 3: Total deformation of Normal structure

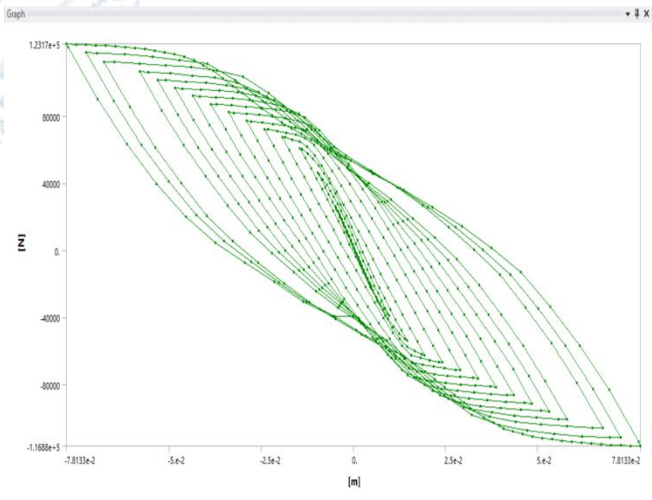

Figure 4: Hystersis curve of normal structure

A comparative study of radius 15mm, 30mm and 35mm RBS beams along with the CFST column was done on cyclic loading. The RBS structure of radius 35mm showed the higher yield stress, ultimate stress and yield stress than the normal structure. There were no significance change observed from the other lower radius of RBS beam (table 2).

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Table 2: Comparison table of R15, R30 and R35 RBS beam

Displacement (mm)	Force reaction (Yield state) (N)	Displacement (mm)	Force reaction (Ultimate state) (N)	Displacement (mm)	Force reaction (Failure state) (N)
30.85	72137	61.734	117300	53.708	102051

Displacement (mm)	Force reaction (Yield state) (N)	Displacement (mm)	Force reaction (Ultimate state) (N)	Displacement (mm)	Force reaction (Failure state) (N)
29.84	71278	53.225	121210	45.24	103028
45.0	79137	70.555	137320	59.97	110722

The hysteresis curve of R 35 possess higher area than the other RBS structures as per the figure 5,6 and 7 respectively.

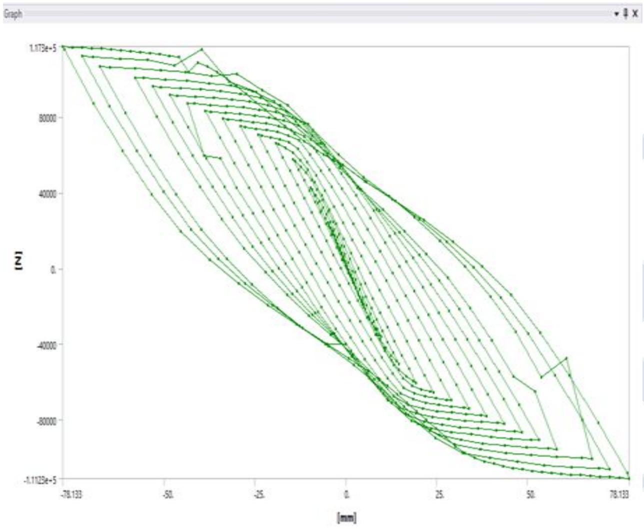

Figure 5: Hystersis curve of R15 RBS structure

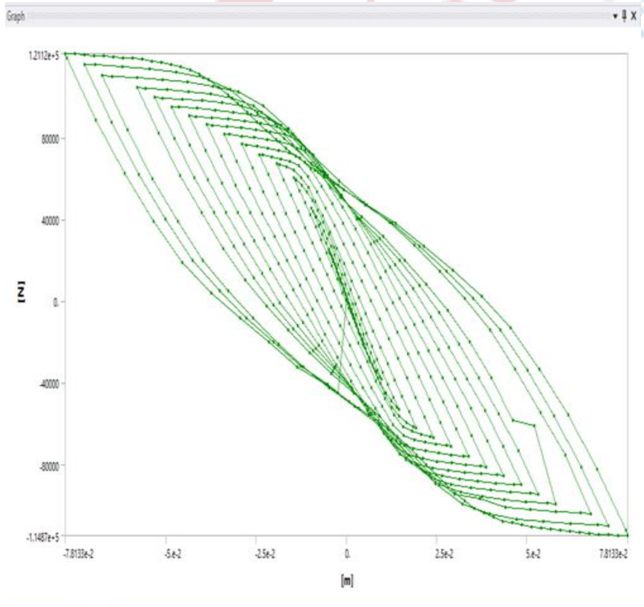

Figure 6: Hystersis curve of R30 RBS structure

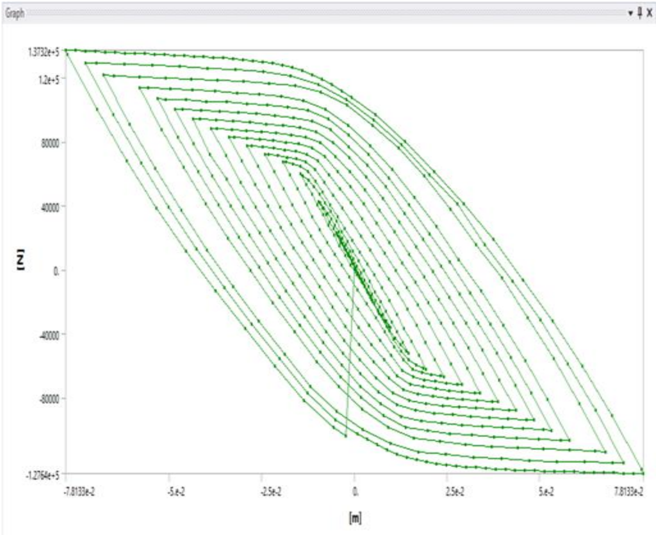

Figure 7: Hystersis curve of R35 RBS structure

V. CONCLUSION

CFST column with RBS sections of radius 35mm i.e. higher radius showed higher yield ultimate and failure load bearing capacity than CFST column with normal beam sections. Higher radius RBS sections are suitable for earthquake prone regions.

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