

STUDY ON PERFORMANCE OF BEAM-COLUMN JOINT WITH ENDPLATES & BOLTS UNDER SEISMIC LOADING

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Abstract - As an important structural system in modern engineering structures, concrete-filled steel tube (CFST) structures take the advantages of both steel tube and concrete and have been widely used in high-rise buildings, long-span bridges, and heavy industrial plants. In this context Beam column connections are of much important. The software is ANSYS workbench. The aim of the study is that to analyse the beam-column joint under seismic loading with bolts and endplates. The work is carried out at the joints having flush endplate & extended end plate with different thickness subjected to seismic loading. Further study is carried out on optimum thickness of plates from the previous analysis results with varying bolt diameter.

Keywords -beam-column joint connections, seismic load, comparison of results, ANSYS Workbench

1. INTRODUCTION

Nowadays, steel and concrete are the most common materials in construction industry, however, their disadvantages and advantages are also obvious if using them individually, such as low tensile resistance in concrete and easy buckling due to the slenderness in steel. Composite structures consisting of these two materials make use of each material to optimally improve the performance of structure. Some relevant advantages of the composite structure are combining high strength, fire resistance, long-span capability and lightness of steel with the inherent stiffness, good damping, favourable ductility, economy of concrete and also good energy dissipation capacities. The usage of composite construction has been increased over recent decades mostly in industrial buildings, high-rise or super-high-rise constructions and bridges due to these advantages. Beam-column joints are used in framed structures and also full fill the function of continuity to the structure, in addition to transferring shear and moment forces from one structural element to another. Along with high-level and the extra-high building had been built rapidly around the world. The frame structures composed of concrete-filled steel tube (CFST) column and steel beam have gradually become the major form in the field of building especially the CFST column has been widely concerned by its advantages of regular shape, cost and easy work.

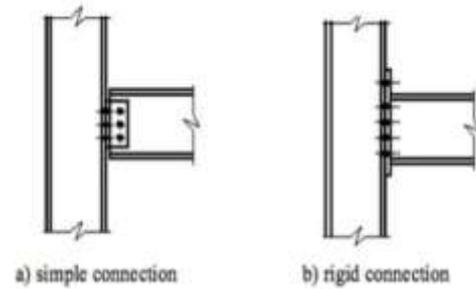


Fig 1.1 Simple and Rigid Connections

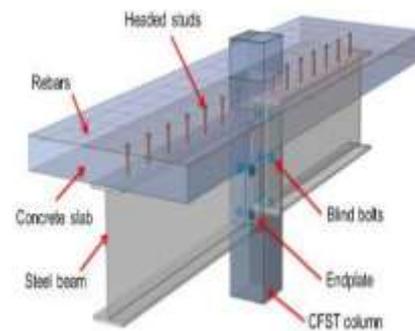


Fig 1.2 Steel beam with CFST column having studs and bolts at joint

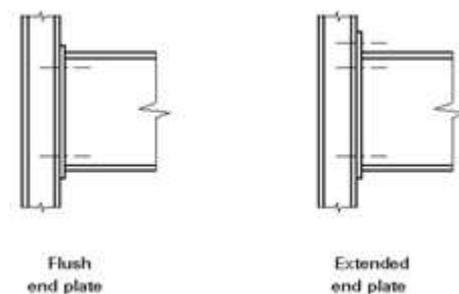


Fig 1.3 flush and extended endplate connections

1.1 Literature review

There are number of works are carried out to behaviour of beam-column joint performances under the action of loading. The literature review has been reviewed to get the data for the numerical study.

J.W. Park, S.M. Kang (2005) The paper deals Cyclic load testing of 7 no. of specimens was a single cantilever type. Increase in the width of the stiffening plates may

increase the stiffness and the strength of the joint but decrease the deformation capacity.

Abdel rahim Khalil Dessouki (2013) Two configurations on the extended end-plate moment connections are studied. Parameter studied are bolt diameter. For diameter of bolts <24 mm: thick plate used – yielding is due to bolt only. For diameter of bolts >24 mm: thin plate used - yielding due to end-plate only.

S. S. Patil et.al (2013) Beam and column where intersects is called as joint or junction. The different types of joints are classified as corner joint, exterior joint, interior joint etc. on beam column joint applying quasi-static loading on cantilever end of the beam. And study of various parameters as to be find out on corner and exterior beam column joint i.e. maximum stress, minimum stress, displacement and variation in stiffness of beam column joint can be analysed in Ansys software.

Guojie Zhou et.al (2018) The 20 specimens including 15 bolted endplate connections and five bolted T-stub connections. From comparison of experimental results for different specimens that the initial stiffness of the joints is sensitive to the thickness of the endplate and diameter of the bolts.

Hong Yanga, Wentong Zhao et.al(2018) Comparing the cyclic behaviour of interior beam-column joints with different loading methods. Two identical specimens were tested under two different loading methods in each group (BL&CL). In CL specimens damage is concentrated in the centre of the joint core with wider diagonal cracks distributed in the joint region. In BL specimens damage occurred in the entire joint region with dense and narrow diagonal cracks.

1.2 Scope & Objective

- To investigate the seismic performance of the CFST column to steel beam joint with end plates and bolts subjected to cyclic loading (seismic).
- To investigate some parameters which can affect the seismic properties of the joint.
- Failure mode of beam-column joint under seismic loading.
- Analyse the influence of bidirectional bolts and endplates at these joint.

2. GEOMETRY

Design as per BS EN1993-1-8:2005, Eurocode 3: design of steel structures-part 1.8: design of joints.

There are two types of connection types are required to analyse the performance of beam-column joint under seismic loading,

- Flush endplate
- Extended end plate

Bolted steel connections, such as T-stubs and end-plate connections, are the assemblages of components (plates, bolts and welds). Because of the large variety of connection configurations possible, many geometrical discontinuities and associated stress concentrations present in bolted connections. Eurocode 3 (1998) contains design rules for determining the properties of several types of connections including the bolted flush end-plate

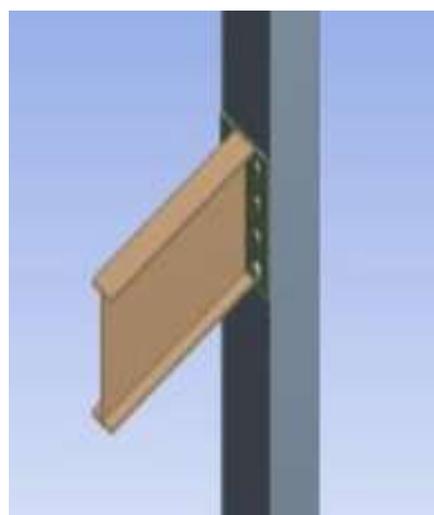


Fig 1.4 Flush end plate connection

2.1 Nonlinear Material Properties

Dimensions of components: (Dimensions of beam, column is from a reference journal no.12)

- CFST column size: 300x300x3000x6mm • Beam size: H beam of 120x400x8x6mm
- Beam length: 900mm
- Endplate of size: 8,10, 12 mm
- Bolt size: M22, 10.9 HSFG bolts (ISO 898-1 Gr. 10.9)
- Bolt type: M22, 10.9 HSFG bolts (IS1367(Part3): 20002, ISO 898-1 Gr. 10.9)
- Grade of concrete of steel pipe: M30
- Axial force acting at joint: 300 KN
- Seismic loading is applied in a cyclic manner with 10 load steps.

Table 1.1 parameter of materials

Component	Yield strength (Mpa)	Limit strength (Mpa)	Tensile strength (Mpa)	Youngs modulus of elasticity
Beam	235	338	375	2.05x10 ⁵
Column	348	451	470	2.05x10 ⁵
Bolt	917	1040	1040	2.05x10 ⁵

2.2 Modelling

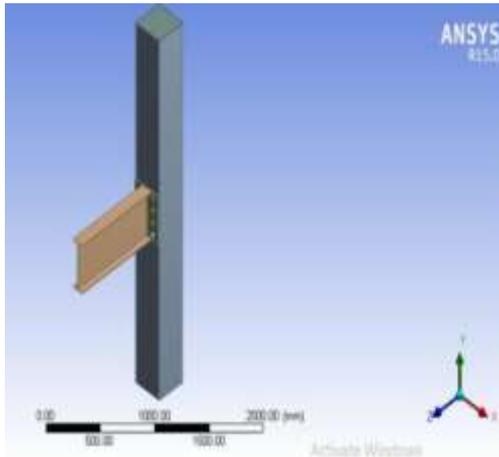


Fig 1.5 Beam-column joint with M22 of 10.9 HSF8 bolts and 12mm thin endplates.

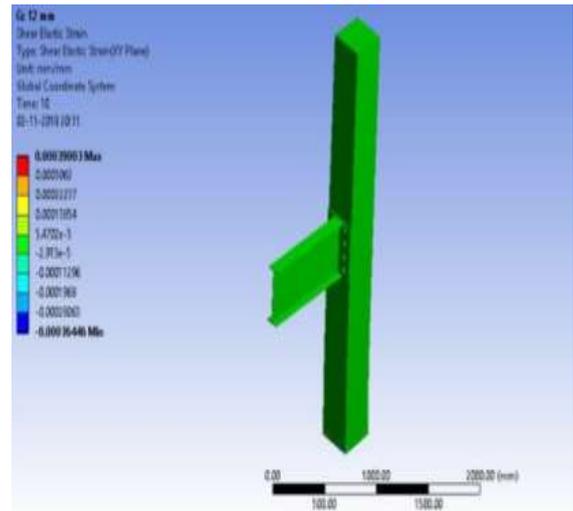


Fig.1.8 Elastic strain diagram

3. RESULTS

Parameters analysed are,

- Total deformation
- Maximum stress
- Maximum strain

For model of 12mm thickness flush endplate

- Total deformation= 3.951mm
- Equivalent stress value= 106.19 Mpa
- Elastic strain= 0.000390 mm

The three main failure modes for a bolted end-plate connection proposed by Eurocode 3 (1998) are considered in this

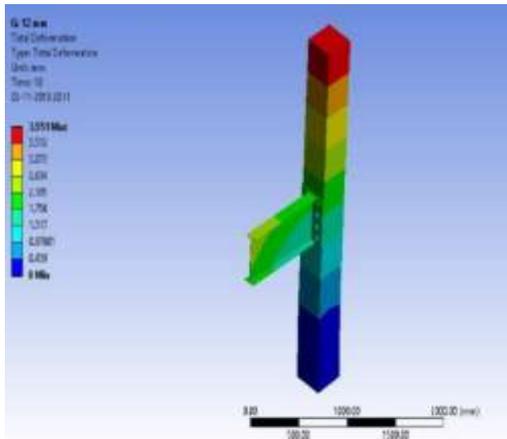


Fig. 1.6 Total deformation

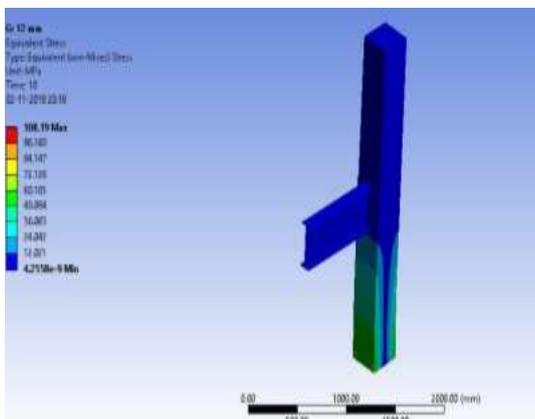


Fig 1.7 Equivalent stress diagram

4. CONCLUSION

From the previous studies it is found that the initial stiffness of the joints is sensitive to the thickness of the endplate and diameter of the bolts. The stiffeners can improve the stiffness of the connections when the thickness of the endplate does not change. Here flush end plate was analysed having total deformation, maximum stress and maximum strain. Therefore, it is decided that the further studies will be on flush endplate with different bolt diameter and extended endplate of different endplate thickness & bolt diameters.

REFERENCES

1. Soo-mi shin (2014) Analysis of the Behavior of Beam-to-Column Connection with the Newly Reformed T-stub Connections by Exponential Function, park international journal of software engineering and its applications vol.8, no.1, pp.275-286
1. Mohammed H Mahmoud (2014) Strengthening of defected beam-column joints using CFRP., Journal of advanced research, J. Struct. Eng.,(2014)5,67-77, 144(11): 04018199 science direct
2. Abdelrahim Khalil Dessouki (2013) Behavior of I-beam bolted extended end-plate moment connections, international Journal of Software Engineering, Applications Vol.8, No.1 (2014),

pp.275-286 Procedia Environmental Sciences, Elsevier

3. Primoz Moze (2018) Bearing strength at bolt holes in connections with large end distance and bolt pitch, Journal of Constructional Steel Research 147 (2018) 13, science direct.
4. J.W. Park, S.M. Kang (2005) Experimental studies of wide flange beam to square concrete-filled tube column joints with stiffening plate around the column, Journal of Structural Engineering, Vol. 131, No. 12, December 1, 2005. ©ASCE, ISSN 07339445/ 2005/12-1866-1876.ASCE131:12(1866).
5. Leonardo M. Massone(2018) Analytical model for shear strength estimation of reinforced concrete beam-column joints. Engineering Structures 173 (2018) 681–692, Elsevier.