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A Literature Survey On Square Hollow Beam And Column For Connection Joint

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Abstract— In this survey paper discussed the steel structures in India are made of conventional steel sections (such as angle, channel and beam sections). However, new hollow steel sections (such as square and rectangular hollow sections) are gaining popularity in recent steel constructions due to a number of advantages such as its higher strength to weight ratio, better fire resistance properties, higher radius of gyration, lesser surface area, etc. This type of hollow sections can save cost up to 30 to 50% over the conventional steel sections (Tata Steel brochure, 2012). But unlike the conventional steel sections these hollow sections do not have standard connection details available in design code or in published literature. To overcome this problem the objective of the present study was identified to develop a suitable and economic connection detail between two square hollow sections which should be capable of transmitting forces smoothly and easy to be fabricated. In the last decade there are different research work presented in this survey paper.

Keywords— Hollow Sections, Non Linear (Pushover) Analysis, Capacity Curve, Plastic Hinge, Deformation And Connection etc…

I. INTRODUCTION

Connecting technology plays an important role in the performance of hollow section structures. A distinction has to be made between CHS and RHS connected members, because the behavior of joints, e.g. local behavior of members is different. A particular case is represented by beam-tocolumn joints in building frames with Concrete Filled Hollow Section (CFHS) columns. Both welded and/or bolted connections can be used in such a case. For beam-to-column joints of hollow section frames (e.g. RHS columns and beams or hollow section columns and I or H section beams), blind bolting technology is available. This section summaries the main aspects concerning the behavior and design of hollow section connections loaded predominantly statically. This means they can also be used for seismic resistant buildings, since seismic motions are not considered as generating fatigue phenomena. European standard [prEN 1993-1-8: 2003], application rules to determine the static resistances of uni-planar and multi-planar joints in lattice structures composed of circular, square or rectangular hollow sections, and of uni-planar joints in lattice structures composed of combinations of hollow sections with open sections. Most of the steel structures in India are made of conventional steel sections (such as angle, channel and beam sections) and were designed by conventional working stress methods. However, new hollow steel sections (such as square and rectangular hollow sections) are gaining popularity in recent steel constructions due to a number of advantages. Not only the hollow sections make the entire structure light weighted as they possess high strength to weight ratio, also they have higher efficiencies in resisting forces in comparison to conventional steel sections. The hollow sections also have better fire resistance properties. Higher radius of gyration, lesser surface area of the sections result savings in transportation, fabrication and painting costs. According to a recent study (Tata Steel Hollow section brochure), up to 30 to 50% saving in cost can be achieved by using hollow steel sections over the conventional steel sections. The steel industry in India started producing such hollow sections and making them available to the builders in regular basis. Fig. 1 presents photograph of typical rectangular hollow section (RHS) available in India. This development has brought attention of researchers to 'the connection design' which is a very important aspect of steel design and construction. Unlike the conventional steel sections these hollow sections do not have standard connection details available in design code or in published literature. The application of hollow sections is not rising up as suitable connection configurations (for shear

force and bending moment) have not been developed between the sections.

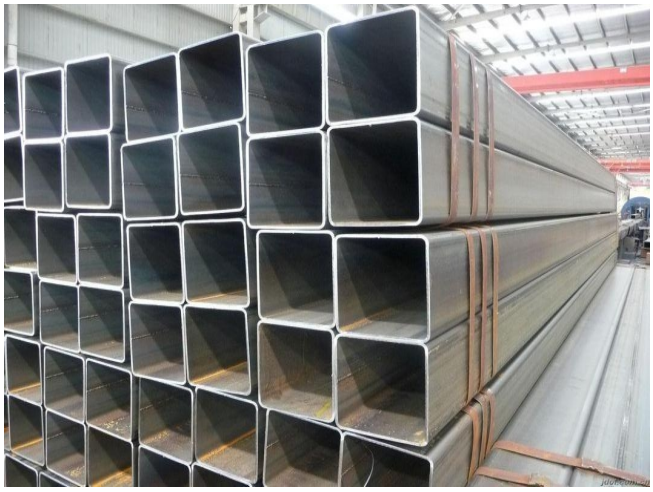

Fig. 1 Typical rectangular hollow section (RHS) available in India

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II. Literature Review

Alekya, Jingfeng Wang,et,al.[2020]-From the experimental investigation and numerical analysis, some conclusions could be listed as follow:

The typical failure modes of the steel beam blind bolte to the CFDST column joints mainly included the slipping of the blind bolt, the bending deformation of the end plate and the local buckling of the beam compressive flange. Compared with CFST column blind bolted joints, blind bolted connections to CFDST column significantly restricted the outward deformation of the column wall. This type of connection can be regarded as a semi-rigid and partial strength connection. (2) Rationality of the FE models considering the complex contacts and material models were observed through the experimental results, indicated that the developed FE model could be used to analyze the structural behavior of the blind bolted joints connecting the steel beams to the CFDST columns**[1]**.

Nader Fanaie,et.al,[2019]-The most important results obtained from this study are outlined below:

1- The rupture index at points with the most stress concentration in finite element analysis decreased over 50% for TSDF-23, TSDF 26 and TSDF 29 in the specimens with constant hole diameter.

2- In the analytical models with variable holes, the equivalent plastic strain (PEEQ) at the joint of stiffener groove welds to beamand column increases with the increase in b/db ratio. However, changes in the b/db ratio do not have a significant effect on the overall behavior of connection and the hysteresis curve.

3- With an increase of b/db ratio in hole drillingwith a constant diameter, the rupture index increases at critical points, which is more intense for b/db ratios greater than 0.45. While, The PEEQ index for the b/db ratio of 0.45 has its least amount and in the models with constant hole diameter, it is less than its value in the variable hole diameter models. In this study, it is recommended that the b/db range be considered equal to 0.4 to 0.5.

4- In the test specimens,with an increase in the ratio of Le/bf to 0.28, the hole edge fracturewas prevented. TSDF specimenwas loaded up to a relative drift of 0.07 rad and no fracture was observed at the hole edge or the joint of the stiffener to beam and column.

5- With a decrease in the Dmin/bf ratio in the models, the probability of brittle fracture increases in the location of change the cross section. Therefore, theminimumamount of 0.12 in the design of hole drilling with various diameters is proposed.

6- With an increase in hole diameters, stress concentration of Tstiffener groove welds and beam moment capacity decreases. It is suggested that the maximum Dmax/bf ratio be limited to 0.2 **[3].**

Md. Tahir et.al.;[2018]-The current paper investigated the performance of blind bolted end plate connections used in square hollow sections (SHS) column through numerical and experimental studies. Based on the experimental results and observations made, the following conclusions can be drawn:

1) Comparison of the results of the test conducted on blind bolted moment connections used in SHS column revealed that the moment capacity and rotational stiffness of connections are significantly affected by the thickness and types of end plate, as well as the size of the beam.

2) The results showed that increasing the beam size and end plate thickness can significantly improve the stiffness as well as the ultimate moment capacity of the connection. However, it is interesting to note that for a specific SHS column size of the connection, increasing the beamsize and end plate thickness more than a specific value reduces the potential of the connection to achieve a partial strength connection status according to the EC3 classifications. It is also concluded that the thickness of the SHS column has a significant influence on the stiffness and strength of the proposed blind bolted connection.

3) The 3D non-linear finite element modeling on blind bolted connections with a SHS columns and steel I section beams was developed. The experimental results were validated by FE modeling in terms of the modes of failure as well as the moment-rotation relationship curves of the connections. The obtained results revealed that FE modeling is able to apply for prediction of the structural implementation of blind bolted moment connections having high accuracy**[4].**

Omid Rezaifar, et.al.,[2017]-Experimental studies in the field of studies shows the use of the proposed external stiffeners (Surrounding Plate and Vase Plate) to improve the seismic performance of the connection under monotonic and cyclic load and to improve the seismic parameters of connection. Since these connections have specific geometry they increased the width of the beam flange around panel zone and (a) Concrete effect (b) Bar mats effect (c) Continuity plate effect(HSS) (e) External stiffeners effect(HSS) (d) Continuity plate effect (CFT) (f) External stiffeners effect(CFT) transferred plastic hinge into the beam. While the column of these connections is CFT, the

behavior of connection is better than HSS. In addition, in present study the use of bar mats was studied instead of continuity plate in panel zone. Generally, the results show that the external stiffeners are good alternatives for continuity plates and can be considered in the design of buildings and they have commercialization ability**[5].**

Zhong Tao,et.al.[2017]-An experimental investigation has been conducted in this paper to study the performance of CFSST 20 column to steel beam joints with blind bolted connections. The following conclusions can be drawn within the limitations of this study:
(1) The presence of composite slabs significantly affected the failure mode, initial stiffness, flexural resistance, and rotation capacity of the joints. In the presence of the composite slab, the initial stiffness and flexural resistance were significantly increased. But the failure became brittle because of the fracture of the longitudinal reinforcement in the slab. The amount of reinforcement may be optimised to achieve desirable rotation capacity.
(2) The binding bars had some effectiveness in increasing the joint stiffness and strength, and reducing the separation between the steel tube and concrete. By adding binding bars, the ultimate hogging moment capacity was improved by 10.7%, whereas the initial stiffness was improved by 62.5%.
(3) Joints with circular columns showed better behaviour than joints with square columns in terms of initial stiffness and flexural resistance. The steel type of the column had very minor influence on the joint behaviour.
(4) The cyclic loading led to slightly decreased joint strength, and had more obvious detrimental influence on the joint stiffness.
(5) According to Eurocode 3, the blind bolted joint without composite slab can be classified as nominally pinned joint. But in the presence of the floor slab, the joint nearly reached its full strength and the stiffness was also significantly increased close to the limit for rigid sway frames**[6].**

Zhi-Yu Wang,et.al.[2016]-The yield and ultimate strengths of a blind bolted endplate to square tubular column connection have been examined for the evaluation of the strength of such connection in joint tensile region. An experimental programme consisting of eleven test connections assembled by T-stubs and SHS columns with the standard bolts and the Hollo-Bolts has been described. The local behaviour manner and its corresponding strength have been identified for the connections in failure modes i, ii and iii. The load–deformation responses were analyzed for the determination of justified yield strength of the test connections. The finite element model explicitly allowing for the component details of the Hollo-Bolt was developed to further the understanding of the local response of the connections. Afterwards, an analytical model was proposed for the prediction of yield strength and ultimate strength of the connections. In this model, the yield line analysis has been adopted for the plastification of SHS column connecting face with combined action of the blind bolt in tension whereby the theoretical formulae have been derived for three failure modes. Moreover, based upon augments relating to membrane forces and circumferential locking action of the bolt, an expression for the prediction of ultimate strength has also been proposed. Finally, the accuracy and applicability of the proposed analytical model have been examined and discussed**[7].**

Yang, Jie; Sheehan,et.al.[2015]- A number of experiments were conducted to investigate the rotation behaviour of simple bolted beam to elliptical column connections. Based on the experimental results, the typical failure mode of the connections with hollow columns was found to be inward local buckling of the column surface near the upper portion of the joints, though stiffeners were arranged in either the major or minor axis direction in some cases. However, the inward deformation was eliminated by the core concrete. Instead, shear failure of the bolts governed the ultimate rotation capacity of the joints with concrete infill.According to the moment versus rotation responses of beam to elliptical column connections, friction was in control in the initial stage with the friction force existing between fin plates, beams and bolts. In this section, the rotation of the connection was quite low but the slope of the moment-rotation curves was nearly constant, with the column, beam and bolts working well together. Then, slippage occurred when the load applied was bigger than the friction force, and the moment climbed slowly with the increase of rotation. Afterwards, the bolts, the bolt holes in the fin plates and the beam webs acted together in resisting the load until the joints failed in one of the modes described previously**[8]**.

V. CONCLUSION

In this survey paper discuss the different Load carrying capacity of the joint and the maximum deformation capacity is highly sensitive to the type of connection used. In this observe that the formation of the plastic hinge is usually found to occur at the beam-to-column joint for all the different schemes of connection details. The plastic hinge in the beam end away from joint. Performance of the joint with connection details columns jacketed with two channel sections and connected with beam by welding performs best among others with respect to the ultimate load, deformation at collapse and formation of plastic hinges. So these are some results that is observed by literature of previous works.

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