

Seismic Conduct of by Way of-Diaphragm Connections between CFRT Columns and Steel Beams

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ABSTRACT:

A series of six full-scale cruciform H-shaped beam to square tube column joint with cast steel stiffener specimens was tested under cyclic loading to study the seismic behavior of the new joints. A parametric numerical analysis based on the test results was also conducted. The hysteretic curves of specimens not filled with concrete were full, and the ones of specimens filled with concrete were pinched. The maximum moment resistance of the joints filled with concrete in the column increased from 10 to 30% compared with that of the joints not filled with concrete. The energy dissipation coefficient of the joints not filled with concrete in the column varied from 2.681 to 3.585, whereas it changed from 1.892 to 1.711 for the joints filled with concrete when the width of the square tube column ranged from 300 to 500 mm. The results demonstrate that the joints with cast steel

stiffeners have excellent moment capacity, deformation performance, and energy dissipation coefficients. The new joints could potentially be applied in a seismic region

INTRODUCTION:

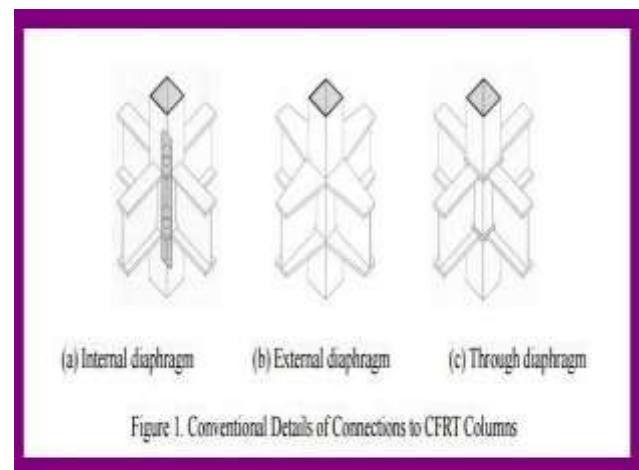
Concrete-crammed rectangular tubular (CFRT) columns had been extensively utilized in functional functions this present day due to their advantages of pleasant mechanical habits and architecturally pleasing benefits. A giant quantity of research has been performed on the connections between CFRT columns and steel H-beams. Earlier investigation on the experimental behavior of H-beam-to-CFST column connections has incorporated that of Kang et al. [1], Varma et al. [2], Ricles et al. [3], Shin et al. [4], Cheng et al. [5], Wu et al. [6], Nie et al. [7], Wang et al [8], Park et al.

[9], and Qin et al. [10-11]. Theoretical be trained on the flexural force and shear strength has been carried out with the aid of Kawano et al. [12], Koester [13], Lu et al. [14], Morino et al. [15], Fukumoto et al. [16], Park et al. [17], Jiang et al. [18], Nie et al. [19], Rong et al. [20], and Qin et al. [21-23]. Moreover, more than a few connection possible choices were proposed and explored through researchers, such as the applying of blind bolt [24-26], combined channel attitude connections [27], and by way of-bolt connections [28]. Damage assessment [29], computationally performance simulation [30], and design approach investigation [31] represent other areas of interest. A couple of today's reports and papers also offered a massive quantity of research outcome on CFRT column-to-H-beam connections [32-36]. However, few reports have considered the improvement of the by means of-diaphragm connections or the seismic habits of the panel zone. As a part of investigations on the seismic habits of CFRT connections, in this research, one average and three elevated by way of-diaphragm specimens have been verified to assess the seismic performance of the connections subjected to cyclic loading. The experimental outcome including moment-rotation response, force and stiffness

degradation, ductility, float rotation and vigor dissipation have been offered in a parallel paper [10]. An extension to this work which considers the conduct of panel zone, the deformation, and the drive switch mechanism is described here.

CFRT CONNECTIONS

2.1 Traditional Connection Types Three conventional connections are currently used for CFRT column moment resisting frame (MRF) system in some Asian countries such as China, Japan and Korea [37]. As shown in Figure 1, each employs an internal diaphragm, an external diaphragm, or a through diaphragm.



The internal diaphragm connection is made via inserting the diaphragm into the steel tube and connecting the beam flanges to the tube floor, as proven in determine 1(a). It has the benefit of not interfering with the

finishing materials outside the column. Nonetheless, imperative measures will have to be taken when infilling concrete into the metal tubes, in order to restrict the occurrence of voids under the diaphragm. On this case, the tensile force transferred from beam flanges is instantly dropped at column flanges. On the grounds that the internal diaphragm is welded around its perimeter to the metal tube and the metal tube column restrains the deformation of the diaphragm, most of the deformation in the panel zone is targeted alongside the course of the thickness of the column flanges. When the tensile drive is enormous sufficient, the failure of the connections could accompany punching shear, which induces the fracture of the weld between the beam flanges and column flanges. Additionally, lamellar tearing of the column flange may occur whilst. This failure mode was determined within the easy tension scan and cyclic loading test performed through Choi et al. [38], as shown in determine 2(a). The outside diaphragm connection element, as shown in determine 1(b), attaches the diaphragm to the outside of the metal tube and needs no chopping of steel tube for fabrication. However, the outside diaphragm lacks aesthetics and could have obstacles on the size of the diaphragm for a joint of an

exterior body. As a result of the abrupt trade of the move-sectional field between the beam flange and outside diaphragm, the stress and deformation awareness there reasons the failure of groove weld [39]. The element of by way of diaphragm connection, as proven in determine 1(c), requires diaphragms penetrating the metal tube and beam flanges directly welding to the by means of diaphragm. In this case, the tensile force is transferred from the beam flanges to the by way of diaphragm. This detail greatly moves the plastic hinge faraway from the metal tube surface and gentle the weight switch course, despite the fact that it entails much on-website welding and imposes building complication. The failure of connections is generally precipitated through the crack developed within the groove weld between beam flanges and by means of diaphragm, as shown in determine 2(b) [38].

Proposed Connections with by way of Diaphragm

To restrict the abrupt trade of cross part between the beam flanges and through diaphragm and scale back the stress awareness there, three expanded by way of diaphragm connection small print were studied herein. Specimen JD-2 had a tapered diaphragm with an expanded size of

320mm, as illustrated in figure three(b). In Specimen JD-three and JD-four, the by means of-diaphragm penetrated the metal tube and extended a size of 20 mm. Horizontal haunches were attached to the beam flange to type the tapered flange at the beam finish as shown in figure three(c) and (d). These important points have been both designed to transfer the tension force from the beam flange instantly to the perimeters of the metal tube and provide a more gradual transition within the geometry of the connection region. The weld entry gap proven in figure four(a) used to be used in specimen JD-1 and JD-2, whilst that in determine 4(b) was once used for specimen JD-3 and JD-four. A extra designated description on the specimen design can also be found in [10]

Comparison of strain distribution amongst four connections indicates that, it's evident that the habits within the beam pressure was noticeably influenced by means of the variant in the connection important points, as illustrated with the aid of results of Specimen JD-1, JD-2, and JD-three. In the determine, it can be found that each the online and flanges of the beams close the connections in all specimens had far exceeded the yield strain. The traditional through-diaphragm connection (Specimen JD-1) gave the impression to be the perfect harassed at each the diaphragm and the beam flange at the same load stage. This phenomenon demonstrates that offering development to connection configuration ensures an develop in rotation potential and a significantly higher force ability. Moreover, the connection details have a enormous affect on the function of the plastic hinge and determine whether or not or no longer the force will also be sufficiently delivered from the metal beam to the CFRT column. In the meantime, Specimen JD-three had the best strain values within the internet, which is cheap on the grounds that the deep longitudinal reduce within the web results in the stress awareness there. That is additionally the neighborhood that used to be designed to

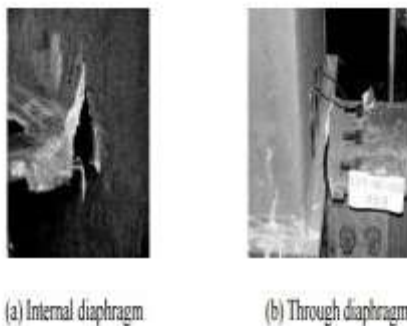


Figure 2. Example of Connection Failure

Key Findings

absorb the seismic energy and as a result, provide a ductile habits of the via-diaphragm connection.

CONCLUSIONS

in this paper, an experimental application comprising 4 by means of-diaphragm connections subjected to cyclic load was once performed, and the connection of lateral drive versus beam-column rotation, shear force versus shear distortion curves, deformation, and pressure distribution were analyzed. The important conclusions will also be drawn as follows:

(1) The lateral drive versus beam-column rotation response of the proposed connections was most likely more advantageous when compared to the traditional connection, attributed to the improved geometrical detail of the connection. This suggests that seismic resistance of the proposed connections is much better than the existing one. As a result, the proposed types are extra compatible for software in moment resisting frames in seismic regions.

(2) The stiffness of the proposed connections is better than that of the normal one. For this reason, the precious outcomes of the factors surrounding the panel zone

should be taken into account to calculate the shear stiffness.

(3) The deformation of the beam finish is the biggest contribution to the complete displacement of the connection. This demonstrates that extra yielding happened there.

(4) The connection details obviously have an effect on the load course how the drive is transferred from the beams to the columns. Additionally, the proposed varieties greatly alleviate the stress concentration in the beam flange and certainly increase the ductility of the natural connection.

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