Comparative Study on CFST and RC Column in the RC Frame Structure: A Review

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Abstract - Steel concrete composite construction refers to the connection of the concrete slab to the steel beam through shear connections, allowing them to function as a single unit. In this study, steel-concrete composite with RCC solutions are explored for a comparative analysis of a G+14 storey residential structure located in seismic zone IV, and the provisions of IS: 1893 (Part1)-2002 are used for earthquake loading. The ETABS 2016 programme is used to do three-dimensional modelling and analysis of the structure. Both Composite and RCC structures are analysed using the Equivalent Static Method of Analysis, Response Spectrum Analysis Method, and Pushover Analysis. In contrast to reinforced concrete columns with transverse reinforcement, the steel section also avoids concrete spalling and reduces reinforcement congestion in the connection zone, which is especially important for earthquake design. Filling steel parts with concrete has been shown to boost strength, ductility, and damping in several experiments. With great success, high-strength concrete has been mixed with high-strength thin-walled steel sections in recent applications. The more brittle character of high strength concrete is somewhat tempered by the confinement provided by the steel section, and local buckling of the thin steel section is postponed by the support provided by the concrete.

Key Words: CFST Column, RC Column, RC frame Building, Time History, ETABS

1. INTRODUCTION

Due to its several benefits over traditional RC and steel building, steel-concrete composite construction has grown in popularity in recent years. Engineers like to create multi-story high-rise buildings in metropolitan regions owing to rising population and land scarcity. Composite members that combine the benefits of steel and concrete are known as concrete-filled steel section members. They are made out of round, square, and rectangular steel parts that are filled with plain or reinforced concrete. The concrete-filled steel section (CFSS) column has a number of structural advantages, including strong compressive strength, fire resistance, ductility, and energy absorption capacity. Compared to similar steel, reinforced concrete, or steel-reinforced concrete structural members, the CFSS structural member offers numerous notable benefits. The steel and concrete in the cross-section are oriented in such a way that the section's strength and stiffness are maximised. The steel is more effective in tension and resisting bending moments when it is located on the outside perimeter. Also, because the steel, which has a significantly higher modulus of elasticity than the concrete, is located farthest from the centroid, where it contributes the most to the moment of inertia, the stiffness of the CFSS is greatly increased. In normal applications, the concrete creates an excellent core to sustain compressive loads, and it delays and frequently avoids local buckling of the steel, especially in rectangular CFSS. Furthermore, it has been demonstrated that the steel tube limits the concrete core, increasing the compressive strength and ductility of circular CFSS and rectangular CFSS, respectively. As a result, CFSS is the best choice for columns that are subjected to high compression loads.

1.1 CFST Column

Concrete-filled steel tubular (CFST) members are made out of a circular or rectangular steel hollow section that is filled with plain or reinforced concrete. They take advantage of the benefits of both steel and concrete. They are widely employed as columns and beam columns in high-rise and multistory structures, as well as beams in low-rise industrial buildings where a robust and efficient structural system is required. The hollow tubes are constructed in such a way that they can withstand a floor weight of three or four stories. The hollow steel tubes are either made or rolled before being constructed to sustain the top levels' building weight. A structural system like this also has the benefit of steel and reinforced concrete frames. Its structural rigidity and integrity are comparable to that of a reinforced concrete structure. The simplicity of erection and manipulation of structural steel components allows for new building options to be explored. Concrete is injected into the tubes from the bottom when the higher levels are finished. The tubes are continuous at the floor level to make pumping easier. Pumping concrete up to three to four stories is simple with the aid of modern pumping technology and self-compacting concrete. The building may be finished quickly due to the simplicity of the construction procedure.

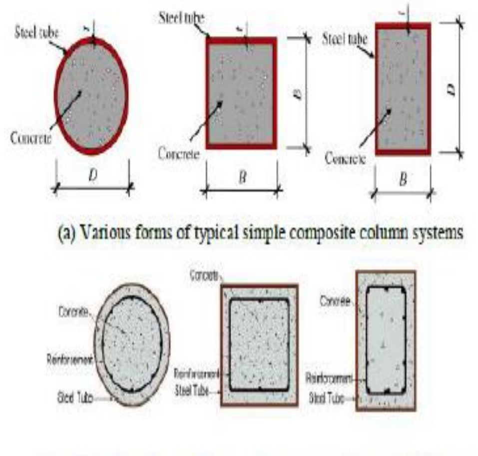

Fig -1: CFST Column

2. LITERATURE SURVEY

After studying a few research paper related to the CFST column, there is a summary of all previous research paper are given below:

[1] Lin et al (2009) Composite frames made out of concrete-filled steel tubular (CFST) columns and steel beams are becoming increasingly common in building constructions, according to this article. Composite frame systems are frequently used with reinforced concrete shear walls to create a high-rise building system in China. However, information on the seismic performance of this type of hybrid building was scarce. The results of shaking table testing on two 30-story building models with composite frames and RC shear walls are described in this study. In the composite frames, CFST columns with round and square sections were employed.

[2] Liao et.al (2009)) In this study, structural engineers discuss how the usage of concrete-filled steel tubular (CFST) columns and reinforced concrete (RC) shear wall mixed constructions has piqued their interest in recent years. On circular CFST columns and RC shear wall mixed constructions exposed to continuous axial load and cyclic lateral stress, an experimental research using four test models was carried out. The axial load level in the composite column and the height-width ratio of the RC shear wall were among the test parameters. The impact of these variables on the specimens' strength, ductility, stiffness, and dissipated energy were studied. In the shear-dominant mode, all of the specimens examined failed. With a rise in axial stress level or a drop in height-width ratio, the specimens' ductility and energy dissipation capability declined.

[3] Lin et al (2014)) The concrete-filled steel tubular (CFST) structure is discussed in this study because it has various structural advantages and is commonly employed in civil engineering constructions. This study examines the evolution of the concrete-filled steel tubular structure family to this point and proposes a research strategy for CFST members. The most current research on CFST structural members has been summarised and discussed, with a focus on China.

[4] Faizulla et al (2015) Structural engineers are faced with the task of finding the most efficient and cost-effective design solution. The use of composite materials is of special interest since it has the ability to significantly improve overall performance with relatively minor modifications in manufacturing and building processes. In today's constructions, steel-concrete composite columns are often employed. There has been a lot of study done on composite columns with structural steel components enclosed in concrete. In comparison to enclosed columns, in-filled composite columns have received less attention. Etabs nonlinear software is utilised in this work to simulate steel-concrete composite (CFT) with steel-reinforced concrete constructions (RCC) of G+14, G+19, and G+24 storeys each for comparison. Parameters such as base shear, axial force, and bending moment are compared.

[5 Asha et.al (2015) In this article, buildings in India are made of RCC, and steel structures are mostly used in industrial buildings and late multi-story buildings, which have become popular due to the use of composite structural materials. Composite columns, on the other hand, have recently gained popularity for use in multi-story buildings due to their excellent static and earthquake-resistant properties, including lower mass, high strength, rigidity, and stiffness, significantly higher toughness and ductility, and large energy dissipation capacity. Aside from these benefits, the ability to easily build and instal columns on site may save money on labour and foundation expenses when compared to RCC columns, and they offer great buckling resistance, maintenance, and fireproofing costs when compared to steel columns. In addition, composite systems are lighter (about 20 to 40 percent lighter than concrete construction). As a result, compared to basic reinforced concrete or steel pieces, the composite system is a more comprehensive structural system.

[6] Hong et al (2016) Shear walls made of concrete-filled steel tubes and steel plate-reinforced concrete (CFST-SPRC) have been proposed for use in super-high-rise structures. The goal of this work is to analyse the seismic behaviour of CFST-SPRC shear walls through an experimental investigation. Under constant axial force and reversed cyclic loading, three CFST-SPRC shear wall specimens with varied steel plate thicknesses and concrete strengths were examined. From web concrete cracking to local buckling of the steel tube plates to fracture of the vertical welds at the corners, all of the specimens underwent a sequence of failure. Due to the abrupt crushing of web concrete, one specimen exhibited brittle failure at the end of testing.

[7] Pandu (2016) Concrete filled steel tubular (CFST) members are discussed in this study, and they combine the benefits of both steel and concrete. They are made out of a circular or rectangular steel hollow section filled with ordinary or reinforced concrete. They are commonly employed as columns and beam columns in high-rise and multistory structures, as well as beams in low-rise industrial buildings when a sturdy and efficient structural system is required.

[8] Shilpa et al (2016) An attempt is made in this study to comprehend the behaviour of concrete-filled steel tubular columns subjected to axial load. Concrete is poured into a steel tube to create a concrete-filled steel tubular (CFST) column. Due to their excellent static and earthquake-resistant properties, such as high strength, high ductility, large energy absorption capacity, bending stiffness, fire performance, and favourable construction ability, concrete-filled steel tubular (CFST) columns are increasingly being used in the construction of buildings. The behaviour of CFST columns has recently piqued the interest of design engineers, infrastructure owners, and researchers, thus this work does a numerical finite element analysis utilising the ANSYS software package to better understand the load-deformation properties of composite columns.

[9] Vishal et al (2016) The massive surge in population and scarcity of land, particularly in cities and towns, have made high-rise building development unavoidable in recent years. Earthquake pressures are the primary cause of multi-story or high-rise RCC structure failure. High-rise structures also require bulky columns to accommodate enormous axial pressures and moments, resulting in a loss in usable area. For high-rise RCC structures, the usage of Concrete Filled Steel Tube (CFST) columns becomes the superior alternative to address such a difficulty. The CFST column is a composite section made by pouring concrete into a hollow steel tube, which resists the applied load due to the combined action of concrete and steel. The CFST section's strength is increased by this beneficial interacting behaviour between steel tube and concrete.

[10] Pooja et.al (2016) A concrete-filled steel tubular (CFST) column is formed by filling a steel tube with concrete. CFST columns are increasingly used in the construction of buildings due to their excellent static and earthquake-resistant properties, such as high strength, ductility, energy absorption capacity, bending stiffness, fire performance, etc.

[11] Vishal (2016) The massive surge in population and scarcity of land, particularly in cities and towns, have made high-rise building development unavoidable in recent years. Earthquake pressures are the primary cause of multi-story or high-rise RCC structure failure. High-rise structures also require bulky columns to accommodate enormous axial pressures and moments, resulting in a loss in usable area.

[12] Junghyun et al (2018) The flexural strength of a composite girder made of concrete-filled steel tubes (CFST) was examined in this research. Based on the plastic stress distribution approach, simple equations were established to determine the flexural strength of the CFST composite girder under both positive and negative bending moments (PSDM). The correctness of the suggested equation was then verified, and the influence of internal shear connections between the steel tube and concrete infill was investigated. To illustrate the failure process and set up the confirmed finite element analysis model, non-linear finite element analysis was done for each test specimen. The proposed equations provided a reasonably conservative prediction of the flexural strength of the CFST composite girder under both positive and negative bending moments, and the effect of internal shear connectors between the steel tube and concrete infill on the flexural strength was negligible, according to the findings. The influence of the D/t ratio, concrete infill compressive strength, and local buckling of the steel tube on the flexural strength of the CFST composite girder was investigated through a series of parametric tests.

[13] Jinlong et al (2018) The axial compressive performance of ECC-encased CFST columns was studied experimentally in his article. The test included four ECC-encased CFST columns and two concrete-encased CFST columns. The concrete-encased CFST column collapsed due to severe concrete spalling and crushing, but the ECC-encased CFST column appears to be in good shape. Even though the outer ECC has identical compressive strength to the outer concrete, the compressive strength of C1-ECC is around 30% greater than C1-C, demonstrating that the ECC encased CFST columns have a superior composite effect than concrete-encased CFST columns. In addition, specimen C1-ECC has a ductility index of 10%.

3. CONCLUSION

For high-rise RCC structures, the usage of Concrete Filled Steel Tube (CFST) columns becomes the prefered alternative. The CFST column is a composite section made by pouring concrete into a hollow steel tube, which resists the applied load due to the combined action of concrete and steel. The CFST section's strength is increased by this beneficial interacting behaviour between steel tube and concrete. When compared to the RC Column in the RC frame construction, the CFST column's ductility capability increases.

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