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JOURNAL OF CIVIL ENGINEERING RESEARCHERS

Introducing Concrete Filled Tube structural technology

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Abstract

In this article, we have reviewed Concrete Filled Tube (CFT) as a modern structural technology, which benefits advantages of both steel and concrete structures simultaneously. Then its materials and construction issues are discussed and concluded that it is one of the efficient technologies, which can be used to increase ductility and strength in structures.

Keywords: CFT, Concrete, Structure, Technology, Design

1. Introduction

Concrete filled steel tube is a new structural member in which hollow steel section is filled with high strength concrete. It is gaining more popularity now a day in construction area. Concrete filled steel tube is component with good performance resulting from the confinement effect of steel with concrete and design versatility. [1] The general term 'composite column' refers to any compression member in which the steel element acts compositely with the concrete as shown in fig 1. So that both elements contribute to the Strength. [2]

Fig. 1(a) depicts three typical column cross-sections, where the concrete is filled in a circular hollow section (CHS), a square hollow section (SHS) or a rectangular hollow section (RHS), where D and B are the outer dimensions of the steel tube and t is the wall thickness of the tube. It is noted that the circular cross section provides the strongest confinement to the core concrete, and the local buckling is more likely to occur in square or rectangular cross-sections. However, the concrete-filled steel tubes with SHS and RHS are still increasingly used in construction, for the reasons of being easier in beam-to-column connection design, high cross-sectional bending stiffness and for aesthetic reasons. Other cross-sectional shapes have also been used for aesthetical purposes, such as

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polygon, round-ended rectangular and elliptical shapes, as shown in Fig. 1(b). [3]

The main economy achieved by using high strength concrete in thin steel casings is that the structural Steel cost is minimized and the high strength concrete resists the majority of the load in compression [4]. However, bare steel or reinforced concrete columns are still used more extensively than CFSTs due to the lack of knowledge and experience that Engineers have with CFST structural systems [5].

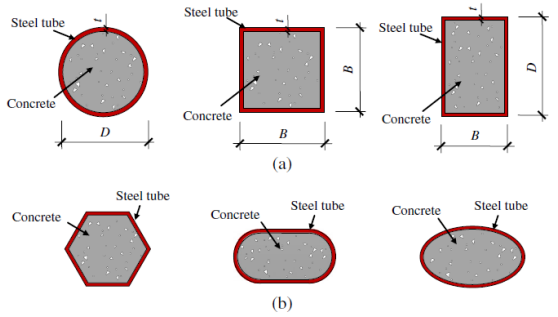

Fig.1. Typical concrete-filled steel tubular cross sections.

2. Materials for concrete-filled steel tubes

2.1. Steel

Various kinds of steel can be used in concrete filled steel tubular members, such as normal carbon ("mild") steel, high strength steel, high-performance fire-resistant steel, weathering steel, etc. The outer profile of the steel tube should not be too small in order to allow proper concrete placement. [3]

2.2. Concrete

The normal weight concrete and the high-strength concrete can be used as the filled concrete in CFST structures. Since the excess water cannot be expelled from the sealed tube, the water to cement ratio of the concrete should be strictly controlled. A water to cement ratio, exceeding 0.4 is inappropriate for normal weight concrete. One of the methods to ensure the construction quality of the core concrete is to use self-consolidation concrete (SCC). SCC can be used in filling the tube without additional vibration, which could be beneficial if some diaphragms are arranged near the connection zone.

3. Construction considerations

3.1. Placement of concrete

Generally, the strength and the compactness of the inside concrete should be ensured despite the construction method. There are different methods for placement of concrete into the tubes. Fig.2 shows the schematic views of two typical concrete filling operation methods. One is the pump filling, i.e., by pumping concrete from the bottom of the column, as shown in Fig.2 (a). The other one is the gravity filling, i.e., by placing concrete from the top of the column, as shown in Fig.2 (b).

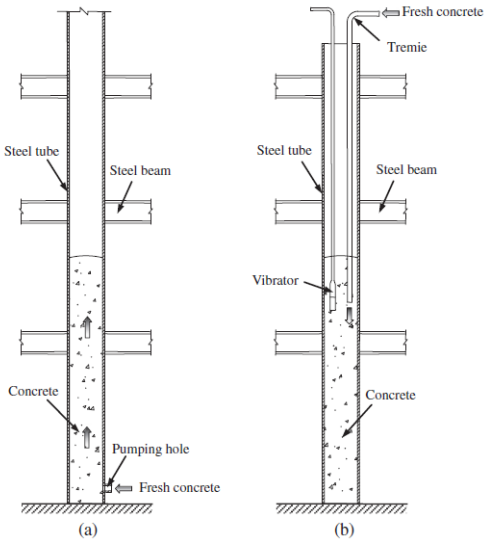

Fig 2. Schematic view of concrete placement.

3.2. Fabrication issues

The fabrication of tubular structural members is the same with other steel structures, and the dimension tolerances of the hollow steel sections should follow the specification of steel fabrication. Small vent holes should be drilled in the tube walls of the concrete-filled tubes, in order to prevent the column from bursting under the steam pressure from concrete material under fire. The diameter of the vent holes should not be less than 20mm. [3].Fig. 3

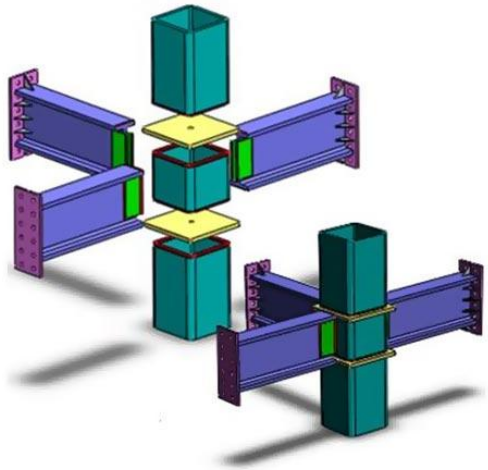

Fig. 3. CFT Fabrication

4. Conclusions

With buildings rising in stories, engineers are trying to find new systems for designing and constructing structures, by which costs of construction can be reduced while better performance and functionality can be reached and more safety can be provided for the inhabitants of that building.

CFT's are one of the newest solutions for resisting vertical loads in structures, which can be designed and constructed like steel framed structures. It has been proven that CFT structures are more ductile and have more strength because they have advantages of both concrete and steel framed structures. It is clear that this type of structures are more expensive. As they need special trained worker, they cannot be used in every situation.

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