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Summary of Axial Compression Behavior of Concrete Filled Steel Tubular Stub Columns after Fire

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Abstract

Concrete filled steel tube is a component formed by filling concrete in steel pipe. Compared with reinforced concrete, it has the characteristics of high bearing capacity, good plasticity and toughness, simple construction and greatly shortening the construction period. In order to study the axial compression performance of concrete filled steel tubular columns after fire, it is of great significance to the fire resistance design and post fire evaluation. This paper will summarize the research status of the mechanical properties of the Special-shaped columns of concrete filled steel tubular in China.

Keywords

Concrete Filled Steel Tubular Column; Axial Pressure Performance; After the Fire.

1. Introduction

Special shaped columns can be divided into reinforced concrete Special-shaped columns, steel reinforced concrete Special-shaped columns, pure steel plate Special-shaped columns and Concrete-filled steel tubular Special-shaped columns. Compared with the traditional rectangular column, the section form of Special-shaped column has changed greatly, such as T-shaped, L-shaped and cross-shaped section. Because of its special performance, it can effectively solve the problem of leakage column, increase the effective use area of building, and facilitate the layout of home. No matter from the aspect of aesthetics or function, the Special-shaped column structure has a good application prospect [1]. Due to the low bearing capacity, poor ductility and long construction period, the traditional reinforced concrete Special-shaped columns can not meet the requirements of standardized production, bearing capacity and seismic performance of building structures.

At present, the research on the axial compression performance of Concrete-filled steel tubular (CFST) columns at room temperature has been relatively perfect. Mainly through theoretical calculation, test and finite element simulation methods, such as Liu Yang [2], through test and finite element analysis, the exertion coefficient of the axial compression bearing capacity of the core CFST core columns is obtained, and the calculation formula of the axial compression bearing capacity of the core CFST composite columns is proposed; Chen Zhihua [3] further verified the feasibility of Concrete-filled square steel tubular composite Special-shaped columns by superposition theory; Zhang Ailin [4] verified that with the increase of steel and concrete strength, the bearing capacity of L-shaped columns with solid web steel increases gradually. Li Zhijun [5] and others have passed the axial compression test of Concrete-filled steel tubular columns with Special-shaped section and restrained tie bars, and verified the feasibility of the component in engineering application. After fire, Concrete-filled steel tubular Special-shaped columns have great changes compared with normal temperature, mainly in the axial compression bearing capacity and axial compression stiffness and other mechanical

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properties have different degrees of reduction. Therefore, it is necessary to study the mechanical properties of Concrete-filled steel tubular Special-shaped columns after high temperature. In this paper, the research status of Concrete-filled steel tubular Special-shaped columns with cross-section, T-section and L-section is reviewed.

2. Research Status of Special-shaped Columns of Concrete Filled Steel Tubular after Fire at Home and Abroad

Domestic scholars' research on Special-shaped concrete filled steel tubular columns after fire can be divided into the following three types according to the cross-section forms, which are listed in Table 1:

Table 1. Research status of concrete filled steel tubular special shaped columns

Section form	Research scholar	Research contents	Relevant conclusions
T-section	SUN Hao [6]	Calculation of axial bearing capacity of reinforced concrete filled steel tubular T-shaped columns under high temperature	Through a lot of theoretical analysis and research, a simple formula for calculating the axial compression bearing capacity of reinforced Concrete-filled T-section steel tubular columns in high temperature fire environment is proposed.
	Xu Yang [7]	Study on axial compression behavior of concrete filled steel tubular T-stiffened stub columns after fire	Based on the calculation formula of ultimate bearing capacity of T-shaped reinforced Concrete-filled steel tubular short columns at room temperature, considering the equivalent strength of concrete and steel tube after fire, the calculation formula of residual bearing capacity of T-shaped reinforced Concrete-filled steel tubular short columns under uniform and non-uniform fire is established.
	Li Yong [8]	Study on mechanical behavior of T-shaped concrete filled steel tubular stub columns under axial compression after high temperature	The initial stiffness of T-shaped Concrete-filled steel tubular column has a certain relationship with temperature, which shows that the thicker the wall thickness is, the greater the initial stiffness is; The initial stiffness of T-shaped Concrete-filled steel tubular column has a certain relationship with temperature, which shows that the longer the high temperature lasts, the smaller the initial stiffness.
	Zhu Guozheng, SUN Hao, sun Qiang [9]	Study on axial compression capacity of T-section CFST columns after high temperature	With the increase of fire time, the speed of axial deformation of T-shaped column is slowing down. It can be considered that the difference between theoretical calculation value and critical load value of T-shaped CFST column under high temperature fire is gradually decreasing.
L-section	Li Zhikun [10]	Finite element analysis of mechanical properties of L-shaped multi cavity concrete filled steel tubular special shaped columns	The smaller the aspect ratio is, the stronger the bearing capacity of the Special-shaped column is, and the energy dissipation performance is slightly improved, but the ductility becomes worse; With the increase of steel pipe thickness, the bearing capacity,

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			stiffness and energy dissipation capacity of Special-shaped columns will increase. With the increase of steel pipe thickness, the deformation capacity of Special-shaped columns will increase slightly, but the influence is not obvious. At the same time, the steel content of Special-shaped columns will increase, and the economic cost will increase.
	Chen Zhihua, Lei Zhiyong, Zhou Ting	Bearing capacity of L-shaped concrete filled square steel tube under axial compression after fire	The ultimate bearing capacity of scfst column obtained by FEM and superposition theory is close to the test value, which provides a reference for the feasibility of using FEM simulation and superposition theory to calculate the ultimate bearing capacity of scfst column in the future.
	Lei Zhiyong [11]	Bearing capacity of Concrete-filled square steel tubular composite Special-shaped columns and its application in high-rise buildings	After the fire resistance test, the material performance and detail structure of the columns have little change, and they still show high bearing capacity in the axial compression test.
Cross section	Yang Yong; Gong Zhichao; Deng Hui; Zhang Lin; Wu Bo [12]	Experimental study on the fire resistance of concrete filled steel tubular cross section columns	The greater the axial compression ratio is, the smaller the fire resistance is. The thicker the fireproof coating is, the longer the fire resistance limit is.
	Deng Hui [13]	Experimental study on fire resistance of new concrete filled steel tubular special shaped columns	The practical calculation formula of the bearing capacity of the new concrete filled steel tubular Special-shaped column under fire is derived.
	Chen Zhihua, Li Zhenyu, Rong bin, Liu Xiliang [14]	Experimental study on bearing capacity of concrete filled square steel tubular composite special shaped columns with cross section under axial compression	The feasibility of using superposition theory to calculate Concrete-filled square steel tubular composite Special-shaped columns with cross-section is preliminarily verified.

Through the comparison of different cross-section types, it is found that: 1

(1) The above tests are basically monotonic load experiments, and there is no force analysis under complex conditions.

(2) Further research is needed on the material properties, local damage, axial compression and eccentric compression of post fire columns.

3. Problems of Special-shaped Concrete-filled Steel Tubular Columns after Fire

Based on the current research situation of scholars at home and abroad, the key problems of Concrete-filled steel tubular Special-shaped columns after fire are as follows

(1) The axial compression mechanism of CFST columns mainly includes the restraint effect of steel tube on core concrete and the bonding effect between them. A large number of experiments show that the restraint effect of CFST Special-shaped columns on core concrete under axial compression is mainly concentrated in the corner of columns, and the bonding

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effect can directly affect the deformation coordination ability of steel tube and concrete, When they bear the load together, the bond effect has little influence on the axial compression performance of CFST. Improving the deformation compatibility between steel tube and concrete can be a direction of future research.

(2) Due to the irregular section form, the mechanical properties of the members can be strengthened by welding batten stiffeners and restraint rods between the central single limb and each limb of the Special-shaped column. Its structure is complex and involves welding and anchoring problems, which greatly increases the construction difficulty and cost, and reduces the economic applicability of the members. New structural measures are proposed, which can be used as a research direction in the future.

(3) After the structure fire, the material is related to the fire-fighting problem. It is necessary to further test and study the constitutive models of steel and concrete under different cooling methods, so as to provide the basis for more accurate mechanical analysis.

(4) For the concrete filled steel tubular Special-shaped column [15], in case of fire, the concrete protective layer may fall off under the action of force and temperature, which makes the steel tube directly exposed to the fire and accelerates the failure of the component. The prediction of concrete falling off position can be studied in the future.

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