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Seismic Response Analysis of Concrete Filled Steel Tubular Structures

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Abstract

Concrete filled steel tubular (CFST) structures are widely used in practical engineering. CFST usually forms composite structures with steel or reinforced concrete in high-rise and super-high-rise buildings. China is a country with frequent earthquakes. The author summarizes the seismic response of concrete filled steel tubular (CFST) structures by studying and analyzing the relevant research literature at home and abroad, and prospects the problems that need further study combined with the current research situation.

Keywords

Concrete filled steel tube structure, seismic response, seismic performance.

1. Introduction

Concrete filled steel tube (CFST) is a component composed of concrete poured into steel tube. Because of the mutual restriction and action of steel and concrete, CFST can give full play to the advantages of the two materials. CFST has superior mechanical properties, especially in high-rise and super-high-rise buildings. Concrete-filled steel tubular (CFST) is widely used in high-rise and super-high-rise buildings. It usually forms a composite structure with steel or reinforced concrete. China is a country with frequent earthquakes. In order to popularize the concrete filled steel tube composite structure more widely, we must have a full understanding of its seismic performance. However, because the concrete filled steel tube composite structure is a new type of structure, concrete has the advantages of high compressive strength and corrosion resistance, but the flexural performance of concrete Energy, plasticity and toughness are relatively poor; the compressive capacity of steel tube is less than that of concrete, but the flexural capacity and plasticity of steel tube are relatively good. Concrete-filled steel tubular structure combines the advantages of the two structures to form complementary advantages. It can not only withstand high pressure, but also show good flexural performance under bending condition. It has high bearing capacity, good overall stability, good toughness, plasticity and good economy.

2. Working mechanism of concrete filled steel tubular structure

The interaction between steel tube and concrete is the key of concrete filled steel tube composite structure under load effect. Coagulation belongs to brittle material with poor plasticity and toughness. Steel tube has high flexural strength, but it is easy to buckle under pressure and structural instability. Under the action of load, the transverse deformation of internal concrete is larger than that of steel tube, so the transverse deformation of concrete can be restrained by the outer steel tube. Because of the restraint of steel tube, concrete is in three-phase compression state when it is subjected to force.

At the initial stage of being subjected to the upper load, the concrete in the concrete filled steel tube structure bears almost all the pressure, and the steel tube is basically not subjected to force. At the

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initial stage of loading, the internal concrete is in the plastic stage. With the increase of load, transverse deformation of concrete begins to occur, and the cracking and destruction of concrete can be delayed by the action of steel pipe hoop. When the load increases to a certain extent, the steel tube begins to deform from elastic stage to plastic stage. When the load increases to the maximum bearing capacity of the structure, the steel tube will be destroyed, eventually losing its stability, and the members will be completely destroyed.

3. Seismic Response of Concrete Filled Steel Tubular Structures

Nowadays, researchers have done a lot of research on seismic response of concrete filled steel tubular structures, which are widely used.

Zhou Shuhua [1] studied the wind-resistant stability and wind-induced vibration response of Guangzhou Yajisha Bridge in the construction stage of main arch circle rotation, and achieved some results. Sun Chao [2] tested the natural vibration characteristics of the Piedmont bridge and simulated the numerical model, and discussed the influence of the length of concrete pouring in the pipe on the natural vibration characteristics and seismic response of the bridge. Zhang Qingjun [3] calculates the natural vibration characteristics of a concrete filled steel tube arch bridge by using the unified theory and the converted section method. The numerical results are compared with the test results of the bridge. The results show that the calculated results by the unified theory are more consistent with the actual values. Chen Youjie [4] constructed the mechanical model of vehicle-bridge interaction based on the dynamic load experiment of the Piedmont bridge, calculated the vehicle vibration effect of the bridge, and analyzed the influence of various factors on the load impact coefficient of the bridge. Fujinaga [5] tests the mechanical properties of concrete filled circular steel tubular (CFST) flexural members under constant axial force with the parameters of axial compression ratio and diameter-thickness ratio of section. The results show that the ductility and energy dissipation capacity of the members tend to decrease with the increase of axial compression ratio and diameter-thickness ratio of section. On the basis of random vibration theory, Lin Jiahao et al. [6] proposed a virtual excitation method, which can accurately consider the partial coherence effect, traveling wave effect, non-uniform modulation effect and non-stationarity. It can transform the stationary random response analysis into the harmonic response analysis and the non-stationary random response analysis into the deterministic response analysis. Therefore, the simplified method can be used to calculate the random seismic response of the structure. Li Yingmin et al. [7] introduced the commonly used power spectral density function model of stochastic ground motion, and put forward the conditions that the power spectral density function model of stochastic ground motion should satisfy. According to the evolution equation of Generalized Probability density, Lijie et al. [8] analyzed the time-varying probability density distribution of power spectrum acceleration time history. Based on Vopgnoi criterion and spatial scaling transformation criterion, the algorithm of multi-dimensional probabilistic space partition is optimized, and the probability density distribution of the measured ground motion records and the artificial power spectral density function model is compared. Li Zongcai et al. [9] used the power spectral density model to calculate the seismic response of the project based on the function model and the measured ground motion data respectively. The comparison results show that the calculated results of the stochastic ground motion function model are basically consistent with the measured ground motion. Tao Zhong and Han Linhai [10] have carried out experimental research and numerical calculation on one-way hysteretic behavior of concrete-filled square steel tubular (CFST) compression-bending members under different test parameters under reciprocating loads. The hysteretic curves obtained from the tests have good plumpness, and the ductility of the specimens decreases significantly with the increase of the axial compression ratio. Li Xuequan [11] took steel ratio, axial compression ratio, section length-width ratio and loading direction as parameters to test 1/2 rectangular concrete-filled steel tubular column specimens under constant axial force and lateral low-cycle repeated load.

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4. Concluding remarks

Concrete filled steel tubular (CFST) is a new type of composite material. At present, there are many studies on its seismic performance and some achievements have been made, but there are still many shortcomings. Although a large number of theoretical and experimental studies have been carried out on the mechanical properties of concrete filled steel tubular (CFST) members, few studies have been carried out on the overall seismic performance of CFST structures. The section form of concrete filled steel tubular (CFST) is few square and mostly circular. Square concrete filled steel tubular (CFST) has many advantages, such as simplicity, easy processing, better stability and simple construction. It has great application prospects. In the study of seismic performance, the experimental study of concrete filled steel tubular structures with fewer stories and spans is the main method, while the overall structural test and finite element analysis of multi-story and high-rise concrete filled steel tubular structures with more stories are less. Therefore, it is necessary to deepen it.

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