ISSN: 2414-1895 DOI: 10.6919/ICJE.202306_9(6).0023

Review on Seismic Performance of Steel-concrete Special-shaped Column Structure

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Abstract

Steel-concrete special-shaped columns have the advantages of high bearing capacity, good ductility and strong seismic capacity. They are widely used in long-span structures, bridge engineering, high-rise buildings and other facilities. Pure reinforced concrete special-shaped columns have weak limbs, limited bearing capacity and poor ductility, which makes the advantages of special-shaped columns unable to be reflected. The steel-concrete special-shaped column can be popularized and used because it can not only reduce the section of the member and the amount of steel, but also improve the bearing capacity and seismic performance of the column. It is of great significance to study the seismic performance of steel-concrete special-shaped column structure for its seismic design and post-earthquake evaluation. This paper will review the research status of seismic performance of steel-concrete special-shaped columns in China.

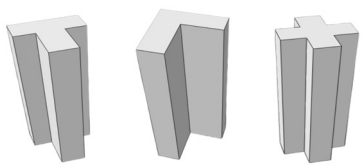
Keywords

Steel-concrete; Special-shaped Column; Seismic Performance.

1. Introduction

At the present stage, the application forms of steel-concrete special-shaped columns mainly include T-shaped, L-shaped and cross-shaped main special-shaped columns. Compared with traditional rectangular columns, the cross-section forms have changed greatly. In the building structure, the special-shaped column is one of the distinctive components of the Chinese construction industry. The column can hide the column limb in the wall, increase the flexibility and aesthetics of the indoor layout, and has been widely used in residential buildings. Steel and steel tubes bring significant support and restraint effects to concrete due to their high steel content, less stress concentration and hoop effect of the structure. Compared with pure reinforced concrete structures, they avoid the defect of insufficient bearing capacity caused by premature yield of steel bars to a certain extent, it greatly improves the safety of building structure.

2. Research Status of Seismic Performance of Steel-Concrete Special-Shaped Column Structure



T-shaped L-shaped cross-shaped

Fig 1. Steel-concrete composite special-shaped columns mainly include T type, L type and cross type

ISSN: 2414-1895 DOI: 10.6919/ICJE.202306_9(6).0023

The section forms of steel-concrete composite special-shaped columns mainly include T type, L type and cross type.as shown in figure 1.

2.1 T-shaped Section Special-shaped Column

Wang et al.[1]carried out experimental research on the compression-bending hysteretic behavior of steel bars, ordinary steel tubes and stiffened concrete-filled steel tubular special-shaped columns. The main reasons for the decrease of bearing capacity of the three structures are analyzed, and it is found that the ductile mechanical properties of the stiffened structures have good performance. Energy dissipation capacity is good.

Deng Zhiheng et al. [2] carried out the test by comparing the steel reinforced concrete and pure concrete T-shaped column joints with low cyclic loading. It is found that the yield, failure and ultimate load of the specimen are smaller than those of the single load under the bidirectional load, and the steel reinforced concrete T-shaped column with steel tube and section steel has better seismic performance.

Dai Shaobin et al.[3] unten carried out seismic research on beam-column joints. By analyzing the failure mode of the joints, it was found that the T-shaped column-steel beam double-web top-seat angle steel connection joints had better energy consumption and strength.

2.2 L-shaped Special-shaped Columns

Zhang et al.[4] carried out seismic analysis of four L-shaped steel beam space frames, focusing on the seismic performance of the structure under different load directions. It is found that the failure law of this structure is similar from the initial loading to the end of loading. The energy is mostly absorbed by the plastic hinge at the joint, the energy dissipation capacity is good, the hysteresis curve is full, and the specimen structure meets the seismic requirements.

Li Jinhang [5]carried out seismic research on steel tube welded continuous batten plate L-shaped columns. In the test, the batten width of the connecting steel tube was used as the main parameter to analyze the hysteresis curve and the corresponding skeleton curve of the specimen during loading. The stiffness degradation of the specimen is aggravated by the increase of the width of the specimen.

Joaguin M [6]conducted experimental analysis on the seismic design of L-shaped short columns, and proposed a set of calculation charts suitable for L-shaped short columns from the results of bidirectional bending analysis, which can be applied to engineering practice.

2.3 Cross Section Special-shaped Column

Wan Bo and Du Guofeng et al. [7] mainly studied the different failure modes of strong and weak joints of cross-section column-steel beam outer ring plate by quasi-static test method. It is found that the damage of the strong and weak joints of this structure is distributed at the beam end and the joint core area. It shows bending failure and shear failure.

Chen Meimei [10] conducted a simulation study on five cross-shaped rectangular concrete-filled steel tubular special-shaped column-steel beam joints. The main parameters include axial compression ratio, inner diaphragm thickness, and concrete strength. It is found that the limb height-width ratio has a great influence on the bearing capacity and seismic performance of the structure, but other parameters have little influence.

Through the classification and comparison of the above different section types, it is found that:

(1) The above test is basically a monotonic load experiment, and there is no analysis of the force under complex conditions.

(2) The above research on the material properties, local damage and axial and eccentric compression performance of columns after earthquake still needs further in-depth study.

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3. The Seismic Problems of Steel-Concrete Special-Shaped Column Structure Still Need Further Study

Based on the current research situation of many scholars, the key problems of seismic performance of steel-concrete special-shaped columns still need to be studied are as follows:

(1) The ability of deformation coordination between steel tube and concrete has great influence on the axial compression performance of concrete filled steel tube. Improving the deformation coordination ability between steel tube and concrete can be regarded as a direction of future research.

(2) Irregular cross-section, special-shaped column between the center of the single limb and each limb can be welded plate stiffeners, binding rod and other measures to strengthen the mechanical properties of components, the structure is complex, involving welding and anchoring problems, greatly increasing the construction difficulty and cost, reduce the economic applicability of components. New structural measures can be proposed as a future research direction [11].

(3) The special-shaped column frame has good seismic performance and has the conditions for application in high-intensity seismic areas. However, the rational allocation of steel in special-shaped columns and the optimal design of beam-column members need to be further studied.

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