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A Review of Eccentric Compression Test Studies on Special-shaped Columns

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Abstract

The special-shaped column has the characteristics of good seismic performance, high section bearing capacity, and can adopt different section shapes according to the layout and use functions of the building, which can fully solve the problem of exposed columns in the building. In practical application, the stress of columns is often eccentric compression, so it is of great significance to study the eccentric compression of columns and improve the bearing capacity of eccentric compression. The difference and influence of failure of different types of special-shaped columns under eccentric compression are compared, and the problems and solutions in some tests are discussed.

Keywords

Eccentric compression; Heteromorphic column.

1. Introduction

With the in-depth development of scientific research and the needs of engineering practice, the limitations of ordinary concrete rectangular columns and square columns in space utilization have gradually attracted people's attention, and the special-shaped columns not only have large rigidity, good ductility and good deformation ability, but also have the advantages of high space utilization and indoor column angle, so special-shaped columns have a wide range of application prospects in real life. Domestic experts and scholars configure the special-shaped column by restraining the steel frame and combining the special-shaped column through the steel plate connection, so that under the condition that the bearing capacity remains unchanged or increased, the smaller cross-sectional area is used to meet the structural requirements. Therefore, this paper sorts out the research status of the performance of different types of special-shaped columns under the more common eccentric compression conditions, and analyzes the existing problems and future development directions.

2. Test Method

2.1. Test device

With the in-depth development of scientific research and the demand of engineering practice, the limitations of ordinary concrete rectangular columns and square columns in terms of space utilization rate have gradually attracted people's attention. Today, with the increasing requirements of safety, durability and functionality of buildings, ordinary concrete rectangular columns are becoming larger and larger in size and occupy more and more space, while special-shaped columns not only have large stiffness, good ductility and good deformation capacity, Moreover, it has the advantages of high space utilization rate and no column angle indoors, so special-shaped columns have a wide application prospect in real life. Domestic experts and scholars make use of smaller sectional area to meet the structural requirements under the condition that the bearing capacity is unchanged or improved by configuring steel pipes for

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constraint and steel plates to form composite special-shaped columns. In this paper, the research status of the performance of different types of special-shaped columns under common eccentric compression is summarized, and the existing problems and future development direction are analyzed.

2.2. Loading scheme

The purpose of preloading is to ensure that the specimen is in good contact with the equipment before the formal loading, and to test the reliability of the measurement instrument, and the preloaded load is usually 10% of the estimated ultimate load of the component. Domestic researchers have slightly different schemes for formal loading, arbitrarily controlling the increase of load in a monotonic graded continuous loading mode, each stage load is 1/10 of the estimated ultimate load, lasting 2 min, when the load reaches 80% of the estimated ultimate load, each stage load is 1/20 of the estimated ultimate load, continuous; Wang Zhoutai's test adopts load control before the specimen reaches 75% of the estimated ultimate load, every 50 kN as a stage, and after the specimen reaches 75% of the estimated ultimate load, the displacement control is adopted, and the displacement value loaded at each stage during the load control is the step size of the displacement control. All of these researchers stopped the test when the load was reduced to 85% of the ultimate load.

3. Test Analysis

3.1. Eccentric compression test of concrete-filled steel tubular composite special-shaped columns

The constraining of steel pipe on the core concrete in the special-shaped column of special-sectional steel pipe concrete is weak, and the steel plate in the shady corner is prone to great deformation and failure under load, resulting in a significant reduction in bearing capacity and ductility. Most of the special-shaped steel pipes are bent and welded after the steel plate, the cross-section geometry is difficult to accurately control, the thick steel plate is not easy to bend, it is not convenient for factory or on-site production and processing, and the quality of the weld is difficult to guarantee. In engineering practice, a steel-tube concrete combination special-shaped column with square steel pipe instead of rectangular steel pipe is proposed.

Du Guofeng and other studies have shown that all specimens exhibit bending failure. During the loading process, the eccentric compression steel pipe is manifested as bending failure during the force, and the combined steel pipe can work well together without weld cracking. The horizontal deflection of the section in the column is small, and the flat section deformation is before the ultimate bearing capacity, and the flat section deformation is no longer maintained in the compression zone after the limit bearing capacity is exceeded. The ultimate bearing capacity decreases when the length and slenderness ratio and eccentricity increase, and it can be seen from the load strain curve of the edge steel that the fiber strain increases significantly when the eccentricity and slenderness ratio increase. With the increase of the slenderness ratio, affected by the second-order effect, the position of the neutralization shaft gradually shifts in the direction of the spindle, and when the compression zone is broken, the neutralization axis begins to shift towards the mandrel shaft.

Wang Zhoutai concluded in the test that the L-shaped square steel pipe combination special-shaped column has good performance, no out-of-plane instability occurs during the whole test, the weld between the steel pipes is not cracked, and the synergy between the parts of the structure is good. The eccentricity and steel pipe thickness have a greater influence on the ultimate bearing capacity, the ultimate bearing capacity decreases when the eccentricity increases, the ultimate bearing capacity increases when the thickness of the steel pipe increases, and the influence of the length ratio and bending moment direction is small, but the rate of

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ultimate bearing capacity decrease is accelerated when the length and slenderness ratio increases. When working in the elastic phase of the specimen, the mid-section strain conforms to the flat-section assumption in the height direction. When the length and slenderness ratio and eccentricity are small, most of the cross-sections are in a compressed state, and the compression zone is damaged after reaching the limit load, and when the load is continued, the load becomes smaller and the internal force is fully distributed, and the downward section of the neutral axis is all converted to the compressed state.

3.2. Eccentric compression test of steel reinforced concrete special-shaped column

The steel bone concrete special-shaped column is a welded steel bone set in the center of the special-shaped column, surrounded by longitudinal bars, stirrups and overall pouring of concrete, so as to form a steel-bone concrete special-shaped column. Experimental studies show that steel frame and concrete can play a role in mutual restraint, which is conducive to giving full play to the tensile performance of steel and reflecting the advantages of good compressive performance of concrete.

Xu Yafeng's T-shaped cut interview is in the linear elastic stage at the beginning of loading, and the steel frame and concrete can work together. When the load increases, the stirrups and longitudinal bars are plastically deformed, and the steel bones that are far from the longitudinal force under the influence of eccentric compression gradually change from compressive strain to tensile strain, the longitudinal bars are first compressed and then tensile due to concrete failure, while the steel bones and longitudinal bars on the side close to the force are continuously compressed, and the compressive strain of the steel bone increases with the increase of the load. When the ultimate load reaches 90%, the longitudinal reinforcement yield load, after reaching the ultimate load, the load borne by the longitudinal ribs begins to decrease, and the stirrup has a greater increase in stress at this time, and the role is more obvious, which improves the ductility of the component. The steel bone concrete will not all completely yield when it is destroyed, so the specimen will not immediately lose its bearing capacity, but gradually reduce the bearing capacity and maintain the bearing capacity for a certain period of time. From the perspective of the load displacement curve, the load increases slowly but the displacement increases quickly after the load reaches 80% of the ultimate load, showing a strengthening process, and the load decreases slowly after reaching the ultimate load, while with the increase of steel content, the bearing capacity of steel frame concrete increases, compared with the brittle failure without steel bone, the descending section of the curve is more gentle, indicating that its deformation ability has been significantly improved.

Wang Hua's experiments show that in the early stage of loading, the steel bone flange, longitudinal ribs and stirrups all change linearly. As the load increases, the stirrups are plastically deformed, the concrete on the tensile side cracks, the steel frame is subjected to the tensile flange, and the longitudinal bar and the steel bone are jointly stressed. When the ultimate load is reached, the lateral deformation of the specimen is large, the steel frame load strain curve with a thickness of 8mm and 6mm decreases gently, the concrete on the compression side is still working, the stirrup strain increases, the restraining effect is more obvious, and the deformation ability is greatly improved, while the steel bone and longitudinal bar of the compressed side flange yield when the ultimate load is reached, and the steel bone and longitudinal bar of the tensile side flange have yielded when the limit load is not reached. It can be seen from the load displacement curve that with the increase of steel bone thickness, the bearing capacity increases significantly, indicating that the addition of steel bone greatly increases the bearing capacity of special-shaped column, and with the increase of steel content, the bearing capacity and ductility also increase significantly.

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4. Conclusion and Prospect

The mechanical properties of the materials composed in different types of special-shaped columns are different, resulting in different forms of failure under eccentric compression. In the case of eccentric compression, the compressive performance of the special-shaped column will deteriorate, which should be paid more and more attention to in research.

(1) The steel pipe concrete special-shaped column is bent shape instability failure at the time of failure, and the combined steel pipe can work together, and there is no weld cracking. However, according to the study, the length and slenderness ratio and eccentricity have a great influence on the ultimate bearing capacity of the special-shaped column, and the second-order effect also affects the failure of the compression zone, and the neutralization axis will shift towards the mandrel axis, and the section is basically under pressure during the failure. Due to the good stability of the steel tube concrete combined special-shaped column, there will be no instability failure when the length is relatively large, and it will show the form of bending failure, while the material strength failure will occur when the length and thin are relatively small, and the failure form meets the general requirements.

(2) Adding steel bone to the special-shaped column to form a steel-bone concrete special-shaped column can increase the deformation capacity of the general concrete special-shaped column, unlike steel tube concrete, the main factor affecting the bearing capacity of steel bone concrete is the steel content, which greatly improves the bearing capacity of the component when the steel content rate increases. The addition of steel bones can also make the component not completely yield when it is broken, and it can still maintain its bearing capacity for a certain period of time. The restraining effect of longitudinal bars and stirrups on the deformation of the steel bone is more obvious when the load increases, which increases the bearing capacity of the steel bone when it yields.

Based on the research situation of domestic scholars, there are still problems that need further research on steel tube concrete combined special-shaped columns and steel-bone concrete special-shaped columns:

(1) In the square steel pipe combination special-shaped column, due to the extensive use of welding process in the combination, the weld cracking phenomenon may be caused by uneven force in the eccentric compression state of the component, how to innovate the combination steel pipe with less welding, low cost and easy processing is a problem that needs to continue to be studied in depth.

(2) The external steel pipe will be bent when the overall deformation of the component causes the steel pipe wall to separate from the concrete part to reduce the deformation capacity, the current main method is to use bolts, embellished plates and stiffeners and other ways to connect, but such methods will increase the difficulty of construction, not easy to promote, so the integration of steel pipe and concrete is also an aspect that needs to be further studied in the future.

(3) In a number of tests, the steel-framed concrete special-shaped columns have shown the phenomenon that the flange steel part yields first, and the method of improving the flange strength and preventing the flange part from yielding first is a problem that needs to be continued to be studied.

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