Research on the Mechanical Characteristics of H-section Steel Frame under the Action of Thermo Mechanical Coupling

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Abstract. The research on the mechanical characteristics of concrete-filled steel tubular composite frame under high temperature fire environment is one of the research hotspots. In this paper, the finite element simulation software is used to analyze the concrete-filled steel tubular composite frame structure. The failure mode of the flexural deformation of the composite frame structure under high temperature fire environment is introduced. The simulation results of the deformation and displacement of the single-layer single span and two-layer two-span composite frame structure are deeply studied, including the different temperature field, structural field, structural field of each beam and column. The results show that: with the temperature rising, the horizontal plastic strain, vertical displacement and local plastic region of beam and column are redistributed and changed in high temperature fire environment, and the flexural effect of two-story two-span concrete-filled steel tubular composite frame under different fire positions is analyzed. The results show that: with the temperature rising, the horizontal plastic strain at the concentrated load is not the results show that the deflection and deformation redistribution are obvious, and the deflection and deformation redistribution are obvious at the joint points of beams and columns. Finally, a mechanism is formed and destroyed. The flexure effect of mode 1 is larger than that of condition 2, which indicates that the flexural effect of two-story two span CFST composite frame under full cross-section fire is larger than that of condition 2. It should be better. The research results can provide reference value for the reinforcement and repair of CFST composite frame under high temperature fire.

1 Introduction

The steel tube concrete composite frame is widely used in contemporary buildings[1]. The unique shape gives people a beautiful appearance. At the same time, Experts [2-6] have also realized the importance of the concrete-filled steel tube composite frame in fire resistance research, and thus invested a lot of time and money in the concrete-filled steel tube composite frame. The research not only analyzed the mechanical characteristics of the concrete-filled steel tube composite frame under a single factor, but also analyzed the mechanical performance of the multi-factor coupling. Especially, Li Guoqiang and Xu Lei made relevant research on the concrete-filled steel tube composite frame [7-8]. But at present, there are few studies on the flexural deformation of concrete-filled steel tube composite frames under high temperature fire environment. This paper uses finite element simulation software to analyze the concrete-filled steel tube composite frame, introduces the failure mode of the flexural deformation of the concrete-filled steel tube composite frame structure under high temperature fire environment, including the deflection effects of the beams and columns of the structure under different temperature fields, structural fields, and coupling fields,

and the redistribution and changes of the deflection and axial deformation of the beams and columns in the high-temperature fire environment. The comparative analysis of the deflection effect of the two-story, two-span concrete-filled steel tube composite frame under different fire positions has reference value for further research on the concrete-filled steel tube composite frame under high temperature fire environment.

2 Numerical calculation of flexural deformation of steel tube concrete composite frame under high temperature fire environment

2.1 Model working conditions

The two-story, two-span concrete-filled steel tube composite frame structure has a frame beam of 12m in length and a column height of 8m in each story. The steel tube concrete composite frame is Q235, the beam section is HN700×500, the column section is HW600×600, and the steel tube in the column is HW500×500. A uniform load is applied to the steel tube

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concrete composite frame beam. The calculation process is as follows:

Condition 1: Single-story and single-span concrete-filled steel tube composite frame structure has a beam of 6m in length, and each column is 4m high. The thermal-mechanical coupling finite element analysis of the whole steel tube concrete composite frame is carried out.

Condition 2: Two-story, two-span concrete-filled steel tube composite frame structure with frame beams of 12m in length and 8m height of each column. Thermal-mechanical coupling finite element analysis of the whole steel tube concrete composite frame is carried out.

Figure 1. Calculation model of a single-story and single-span concrete-filled steel tube composite frame

2.2 Model analysis

Through the finite element numerical simulation, the temperature cloud diagrams of the two-story, two-span concrete-filled steel tube composite frame under working conditions 1 and 2 at different temperature moments are obtained:

Through the finite element numerical simulation, the deflection cloud diagrams of the two-story, two-span concrete-filled steel tube composite frame under working conditions 1 and 2 at different temperature moments are obtained:

(a)

(b)

Figure 2. Vertical displacement cloud diagram of concrete-filled steel tube composite frame under working condition 1 3600s

As the temperature continues to rise, first, the horizontal plastic strain at the concentrated load continues to increase, the vertical displacement also continues to increase, the local plastic area continues to expand, and the deflection and deformation are redistributed significantly. The redistribution of the deformation is more obvious, and the mechanism is finally formed, and the damage occurs. The deflection effect of the working condition one is greater than that of the working condition two, indicating that the two-story, two-span steel tube concrete composite frame has a better deflection effect under the full-section fire.

3 Conclusion

In this paper, through the analysis of the finite element simulation results of the deflection deformation of the single-story single-span and two-story two-span concrete-filled steel tube composite frame under a high temperature fire environment, the following conclusions are obtained:

(1) Analyzed the failure mode of the flexural deformation of the concrete-filled steel tube composite frame structure under the high temperature fire environment, and compared the flexural effect of the

concrete-filled steel tube composite frame under different structural levels, and compared the results. The two-span concrete-filled steel tube composite frame has better fire resistance.

(2) Numerical simulation of the displacement of the concrete-filled steel tube composite frame under a high temperature fire environment is carried out. As the temperature continues to rise, the displacement of each frame of the single-story and single-span concrete-filled steel tube composite frame increases with temperature, and the increase is greater.

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