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Experimental Research on Thread - Brick Masonry Combination Beam Machinery Properties

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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 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: 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.

Keywords

High temperature fire; Concrete filled steel tubular composite frame; Flexural deformation; Finite element analysis.

1. INTRODUCTION

The requirements for large-scale urban construction are constantly improving, and the existing old buildings with mostly masonry and concrete structures can no longer meet people's living needs for large-space buildings. In order to meet the housing needs, there are two main treatment methods. One is to rebuild modern buildings after dismantling the original buildings; Steel-clad reinforcement [1]~[4], channel steel-concrete composite structure reinforcement, reinforced concrete structure reinforcement and external prestressing reinforcement [5]~[8]. A lot of in-depth research has been done on the composite structure of steel plate and brick masonry in China, and the bearing capacity and deformation meet the requirements of the code by adopting the load-bearing wall to be reinforced with steel beams. Based on the existing test and numerical simulation analysis of steel plate-brick composite structure, the calculation method of local buckling critical stress of steel plate-brick composite structure is put forward.

In this paper, the mechanical properties of composite beams are analyzed by means of theory, experimental study, the mechanical properties of prestressed steel plate-brick composite beams and linear prestressed steel plate-brick composite beams are deeply studied, and the reinforcement methods and load-bearing effects of the two schemes are compared and analyzed according to the changes of stress, strain and displacement of composite beams, which provides some reference for reasonable selection of reinforcement and reconstruction in actual engineering situations.

2. STEEL BRICK MASONRY COMBINATION BEAM REINFORCEMENT FORM

In this paper, the mechanical properties of prestressed steel plate-brick masonry composite beams and linear prestressed steel plate-brick masonry composite beams are deeply studied.

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Under different loading modes and different coupling field effects, the bearing capacity of exposed and strengthened steel plate-brick masonry composite structures is analyzed.

2.1. Straight Prestressed Steel Plate Brick Masonry Combination Beam Reinforcement Form

The linear prestressed steel plate-brick masonry composite beam has anchoring devices, and the linear force bars directly penetrate into the anchoring points at both ends of the beam to connect with the composite beam. The anchoring ends are generally located at the lower part of the composite beam to strengthen the bearing capacity of the composite beam. Linear reinforcement is convenient to construct and saves resources, as shown in Figure 2.

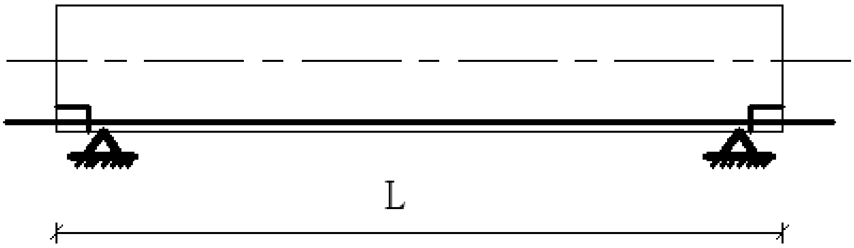

Figure 1. Arrangement of external ribs of linear type

The layout scheme of simply supported beam prestressed reinforcement is introduced in detail above. For continuous beams, external force bars are continuously arranged in the beam to resist the negative moment effect of members. The type of external prestressed reinforcement of continuous beams is the same as that of simply supported beams, which can improve the bearing capacity of steel plate-brick composite beams after reinforcement.

3. THEORETICAL CALCULATION OF THE BEAM CAPACITY OF BRICK MASONRY COMBINATION BEAMS IN IN VITRO PRESTRESSED REINFORCED STEEL

3.1. Theoretical Calculation of Bending Capacity of Linear in Vitro Prestressed Combined Beams

According to the calculation of the flexural capacity of the composite beam, the resultant force of the linear prestressed reinforcement will affect the neutral axis of the structure and change the height of the compression zone of the composite beam. Therefore, the plastic limit state of the structure should be considered, but in the elastic stage, the elastic calculation of the steel plate brick masonry has little influence

(1) Plane section assumption;

(2) The tensile strength of masonry is ignored;

(3) The secondary effect of small displacement on members is not considered.As shown in Figure 4:

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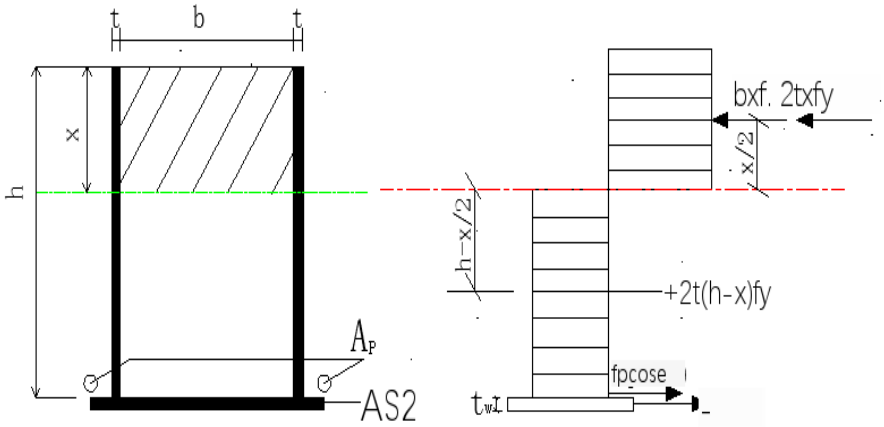

Figure 2. Theoretical calculation formula for ultimate bearing capacity of normal section of linear composite beam

According to figure 4, according to the balance condition of internal force in horizontal direction and the moment of neutral axis of composite beam, the ultimate bearing capacity of normal section of steel plate brick masonry composite beam strengthened by external prestressing is calculated as follows:

$$\begin{cases} bxf_b + 2txf_y = f_p \cos\theta + 2t(h-x)f_y + As_2 f_y \\ M_u = f_y t(h-x)^2 + \dfrac{bx^2}{2} f_b + tx^2 f_y + As_2 f_y (h + \dfrac{t_w}{2} - x) + f_p (h-x) \end{cases} \tag{1}$$

In formula 2, θ The angle is the angle between the linear prestressed reinforcement and the horizontal plane. The calculation formula mainly considers the influence of the force of the linear prestressed reinforcement on the neutral axis of the structure. For the linear layout, the force is the horizontal component effect of the linear prestressed reinforcement at the steering device.Calculation of plastic ultimate bearing capacity the calculation formula of ultimate bearing capacity of linear external prestressed structure is as follows:

$$\text{Linear type:} \quad M_{\max} = M_u \tag{2}$$

4. EXPERIMENTAL ANALYSIS OF STEEL PLATE BRICK MASONRY COMPOSITE BEAMS STRENGTHENED BY EXTERNAL PRESTRESSING

4.1. Model Conditions

In this paper, the numerical analysis of composite beam is carried out, in which the brick masonry beam section size is 3000 × 240 × 370, the steel plate section size is 3000 × 5 × 370, the split bolt is arranged in two rows, the upper row of split bolt is eight, the lower row of split bolt is nine, the form is plum shaped, the specification is M16, the bolt structure is shown in Figure 5, the steel plate brick masonry composite beam structure is shown in Figure 6

Condition 1: the steel plate brick masonry composite beam without prestressed reinforcement is exposed. The thickness of the steel plate outside the beam is 5mm, and the dimension of the bottom batten plate is 5mm × 200mm × 300mm.

Condition 2: steel plate brick masonry composite beam strengthened with linear prestressed reinforcement, other dimensions are the same as that of condition 1, and linear prestressed

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reinforcement is 1 × 7 × 15.2 φ^s One steel strand is selected at both ends of the composite beam for tensioning, and the steel strand is anchored at the height of 40mm.

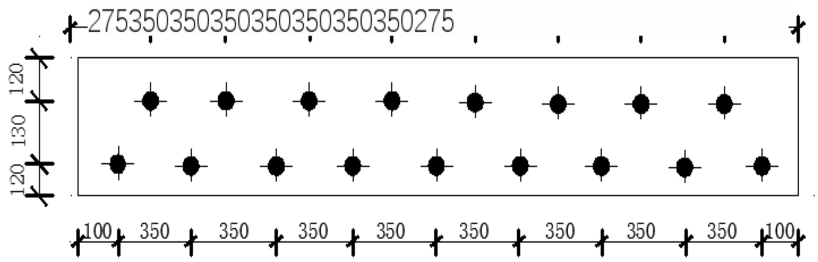

Figure 3. Structural diagram of split bolt

4.2. Test Conditions

In this paper, the overall test process of the test beam is mainly carried out in the structural Hall of Anhui Jianzhu University. Two test beams 1 ~ 2 with the same working conditions as the numerical simulation analysis are used for the test analysis. The size of the composite beam is the same as that of the theoretical numerical simulation. Q235 steel is used as the steel plate and building structural adhesive is used as the bonding material. The specific overview is shown in Table 1.

Table 1. Basic working condition of test beam

Composite beam No	Composite beam condition
1	Exposed steel plate brick masonry composite beam
2	Steel plate brick masonry composite beams strengthened by linear external prestressing

4.3. Test Loading Process and Failure Mechanism Analysis

During the loading process of the two kinds of composite beams, the failure forms of composite beams 1~2 remain the same in the initial stage, and the bearing and deformation performance of composite beams are consistent in the initial stage. When the loading value reaches the yield load, the cracks begin to widen. As the loading value approaches the plastic critical load, the outer steel plates of composite beams 1~2 will appear obvious bending deformation state. After the outer steel plates are damaged, the phenomenon of brick masonry falling off in composite beams will be observed. Bonding materials began to separate, and when the plastic limit load was reached, the outer steel plate and brick masonry fell off, the structural adhesive cracked, and the compression composite beam as a whole had obvious deformation failure, so it was considered that plastic failure occurred in composite beams, and cracks with a width of 20~30mm appeared between steel plate and brick masonry during failure. Although there are differences between the two kinds of composite beams 1~2 in the later period, the overall failure phenomena are consistent, but the failure modes of steel plate-brick composite beams strengthened with linear external prestressing are slower than those of exposed steel plate-brick composite beams. The plastic limit load value of steel plate-brick composite beams strengthened with linear external prestressing is 550kN, while that of exposed steel plate-brick composite beams is 480kN, which indicates that the plastic limit bearing capacity of reinforced composite beams is improved and the bearing capacity is good, and the ultimate failure positions are all at the same time. The loading process and failure mechanism of composite beams are shown in Figure 4.

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Figure 4. Loading and ultimate failure mode of test beam

4.4. Research on Test Results

Through the analysis of 1 ~ 2 midspan section of composite beam, the strain distribution of the two composite beams under different load values can be obtained, as shown in Figure 5 and Figure 6.

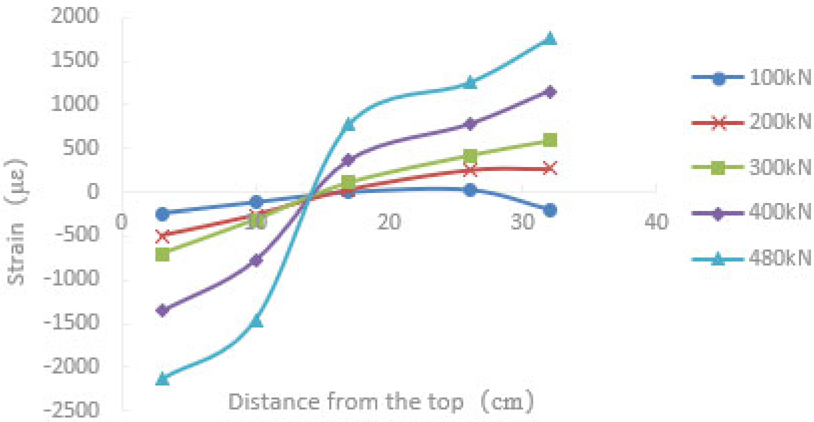

Figure 5. Strain distribution of 1-span section of composite beam

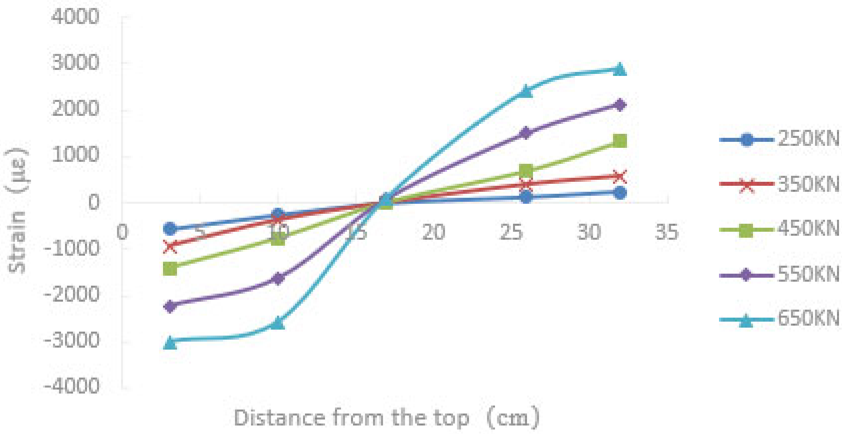

Figure 6. Strain distribution of 2-span section of composite beam

The results of finite element numerical simulation and test were compared

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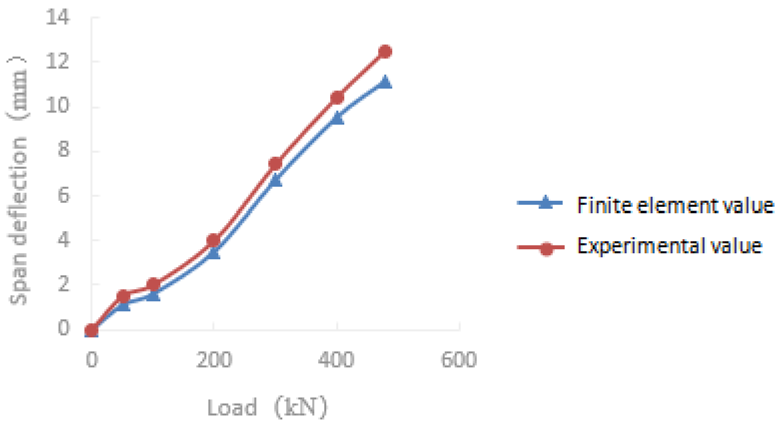

Figure 7. Comparative analysis results of deflection in 1 span of composite beam

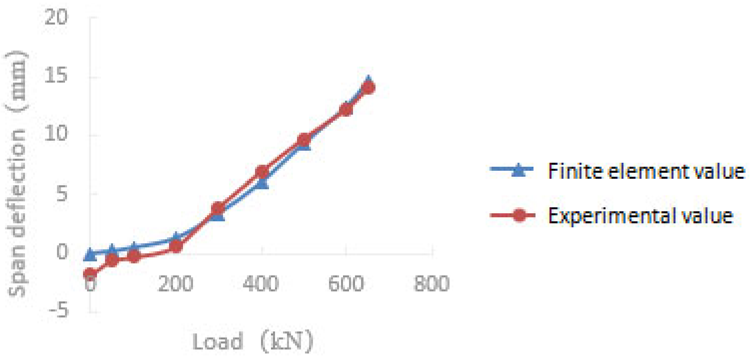

Figure 8. Comparison and analysis results of deflection in 2 span of composite beam

According to the analysis of the results in the figure:

(1) The numerical simulation of steel plate-brick masonry composite beams strengthened by linear external prestressing is consistent with the experimental results.

(2) The ductility of steel plate-brick masonry composite beams strengthened by linear external prestressing has been improved, and the overall compressive capacity of the structure has been improved, and the deformation of composite beam structure is within the specification requirements.

5. CONCLUSION

Through theoretical calculation, numerical simulation and experimental study of exposed steel plate-brick masonry composite beams and linear externally prestressed steel plate-brick masonry composite beams, the following conclusions are drawn:

(1) By comparing the displacement of composite beams under different loads, it can be concluded that the overall displacement of the structure can be effectively reduced by strengthening the steel plate-brick masonry composite beams with linear external prestressing.

(2) Through the comparative analysis of theoretical calculation, numerical simulation test and experimental research results of composite beams before and after reinforcement, it can be concluded that the plastic ultimate bearing capacity and ductility of steel plate-brick masonry composite beams strengthened with linear external prestress can improve the structural performance, which has reference significance for reinforcement and reconstruction in actual engineering situations.

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