International Core Journal of Engineering Volume 7 Issue 8, 2021
ISSN: 2414-1895 DOI: 10.6919/ICJE.202108_7(8).0055

Research on Bearing Performance of Brick Masonry Combination Beams -Brick Masonry Combination Beam

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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 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 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

With the rapid development of China's society and economy,the other is to transform the load-bearing structure [1-4] by underpinning technology, and to reinforce the original building. In practical engineering, the method of underpinning reinforcement is often adopted in consideration of maximizing economic benefits. Reasonable use of underpinning technology can not only make the construction convenient and short, but also improve the bearing capacity of the structure without affecting the whole structure. Common reinforcement methods include enlarged cross-section reinforcement [5-8],channel steel-concrete composite structure reinforcement.

In this paper, the mechanical properties of composite beams are analyzed by means of theory, numerical simulation, and the structural performance changes of composite beams before and after reinforcement under different schemes are studied, which provides some reference for reasonable selection of reinforcement and reconstruction in actual engineering situations.

2. Steel plate brick masonry composite beam reinforcement scheme

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

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2.1 Reinforcement scheme of exposed steel plate and brick masonry composite beam

Steel plate-brick masonry composite system is a combination of advantages of steel and masonry materials, which fully improves the loading and deformation status of components in engineering application on the basis of original components. Because both of them wrap the internal masonry through outer steel plates, they are stabilized by pouring bonding materials between them, and the steel plate-brick masonry composite system is fixed with opposite bolts, concrete and steel plates at the cross section, as shown in Figure 1.

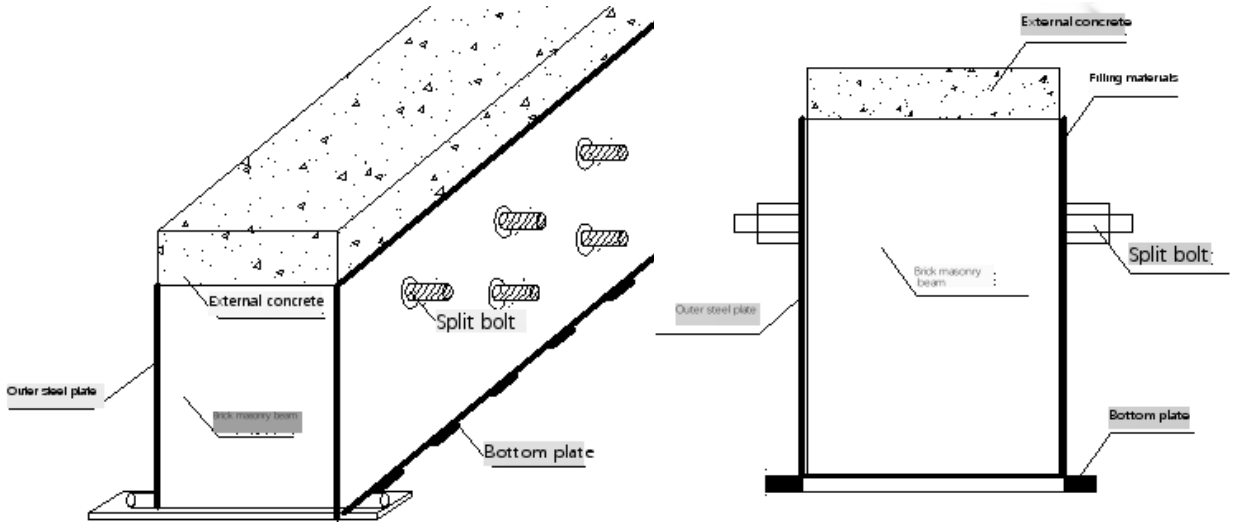

Fig. 1 Basic composition diagram of steel plate-brick masonry composite beam

3. Theoretical calculation of bearing capacity of steel plate brick masonry beams strengthened with external prestress

3.1 Theoretical calculation of bearing capacity of linear externally prestressed beams

The theoretical calculation of bearing capacity of straight line is shown in Figure 2:

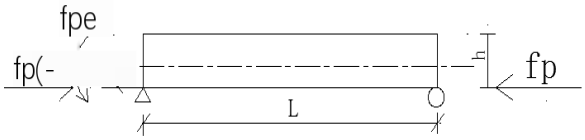

Fig. 2 Theoretical calculation diagram of bearing capacity of linear composite beams

According to figure 3, the bending moment of the steel plate brick masonry composite beam strengthened by external prestressing is equivalent to providing equivalent replacement

$$M = f_p e_1 \quad (1)$$

Where: f_p- the force produced by the linear reinforcement

e_1- the distance from the reinforcement to the anchorage end of the section

4. Numerical analysis of steel plate brick masonry 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

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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 3, the steel plate brick masonry composite beam structure is shown in Figure 4.

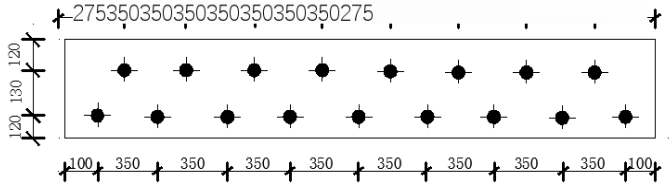

Fig. 3 Structural diagram of split bolt

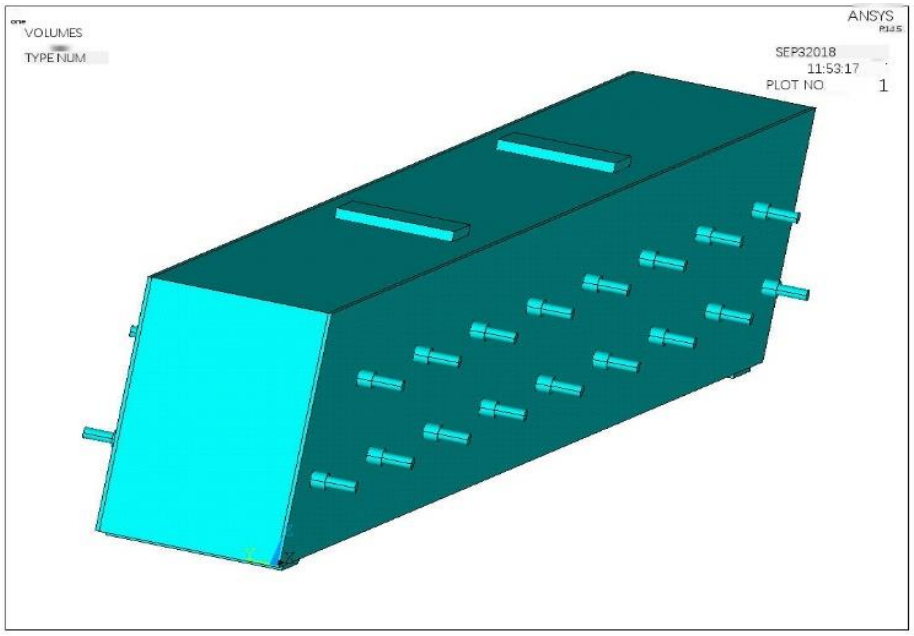

Fig. 4 Structural diagram of steel plate brick masonry composite beam

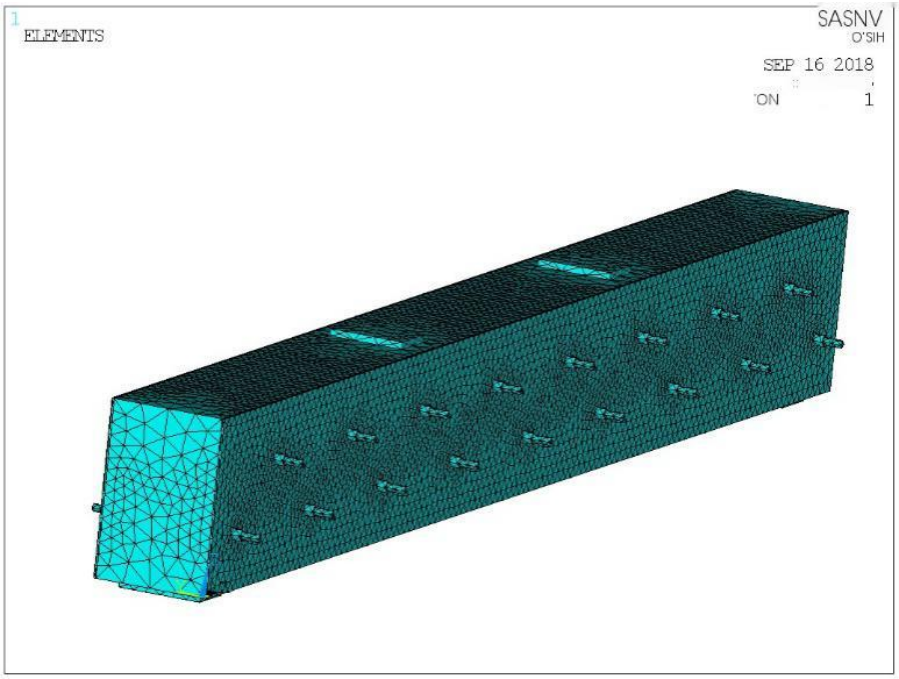

Fig. 5 Grid division of steel plate brick masonry composite beam

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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 reinforcement is $1 \times 7 \times 15.2\phi^s$ 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.

4.2 Model analysis

Through the finite element numerical analysis, a concentrated load of 480kn is applied to the exposed steel plate brick masonry composite beam under condition I. The cloud chart of plastic ultimate bearing capacity of the exposed steel plate brick masonry composite beam without prestressed reinforcement is obtained.

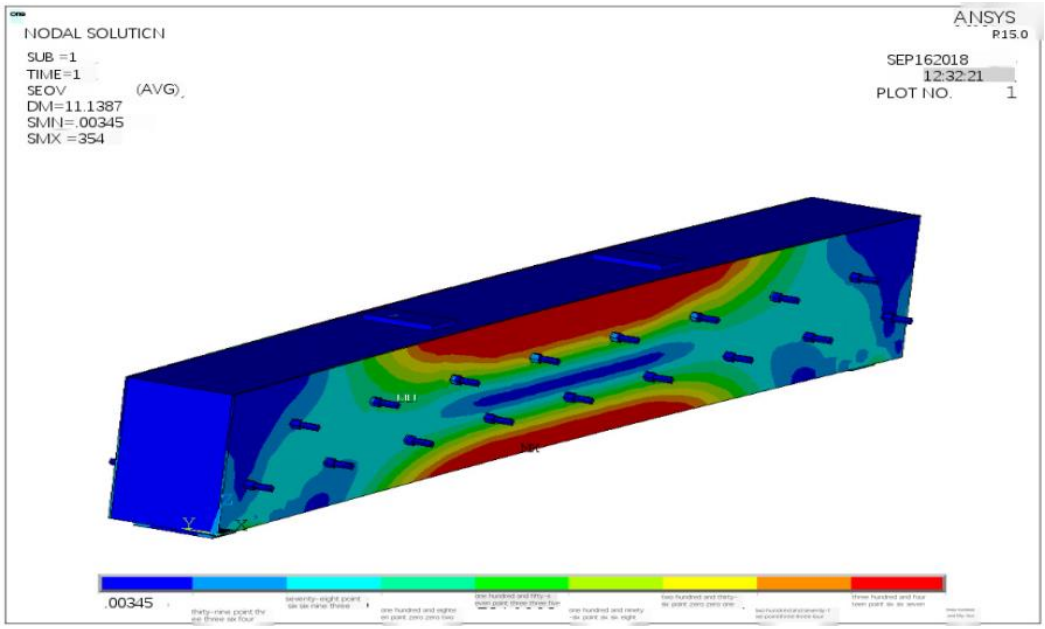

Fig. 6 Stress nephogram of exposed composite beam

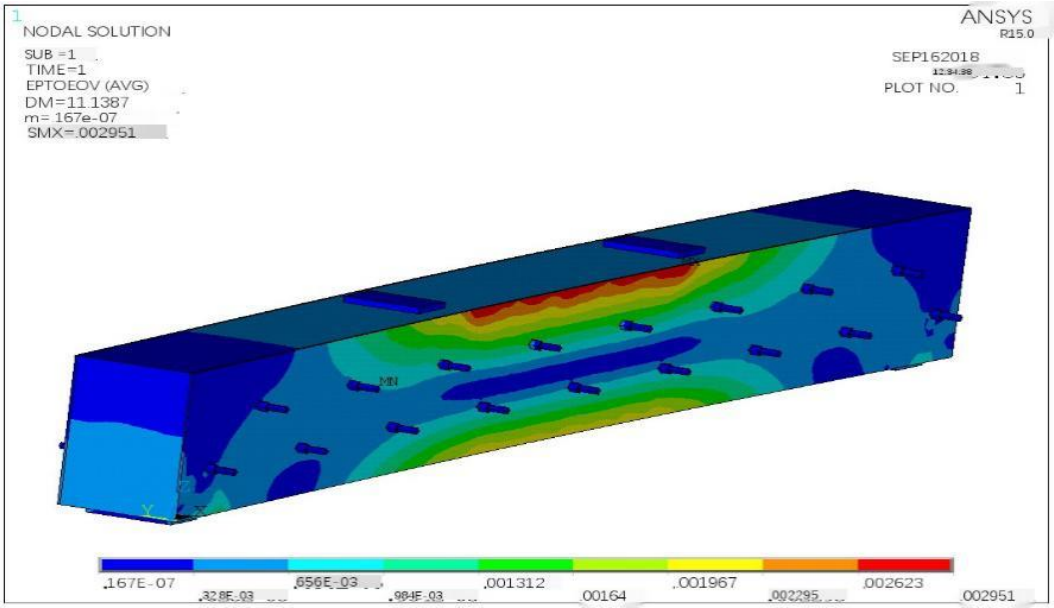

Fig. 7 Strain nephogram of exposed composite beam

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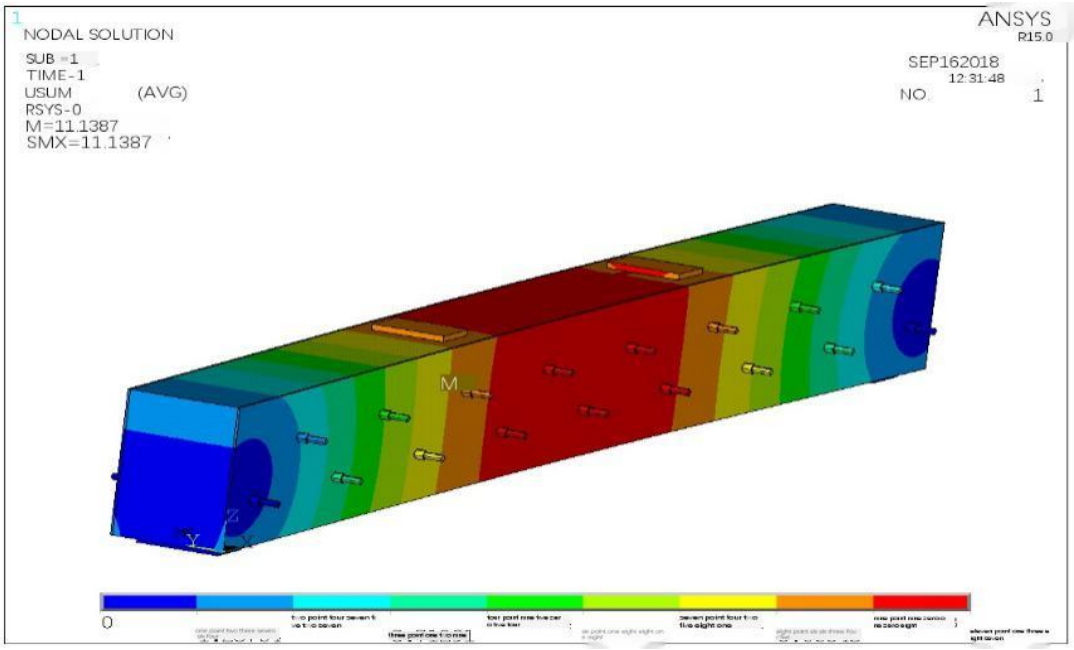

Fig. 8 Displacement nephogram of exposed composite beam

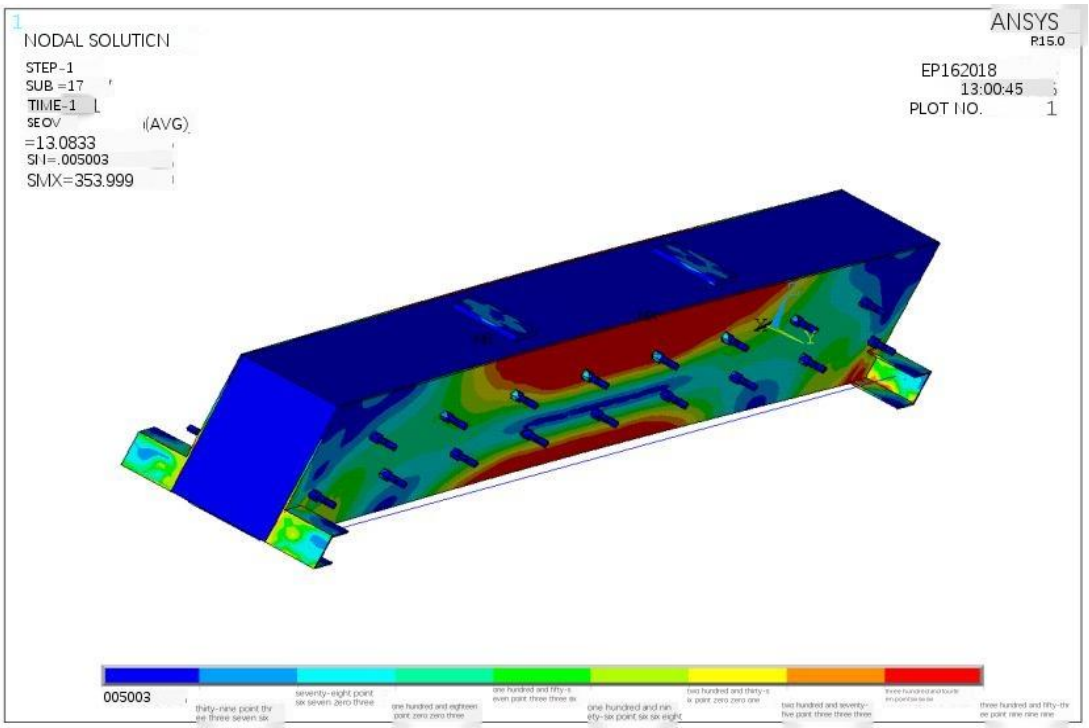

Fig. 9 Stress nephogram of linear composite beam

According to Fig. 6 and Fig. 7, under the action of mode 1, the stress of the composite beam is the largest at the upper and lower part of the outer steel plate at the concentrated load, while the strain is the largest at the upper part of the steel plate at the concentrated load. It shows that the failure of the composite beam is analyzed by numerical simulation. Because the steel plate at the concentrated load first buckles, then plastic failure occurs, and the failure position is between the loading positions, The results show that the accuracy of the numerical simulation analysis results have been verified. The maximum value of the stress nephogram of the exposed composite beam is 314.7n/mm2-354.0n/mm2, the maximum value of the strain nephogram of the exposed composite beam is between 2.6mm-2.9mm, and the maximum value of the displacement nephogram of the exposed composite beam is

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between 9.9mm-11.1mm, which meets the requirements of the code within the range of 1 / 200 span, that is, 15mm, From these data, it can be concluded that the upper steel plate is in the plastic limit state. Combined with the results of stress and strain nephogram, the change of stress and strain of composite beam accords with linear correlation, which is consistent with the plane section assumption theory, which shows that the numerical simulation analysis results have verification effect.

Similarly, through the finite element numerical analysis, the concentrated load of 550kn and the temperature load of 191.33 ° are applied to the steel plate brick masonry composite beam strengthened by external prestressing. The cloud chart of plastic ultimate bearing capacity of the steel plate brick masonry composite beam strengthened by external prestressing is obtained

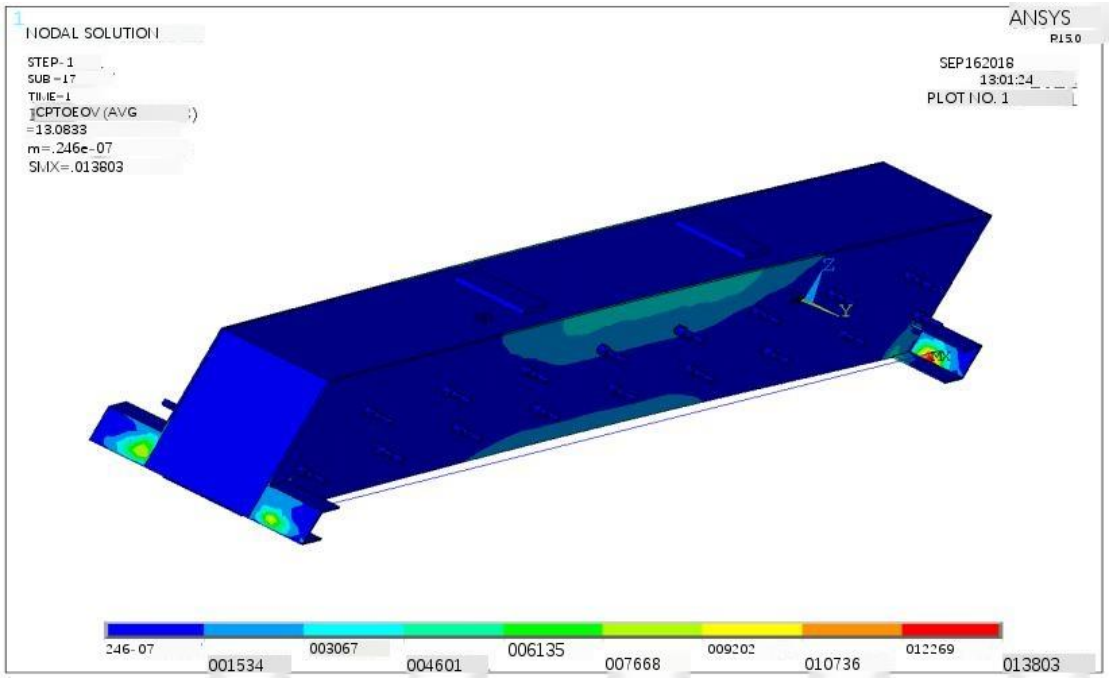

Fig. 10 Linear strain nephogram

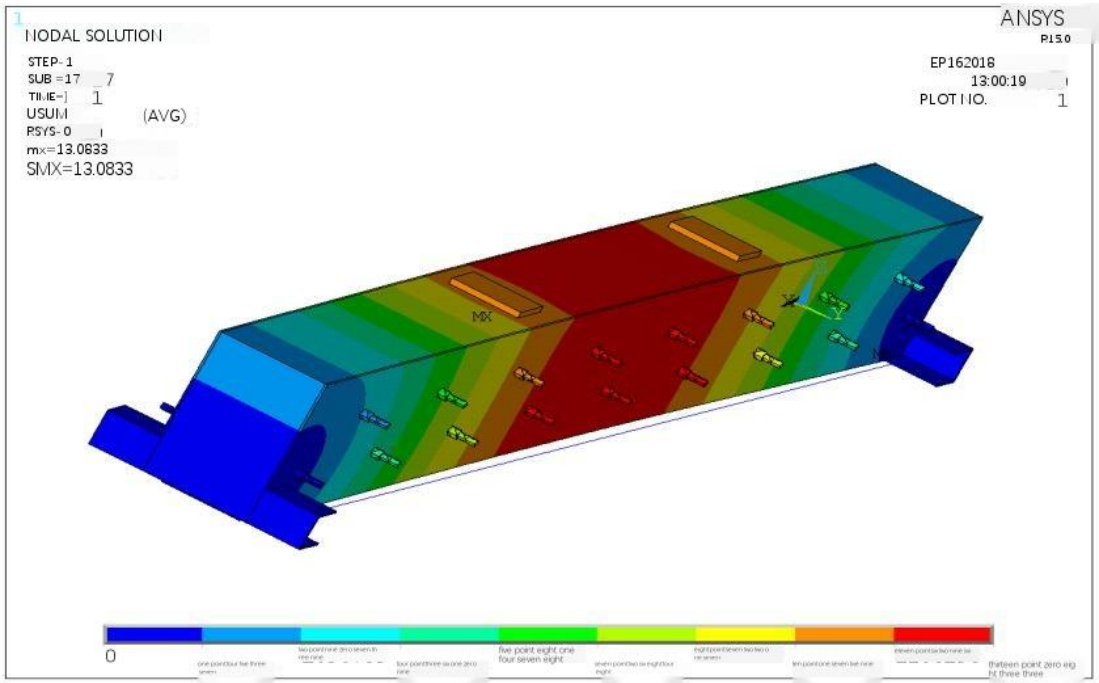

Fig. 11 Linear displacement nephogram

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The results of finite element numerical simulation also show that the maximum stress and strain of the steel plate brick masonry composite beam strengthened by external prestressing are at the outer side of the concentrated load, and the upper and lower parts of the steel plate are the largest. The change of the stress and strain of the composite beam conforms to the linear correlation, which is consistent with the plane section hypothesis theory, The stress, strain and displacement of linear external prestressed composite beam meet the requirements, and the change area after reinforcement is obviously smaller than that before reinforcement, which shows that steel plate brick masonry composite beam with linear external prestressed reinforcement can effectively improve some data and improve the mechanical properties of composite beam.

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) The overall change trend of flexural deformation of composite beams before and after reinforcement is the same. Under the same conditions, the bearing capacity of steel plate-brick masonry composite beams strengthened with linear external prestressing is superior.

(2) Under the same load, the deformation and bearing capacity of exposed steel plate-brick masonry composite beams change greatly, and the plastic ultimate failure state appears first. The layout scheme of linear prestressed tendons can improve the performance of composite beams in all aspects.

Acknowledgments

Fund projects:Anhui University Natural Science Research Project (KJ2020A0805) School Class Teaching Team (2019JXTD123), Modern Manufacturing Curriculum Teaching Team (20ZLGC025), mechanical design guidance and automation (20ZLGC002).

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