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Analysis of Seismic Performance of Prefabricated Seismic Building Wall Based on ANSYS

Yujuan Liu*, Xiang Wang, Duo Zhao

Zhengzhou Business University, Zhengzhou, Henan, China.

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***Corresponding author:** Yujuan Liu, Zhengzhou Business University, Zhengzhou, Henan, China.

Abstract

Assembly type buildings is a new form of buildings in our country. It can build quickly and lower cost of production. In order to study the seismic performance of prefabricated structural wall, based on the analysis of the structure composition of the existing seismic wall, through the practical project, Vanke Metropolitan Jinyue Yuan No.6 building, the finite element model of prefabricated wall building was established by ANSYS. The wall unit comprises a wall panel and a lower fixed assembly, a connecting assembly between two wall panels, and a connection limit for two wall panels is implemented by providing a connecting plate. It is analyzed whether the seismic performance of the vibration mode, stress and strain of the new aseismic wall conforms to the requirements of the relevant codes, and further adjustment is made. Using the finite element analysis software, six finite element models with different vibration modes are established and calculated. The failure modes and seismic performance of the models are basically the same as the expected experimental results, which verify the effective seismic performance of the finite element model.

Keywords

Prefabricated construction, Anti-seismic wall, Node connection, Finite element analysis

Assembly building in our country is a new building form, it is built quickly, and lower cost of production, and promoted in all parts of the world, is the goal and inevitable trend of the whole construction industry. The application of building curtain wall is more and more widespread. Curtain wall is widely used in building exterior decoration because of its advantages such as easy installation and factory processing quality assurance. In the process of modern building construction, in order to increase the seismic ability of the wall, the wall is usually divided into several wall units. Through the mutual restriction of the shock absorber between the wall units, the damage to the wall is reduced [1].

1. Engineering Summary

Jinyue Garden is the fourth phase of Vanke Metropolitan Project. It is located in the southeast of the intersection of the South Fourth Ring Road, University Road, Erqi District, Zhengzhou City. It consists of 7 residential buildings and 1 kindergarten, adjacent to Metro Line 7 (in the planning), and connected to the South Fourth Ring Road and other highways, University Road, Songshan Road and other urban arterial roads. Including 6-32 storey residential buildings, frame shear wall structure, the use of assembly integral construction.

The seismic fortification intensity of the engineering is 7 degrees, the design earthquake acceleration value is 0.15g, the design earthquake group is the second group, the site category is the second class, and the characteristic period value is 0.40s. According to the "seismic fortification Classification Standard for Building Engineering" (GB50223-2008), the seismic fortification category of residential buildings is Class B, the structural safety grade is class 1, the ground roughness category is class C, the wind load is considered once every 100 years, and the revised basic wind pressure (kN/m^2) w_0=0.55kN/m^2 [2-3].

2. Seismic Performance Analysis

2.1 Finite Element Analysis Model

The prefabricated seismic type building wall model includes the wall panel and the lower fixed component, the connection component between the two wall panels, by setting the connection board to implement the connection limit of the two wall panels, the wall panel has a certain buffer space when subjected to vibration, and then through the base slot clamp at the bottom of the base and the wall panel to further limit the wall panel. By setting the limit component, the sleeve is located in the slot, the wall panel will drive the sleeve to produce a certain amplitude of shaking when it is subjected to vibration, so that the wall panel can have a certain buffer space, and then drive the sleeve to move on the surface of the fixed rod, so that the wall panel has a certain buffer space, and then through the base and the base slot clamping can complete the further limit of the wall panel.

A connecting component is arranged between the wallboard, and the connecting component comprises a connecting plate and a slot, and a connecting plate is arranged between the two wallboards, and the inner wall of the wallboard is provided with a slot. The connecting plate is a "work" shape structure, the groove is a "T" shape structure, the connecting plate and the groove are sliding connection. A number of connecting steel bars are connected between the connecting plate and the base, and the connecting plate and the base are cast integrated structures. ANSYS software is used for modeling, and the finite element model is shown in Figure 1. According to relevant literature [4-5], the concrete strength grade is C35, the concrete bulk weight is $26KN/m^3$, the reinforcement grade is HRB400, the reinforcement bulk weight is $78KN/m^3$, and the concrete strength grade is $26kN /m^3$. Elastic modulus =1.02×109 kg/m^2, Poisson's ratio = 0.5, linear expansion coefficient =1×10-5/℃.

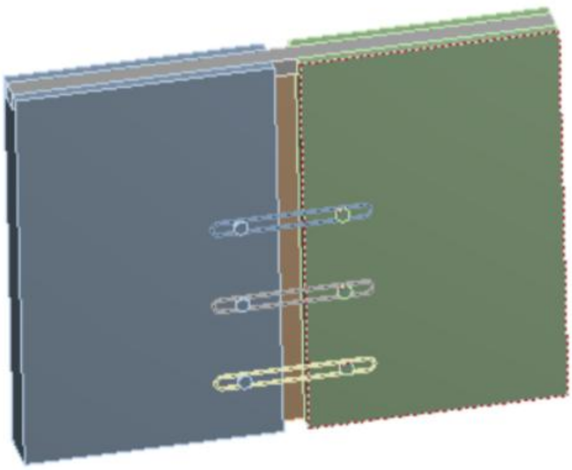


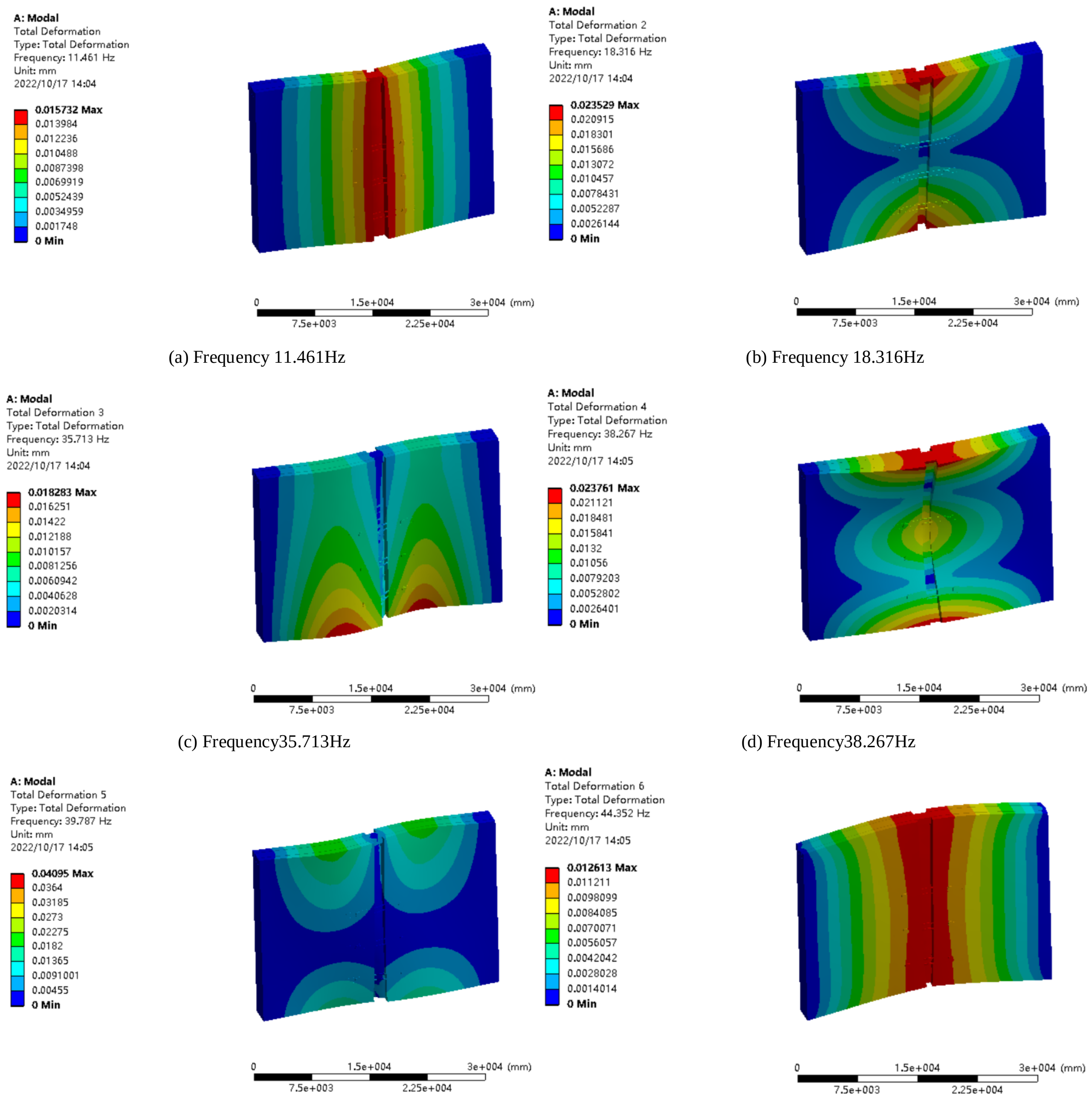
Figure 1. Finite element model.

2.2 Mode Decomposition Reaction Spectrum Analysis

Mode decomposition response spectrum method is a method used to calculate the seismic action of systems with multiple degrees of freedom. This method uses the principle of acceleration design response spectrum and mode decomposition of the system of single freedom to solve the equivalent seismic effect of each order mode, and then combines the seismic effect of each order mode according to certain combination principles, so as to obtain the seismic effect of the system of multiple freedom.

The core principle of the response spectrum theory of mode decomposition is that the mass of the structure can be concentrated at each floor for simplification, and the mass points of these concentrated floors are regarded as degrees of freedom. Such simplification enables the system of multiple degrees of freedom to be decomposed into multiple separate systems of single degrees of freedom for seismic action respectively during seismic calculation. The seismic response value of each single degree of freedom can be calculated from the response spectrum. In essence, the seismic action is regarded as a load effect imposed on the structure, so as to find the response generated by the seismic action of the structure. In the process of solving, the acceleration of the ground and the vibration characteristics of the structure itself are considered.

The finite element analysis software ANSYS was used for parametric analysis of the wallboard. The frequency of vibration mode was selected as 11.461Hz, 18.316Hz, 35.713Hz, 38.267Hz, 39.787Hz and 44.352Hz, and the wallboard and the fixed components below were studied at different frequencies. The connecting component between the two wall panels, and the connecting plate on the two wall panels to implement the connection limit of the shape variable, thus the seismic performance of the wall panel.



(a) Frequency 11.461Hz

(b) Frequency 18.316Hz

(c) Frequency35.713Hz

(d) Frequency38.267Hz

(e) Frequency39.787Hz

(f) Frequency44.352Hz

Figure 2. Mode nephogram of response spectrum analysis.

As can be seen from Figure 2, the deformation of the wall under different vibration modes starts along the connecting components between the two wall panels. The maximum displacements of the wall deformation with 6 different frequencies are 0.015732mm, 0.023529mm, 0.18283mm, 0.023761mm, 0.04095mm and 0.012613mm respectively. It can be found that, when the vibration frequency is 11.461Hz and 44.352Hz, the deformation is that the connecting parts of the wall gradually decrease to the left and right sides. When the local vibration frequency is 18.316Hz and 38.267Hz, the deformation means that the upper and lower ends of the wall connecting part gradually decrease to the middle part. When the vibration frequency is 35.713HzHz and 39.787Hz, the deformation is mainly in the wall at both ends, but the deformation of the connecting body in the middle is small. When the frequency of the model increases, the maximum shape variable of the model will increase first and then decrease. When the frequency is 39.787Hz, the deformation reaches the maximum value of 0.04095mm.

2.3 Stress and Deformation Analysis

Time history analysis method is called step by step integral method in mathematics, and it is also called "dynamic design" in seismic design. The seismic response of the whole time is obtained by integrating the basic motion equation of the structure into the ground acceleration record. In this method, the seismic wave corresponding to the site of the structure is input as the seismic action, starting from the initial state, and gradually integrated step by step until the end of the seismic action.

Is the basic motion equation of engineering, input corresponding to the engineering site of a number of seismic acceleration records or artificial acceleration time history curve, through integral calculation to obtain the whole process of the change of the internal force and deformation state of the structure during the change of the ground acceleration with time, and based on this check calculation of the seismic bearing capacity of the section of the structural members and deformation check calculation. This structure adopts the elastic dynamic time history analysis method, input three seismic waves, two natural seismic waves and one artificial seismic wave, calculate the stress and displacement of the structure, select the maximum result, as shown in the figure below, the maximum stress and displacement are occurred in the middle of the connection of two walls, the maximum stress is 6.8866MPa, the maximum displacement is 0.57704mm.

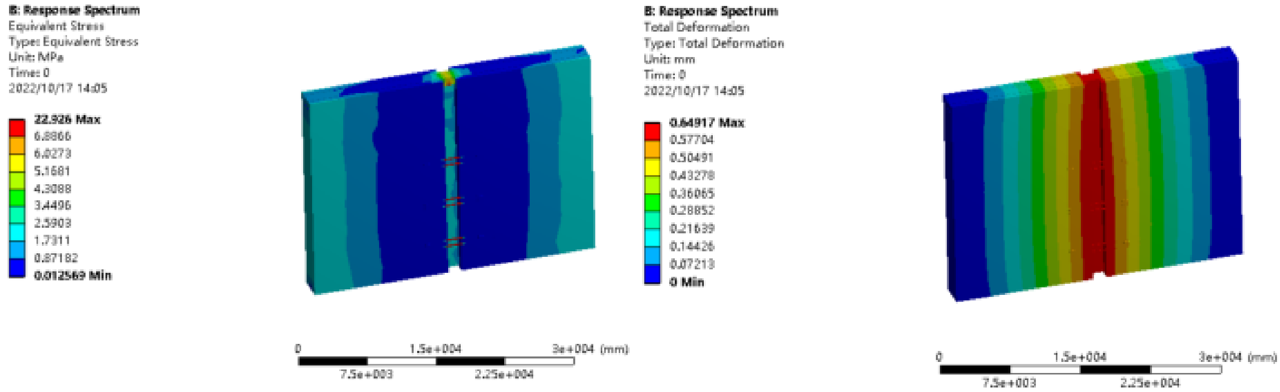


Figure 3. Stress nephogram and deformation nephogram of response spectrum analysis.

3. Conclusion

Based on the constructed model and the analysis of the seismic performance of the prefabricated seismic building wall, this paper introduces in detail how to enhance the seismic capability of the wall, divide the wall into several wall units, and reduce the damage to the wall through the mutual restriction of the shock absorbers between the wall units. In this paper, it is proposed to enhance the seismic performance and provide more ideas for engineering construction. Based on data model analysis, the seismic performance of the structure is studied. Using finite element analysis software, six finite element models with different vibration modes were established and calculated. The failure modes and seismic performance of the models were basically the same as the expected experimental results, which verified the validity of the finite element model. Based on the experimental results and finite element analysis model, the research content and results of this paper were completely summarized. The plane layout of the structure built in this paper is relatively simple, but there are many complex and irregular plane structures in practical engineering, so it is necessary to study the seismic performance of different types of structures.

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