Mechanical Analysis of Floor Heating Decoration of High-rise Residence

Zhijun Yang and Chao Yun

Inner Mongolia University of Science and Technology, College of Civil Engineering, Baotou 014010
Email: Yzj4569@sina.com

Abstract. The mechanical analysis of the vertical load and the wind load of the high-rise building is carried out by using the finite element method. The law of internal force and deformation is obtained. It is found that the reinforcement ratio is increased compared with the original design value, and there is a potential safety hazard. It has reference and guidance significance for the future practical design.

1. Introduction
With the emergence of a large number of high-rise residential buildings, people decorate them with floor heating before moving in, but there are many safety problems. In this paper, taking a real house as an example, the mechanical simulation analysis of the later decoration is carried out by using the finite element method, and the distribution law of stress and deformation is obtained. The results show that there are potential safety hazards. This study provides a good reference value for similar design and decoration maintenance in the future.

2. Problem Background and Existing Problems
With the popularity of urban high-rise housing, decoration has become a process that every family must go through. Among them, the floor heating decoration has the advantages of comfort, energy saving, less land occupation and so on, which is loved by people. However, in practice, some households increase the thickness of floor heating or even transform the structure form without permission. Sometimes developers, design units and properties have no time to pay attention to it, which has a great potential safety hazard to the building structure itself.

The damage of high-rise buildings is often the most affected by earthquake. The main significance of this paper is to use the finite element method and the traditional calculation method to carry out the mechanical analysis of static load and wind load, and to judge the safety of the building.

3. Establishment and Solution of Finite Element Model

3.1. Solution Under Conventional Design
Select solid-concrete 65 element in ANSYS software and use reinforcement ratio to simulate reinforcement action:
- The shear wall of 1-3 floors is one kind, C35 concrete is selected, and the reinforcement ratio is 0.35%;
- The floor of 1-3 floors is one kind, C35 concrete is selected, and the reinforcement ratio is 0.26%;
- The 4-11 story shear wall is one kind, C30 concrete is selected, and the reinforcement ratio is 0.32%;
The floor of floors 4-11 is one kind, C30 concrete is selected, and the reinforcement ratio is 0.25%. Dead weight is 400kg/m², Live load is 200kg/m².

**Figure 1.** Overall model stereogram

**Figure 2.** Vertical deflection under stress
It can be seen from the deflection diagram that the maximum deflection is 1.903mm under the condition of only self weight and standard live load, \( \frac{1.903\text{mm}}{31900\text{mm}} = 5.966 \times 10^{-5} < 0.0025 \); The side shift value is 0.157mm. The aspect ratio is: \( \frac{0.157\text{mm}}{31900\text{mm}} = 4.9 \times 10^{-6} < 0.001 \), Meet the design requirements of the specification. The deflection of the floor without heating load is 0.397mm, which is used to compare with the deflection and stress diagram of the floor after heating. \( \frac{0.397\text{mm}}{16900\text{mm}} = 2.352 \times 10^{-5} < 0.001 \), Compared with the requirements of the code, it meets the design requirements of the code. The reinforcement ratio of the corresponding shear wall calculated by PKPM is 0.3%, which is smaller than that calculated by the design drawing 0.35%; the reinforcement ratio of the corresponding floor is 0.23%, which is lower than that calculated by the design drawing 0.25%.

3.2. Mechanical Analysis of Increasing Decoration Load
Considering that there is no clear stipulation on the thickness of the floor heating in the regulations of the floor heating, with reference to the example, this paper takes the value of 9cm, and finally converts the weight of the floor heating into the force with the equivalent load of 1.66KN/m², which is used for the calculation of the floor heating load.

The deformation of the model is also increased to 1.984mm. \( \frac{1.984\text{mm}}{31900\text{mm}} = 6.219 \times 10^{-5} < 0.0025 \), Meet the structural design requirements. The lateral displacement of the whole model becomes 0.166mm, which is 0.157mm more than the previous 0.09mm. \( \frac{0.166\text{mm}}{31900\text{mm}} = 6.220 \times 10^{-6} < 0.001 \), Compared with the design requirements of the code, it meets the structural design requirements.

After increasing the decoration load, the reinforcement ratio of the shear wall calculated by the finite element model has not changed, which shows that the increase of the floor heating load has little impact on the safety of the structure.

According to the reinforcement diagram obtained by PKPM, the reinforcement ratio calculated by the concrete structure design code is 0.23%, which has not changed. It shows that the increase of load has little effect on the safety performance of the floor, which is also less than the reinforcement ratio 0.25% of the corresponding floor calculated according to the design drawings. Meet the design
requirements of the specification.

After increasing the floor heating load, the deflection of the floor changes from 0.379mm to 0.423mm, which increases by 0.044mm compared with that before adding the floor heating load, and the increased value accounts for a large proportion of the total deflection. 0.423mm/16900mm = 2.502 × 10⁻⁵ < 0.001, Meet the design requirements of the specification.

3.3. Mechanical Analysis of Increasing Wind Load

Because in the actual project, there are different working conditions, it is necessary to carry out the necessary stress analysis under various complex stress conditions. The actual high-rise buildings are mainly faced with wind load, earthquake action and so on. In this paper, the wind load of a certain area is calculated according to its natural conditions. The standard value of wind load on both sides is obtained as follows: q₁ = 0.625 × 16.9 = 10.56KN/m, q₂ = 0.0391 × 16.6 = 6.6KN/m.

Under the joint action of wind load, decoration load and self weight load, the deformation of the finite element model is 2.03mm, which is compared with the code. 2.03mm/31900mm = 6.36 × 10⁻⁵ < 0.0025, The deflection span ratio meeting the design requirements of the code.

However, it can be seen from the change of deformation that the vertical settlement of buildings caused by wind load is relatively small. In the case of right blowing, the lateral displacement of the structure is larger, which is 0.456mm. According to the judgment basis of whether the overall lateral displacement of the structure is damaged, Namely: 0.456mm/31900mm = 1.43 × 10⁻⁵ < 0.001, According to the code, it can be considered that under the action of wind load, the anti lateral displacement strength of the building meets the design requirements. The reinforcement ratio calculated according to the code for design of concrete structures has not changed to 0.3%, which is smaller than 0.35% calculated according to the design drawings, meeting the structural design requirements.

4. Results

Through the above summary, the conclusion that the structure studied in this paper can meet the safe use conditions after increasing the load is drawn. However, combined with the actual project, the stress of the building will be more complex, and it is suggested that the stress conditions that can be added during the relevant stress analysis and checking calculation in the future will be more abundant, such as increasing the seismic load, etc., so that the stress situation analyzed can be more real and reliable, It provides a more comprehensive mechanical analysis for practical engineering.

5. References

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