Numerical Simulation of Axial Pressure Bearing Capacity of Building Concrete Short Column Based on Finite Element Analysis

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Abstract. Based on the ANSYS finite element platform, considering the geometric parameters and calculation method of the short column Axis material of concrete building, a numerical model of the Axial bearing capacity of concrete building under the finite element analysis is established. On the basis of the model, the load displacement curves of concrete bearing concrete bearing short column Axial pressure under the characteristics of different straps are analyzed, the standard values are set, and the concrete compression strength is set. The concrete conditions and numerical model simulation are established. Feasibility analysis, Through the test results and its specific test content to judge, put forward the test results of the matching method and strategy, give a personal opinion and test description.

1. Introduction
With the increasing scale of construction in our country, its standard is more and more strict. The new mixed structure combination of reinforced concrete has become better and better with the development of the market. The short column bearing capacity of building concrete is steel plate. It has strong application value. Through the basic mechanical properties of the steel plate concrete structure system by selecting different thickness and strength grades for group classification, according to certain parameters for design and treatment, steel plate facade strength test, concrete short column pressure test, in the study found the difference between ordinary short column and steel plate concrete short column, according to the effective data record, study the compressive capacity and seismic capacity of its Liang Zhu node, analyze the ductility of steel plate Liang Zhu node, study the indexes of steel plate and concrete with different thickness, bearing capacity and ductility record, It is also good at numerical simulation of bearing capacity of short concrete columns. In a word, the finite element analysis of bearing load of short column is put forward on the basis of research, and the finite element analysis is constructed on the basis of ANSYS software, and the concrete direction and feasibility of establishing numerical model are discussed.

2. Construction of Finite Element Model

2.1. Constitutive relationship
In order to design the finite element model, we should consider the design structure of the constitutive relation, design the steel cage according to the specific elements in the finite element model, and construct the finite element model to determine the structure of the steel cage. Two methods of steel cage design, one is mixed method separation design, as shown in figure 1.
According to the standard "Code for Design of GB50010-2013 Concrete Structures", the formula of compressive stress is as follows:

\[
\sigma = \begin{cases} 
\frac{f_c - 0.1\varepsilon_0}{\varepsilon - \varepsilon_0} - (\varepsilon - \varepsilon_0) & \varepsilon_0 \leq \varepsilon \leq \varepsilon_0 \\
\frac{f_c - 0.1\varepsilon_0}{\varepsilon - \varepsilon_0} - (\varepsilon - \varepsilon_0) & \varepsilon_0 \leq \varepsilon \leq \varepsilon_0 
\end{cases}
\]

(1)

On the basis of formula (1), we can know that in the structural members of the model, a series of data are used to simulate the fitting input, and according to the definition model of nonlinear elastic material, the method of calculating the strain force laid by multi-linear directional strengthening is used. According to the MISO simulation of strengthening tensile force, the elastic modulus of concrete is input as tentative modulus, \(E_C=30\) Gpa, Poisson's ratio is 0.2, the failure criterion is tested by Willam-Qwarnker five parameter strength criterion, and the shear transfer coefficient of concrete open crack is 0.6. The shear link coefficient of closed crack is 1.0. The relationship between stress value and profit is calculated according to the above formula.

2.2. Module selection

During the use and design of the parts in this experiment, the dimensions and other main parameters need to be related to the ANSYS finite element model, and the parts content should be designed according to the details in the simulation figure, as shown in figure 2.

On the basis of the design elements of 3D 8 joints of concrete that need to be considered, the joint sharing of steel plate and concrete in solid construction needs to consider the effect of bond and sliding. According to the element of concrete, the design length is kept at 95 cm, width 38 cm, easy to fill material, and easy to control external length and hardness. Considering the cracking and crushing method of concrete, the steel plate adopts 3D 4 joint design reasonably, and the stress change considers the element thickness change and ballast change according to the concrete condition of shell unit linear analysis. The rigid link between concrete solid element and steel shell element is carried out, the common node characteristics of element and solid element are considered in modeling, the main node is designed according to shell element, the solid element is used as node, the degree of freedom and node order of main node are guaranteed, the constraint equation of \(U_x\) and \(U_z\) of master node is established, and the constraint equation is generated independently according to rigid line. This method is simple and practical, describes the outer contour coordinates according to the constraints of the degree
of freedom and the outer contour of the shell link, determines the calculation amount of the model according to the coefficient at the secondary node, avoids overstretching the steel plate structure after generating the load concentration value, replaces the steel cushion plate with the equivalent load distribution approximation, uses the line constraint method to apply a three-dimensional reinforcement at the bottom of the short column, and uses $X, Y, Z$ three coordinate measures to control the crack part, considering the specific stress concentration, it is more suitable to control the cracking part within 8 mm. The reason is that only low damage or error can effectively complete the whole process of the test.

3. Test overview

3.1. Specimen Materials and Manufacture

The steel pipes used in the test were produced by Jinhe Steel Factory in Foshan, Guangdong Province, made of seamless round steel, Q235/Q345, material Steel pipe cutting using G4025 horizontal band saw machine cutting, Hexagonal steel tube short column with 90 mm, side length mm, 9.0 thickness of steel pipe For steel, 350 MPa, strength Concrete for the test site configuration of the selected material. Specific ingredients can be presented as: Portland cement 525, limestone macadam 25 mm, in diameter Medium coarse Sand, Sand rate 0.45, FDN superplasticizer, 3 950 mm, of similar length produced A short column of steel plate concrete with a width of 380 mm.

Because it is a new type of concrete structure, which has the advantages of fast construction speed, easy control of construction Prefabricated Cage System PCS quality, good ductility and strong energy dissipation ability, and can be widely used in various components of concrete structure. In the process of using and popularizing construction technology, an important feature of concrete structure system is to control the concrete bearing reasons and details of steel plate concrete short column according to the characteristic value of steel plate concrete, To determine the ductility and maximum length of steel plate concrete in fracture state, the energy consumption of steel plate concrete and the configuration of steel plate concrete need to be connected with each other, to master the lateral pressure of short column of steel plate concrete, the tension of steel plate protruding outwards, and to master the axial tension of steel plate surface to produce transverse strain. At the same time, the elastic recovery of steel plate and the transverse binding force of concrete are also reflected. The cracking state of short column concrete will bear the pressure. This value needs to be recorded as the foundation for future research. When the column concrete cracks into elastic-plastic state, the transverse deformation of concrete will recover little. The accumulation of transverse strain of steel plate hoop is accompanied by the accumulation of

| Specimen Number | Steel pipe size/ mm | Limit f/MPa | fc/MPa | Nrc/kN |
|------------------|---------------------|------------|--------|--------|
| Experimental Short Column 1 | mmX380mm 950 | 360L/1.5 | 350 | 75.2 | 3011.21 |
| Experimental Short Column 2 | mmX380mm 950 | 360L/1.25 | 350 | 75.2 | 3011.21 |
| Experimental Short Column 3 | mmX380mm 950 | 360L/0.99 | 350 | 75.2 | 3011.21 |
vertical strain. At the same time, the transverse constraint of steel plate hoop on column concrete is also accumulated.

3.2. Specimen Parameters and Calculation Formula
The parameters of high strength concrete need to have strong flexibility and brittleness. Microcracks will make destructive force reach high value during stress, so microcracks need to be properly controlled. The influence of loading speed and continuous loading practice team high strength concrete compression is very important.

\[ F_c = 0.6 F_{cu} \]

- The failure load of short columns should be controlled at
- \( N_{rc} = A_c F_c + A_s F_s \)

Formula, \( A_c \)-- steel plate concrete short column core concrete section area
- Cross section area of \( A_s \)-- steel plate concrete short column steel pipe

In the recorded known data, some scholars have repeatedly mentioned the measurement results and records of numerical simulation of bearing capacity under finite element foundation:
- The design value of axial tension \( N = 636 \) kN
- The design value of diagonal moment \( M = 271 \) kN·m 1.1.2
- Rectangular section, section height \( h = 300 \) mm, section width \( b_h = 300 \) mm 1.1.3 concrete strength grade is 11.9 N/mm²
- Steel bar tensile strength design value \( f_y = 350 \) N/mm, steel bar compressive strength design value \( f_y \), steel bar elastic modulus \( E_s = 200000 \)
- The thickness of concrete cover of longitudinal reinforcement \( c = 30 \) mm; and the minimum reinforcement ratio of tensile longitudinal reinforcement \( \rho_{min} = 0.2 \).

3.3. Test Device and Measurement Method
The pressure test of short column is used in 5000 kN foundation pressure tester. The strain test point of the specimen should be pressed according to the position of both sides. The displacement results are determined by installing displacement meters on both sides of the specimen.

3.4. Test addition and measurement results
According to the near limit load capacity, determine the minimum and maximum load capacity, with the increase of slowly increasing and decreasing amplitude, can bear the pressure of the short column external and internal structure bear the force effect, on the specimen can also wait for the end of the installation, preloading 3-2 times, determine the specific strain situation, until the central position of the specimen symmetrical strain gauge is longitudinal tensile, longitudinal edge is worth recording, the difference is not more than 15%, otherwise will face the risk of fracture, after measuring the corresponding value, the central position of the specimen corresponding to the strain gauge maintain geometric position center, symmetry, In order to raise the full load pressure of the specimen to the compression result, the statistics of the pressure numerical results of the concrete short column bearing in three steel plate buildings are shown in Table 2.

| Specimen Number | Measured flexural load Nsc/kN | Ns/kN of measured ultimate load | \( g\% \) of measured ultimate compressive strain | Nsc/Nrc | Nu/Nrc |
|-----------------|------------------------------|--------------------------|---------------------------------|-------|-------|
| Experiment 1 Short Column 1 | 2955 | 3451 | 1.65 | 1.992 | 1.22 |
| Experiment Short | 2987 | 3677 | 1.24 | 0.789 | 1.45 |
According to the information recorded in the table, it can be seen that the measured flexion load of the experimental short column 1-3 (Nsc/kN) are the measured ultimate load values (Ns/kN) are 3451/3677/3011, and the measured ultimate compressive strain values (g~/%) are 0.99/1.467/1.56. According to these numerical results, it can be seen that the function of the experimental short column in the bearing capacity test is confirmed, and the boundary value and the expected occurrence value are kept in the same position range, and the test effect can be seen to meet the requirements.

4. numerical simulation

4.1. Load displacement curves
According to the finite element numerical analysis model established above, we can see that the experimental results of load displacement curve are basically consistent with the calculated simulation results. The finite element model of steel cage concrete short column established in this paper is effective, and the selection of material and constitutive law is reasonable. From Fig. 4-1, we can see that the bearing capacity of steel plate concrete short column increases with the increase of hoop characteristic value, which is due to the longitudinal compression deformation of steel plate and concrete under axial load, and the Poisson effect of material. When the transverse deformation of core concrete is larger than that of steel plate, the steel plate produces transverse constraint, which hinders the expansion of concrete and the interaction between core concrete and steel plate. With the increase of the hoop ratio, the concrete in the core area is closer to the three-direction compression, and its axial compressive strength is continuously improved. The corresponding ultimate load comparison is shown in the figure. The bearing capacity of three short columns in 4-2 is shown in the comprehensive view.

4.2. Axial compressive bearing capacity of concrete short columns
In the finite element model analysis of three specimens of steel plate concrete short column, the fitting degree of the numerical curve of the experimental short column 1 is the best, the test failure effect is obvious, but the concrete strength of the No. 1 model is excellent, as shown in Fig. 3-6, respectively.
In Fig. 3, we can see the concrete condition of deformation and the wrapping tightness and bearing condition of steel plate concrete. Fig. 4 records the concrete condition of vector deformation. The concrete condition of vector deformation is that the red is the strongest under pressure, the yellow color is the second, the green, the light blue and the gray are sorted in turn. It can be found that the stress structure of the steel plate becomes smaller from top to bottom. Fig. 5 shows the stress structure diagram of the steel plate. It can be seen from the diagram that the blue part of the steel plate is the most stressed, and the yield load value is 290. The ultimate load value of experimental short column 1 obtained by test data is 28.33 Mpa, MPa, the longitudinal measured yield strength of steel plate is 289.44 MPa, and the test data are close to the numerical results and show good stability.

5. Fruit analysis
A simulation test of short columns of steel plate concrete in nonlinear ANSYS finite element model of concrete material is constructed. By comparing the data, the effect of axial compression bearing capacity of concrete short columns under steel plate hoop environment is obtained and the analysis results are as follows: measured flexion and extension load of short columns 1-3(Nsc/kN) are the measured ultimate load values (Ns/kN) are 3451/3677/3011, and the measured ultimate compressive strain values (g−%/ According to these numerical results, it can be seen that the function of the experimental short column in the bearing capacity test is confirmed, and the boundary value and the expected occurrence value are kept in the same position range, and the test effect can be seen to meet the requirements. The maximum stress of steel plate and core concrete is close, which indicates that the model can effectively simulate the axial compression performance of steel plate concrete short column. In addition, with the increase of hoop ratio, the steel plate spacing decreases, the bearing capacity of steel plate concrete short column increases, and the compressive strength of core concrete increases.

6. Conclusion
In the process of expanding the development scale of construction industry in China, the speed of upgrading construction technology has become faster and faster, and the improvement of building related standards has become more and more strict. Establishing and carrying out the finite element model test of nonlinear ANSYS of concrete materials is helpful for the mass use of short columns of steel plate concrete in construction environment and its application in practice. At the same time, it can show the strong support ability of the short column bearing capacity of high strength steel plate hoop concrete, and on the other hand, it can reflect the more accurate axial compression load strain ability, so that the function of finite element ANSYS can be better brought into play.

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