Research on the Application of Models Based on Mathematical Theory in the Analysis of Building Structures

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Abstract. With the development of urbanization, the demand for various high-rise buildings is also increasing. The stability and safety of the building structure are an important issue. This article uses various mathematical models to analyze high-rise buildings, studies how to analyze high-rise structures and theoretically provides support for the analysis of high-rise structures.

1. Introduction
With the maturity of Chinese resistance theory, especially the development and continuous improvement of computer-aided information technology, it is used to analyze structural problems in buildings, laying the foundation for the development of skyscrapers. Under the influence of external forces such as strong winds and earthquakes, certain structural damage or loss of functions of a skyscraper usually causes the entire skyscraper to collapse. Applying mathematical models to accurately analyze the performance of high-rise components under heavy loads can significantly shorten the analysis process of high-rise structures and improve analysis efficiency.

2. The meaning of the mathematical model
As people use numbers, we will continue to build various mathematical models to solve various practical problems. Mathematical models can be established for most scientific and technological workers to evaluate the overall quality of students, and evaluate teachers’ performance and daily activities. The so-called mathematical model is the use of mathematical language, mathematical ideas and mathematical logic to establish corresponding engineering models and solve various practical problems. Mathematical models are mainly static models and dynamic models. [1] They are distributed and collective, with specific domains and specific system characteristics, and their internal and external connections through formulas, graphics, icons, mathematical logic, etc. Describes the parametric model, continuous time model, discrete time model, and random deterministic model.

In order to fully prove their insights, the ability and judgment to make model assumptions and linearize and simplify problems can add value to the mathematical model constructed. Then use appropriate logic to view calculations, formula guessing, image rendering, numerical calculations and other mathematical methods, or use computers and technology to simulate the power consumption of skyscrapers. It is presented in three dimensions in various situations. The deformation of different parts of the building components and the entire building uses complex and detailed methods in the mathematical model to minimize the errors in the mathematical model and ensure the stability of the
mathematical analysis of the mathematical model. In the end, a mathematical model that is quick and accurate and can actually solve the problem is formed. [2]

3. High-rise building structure analysis

3.1. Definition and stress characteristics of skyscrapers

The definition of a skyscraper depends not only on its height, but also on its "height". Therefore, when designing high-rise building structures, the combined effects of shear stress and gravity must be considered. When planning and structural analysis of high-rise buildings, it is necessary to ensure the strength, stiffness and stability of the load combination, and to control the surface acceleration due to wind loads so that users can feel it. When analyzing the structure of high-rise buildings, we mainly analyze two aspects: vertical load (frame structure system with low lateral stiffness) and horizontal load (diagonal support truss system with high lateral stiffness). [3]

![Diagram](image)

**Figure 1. Load-bearing analysis of high-rise buildings**

It can be seen from the force and deformation characteristics of high-rise buildings that the main load-bearing components of high-rise buildings have relatively large axial forces under horizontal loads. Bending moment and horizontal load. The shear force is large, the upper side shift is large, the relative displacement of the layer is large, the foundation pressure is large, and the horizontal shear force is large. Secondly, it is the components of the main bearing vertical structural system (under horizontal and vertical gravity loads) that determine the main force and deformation performance of high-rise buildings, which significantly increases the amount of material. Third, each floor should act as a horizontal rigid partition. This allows the vertical bearing members on each layer to work together under the action of horizontal forces, rather than working individually.

3.2. Analysis of high-rise building structure.

The structural analysis requirements of skyscrapers are becoming more and more complex. According to the advantages and disadvantages of high-rise building seismic wall structure system, frame structure system, frame seismic wall structure system, frame seismic truss structure system and other structural systems, it is first necessary to have an understanding of knowledge. Structural analysis of high-rise buildings. [4]

In order to accurately analyze the performance of high parts under high loads, many basic assumptions have been made in the finite element analysis. The rigid floor assumptions and calculation graphics must be correctly represented by the plastic hinge method, and some simplified shapes have been established. Effectively use mathematical models to accurately analyze skyscraper frame seismic wall systems, seismic wall systems, pipe structures and other structural systems to optimize and improve the relationship between skyscraper structures and components. Can be improved. China's skyscrapers can withstand strong winds and earthquakes.
4. Application of mathematical model in structural analysis of high-rise buildings

The building systems used in high-rise buildings, especially those over 200 meters, are mainly reinforced concrete structures and steel structures. The steel structure has excellent performance, can reduce the size of pillars, and can improve the seismic performance of high-rise structures. Therefore, in this article, we will perform the following mathematical analysis on the skyscraper model:

4.1. Principles and basic assumptions of mathematical model calculation

The calculation principles of using mathematical models to analyze skyscrapers include non-seismic structures of steel structures, and must fully consider analysis, internal force displacement, elastoplastic analysis and deformation calculations. In the elastoplastic and elastoplastic analysis of composite beams, the interaction between floor beams and steel beams should be ignored, and frames and steel beams should be considered. On the other hand, the mathematical model analysis of steel parts considers the comparison of skin effect due to the influence of secondary parts and non-structural parts.

To analyze the structure of a high-rise building, please carefully consider the material, shape and force level of the high-rise building, and use various calculation and analysis methods centered on the linear elastic analysis method. When using mathematical models to analyze the steel structure of skyscrapers, when reviewing and analyzing mathematical models, the bending, axial and shear deformations of beams and columns should be considered.  

4.2. Simplified model and accurate analysis model

When analyzing skyscrapers, a simplified mathematical model is usually used to quickly calculate in the pre-design stage, and accurate mathematical models are used to perform accurate result analysis in the intermediate and final design stages. Since the structure of a skyscraper is a complex three-dimensional space force system, the selection of the mathematical model should be based on the actual selection of the mathematical model, which can more accurately reflect the actual force state of each part of the skyscraper. The structure of a high-rise building.

The actual structure of a skyscraper is not only a complex space system, but also the actual load on the structural components. Even with electronic computers, it is difficult to accurately calculate the structure of several skyscrapers. Especially when calculating and estimating the design of high-rise buildings, a lot of manual calculations are required. Many structures and specific stress conditions require basic assumptions to simplify the structure and obtain reasonable design drawings to simplify the design. First of all, the cutting force (bending moment, axial force) of the steel frame under vertical load is mainly calculated by the simplified model of the surface of the skyscraper steel structure. If the load is horizontal, the bending will reverse. Use point method or D value method to analyze the internal force and displacement of the steel frame of high-rise buildings. The mathematical model used to analyze the usual layout frame structure uses this mathematical model to analyze the seismic wall structure of a high-rise building. This facilitates adjustment when the load is level. Secondly, the accurate analysis model of high-rise steel structure usually uses the rebar system model for finite element analysis. This is mainly due to the complicated construction system and the irregular arrangement of the flat vertical steel structure.

4.3. Steel analysis method

In the structural analysis of steel frame, the conical frame tube structure can significantly reduce the impact of earthquake and wind load, which is due to the large and small tower structure of the foundation, the smaller wind carrier shape factor and the horizontal axis fraction. The ground can offset the horizontal load and other advantages of high-rise buildings, thereby increasing the tilting force of the outer column.

For example, assuming that the conical frame tube structure of a skyscraper is affected by horizontal loads, a continuous mathematical model can be used instead of its bending moment, shear force, stress and axial force to simulate the conical frame. For the equivalent conical shell of a steel structure made of high-rise steel pipes, the equivalent stiffness of the simplified mathematical model is extended to the
ordinary steel pipe structure, then the moment of inertia of the beam and column, the cross-sectional area of the column and the frame tube. The elastic coefficient of the material is analyzed. By analyzing the force characteristics, static force and total potential energy of the tapered frame tube structure under tension, the weight and cost of the steel frame can be reduced, and the seismic performance can be improved.

4.4. The practical application of mathematical model analysis software in high-rise building structure analysis

Due to the rapid development of information management technology in computer networks and its applications in various fields, building structure analysis software based on mathematical learning models has been widely used in computer networks. In the structural analysis step of high-rise buildings, the appropriate structural shape is usually selected according to the function, seismic performance and economic requirements of the building, and then the cross-sectional size and quantity of each component of the selected structure are determined. Finally, for the calculated load value, select internal force analysis and deformation structure calculation, and then calculate the cross-sectional design of the component and various strength or deformation tests.

Based on various mathematical models, you can use key analysis techniques (such as calculating seismic wall and floor elements) and dynamic solvers to analyze various complex situations that appear in skyscrapers. For example, PMSAP uses common programming techniques to organize the overall structure of the program. In addition to the new high-precision seismic wall elements that can be opened freely, finite element analysis is also carried out on the design of the entire building and thick slab transfer layer, slab column system, inclined slab and conventional floor slab. There are various floor deformation assumptions, such as overall stiffness, block stiffness and perfect elasticity, which provide a vibration mode for vertical earthquakes. Decomposition response spectrum analysis; engineering elastic analysis considers three-dimensional seismic waves.

5. Conclusion

In short, compared with conventional methods, the mathematical model, ideas and mathematical analysis methods proposed in this paper are aimed at high load, hysteresis inelastic properties and other structural analysis of high-rise building components. A method with a simple method and dynamic properties of calculation. It has obvious advantages such as small size and accurate analysis and can be used for the analysis of high-rise building steel supports, beams, columns and other components. It provides new ideas for structural analysis of high-rise buildings and is widely used.

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