Research on Construction Quality Detection Method of High-rise Buildings based on CFD Theory

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Abstract: This paper takes modern high-rise buildings as research objects, and takes the quality inspection of modern high-rise buildings as a research problem. This paper introduces in detail the key points of construction inspection of modern high-rise buildings and the method of inspection of construction quality based on CFD theory (Computational Fluid Dynamics), and puts forward effective ways to improve the quality inspection of high-rise buildings.

Keywords: CFD theory; Computational fluid dynamics; High-rise building construction; Quality inspection

1. Introduction

In today's society, land resources are showing an increasingly tense situation on a global scale, and the emergence of high-rise buildings has undoubtedly played an important role in alleviating the pressure on land resources. The emergence of high-rise buildings has caused great changes in the living conditions of the city. For example, high-rise buildings can expand the vertical space of the building; enrich modern architectural styles, enhance the practical functions of modern buildings, and so on. Due to this unique superiority, high-rise buildings have been well received since their inception and are accompanied by the high-speed process of modern urbanization. The development of high-rise buildings has also been amazingly shifting, making it a super-tall building stage in just a few decades.

However, due to the complexity of the structure of modern high-rise buildings and the relatively low-level construction, the amount of construction work is cumbersome, and the construction involved in the construction process is complicated and diverse. This undoubtedly exacerbates the difficulty of construction and will inevitably lead to some inevitable construction safety quality problems. As we all know, the detection of the construction quality of modern high-rise buildings is focused on the issue of "high-rise building", that is, how the builders ensure the quality of high-rise building construction. How to maintain and control the safety of high-rise construction in a normative manner has become a topic of concern for high-rise buildings by construction enterprise managers in the context of high-speed economic times [1] In recent years, the construction of wind-powered safety construction quality of high-rise buildings based on computer fluid dynamics (CFD) theory has received increasing attention.

2. The Focus of Quality Inspection of High-Rise Building Construction - Wind Load

The most important point in the test and evaluation criteria for the construction quality of modern high-rise buildings lies in the impact of wind on buildings. This effect is very complicated, mainly for three reasons: first, the formation of wind is random; the second is the unique dynamic characteristics of high-rise buildings that make them uncertain under wind loads; finally, the air and building forces interact with each other during air flow. Therefore, when the airflow bypasses the building, because the building is mostly a non-linear cross section, the flowing air creates vortexes or airflow separation around the building, making the wind on the building more complicated. When the rigidity of the building is relatively large, the building can basically maintain a stable stillness in the wind. At this time, the power of the air can be seen as the static effect of the wind load on the building. When the stiffness of the building itself is small, the building will vibrate under the action of the wind. [2].

In the actual construction work of high-rise buildings, the problems of construction quality are as follows: 1. The excavation depth of the foundation is large. Due to the increase in floors, the pressure on the foundation area of the construction company has gradually increased. Therefore, the actual bearing capacity of the foundation should be determined according to the overall construction quality of the building, and the excavation depth of the foundation should be determined, and the foundation should be scientifically treated. 2. The relative drop in high-rise buildings is large. Modern high-rise buildings are generally super-high-rise buildings, and their distance

from the ground level is extremely large. Because of the difference in height, there will be actual height differences and accelerations of landing. If a small piece of steel falls on top of a tall building, this small piece of steel can penetrate the board because of the distance drop and acceleration problems. At this time, the safety of life of high-altitude workers in high-rise buildings will be threatened. Because in order to avoid the occurrence of construction safety accidents, it is necessary to attract the attention of workers engaged in aerial work. Because the construction of high-rise buildings took a long time, for example, the construction time of high-rise buildings is often greater than or equal to two years. Therefore, during this period, the performance of construction equipment will change due to the influence of construction workers and mechanical equipment and climate, and construction accidents will occur when failure occurs. It has even led to inefficiencies in tall buildings, so the management and security control of tall buildings is essential3. Wind load caused by convective winds. Convective winds are formed when air flows relative to the Earth's surface. The main cause of this convective wind is that the Earth's atmosphere is not uniformly affected by solar radiation, while the rise of hot air and the fall of cold air lead to convection of the air. Simply put, because the wind is caused by an uneven distribution of heat and power in the atmosphere, different pressures are generated between two points at the same height. Among them, the near-earth wind is closely related to the building. As the surface of the earth reaches a certain height, affected by the surface of the earth, mountains, trees, etc., the average wind speed value will decrease with height, and will reach zero until a certain height reaches the surface of the earth; At an altitude of 300 to 600 meters, there is no obstacle and the average wind speed remains basically the same. The height at this time is called the gradient wind height. The space at this height is called the atmospheric boundary layer. The wind in the atmospheric boundary layer is blocked by structural objects such as buildings, and the kinetic energy generated by the stroke during the flow is converted into an external force acting on the structure. We believe that the influence of this external force on the structure is the load it bears, that is, the load of the wind [3] .Since the height of most engineering examples is within this range, the investigation of wind loads is only for the atmospheric boundary layer. The wind in the atmospheric boundary layer is affected by spatial location and time processes, making it irregular and transient.

3. High-Rise Building Quality Inspection Method based on Computational Fluid Dynamics (CFD) Theory

Since the 1950s, due to the development of advanced computer technology, computer science has been widely used in various fields. It has also promoted the cross-integration of disciplines and technologies, and has spawned a new discipline - computational fluid dynamics (or CFD for short). This kind of computational fluid dynamics (CFD) theory is the calculation of the numerical model of the research object by computer technology. The analysis method is called CFD numerical simulation technology. Based on fluid mechanics, mathematics, and computer science, CFD numerical simulation technology perfectly combines the advantages of three different disciplines, making computational fluid dynamics an unparalleled prospect. Modern CFD numerical simulation technology relies on the high-speed digital computing capability of electronic computers. It establishes a numerical calculation model through massive discrete data analysis methods, and combines different hydrodynamic problem scenarios to perform numerical simulation analysis. And get data that accurately reflects the mechanical properties of the fluid [4].

In the past two decades, with the rapid development of computer science, the performance of electronic computers has been continuously improved, which also provides a basic guarantee for the development of power. With the deepening of modern research, the computational process has been greatly enriched, which is also the theoretical basis of fluid dynamics (CFD). The continuous maturity of CFD numerical simulation technology has caused the construction field scholars to apply CFD numerical simulation technology to wind load research experiments, improve research efficiency and save research cost. Moreover, CFD numerical simulation technology can reproduce the characteristics of the stroke field in a specific environment, and can accurately simulate various types of wind fields in practical problems. Therefore, the simulation technology of CFD values has been widely used in wind load research. The core process of finite element analysis software participating in CFD numerical simulation technology is as follows: 1. Discretize the model to be analyzed into a set of governing equations; 2. Establish three conservative equations for each discrete element; 3. Discrete partial differential equations to describe the state of the fluid as an algebraic equation; 4. Get the flow by solving the algebraic equation The solution of the field physical quantity.

This method of quality inspection of high-rise building construction is the wind-power quality safety inspection of the ‘eight-fork fork method’. This approach selects a larger cube network to cover the entire computational domain, then subdivides the computational domain based on the previously set grid size, and divides a cube into eight subcubes. Finally, all cubes are divided into tetrahedrons, completing the division of the entire computational domain.

4. Effective Measures for Construction Quality and Safety Control of High-Rise Buildings Based on CFD Theory

With the rapid development of computer technology in the past two decades, the practical engineering proposed by computer modules has received extensive attention from researchers. This method is based on the theory of fluid mechanics and the powerful computational functions of computers. More and more detectors use numerical calculations to simulate the interaction between buildings and winds. In the simulation process, due to the complexity of the interaction between wind and building structure, wind tunnel tests are often required to verify [5]. However, the quality of construction of high-rise buildings is not only based on pure quality testing, but also on management ideas. This paper believes that the effective measures for construction quality and safety control of high-rise buildings based on CFD theory should have the following points:

First of all, it is necessary to establish a new and clear management idea for the construction quality inspection, including the quality inspection management before the project, the quality inspection management during construction and the quality inspection management after construction. High-rise construction projects have similarities with general engineering, and usually include enterprise engineering, distributed construction engineering, and sub-engineering. However, the design of the project is not a simple task, but a complex process. Therefore, starting from the quality of the process, it is necessary to improve the quality management process of the entire project based on the quality of the subproject and through the quality of the specific project. In addition, the quality management of the project should include the management of raw materials, the quality of the materials tested and the implementation of specific construction projects. Project management standards, general standards as a reference for quality management, applicable to the construction phase, can also be used to scientifically guide construction projects. This requires an understanding of the documents and documents issued by the state, the government, and the government, as well as other relevant units and engineering contract documents. Another criterion is the provision of professional skills, which involve various limitations and standards, and are subject to different professional skills and quality management factors. The content and mode of quality management. The construction work of high-rise buildings requires quality management of multiple construction processes, including supervision and review of various departments, management of construction objects and construction progress to ensure efficient operation of high-rise buildings [6]. First, pre-construction management. Pre-construction project preparation is pre-construction management. The construction object of the project should be required to carry out a detailed construction preparation plan in advance, determine the quality management objectives and quality standard parameters, and then formulate the specific construction process in combination with the planned construction steps. Including environmental testing, construction planning, construction machinery or construction personnel management. Second, management during construction. According to legal requirements, the construction operators' construction operations are restricted and the construction quality is controlled. On the one hand, it involves the quality management of construction activities, and on the other hand, it involves the supervision and management of the construction party. The construction manager should strengthen self-control and management awareness and promote the construction to achieve the desired results. Finally, post-construction management. Building quality management requires evaluation of building quality, review of quality reports submitted by buildings, and screening of building documentation. Fundamentally manage construction quality and improve construction quality.

Secondly, using computer fluid dynamics (CFD) theory, the wind force of high-rise buildings is simulated by computer experiments. The computing power of modern computers is very powerful. It can not only establish a basic numerical wind tunnel model by combining fluid mechanics and computer numerical calculation, but also simulate the wind load wind load effect of super high-rise buildings through extreme and numerical calculations. The obtained data obtained the calculation of the construction quality of high-rise buildings [7]. The simulation data works efficiently, the numerical results are accurate, the cost of the simulation experiment is low, and corrections can be made. For example, if the wind direction is relatively simple or the proportion of a certain wind direction is relatively large, the approach of the super high-rise building can choose a more complicated approach, however, the volume of the upper part of the building and the height of each frame tube should not be too large; If the local wind direction distribution is more complicated, at this time, the entrance mode of the super high-rise building should adopt a more symmetrical and regular way. Also pay attention to properly reduce the upper volume of the building, the height difference between adjacent frame tubes should not be too large. At the same time, the numerical simulation results are compared, and the characteristics of surface wind pressure distribution, flow field distribution, base shear force and bending moment under wind load are analyzed.

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