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Intelligent Analysis of Energy-Saving and Environment-Friendly Concrete Materials Based on Finite Element Simulation and Supercomputer

Xiaoyun Zeng*
College of Water Conservcyan and Architectural Engineering
Shihezi University, Shihezi 832000, China

Yushan Wang
College of Water Conservcyan and Architectural Engineering
Shihezi University, Shihezi 832000, China

Guangzhou Li
College of Water Conservcyan and Architectural Engineering
Shihezi University, Shihezi 832000, China

Abstract:In this paper, based on the finite element simulation method of supercomputer, a three-dimensional intelligent modeling analysis of energy-saving and environmentally friendly concrete materials is carried out. First, the basic principles of the finite element iterative integral equation are introduced. The various characteristics of concrete materials and the interaction between steel and concrete, through calculation, people have a more comprehensive and in-depth grasp of the properties of reinforced concrete structures. In the process of nonlinear finite element analysis of reinforced concrete, physical models, numerical methods and programming techniques are involved. The final formation of the analysis program is an important part of it. By using the balanced grid division strategy of graph partition theory and sparse matrix reordering technology, the performance and scalability of the program are improved to 97.2%

Keywords: Energy-Saving, Supercomputer, Concrete Materials, Finite Element Simulation

1. INTRODUCTION

Energy shortage is a shortcoming that restricts social and economic development, and the rational and effective use of energy is the principle of sustainable development. In the context of China's rapid economic development, primary energy consumption has grown substantially, and building energy consumption accounts for about 30% of the total energy consumption in society, and this proportion is on the rise. Therefore, the construction industry has great potential for energy conservation, which is of great significance for further accelerating the construction of a resource-saving and environment-friendly society and guaranteeing China's energy security. In the environment of building energy-saving materials, as a new wall insulation material, concrete sandwich straw blocks are widely used in cold areas and hot summer and winter areas to meet the needs of energy-saving renovation and have broad market prospects [1-6].

With the improvement of the current construction technology level of construction projects, R&D personnel have developed many new concrete materials, which have been widely used. In the traditional concrete construction process, the construction unit attaches great importance to the strength of the concrete and ignores the durability of the concrete, which leads to frequent cracks in the concrete, which affects the construction quality of the project. In order to ensure the construction quality of the project, the construction unit must rely on the existing construction technology, analyze the characteristics of the new concrete, control the mix ratio, clarify the construction technical standards, and improve the construction quality. Therefore, this article mainly discusses new concrete materials and their applications, and puts forward reasonable suggestions based on the actual situation of current engineering construction. In the current construction process of construction projects, construction materials will affect the safety and applicability of the overall quality of construction projects. In order to meet the basic requirements of actual production, in the current building development process, the construction unit should pay attention to the application of new materials. According to the actual situation, continue to use energy-saving, consumption-reducing and high-quality materials to continuously improve the quality and benefits of the project. Reduce project investment costs. In the construction of the entire construction project, concrete materials occupy a large proportion [7-15].

In order to meet the basic needs of the current rapid development of the construction engineering industry, the construction unit needs to continuously develop new types of concrete for different types of project projects, combining the actual conditions, and continuously reduce actual consumption, save engineering costs, and give full play to the importance of concrete in the entire project construction. It can meet the basic conditions of actual construction, change the traditional construction technology and improve the economic benefits of project construction. When the engineering form is special and the load and material properties are very complicated, people often use model tests to determine its mechanical performance. However, due to the limitations of the site and equipment, only small model tests can be done, and it is difficult to fully reflect the actual structure. If you want to study the influence of a certain parameter on the structural performance, you need to do multiple similar components and repeat the test, which is very labor-intensive. If computer simulation technology is used, experiments can be done on the computer, and it is completely in the original size, without reducing the scale; when studying the influence of certain parameters, only a few input parameters need to be modified, which is very convenient and easy. The computer simulation is essential when the structure reacts quickly or the reaction time is extremely long, and when analyzing the internal microscopic changes of the structure. Because reinforced concrete is a combination of two

different materials, concrete and steel, its performance directly depends on the performance of these two materials [16-21].

Especially in the non-linear stage, the various non-linear properties of concrete and steel bars and the non-linear properties of the connection between the two will be reflected in this combined material to varying degrees. At this time, if the linear elastic method is still used for simulation, it will be difficult to accurately reflect the actual deformation and force characteristics of the structure. Specifically, there are the following problems. Due to the large difference in the tensile strength of steel and concrete, under normal use of the reinforced concrete structure, most of the flexural members have cracked and entered a non-linear state, but the steel has not yielded and is still working in an elastic state [22-24].

2. THE PROPOSED METHODOLOGY

2.1 The Energy-Saving Environmentally Friendly Concrete Material

High-performance concrete has been extensively developed and utilized, referred to as HPC. With the development of science and technology, the composition of high-performance concrete is more complex, and the mix ratio requirements are more precise. With the application of high-performance concrete, it can effectively reduce the size of the concrete structure, reduce its own load, and reduce construction costs and construction energy consumption. First, the characteristics of high-performance concrete.

From the perspective of the workability of fresh concrete, it has the characteristics of fluidity, uniformity and filling. Compared with the previous concrete, the components of high-performance concrete are more complicated, and it is necessary to add a variety of admixtures and superplasticizers to improve the performance of the concrete. In order to prevent slump loss and segregation and stratification, it is necessary to deal with the relationship between retarders, air-entraining agents and stabilizers.

2.2 The Finite Element Simulation

The tensile strength of concrete is much lower than the compressive strength, and cracks will appear under the action of low tensile stress. The cracking of concrete can be said to be one of the most important nonlinear characteristics of reinforced concrete structures. In the finite element analysis of reinforced concrete structures, the commonly used crack models are as follows: distributed crack model; separated crack model; fracture mechanics model. In addition, there are other forms of models. The separation crack model formed along the element boundary has certain advantages.

If the influence of the main crack of the structure is studied, it is reasonable to use a separate crack, because this crack model expresses the discontinuity of the strain and makes the result closer to the actual situation. If the role of aggregate occlusion and hidden pin is very important and the local stress of concrete is to be studied, the separation crack model is often used. But this model also has great limitations. First of all, this model has to constantly re-divide the elements and increase the nodes in the calculation, which is a waste of time. At the same time, it affects the narrow bandwidth of the original overall stiffness matrix, which leads to the reduction of computer efficiency in solving displacement calculations. In the application of the distributed crack model calculation, it can be found that when the load continues to increase on the cracked structure, the crack area develops from the initial crack unit to the surrounding area. After the analysis is completed, most of the elements of the component have cracks. It will inevitably lead to a direct relationship between the number of crack units and the density of unit divisions. When the unit division is small, the number of crack units is correspondingly small. On the contrary, when the finite element division is dense and large, the number of crack units is correspondingly also Just more.

Not only is it inconsistent with the crack form obtained in the test, but also due to the stress release of the cracking unit, the internal stress distribution of the component is also different from the actual structure. In fact, when a crack in a concrete structure develops outward from the initial cracking point, it develops in a band along the crack tip, while the concrete on both sides of the adjacent crack will not immediately produce new cracks due to stress relaxation. For reinforced concrete structures, due to the nonlinear characteristics caused by concrete cracking and nonlinear stress-strain relationship, this is a material nonlinear problem in the classification of the finite element method. In terms of nonlinear solution methods, many researchers have proposed many methods to reduce,"], among which the incremental method and iterative method are commonly used. When the incremental method is used to analyze nonlinear problems, the load is divided into many load increments.

2.3 The Finite Element Analysis of Concrete Based on Supercomputer

The direct method has strong reliability and high accuracy, and can solve matrices with a high condition number close to singularity. The disadvantage is that the degree of parallelism is limited and requires more memory; the iterative method has a high degree of parallelism and can solve very large-scale linear systems, such as There are applications in the field of fluids that can solve more than 1 billion degrees of freedom. The disadvantage is that it is difficult to guarantee convergence and requires high preprocessing. This section focuses on the core acceleration for the time-consuming process in the matrix calculation process, so we further optimize the program on the basis of the optimization method in Chapter 3. The finite element method is widely used in accurate electromagnetic simulation of complex and fine structures. The sparse matrix generated by the differential equation of the discrete electromagnetic field of this method has poor performance, and has problems such as large amount of calculation and slow iteration convergence. In view of the above situation, this paper studies the large-scale parallel calculation of finite element. The so-called FE-IIEE (Finite Element-Iterative Integral Evaluation) method is used as the basic finite element algorithm. This method can reduce the amount of additional calculations and has a higher efficient. Formulas can be divided into two groups: differential form and integral form, each of which actually corresponds to an electrical law. Only three of the equations in the four groups are independent, and the other group can be derived from the other three (in fact, Maxwell’s own original equations are more than 20, because they are all expressed by scalar fields. Later, it was a low-key big cow. Oliver Heaviside wrote it in a common form today, not only concise but also clear in physical concepts). For a hundred years, people in the microwave field have been studying how to solve this equation under different conditions.

3. CONCLUSION

This paper refers to the work of nonlinear finite element analysis of reinforced concrete at home and abroad in recent years, and on the basis of absorbing and using the existing results of other researchers, a complete nonlinear finite

element simulation analysis program of reinforced concrete is compiled. A lot of work has been done from the two aspects of finite element model and algorithm selection and programming realization. The more mature constitutive model, failure criterion and crack model are adopted, and the analysis of reinforced concrete structures has high reliability. It mainly analyzes the randomness of structural cracks caused by factors such as material uncertainties, and establishes the corresponding random model adopts Monte Carlo method to realize the simulation of the random quantity of the structure.

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