
Discussion on the Application of Finite Element in Mechanical Engineering

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Abstract

With the continuous development of computer technology, many new technologies have been constantly innovating and developing. Finite element method (FEM) is a modern computing method developed rapidly with the development of electronic computer. In the field of engineering, finite element analysis (FEA) is increasingly used in simulation to solve real engineering problems. It has obvious advantages in design, science, technology and analysis, which simplification of many complex design and analysis problems. In this paper, the advantages and disadvantages of the finite element are analyzed, the application steps of the finite element method in the construction of the engineering machinery are clarified, and the application of the finite element method in the modern mechanical engineering structure is analyzed.

Keywords

Finite element; Mechanical engineering; Structural analysis; Application.

1. Introduction

As the competition in the machinery manufacturing market is becoming fiercely competitive, the machinery manufacturing enterprises must take the corresponding measures to the cost and quality of the products so as to take the rapid occupation of the market, which makes the enterprises need innovation to develop a fast and new technology. A new design method with low cost.

In the field of engineering, finite element analysis (FEA) is increasingly used in simulation to solve real engineering problems. Over the years, more and more engineers, mathematicians and physicists have proved that this method of solving the partial differential equation (PDE) can solve many physical phenomena[1]. These partial differential equations can be used to describe the flow, electromagnetic field and structural mechanics. The finite element method is used to transform these well-known mathematical equations into approximate digital images.

The finite element method developed by the continuous popularization of computer technology also provides new development ideas for the structure design of engineering machinery. The finite element method has a unique advantage in the structure design of engineering machinery, and its role in product design and research and development is more and more indispensable. Now it has become a worker. Cheng machinery manufacturing enterprises are one of the necessary tools in market competition.

2. The Advantages and Disadvantages of the Finite Element

Finite element method (FEM) is a kind of CAE technology which is developed by computer technology. Finite element has many advantages. It can simulate the complex and diverse geometry, so that the structure of heterogeneous engineering can be implemented and studied. At present, the finite element software has been fully improved in the front and back processing technology, making the problem solving step more and more systematized and standardized, and the finite element can also use the graphics to realize the rapid calculation of the results. It can also calculate the structure

and load relationship of many complex materials, and optimize the design scheme to the greatest extent. The use of finite element method makes the processing steps of mathematics more simplified[2]. Of course, the finite element method also has its shortcomings. Its shortcomings are mainly in terms of computing time, resources and infinite solution domain. And the current finite element software is still using the network adaptive technology, and the research of network adaptive technology remains to be improved. The finite element method needs the user to rely on its own experience to select the network and density.

3. Calculation Steps of Construction Machinery Based on Finite Element Method

The ideas and methods of finite element analysis and calculation can be summarized as follows:

Discretization of objects[3].

An engineering structure is discretized into a computation model composed of various elements. This step is called unit dissection. The unit nodes are connected to each other after discrete units and units; the setting, nature and number of the unit nodes should be based on the nature of the problem, and describe the needs of the deformation form and the calculation progress. So the structure of finite element analysis is not the original object or structure, but the discrete object connected with the new material by a number of elements in certain ways. In this way, the results obtained from the finite element analysis are approximate. If the number of division units is very large and reasonable, the results obtained are consistent with the actual situation.

2) Element characteristics analysis

A. Selective displacement mode

In the finite element method, the displacement method is called the displacement method when the node displacement is chosen as the basic unknown quantity, and the force method is called the force method when the node force is chosen as the basic unknown quantity; and a part of the node force and a part of the node displacement are called the mixed method when the displacement of a part of the node is taken as the basic unknown quantity. The displacement method is easy to realize the computation automation. Therefore, the displacement method has the most extensive application in the finite element method.

When the displacement method is used, after the discretization of objects or structures, some physical quantities such as displacement, strain and stress can be expressed by nodal displacement. At this time, some approximate functions which can approximate the original function can be used to describe the distribution of displacements in the cell. Usually, we use the finite element method to represent displacement as a simple function of coordinate variables. This function is called a displacement mode or a displacement function.

B. The mechanical properties of the analysis unit

According to the properties, shape, size, number, position and meaning of the element, the relation between the node force and the node displacement is found, which is the key step in the element analysis. At this time, we need to use the geometric equation and physical equation in elastic mechanics to establish the equation of force and displacement, thus deriving the element stiffness matrix, which is one of the basic steps of the finite element method.

C. Calculating the equivalent nodal force

When the object is discretized, the force is transferred from one cell to another through the node. However, for practical continuum, force is transferred from the common side of the cell to another unit. Therefore, the surface force, volume force and concentrated force on the boundary of the unit need to be moved to the node equivalent, that is, to replace all the forces acting on the unit with the equivalent nodal force.

3) Unit set

By using the equilibrium conditions and boundary conditions of structural forces, each element is rejoined according to its original structure to form an integral finite element equation.

4) Solving the displacement of unknown node

The displacement is obtained by solving the finite element equation. Here, we can choose the appropriate calculation method according to the specific characteristics of the equations.

4. Thinking on Structural Problems of Construction Machinery Based on Finite Element Method

(1) Statics research

In the structure design of engineering machinery, if the structure load does not change with time, or as the time goes on, the structural change is not obvious enough, the statics of the construction machinery should be studied. The finite element method needs to analyze the deformation and stress change of the structure after the structural force. This is also the most common and basic application of the finite element method in the construction machinery structure[4].

(2) Kinetic study

In the structure of the engineering machinery, the mechanical parts will not only produce static load, but also produce resonance phenomenon, which will inevitably cause the mechanical structure to be damaged, thus losing its original function. Therefore, the finite element method should not only consider the static stiffness requirement, but also take the test measures to the dynamic stiffness, so that the finite element method can be realized smoothly.

(3) Thermal stress study

The application of the finite element method in the structure of the construction machinery is mainly to analyze the work and the disagreement of the installation temperature. The thermal stress study of the finite element method can also be used to study the stress of the internal temperature and the temperature distribution in the working state.

(4) Contact research

The contact research on the structure of the engineering machinery by the finite element method is mainly to study the normal force produced by the contact between different structures and the state of the contact surface. The transfer form of force between mechanical structures is mainly formed through contact. Therefore, the study of mechanical structure is mainly used for contact state research. This kind of contact study should be summed up in the nonlinear research way. Since the past computing power is restricted, the practical content of the contact contact research in the mechanical structure of the finite element is less.

(5) Study of buckling

The method of buckling study on the structure of engineering machinery by finite element method is to study the buckling mode and the shape of the load condition produced by the critical state of the structure in the case of unstable state.

5. Several Trends in the Development of Finite Element Software

Looking at the development of CAE software internationally, we can see some development trends of the finite element software.

(1) Seamless integration with CAD software

One development trend of the present finite element analysis software is to integrate with the general CAD software. That is, after the design of the components and parts is completed with CAD software, the model can be transferred directly to the CAE software for the finite element mesh division and analysis and calculation. If the result of the analysis is not satisfied with the design requirements, the model can be re established. The analysis and calculation are satisfactory until the design level and efficiency are greatly improved[5].

(2) More powerful grid processing capability

The quality and efficiency of grid generation have been greatly improved by the software developers who have increased their investment in grid processing because of the direct impact of the grid quality after the discrete structure on the solution time and the correctness of the results.

(3) The openness of the program to the user

With the improvement of commercialization, the software developers have invested a lot of investment in the functions and usability of the software in order to meet the needs of the users. However, because the user's requirements are different, no matter how hard they are trying to meet the requirements of all users, it is necessary to give the user an open environment. The user expands the software according to its own actual situation, including user custom unit characteristics, user custom material constitutive, user defined flow boundary condition and so on.

6. Conclusion

In this paper, the advantages and disadvantages of the finite element method on the structure of engineering machinery are discussed, and the calculation steps of the finite element method on the structure of the engineering machinery are clarified, and the related research methods on the structure of the engineering machinery are analyzed based on the finite element method. The modification and adjustment of the design plan are carried out by using the finite element method, so that the product can achieve the best performance and quality, and the raw material consumption is the lowest. Therefore, the research and application of CAE technology based on computer analysis, optimization and simulation is the guarantee for product design and development of high quality, high level and low cost. The application of finite element method in the field of engineering machinery structure makes the enterprise greatly shorten the development cycle and make the structure of the engineering machinery more scientific and reasonable in the design of the structure of the engineering machinery.

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