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Research Article

Research on the Application of Finite Element Simulation in the Teaching of Principles of Steel Structure Design

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Abstract

The course "Principles of Steel Structure Design" has complex theories, numerous formulas, and abstract concepts, making it difficult for traditional teaching methods to achieve good teaching results. Applying finite element simulation to the teaching of "Principles of Steel Structure Design" allows students to intuitively observe the stress, deformation, and failure of components, enhancing their learning interest and initiative. Practice has shown that finite element simulation is an effective means to improve the teaching effectiveness of the course "Principles of Steel Structure Design".

Introduction

"Principles of Steel Structure Design" is a core course for civil engineering majors, which mainly includes the calculation of strength, stiffness, and stability of three types of load-bearing components: steel structure connections and axial load-bearing components, bending components, and tension compression bending components. The specific knowledge of the course involves engineering materials, stability theory, structural mechanics, elasticity, and other related content. The concepts are complex, the formulas are numerous, and the deformation is abstract [1-2]. Therefore, high requirements are placed on students, who need to have a good foundation in mechanics and mathematics.

With the increasingly widespread application of steel structures, society has put forward higher requirements for the teaching of steel structure courses in universities. At the same time, steel structure design institutes and steel structure construction units have also put forward higher requirements for the knowledge and abilities of students in the field of steel structures. Years of teaching practice and experience have shown that the effectiveness of traditional teaching methods such as theoretical explanation and formula derivation is very mediocre. Students focus more on the meaning and derivation of formulas themselves, while ignoring the essence of steel structures themselves. It is difficult for students to understand and imagine the physical essence and phenomena of the actual structure described by formulas. Therefore, many teaching teams have proposed combining practical teaching to deepen students' understanding and have achieved good results [3-5]. However, there are the following problems in the practical teaching process:

(1) The construction of experimental conditions requires expensive expenses, including laboratory construction, purchase of

experimental instruments, etc. Experimental teaching requires customized test specimens, so both early investment and later maintenance and use have high requirements for funding.

(2) The class hours are tight, the preparation period for experiments is long, and the operations are relatively complex. At the same time, it also poses certain risks for steel structure experiments.

Based on the above issues, more and more teaching teams are using virtual simulations such as finite element methods to replace practical teaching. Compared with traditional experimental teaching, virtual simulations not only provide a detailed and intuitive display of the model characteristics of stress, strain, deflection, local buckling, and overall instability during the stress process of steel structural components, but also have advantages such as repeatability, parameterization, and short experimental cycles [6-10]. However, at present, there are also some areas that need improvement in teaching based on virtual simulations such as finite element analysis, such as:

(1) The systematic and comprehensive nature of the finite element model library is insufficient, and it cannot fully cover the teaching content and knowledge points of the course.

(2) The integration and correlation between the knowledge points of finite element simulation and course teaching still needs to be further strengthened, so that students can delve into the essence.

(3) Virtual simulation still needs to be conducted in the laboratory, with certain class hours and laboratory conditions.

Therefore, in order to solve the new problems of virtual simulation teaching mentioned above, this article proposes a new teaching method based on finite element virtual simulation, comprehensively establishing a finite element model library based on course knowledge points and establishing a summary and explanation of finite element simulation knowledge points, which is fundamentally related to finite element simulation and course knowledge. At the same time, through WeChat official account, students can use their spare time to study at any time, provide new ideas to improve teaching quality, and use mobile phones to stimulate students' learning initiative.

Virtual Simulation Practice Based on Finite Element Analysis

Establishment of finite element model library based on course knowledge points

The primary issue in establishing a finite element virtual simulation model library is to determine which knowledge points need to be assisted by finite element simulation for learning. Therefore, based on course knowledge and student feedback, relevant knowledge points are organized according to chapters, corresponding finite element models are established, source files, deformation images, animations, and other resources are established for students to use. Taking the overall instability of the beam as an example, as shown in Figure 1.

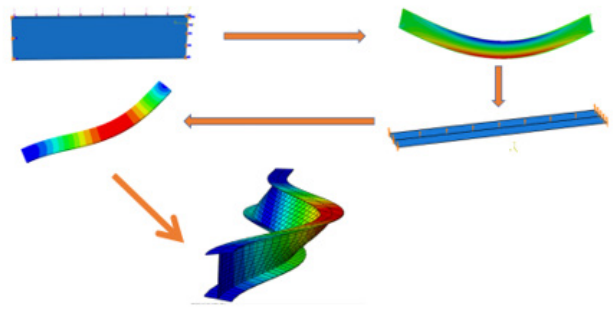

Figure 1: Overall instability of the beam.

Summary of knowledge points based on finite element model simulation

Although the finite element model library can allow students to intuitively observe the deformation and failure forms of steel structures or components, it cannot fundamentally help students understand their internal physical mechanisms. Therefore, based on the finite element model library, a summary of knowledge points is adopted to provide detailed analysis and explanation of the corresponding knowledge points with the teaching materials, making students have a clearer understanding of steel structures.

Finite element simulation application based on WeChat official account

In order to introduce the main functions of smartphones into teaching classrooms, provide new ideas for improving teaching quality, and use smartphones to stimulate students' learning initiative. This research also publishes a summary of knowledge points based on finite element simulation on the network in the form of WeChat official account for students to learn and digest corresponding knowledge points in their free time.

After class testing

In order to consolidate and test students' understanding and mastery, based on the course progress, regular post class tests are conducted on students based on cloud class courses. The tests are conducted in the form of multiple-choice questions, and finally included in the final grade.

Conclusion

This paper learn and the author's teaching experience in integrating finite element simulation into the undergraduate course "Principles of Steel Structure Design", comprehensively combines the knowledge points of the course with the help of finite element simulation analysis method, carries out one-to-one correspondence, makes model library, summarizes and explains the knowledge points, publishes them on the official account for students to learn, and assists in strengthening the post class test. The finite element simulation results can help students understand relevant concepts and theoretical formulas more intuitively and stimulate

their interest in self-directed learning. Practice has shown that students show great interest in finite element simulation, and their enthusiasm for participating in problem thinking and discussion in class has greatly increased. Their academic performance has also greatly improved.

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Conflicts of Interest

There are no conflicts of interest to declare.

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