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"Principles of Steel Structure Design" Design Course Construction Based on BIM Technology: A Case Study in a Normal University in China

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Abstract

Nowadays, the teaching mode of "Principles of Steel Structure Design" is more traditional, and students' understanding of textbooks is insufficient, which affects the teaching quality of teachers. Many colleges and universities use the advantages of BIM technology visualization, coordination, optimization, simulation and drawing to solve the shortcomings in the design of the traditional "Principles of Steel Structure Design". Based on the teaching status of the course, this paper proposes the idea of teaching reform by taking advantage of the advantages of BIM, and provides an idea for how BIM technology can be integrated into the teaching of the course.

Keywords: steel structure, BIM technology, pedagogical reform

1. Introduction

"Principles of Steel Structure Design" (hereinafter referred to as "Steel Structure") is an extremely important course in the undergraduate teaching of civil engineering. Steel structure has the advantages of light weight, high strength, seismic performance and overall stiffness, etc., and is widely used in large-span buildings, super high-rise buildings and industrial buildings, and it is mentioned in the work of the Ministry of Housing and Urban-Rural Development in 2019: to vigorously develop prefabricated buildings such as steel structures. At present, steel structure has gradually become the development direction of buildings, which can realize building assembly and green buildings, and has a lot of room for development (Ruifang Cheng & Yafeng Ning, 2020). In urban construction, the State Council has formulated in 10 years to achieve in the new buildings, steel structures and other prefabricated buildings accounted for 30%, steel structure talents in the social demand further increased.

In the "Steel Structure" course, students mainly learn the application characteristics of steel structure, the understanding of complex nodes of components, design principles and development trends. Mastering and distinguish the complex nodes of steel structural components that is a basic requirement for each student, and it also provides convenience for students in their future work.

The course is closely related to the practice of steel structure engineering, both theory and practicality of direct application to practical engineering, at present, students have little contact with steel structure engineering, and the knowledge in the course is told by the teacher, so that students lack a comprehensive understanding of steel structure engineering, not to mention the node design of complex areas. Therefore, in order to effectively train students to have the core competencies of the post, it is imperative to introduce BIM technology to the "Steel

Structure" course so that students have a deeper understanding of steel structure.

In recent years, BIM technology has gradually become a hot topic in civil engineering majors, and linking BIM technology with the traditional "Steel Structure" course will become a development trend of this major in the future (Bin WU., 2018).

2. Research Background

2.1 Development of BIM Techniques in the "Steel Structures" Course

BIM for people who do not understand it, is a simple modeling software, in fact, not, the full name of BIM is building information model, is widely used in engineering design, construction, management, in the engineering project design, construction, operation of each stage of the life cycle, to achieve the construction of the data, information integration into a three-dimensional model of the information database, so that all parties to the project through BIM technology to work together, the project building information has a deeper understanding, in improving the work efficiency of all parties, Saving resources and shortening the duration of engineering projects is of great importance.

In August 2020, through the Ministry of Housing and Urban-Rural Development, the Ministry of Education and other nine ministries jointly issued the "Several Opinions on Accelerating the Industrialization Of New Buildings", it was clearly proposed to vigorously promote the development of integrated applications of the integrated application of BIM technology in the whole life cycle of building industrialization. Since BIM technology has the characteristics of visualization, coordination, simulation and optimization, the engineering project parties through the BIM technology designed the engineering project three-dimensional model, effectively improve the integration of engineering data and information, so that the development of BIM technology in the field of architecture has been greatly improved.

The "Steel Structure" course will often be involved and applied for civil engineering students in future work practice. According to its educational content and position in the entire discipline, the summary of its support for graduation requirements mainly includes three aspects: engineering knowledge, problem analysis and design/development solutions. The indicator points for the different graduation requirements are shown in Table 1.

Table 1. "Steel Structure" course supports graduation requirements and indicator points

ordinal	Graduation requirements	Indicator points
1	Engineering knowledge	Students can build mathematical simulations and solve specific objects for civil engineering majors。
2	Problem analysis	Students can use the relevant scientific principles of the civil engineering profession to identify and judge the key links of complex engineering problems in the profession.
3	Design/develop solutions	Ability to design the basic components of the civil engineering profession according to specific needs

There are two very serious problems that need to be solved, first, it is difficult for students to understand the complex nodes of steel structures only through textbooks, teachers' dictations and PPT, and if this problem is not solved, it will have a serious impact on students' future work. Second, students do not correspond to the content of the calculation book and drawings when doing course design. The three-dimensional model designed by BIM technology can help students understand the complex nodes of steel structure more comprehensively, and also help improve students' understanding of construction drawings, which is of great help to students' drawing and drawing. In addition, BIM technology can directly export construction drawings and calculation books through its characteristics of drawings, which can reduce the complexity of students' calculations.

At present, BIM technology has not developed long in China, but due to its three-dimensional modeling capabilities, it has gradually been applied to the field of education (Jiexin Yu, Benfei Xie & Yiting Zhu, 2021), so the use of BIM technology "Steel Structure" course to carry out teaching reform, improve the teaching quality of teachers, enhance the ability of students.

2.2 The Current State of Teaching in "Steel Structure"

At present, almost all civil engineering majors in colleges and universities have the course "Steel Structure", but because the teaching of this course is relatively traditional, there are the following problems:

2.2.1 Theoretical Knowledge Is Abundant and Difficult to Understand

At present, the teaching of the "Steel Structure" course focuses too much on the theoretical aspect, and the students' engineering examples are almost all explained by the teacher, while the construction drawings of the steel structure are two-dimensional, and the two-dimensional drawings cannot reflect the structural structure of the project well, and some complex nodes are very difficult for students to understand and master.

2.2.2 Students' Interest Is Low and the Practical Effect Is Low

The course design of "Steel Structure" involves a lot of knowledge, which is more difficult for students, and students now have a calculation part of the course design of "Steel Structure", most of which are copied and calculated through the example problems on the textbook, without considering the local details of the components. And because the calculation and drawing of steel structures are more troublesome, when choosing a graduation design, students have little interest in steel structures, resulting in a great reduction in the practical effect of the course.

2.2.3 Practical Knowledge Is Small, and the Understanding Is Not Comprehensive

Students have little contact with steel structure engineering, lack of engineering practice, and lack of comprehensive understanding of steel structure engineering, resulting in students' understanding of steel structure node connection only limited to theoretical aspects, no intuitive impression, and unable to grasp the essence of steel structure.

2.2.4 The Teaching Model Lags Behind the Actual Development

At present, the teaching mode lags behind the development of steel structure, many newly developed processes, and the structural form has not been updated in the teaching materials, which has a great impact on the teaching quality of teachers.

2.2.5 There Are Many Teaching Contents and Relatively Few Class Hours

Currently, the Steel Structure course usually has 48 or 64 teaching hours. According to the teaching and research group, classroom teachers generally reflect that the number of existing hours is too small, so that the pace of classes is too fast. In the course of the lesson, the main lessons are used for the teaching of new lessons, and the exercises are less time. In the course of class, the teaching of new knowledge points is carried out on the basis of the poor mastery of students' previous knowledge points, which reduces the learning effect of students.

Traditional 2D construction drawings have many defects, for example, poor sharing, drawing and inspection of drawings take a lot of time, and all parties are prone to omissions. BIM technology can effectively solve the above problems and is more in line with today's engineering model. However, steel structure in high-rise buildings, has other components cannot replace the advantage, therefore, steel structure in the construction process has higher requirements, the steel structure of the node design needs to be continuously improved and updated, the quality of the steel structure also needs to be guaranteed, in order to build a building with ultra-high quality, the development of construction projects play a role in promoting.

3. Implementation of the Reform of "Steel Structure" Based on BIM Technology

3.1 The Objectives of the Teaching Reform

For colleges and universities, it is not only necessary to cultivate students' theoretical knowledge, but also to improve students' engineering practice ability. The purpose of the teaching reform is to form a curriculum system based on the combination of BIM technology and the "Steel Structure" course, and to improve the teaching effect and students' interest in the "Steel Structure" course. For the node connection of the steel structure, there are mainly steel beams and horizontal supports and tie rod connection nodes, steel beams and purlins and corner support connection nodes, purlins and pull bar connection nodes, students compare the two-dimensional drawings with the three-dimensional BIM model drawings (Huali Liu & Tieshan Xu, 2017), but the two-dimensional drawings are more complex and have certain difficulties; For the node connection of steel structural components, the three-dimensional model is better understood than the two-dimensional drawing, and the cross-sectional shape of the component node can be directly seen, which promotes students' proficiency in BIM technology and cultivates architectural talents for the society.

3.2 Specific Implementation Methods of Teaching Reform

3.2.1 Online Teaching of Steel Structure Platform

Rational use of teaching resources, the establishment of teaching resources library. In the course of "Steel Structure", the use of BIM technology, the design of a three-dimensional BIM model of the steel structure platform, and applied to each chapter, for each chapter of the continuous integration of the role of promotion. In addition, different from the traditional PPT narration, teachers can use the visual characteristics of BIM technology to record in advance how to use BIM technology to establish a video of steel structure model, such as installation, welding, bolts, nodes and other technological processes, combined with online and offline mixed

teaching, which cannot only enable students to have a deeper understanding of three-dimensional models, but also improve the quality of teachers' teaching.

3.2.2 BIM Model 3D View Teaching

Improve students' ability to read pictures. Due to the lack of students' understanding of two-dimensional drawings, which directly reflects the lack of students' ability to read drawings, combined with BIM technology modeling, the formation of the entire structural building model, students can be transformed into two-dimensional forms through the built three-dimensional BIM model, thereby improving their ability to read the steel structure drawings, but also deepening the students' understanding of the steel structure drawings.

3.2.3 Teaching of Simulated Practical Engineering

Enhance students' practical ability. Nowadays, most students lack engineering practice, even if the teacher leads the team to visit the construction site for internship, there are many restrictions, and the steel structure engineering cannot intuitively understand the key parts of the steel structure, these defects seriously affect the internship effect. The construction simulation carried out by students through BIM technology in the classroom has played an effect of allowing students to go to the construction site for internship, and has the effect of immersing students in the scene.

3.2.4 Carry out Innovative Activities to Teach in Competitions

An innovative competition combining steel structure and BIM was launched. The competition of steel structure model can be carried out in the school, and students can use BIM technology to simulate, which cannot only save teaching resources, but also promote students' interest in steel structure, and play a role in promoting the teaching of "Steel Structure" course based on BIM in the future.

Through the reform of the above teaching forms, the maximum utilization of teaching resources is realized, and the various chapters of the "Steel Structure" course are connected by BIM technology to make it more close, so that the transition between theoretical teaching and practical teaching is more natural.

4. Conclusion

With the gradual maturity of the development of BIM technology, many colleges and universities have combined BIM technology with the "Steel Structure" course for teaching, combined with three-dimensional models, can help students better understand the two-dimensional drawings, enhance students' interest in the course, and also have a great improvement in students' practical ability, laying a good foundation for future career development, and then improving the quality of BIM technical talent training in the field of construction engineering.

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