The Reform of Future Education and Software Application of Building Structure Test Course Under the Background of New Engineering

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Abstract. Structural experiment course is a extremely significant course in civil engineering, and under the influence of new engineering background, structural experiment course has higher requirements for perfection, comprehensiveness, innovation and universality. Through the understanding of domestic and foreign issues, this paper describes the process of measuring the sensitivity coefficient of resistance strain gauges and measuring the compressive strength of concrete by rebound method, through the application of ABAQUS software analysis of the building test course in the future development, summarizes the application of ABAQUS in the modeling process of building structure test course, and proposes and constructs a set of reasonable reform and adjustment methods suitable for cultivating applied talents, and made a more systematic demonstration in terms of innovation.

Keywords: future education · structural test experiment · ABAQUS modeling analysis · teaching reform · practice innovation

1 Introduction

Under the background of new engineering, in order to cultivate innovative and outstanding engineers and meet the needs of national economic development, the role of structural experiment courses is crucial. Structural test course is a course with strong engineering practice in undergraduate professional teaching, and structural test course can promote the development of new structural systems and new theories, and can also identify structural damage and deal with engineering accidents. The mechanical performance and safe load provide professional judgment.

Under the influence of the new engineering background, this paper takes the School of Civil Engineering, Changchun Institute of Technology as an example. Through the investigation of today's graduates, the graduates cannot quickly adapt to the working environment of civil engineering after graduation, and they cannot apply the knowledge they have learned to practice. Therefore, it is necessary to discuss and reform the practical teaching link of the structural experiment course. The key problems that need

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to be solved are: optimizing the experimental courses of civil engineering structures to meet the requirements of the "Guiding Professional Specifications for Civil Engineering Undergraduates in Colleges and Universities" for the testing technology experiments of civil engineering; enabling students to master the program design capabilities and basic testing required for engineering. Ability, equipment application skills, data analysis ability, and have the basic qualities of a future job site construction safety analysis engineer [1]. The innovation of the reform lies in: integrating teaching and teaching resources, designing comprehensive experimental projects, and cultivating students' ability to solve complex engineering problems within effective teaching hours; using advanced detection technology for undergraduate practice teaching, leading students to participate in practical engineering projects Test, conduct practical drills for students' future engineering site safety analysis, and cultivate students' practical ability and innovation ability [2, 10].

2 Research Status of Domestic and Foreign Subjects

The index put forward by the World Economic Forum shows that nearly 81% of graduates in the United States are able to take up relevant jobs after graduation, while in China, the proportion of graduates who can take up relevant jobs has become quite few, only about 10% of graduates. This phenomenon shows that the outstanding problem of poor practical ability of higher education graduates in our country. In order to improve the teaching quality of higher education, the Ministry of Education, together with relevant departments and industry associations, jointly implemented the "Excellent Engineer Education and Training Program". The Ministry of Housing and Urban-Rural Development will select some colleges and universities that have passed the civil engineering professional education evaluation to participate in the pilot program of the "Excellence Program" and provide support.

3 Part of the Experimental Content of the Building Structure Course Under the Background of New Engineering

Realize the open teaching of all experimental projects, integrate the existing teaching equipment resources in the laboratory, and make full use of the existing equipment in the laboratory; combine the sharing of large-scale instruments and equipment, train young laboratory teachers and teachers, give play to the enthusiasm of young teachers to participate, and increase the openness of the laboratory, including time, laboratory resources. Combined with the cutting-edge development technology of civil engineering, integrate the experimental content, improve the experimental methods and means, design the experimental content that reflects the comprehensive and innovative characteristics, and improve a set of advanced, reasonable, complete and operable structural experimental course syllabus and teaching. Experiment scheme; design a scientific and reasonable advanced experimental detection technology scheme in combination with advanced technology in practical engineering; the integration and optimization experimental course specifically includes the following contents:

3.1 Determination of Sensitivity Coefficient of Resistance Strain Gauge

1). Fundamental

The sensitivity coefficient K value is a comprehensive performance index of the resistance strain gauge. Its size has a great relationship with the metal material, geometric shape and material stress state. The size of the error will directly affect the measurement result of the strain. But for the strain measurement with higher requirements, the determination of the strain coefficient K value is more important.

The K value is measured by the relative change ΔR of the strain resistance and the component strain ε, and the relationship between the two is combined with the corresponding formula to measure. It is generally necessary to use equal-strength beams for measurement.

There are two ways to determine A, one of which is to measure it with a resistance strain gauge, and the other is to measure it with a resistor whose resistance value can be changed in parallel. The former is the resistance change obtained after applying the load P by using the strain gauge that has been connected to the compensation sheet and the working sheet. The latter needs to apply the load P after leveling, read the corresponding strain value, then remove the load, connect a varistor that can change the resistance value in parallel, and keep the control consistent with the strain displayed before the load is applied, and then obtain the corresponding ΔR value. Through the determination of the ΔR value and the ε value, the corresponding K value is obtained according to its positive and negative proportional relationship.

2). Test Content

What this test needs is a static resistance strain gauge with the specification model DH3816, a beam sample of equal strength, four measurement wires, and a piece of insulating glue.

Determine the values of each parameter in the test. The parameter values in this test are the elastic modulus $E = 206000$ MPa, the Poisson's ratio $\mu = 0.26$, and the strain gauge sensitivity coefficient $k_l = 2.0$. The size of the strain ε is shown in the formula (1) through the calculation formula of the theoretical strain value:

$$\varepsilon = \frac{6Pl}{Ebh^2} \tag{1}$$

Among them, take $b = 31.5$ mm; take $h = 5$ mm; take the power arm length $l = 300$ mm.

Measure and read the load strain value of each level, and measure the sensitivity coefficient through the obtained ε value. The determination formula is shown in formula (2):

$$k = \frac{\varepsilon_l}{\varepsilon} k_l \tag{2}$$

The average value of the obtained sensitivity coefficient is shown in Table 1.

It can be seen that with the continuous increase of the test force, the measured value of strain and the theoretical value of strain gradually become larger, but the difference between the two is becoming more and more obvious. However, the sensitivity factor value remained around 2.1.

Table 1. Calculation table of the average value of sensitivity coefficient

Level	P(N)	$\varepsilon_l\left(10^{-6}\right)$ (Measured value)	$\varepsilon\left(10^{-6}\right)$ (Theoretical value)	k (sensitivity coefficient)
0	0	0	0	
1	5	56	55	2.04
2	10	118	110	2.15
3	15	176	166	2.12
4	20	234	222	2.11
5	25	297	277	2.14
Average value	2.11			

3.2 Determination of Compressive Strength of Concrete by Rebound Method

1). Fundamental

The most widely used technique for inspecting concrete on the spot is the rebound method. It involves using a hefty hammer to strike the concrete surface. After rebounding, the associated bounce distance is calculated, and the strength of the concrete is determined by dividing the distance by the spring's original length [3].

2). Test Content

This test uses a concrete rebound tester with the specification model zc3-A and a concrete carbonation depth measuring instrument with the specification model TH-1. The components are "T-shaped" concrete components, the designed concrete strength grade is C25, and the measured rebound angle is 90°.

The average carbonization depth was measured by taking three places on the member to obtain the carbonization depth, and finally calculating the average value of the carbonization depth. The average value of the carbonization depth of this test member is $d_m = 3.8$.

Record the data displayed for each rebound, measure a total of 16 rebound values, remove the 3 largest and 3 smallest rebound values, and obtain the corrected rebound value after correcting the angle and the rebound pouring surface, and then The converted value of concrete strength in the test area is obtained through the corrected rebound value and the average carbonation depth. As shown in Table 2.

4 Analysis of the Development of Informatization of Structural Test Courses

The development of informatization is the trend of realizing the modernization of education and teaching, and it is also an important component of future education. Nowadays, the way of structural course informatization development is mainly reflected in computer

Table 2. Concrete strength conversion values in the testing area (unit: MPa)

Testing area	Rebound value R_m	Average carbonation depth d_m	The conversion value of concrete strength in the testing area $f_{cu,i}^{c}$
1	24.5	3.8	12.1
2	35.1	3.8	24.0
3	35.2	3.8	24.1
4	36	3.8	24.1
5	36.5	3.8	25.7
Estimated value of component strength	12.1		

applications, and the application of ABAQUS software is an important part of promoting the experimental analysis of building structures and the development of education informatization.

4.1 Advantages of ABAQUS Software

Among the many design software, ABAQUS not only brings great convenience in modeling, but also absorbs the advantages of major design mainstream software such as CAD, and further combines with the solver.

ABAQUS can adopt CAD modeling and visual window system, with good human-computer interaction; ABAQUS has powerful model management and load management methods, which can facilitate the modeling and simulation of multi-task, multi-condition practical engineering problems.

In view of the prevalence of contact problems in actual engineering, ABAQUS has set up a separate connection module, which can accurately simulate a variety of contact problems in actual engineering; And the parametric simulation method is adopted, which provides tools for parameter design and optimization and structural modification in actual engineering.

4.2 Analysis of the Application Development Trend of ABAQUS Software

With the development of ABAQUS software, its proportion of major design software in the market is also increasing, and the global scale occupied by ABAQUS is shown in Fig. 1.

It can be seen that the development of global ABAQUS showed a gradual upward trend before 2018, but the increase was not large. From 2016 to 2017, the increase was 140 million US dollars, from 2017 to 2018 increased by 1.13 billion US dollars, from 2018 to 2021, the scale of market investment jumped from 8.13 billion US dollars to 12.97 billion US dollars, it can be seen that in the past three years, the market application of ABAQUS has shown a rapid upward trend, which also reflects that ABAQUS software is indeed becoming more and more popular.

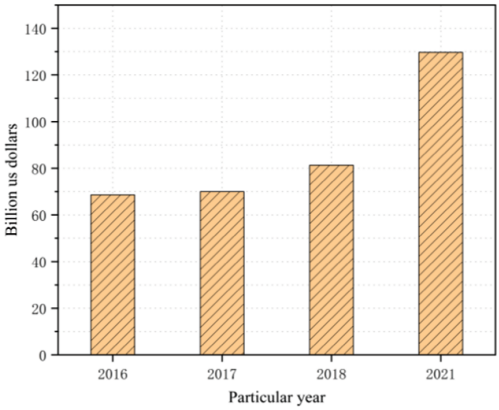

Fig. 1. Global ABAQUS market application size

Combined with the development of ABAQUS software now, its application in the future is immeasurable. The structural test course requires a lot of modeling and theoretical analysis, so with the development of ABAQUS software in the future, the informatization and softwareization of the structural test course will also be more comprehensively developed and improved.

4.3 Application of ABAQUS Modeling in the Building Structure Test Course

As a very popular structural design software, ABAQUS can also reflect the force and deformation of the structure into the final structural analysis, so if it is difficult to carry out the corresponding structural test of a large component in reality, the corresponding structural simulation analysis can be carried out after ABAQUS modeling.

5 Reform and Adjustment of the Content of the Architectural Structure Experiment Course Under the Background of New Engineering

5.1 Constructing the Hierarchical System of Structural Experiment Teaching

Innovation will increase the adaptability of structural testing to the advancement of the times from theory to practice to innovation. In order to improve the positioning requirements for professional talent training, it is necessary to start with theory, combine theory with practice, complete the transformation from “senior specialized talents” to “application-oriented senior engineering and technical talents” and then to “innovative senior engineering and technical talents”, improving the positioning requirements of professional personnel training [5].

5.2 Teaching Seminar

A civil engineering experimental course research group was established in the early stages of the subject's study to research practical engineering applications, the situation of the skills needed by employers, professional teachers, and enterprise experts, as well as the actual outcomes of the "excellent planning class" students taking civil experimental courses. To determine the experimental course's teaching reform content, there will be analysis and discussion. In the middle of the project research, the teaching plan, the teaching syllabus, the experimental course study guide, the experimental report, and other teaching materials are prepared in accordance with the teaching reform content of the experimental course and the characteristics of each experiment. To create phased research outcomes, a timely midterm work promotion meeting will be arranged. The experimental courses are integrated and optimized for trial implementation at a later point in the project research, and any issues that might develop throughout the course are considered and assessed. The research group members summarize and report the work and write the research report [4].

5.3 Implement Measures

Taking appropriate implementation measures is essential for raising the educational level of the building structure test course, but they must also be adjusted in light of various circumstances, which can be broadly categorized into the following three categories [6].

1). Research
Investigate the curriculum and delivery strategy for civil experiment courses at comparable colleges and universities, and create programs and offerings that are appropriate for the present state of our school's teaching resources and plans.

2). Case Teaching Method
In the establishment of experimental courses, actively combine the needs of enterprises to introduce practical engineering problems into the classroom, or bring students to the engineering site for specific case teaching and experiments [7, 9, 10].

3). Quantitative Analysis
Quantitative analysis is used to carry out the test, and to formulate a clear number of test beds and test data analysis; the conclusion of the project research is also planned to be quantitatively analyzed to provide quantitative data support for the analysis of the degree of achievement of civil engineering courses and the analysis of achievement of graduation requirements.

5.4 Innovative Structure Trials

Because the instruments, materials, and equipment needed for civil engineering tests are frequently updated, the first step in creating an innovative structure test base is to be new and to seek "creation" in "new". Along the way, repairing and modifying older

instruments and actively introducing and using new instruments and equipment are the fundamental guarantees for the material teaching of civil engineering structural tests [8].

In the innovative structure test, according to the specific test steps, the test plan is designed by oneself, which requires the students to complete the test independently under the supervision and reminder of the teacher. In addition, the teacher should leave the corresponding thinking space for the students to complete each step of the experiment process.

6 Conclusion

Under the background of new engineering, the reform of structural experiments has become more important than ever. In the effective teaching time, integrating all teaching resources and designing comprehensive experimental projects will all will become the top priority of the Innovative Structure Experiment Course. In the future development of structural experiment courses, "application-oriented" professionals will become quite vital. It will be an indispensable part to focus on the necessary training of students' practical ability, and students' ability to better integrate theory with practice will play a better role in promoting the development of the curriculum. Relying on the building structure and selection, the two courses are integrated at different levels and stages, and advanced experimental technology is used to carry out undergraduate experimental teaching. Lead students to participate in the project testing of actual projects, conduct practical drills for students' future engineering site safety analysis, cultivate students' hands-on ability and innovation ability, and actively summarize and improve students' mistakes in actual projects and experiments, to strengthen the students' practical ability, and the structural experiment course will also achieve better results under the influence of the new engineering background.

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