Output-Oriented Reform of Experimental Teaching Methods for Bridge Inspection and Strengthening

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Fund project: Experimental Teaching Reform Project of Liaoning University of Science and Technology (SYJG202239); Model Course Construction Project of Postgraduate Course Civics of Liaoning University of Science and Technology (2021YJSCX17); Undergraduate Teaching Reform Research Project of Liaoning University of Science and Technology at School Level in 2022 (XJGSJ202213); Undergraduate Teaching Reform Research Project of General Higher Education in Liaoning Province in 2022.

Abstract: In order to train students with the ability to solve complex engineering problems, the current situation and problems of experimental teaching of bridge inspection and strengthening are analyzed in depth, and the teaching reform is carried out in terms of experimental teaching objectives, teaching contents, assessment and evaluation with students as the center, taking "appearance inspection-strength testing-static load test-dynamic load test" as the main line to let students go through the whole process. The main line is to let students go through the whole process of bridge testing, and provide reference for other experimental teaching.

Keywords: Bridge Inspection and Strengthening; Experimental Teaching; Output-Oriented

The research and reform of teaching with the concept of output orientation is one of the trends in the development of higher education in China, and the research and reform at the macro level, such as the development of training programs, are in full swing and have achieved promising results [1-5]. However, the research and exploration results of the OBE concept in the micro level of experimental courses are not much, and there are still many urgent problems to be solved in practice.

In order to cultivate students with the ability to solve complex engineering problems, the experimental teaching of the course "Bridge Inspection and Strengthening" is carried out based on the output-oriented research of the experimental teaching reform of the course, and the output-oriented experimental teaching mode is explored to achieve the desired teaching effect.

1. Analysis of the current situation of teaching

The course of "Bridge Inspection and Strengthening" is theoretical and practical, with a wide range of knowledge. The course has 8 hours of experimental classes, the experimental projects are ultrasonic rebound integrated method of concrete strength testing (2 hours), rebar position determination and crack width observation experiment (2 hours), strain gage adhesion and strain measurement technology (2 hours), carbon fiber reinforced reinforced concrete beam bending experiment (2 hours), the learning effect of the experimental course is directly related to the realization of personnel training objectives. After the experimental teaching summary found that the course in the unit experimental teaching deficiencies are as follows.

1.1 experimental teaching objectives and content design is not reasonable. The experimental content involves bridge inspection and measurement technology, nondestructive testing technology, bridge inspection technology, static load test of reinforced and unreinforced reinforced concrete beams, although the experimental content is comprehensive, but each experiment is individually designed and executed, and there is a lack of continuity and correlation between each experiment, and students still cannot master the procedures and steps of bridge inspection as a whole after doing the experiments. In addition, the experimental content, the lack of bridge dynamic load experiments, strain gauge measurement technology is only around the equal strength beam to carry out, many students are not finished after the experiment, experimental teaching objectives, experimental content and experimental open to continue to improve.

1.2 The experimental teaching mode and experimental conditions lack relevance and directivity. Experimental teaching mode, ignoring the students' motivation and personalized development, the guidance method is not targeted. Bridge inspection and strengthening knowledge is more abstract, many students before the experiment, the experiment, can not better understand the experimental teaching content, resulting in "no" experiment, "listening" experiment, "see "experimental phenomenon is more prominent, teaching and learning two skins, it is difficult to achieve the "unity of knowledge and action. In addition, the experimental report format used now deviates from the actual engineering project test report form, and students are not interested in writing experimental reports. In the experimental teaching mode, the integration of political education elements is not in place, and the students' awareness of responsibility and innovative thinking in bridge inspection is not enhanced simultaneously.

1.3 The evaluation of experimental teaching lacks relevance and continuous improvement. Bridge inspection and strengthening technology in the experiments, are carried out in groups of 4 to 5 people, but in the assessment, still based on individual experimental reports. This evaluation method is single, individual rather than group, results rather than process, continuous improvement mechanism is not sound, lack of hands-on ability, innovation consciousness, teamwork ability of targeted assessment, teachers can not find common and individual problems in a timely manner, resulting in teacher guidance and teaching methods adjustment is not timely, continuous improvement of teaching quality becomes empty talk.

Overall, how to truly reflect the "student-centered" course experimental teaching, how to do a good job in the training of personnel under the general objective, the development of strong support for the course experimental teaching objectives and the design of teaching content, teaching implementation, teaching evaluation according to the course experimental teaching objectives, many issues need to be considered.

2. Teaching reform construction and implementation

2.1 Positioning of teaching objectives

Adhering to the guiding ideology of values guiding in knowledge transfer and ability cultivation and output-oriented, the specific objectives are as follows.

Objective 1: Combine independent experimental projects and develop them into a comprehensive and design-oriented experiment. The main line is "appearance

inspection - strength test - static load test - dynamic load test", combined with the hybrid teaching mode, so that students can really integrate into the work of bridge inspection, thus achieving the purpose of improving students' practical ability.

Objective 2: In the process of experimental implementation, the elements of Civic Science are effectively integrated, so as to enhance the students' sense of responsibility and commitment and cultivate their innovative thinking.

Objective 3: To improve the assessment mechanism and continuously improve the quality of experimental teaching of bridge inspection and strengthening course.

2.2 Specific implementation methods

2.2.1 Inspection objects

The testing revolves around 2 reinforced concrete beams with damage. The beam size is 140cm×10cm×15cm, and 1 of them is reinforced with carbon fiber cloth. The main technical specifications of the reinforced concrete beams are: beam length 1.4m, calculated span 1.2m, beam height 0.15m, concrete grade C30, longitudinal reinforcement and erection reinforcement 10mm in diameter, Class II reinforcement. The hoop reinforcement is 8mm in diameter, Class II, with a spacing of 100~150mm. Carbon fiber cloth thickness 0.111mm, length 100cm, width 10cm, 1 layer is pasted at the bottom of the beam. Near the support, there is U-shaped hoop anchorage, 12.5cm high and 15cm wide.

2.2.2 Inspection content

The beam testing is carried out around the testing object, and the specific testing contents are shown in Table 1.

2.2.3 Inspection process

The testing is carried out in accordance with the testing items in Table 1. Before the start of the inspection, the SuperStar system was used to organize online pre-study for students, mainly in the form of videos and courseware to pre-study the basic knowledge of bridge inspection, inspection steps and inspection report writing requirements. Then, the offline girder inspection was conducted, with students as the main focus and teachers as the support. In order to ensure that the inspection is in line with the actual engineering process and that the workload is equal for each inspection, four inspections are designed, the first for appearance inspection and reinforcement testing (2 hours), the second for concrete strength testing and strain gauge attachment (2 hours), the third for static load strain measurement (2 hours), and the fourth for static load experimental analysis and dynamic load experiment (2 hours), for a total of 8 hours, which is consistent with the original teaching hours. The total number of 8 hours is the same as the original teaching hours. The test report is interspersed with the experimental writing, and the test report is submitted after the test is completed. The testing process is shown in Figure 1.

Table 1 Bridge inspection projects and specific testing content

Test items	Specific testing work	Experiment purpose
Visual inspection (1 class hour)	Observe whether the beam body and its surface are smooth, whether there are honeycomb, pitted surface, dog hole and other defects, and whether the cross section size meets the design requirements. The existing cracks of the two beams are recorded and described in detail.	Master the method of bridge appearance inspection.

Reinforcement inspection (1 class hour)	Detect the diameter, position and thickness of protective layer of longitudinal load-bearing reinforcement and erection reinforcement. Detect the diameter, position and spacing of stirrups. Record, describe and compare the reinforcement inspection.	Master the detection method of bridge internal reinforcement.
Concrete strength test (1 class hour)	The actual concrete strength of the beam body shall be tested. Three measuring areas shall be selected for each side of each beam body, with a total of 12 measuring areas. 16 rebound points shall be determined for each measuring area to rebound separately. The concrete strength shall be recorded and evaluated in detail, and compared with the technical indicators.	Master the actual strength testing method of bridge concrete.
Static load test (1 class hour for strain gauge pasting, 2 class hours for strain measurement, 1.5 class hours for bending experiment analysis)	The heavy objects are used for concentrated loading, and the loading is divided into three levels. Under each level of load, measure the deflection at the mid span of each beam and the settlement of two supporting points. The machine measurement method and electric measurement method are used to measure the strain at the mid span of each beam, and the corresponding strain data are recorded and compared in detail. The strain test curve of concrete of two beams under the third level load is drawn by selecting the data of electrical measurement method. Observe whether the beam body produces new cracks and changes of cracks under the load. Based on the static load test data, the beam stiffness analysis, the mid span concrete strain analysis, and the beam experimental bending moment analysis are carried out. Compare the performance difference between the strengthened beam and the unreinforced beam.	Master the static load test method and data analysis principle of bridge. Master the bridge reinforcement method and the mechanical performance of the strengthened structure.
Dynamic load test (0.5 class hour)	Bumping is simulated by hammering method to make the beam generate free vibration. The experimental curve is recorded, and the natural vibration period and damping ratio of the beam are calculated and compared with the theoretical value. Compare the performance difference between the strengthened beam and the unreinforced beam.	Master the dynamic load test method of the bridge and the performance of the strengthened structure.

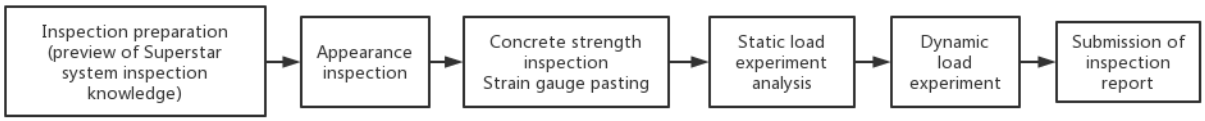

Figure 1 Detection process

2.2.4 Inspection report

In accordance with the actual bridge inspection report form, one set of experimental report form was designed to record the inspection process and experimental data of two reinforced concrete beams with damage, and to evaluate the technical condition of the beams truthfully according to the bridge inspection related specifications. Considering that the experiment execution process requires 4~5 people to cooperate collaboratively in order to complete, the experimental report is written and submitted as an experimental team. The inspection report is printed and bound in A4 paper and contains the following contents: cover page (1 page), test commitment letter (1 page), overview of the

test object (1 page), appearance inspection (2 pages), reinforcement inspection (1 page), concrete strength test (3 pages), static load test (4 pages), dynamic load test (4 pages), and test conclusion (1 page). All the pictures involved in the test report need to be given. The date of the test report, subject to the date of submission of the report.

2.2.5 Civic education

In the implementation of the test, integrate the elements of Civic Education. Combined with the characteristics of this experiment, Civic Education is mainly carried out in the following aspects: before the start of the test, students are required to fill out a letter of commitment to integrity, strictly in accordance with the standards of testing, to ensure that the test is fair, scientific and accurate, prohibit falsification of test data, prohibit the issuance of false reports; testing process to cultivate the spirit of mutual help, solidarity and love, adhere to the "learning by doing, learning by doing "spirit, guide students to establish the correct "three views", build a good personality; submit a report, train students to professional ethics, awareness of responsibility and responsibility, establish the spirit of not forgetting the original intention, adhere to innovation.

2.2.6 Assessment methods

Using Super Star to organize students' pre-study and conduct attendance assessment in the testing process, the score of this part accounts for 30% of the assessment score. From the perspective of Civics, students are assessed on the quality of Civics, and the score of this part accounts for 20% of the assessment score. From the perspective of the submitted testing report, the students' testing work is evaluated, and the score of this part accounts for 50% of the assessment grade. The scores of the three parts are added together and the total experimental score of each student is summarized.

3. Teaching reform effect

This experimental teaching reform solves the problem of continuity of the four experimental items of bridge inspection and strengthening, so that students can master the procedures and steps of bridge inspection and strengthening as a whole; solves the problem of students' enthusiasm in the process of experimental execution, so that students can conduct experiments according to the engineering standards and have a good sense of social responsibility; solves the problem of diversification of the experimental contents of bridge inspection and strengthening, and improves the in-class Open rate; solve the problem of students' "passive" experiments, make students "active" experiments, solve the problem of students' single experimental assessment. After the completion of the experiment, the author communicated with the students and found that the students were enthusiastic about the online and offline hybrid experimental teaching, and they were excited about the teaching reform of bridge inspection experiments by engineering projects.

4. Conclusion

Bridge inspection and strengthening experiments are tedious. The experiment takes two damaged reinforced concrete beams as the test object, and the main line is "appearance inspection - strength test - static load test - dynamic load test", so that students can be deeply involved in the whole bridge inspection. This experiment can be used as a reference for other experiments.

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