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Teaching Reform of Comprehensive Experiment of Civil Engineering based on Ability Cultivation

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Abstract: The traditional experimental of civil engineering was single, conventional and confirmable, and lack of innovation and comprehensive ability, however, It was an effective way to train students' autonomous learning ability of establish a civil engineering experiment teaching system, and to design a comprehensive experiment which was suitable for the training of undergraduate students. The result indicated that the comprehensive experiment of reinforced concrete and the design of practical courses, not only deepened the students' study of theoretical knowledge, but also facilitated students' communication skills, calculation ability, drawing ability and other aspects, so as to meet the social requirements of engineering personnel ability.

1. Introduction

At present, the enrollment rate of domestic colleges and Universities is increasing year by year. China has made breakthrough progress in higher education, and has constantly moved towards the goal of mass education [1].However, after the popularization of higher education, the quality of graduates is worrying: employers believe that students' working ability is not enough and lack of initiative. Students were not satisfied with themselves. They think "The knowledge learned in the school could not meet the needs of work, there was no use of the knowledge they have learned." In China, the quality education and ability training of students had been raised for many years, but the ability of college graduates to adapt to social development had not improved [2].

With the rapid development of China's economy in twenty-first Century, the state invested a lot of money in infrastructure construction, which provided wide employment space for graduates from civil engineering. At the same time, it also puts forward to higher requirements for them . Strong practical ability, professional knowledge and skill of high-quality talents are attracting more and more social pursuit [3,4].In recent years, in order to implement the national medium and long term educational reform and development plan (2010-2020 years), colleges and universities pay more attention to the cultivation of engineering ability of civil engineering students. High quality and high level front-line engineering managers are the goal of cultivating civil engineering professionals in Colleges and Universities [5,6].

Therefore, this article aims at the present situation that the quality of the graduates is declining and the students' comprehensive ability is insufficient, comprehensive all-round development needs and professional skill requirements for the comprehensive society. Through the establishment of civil engineering experimental teaching system with ability to target output,we design a comprehensive experiment that accords with the ability training of application-oriented undergraduate students, and train students' autonomous learning ability across different disciplines, so as to play a demonstration and reference role for experimental teaching in similar universities.

2. Problems existing in the existing teaching system

At present, the main problems in the experimental setup are:

(1) Traditional experimental setting is too mechanized.In the course of the experiment, students tend to follow the instructions of the experiment, and lack independent thinking.It is difficult to

arouse the students' initiative of learning, which leads to the poor effect of the experimental teaching.The students' understanding of the experiment is only on the surface, and there is no deep understanding of the relevant theoretical knowledge.

(2) The subject is not related to the setting of the experiment, and the knowledge points of each experiment are relatively independent. Students' understanding of knowledge points is lack of coherence, which leads students to not flexibly use their professional knowledge when they go to work.

(3) Lack of evaluation of students' experiment process,it leads students to pursue the accuracy of experimental results too much, but ignores the in-depth exploration of scientific problems encountered in the process of experiment, thus hindering the cultivation of College Students' ability to discover and solve problems.

3. Comprehensive experimental design and requirements based on ability training

3.1. Selection of object in experimental design

The reform of civil engineering comprehensive experiment should follow the principle of student orientation, and achieve the goal of training and improving students' ability of innovation, teamwork and problem solving through experimental teaching, pay attention to the coordinated development of "knowledge, ability and quality", design the comprehensive experimental project for the goal of achieving the output of ability.(1)Research on the comprehensive ability of Applied Undergraduate Talents in Civil Engineering: the training of Application-oriented Undergraduates in civil engineering needs the goal of capacity output, which includes students' basic theoretical ability, drawing ability, computing power, practical ability, problem-solving ability, teamwork ability, reporting ability and so on.What kind of ability to meet the social needs of the industry needs to be studied and understood.(2)Research on the relationship between the cultivation of comprehensive ability and the professional course: the cultivation of comprehensive ability is the result of the intersecting of a curriculum system. Different knowledge points correspond to different courses, and different courses reflect the single skill of the students.The application of knowledge points connects theory courses with practice links. By studying the links between different knowledge points and different courses in practice, we can achieve the purpose of training comprehensive ability.

Therefore, the research and design of suitable experimental objects is an important factor to cultivate the comprehensive ability of civil engineering specialty. The design of reinforced concrete beams fully meets the training of professional characteristics. In the design link, students need to master the knowledge of materials mechanics, structural mechanics, the principle of reinforced concrete design, the design of reinforced concrete structure and many other courses. According to the maximum load-bearing capacity of the beam, the steel marks required to be arranged, the arrangement and the construction mix ratio of the required concrete are designed.It provides the basis for the construction of the next beam. Through this design link, we have exercised the student's hand counting ability. In actual engineering, carrying out a preliminary calculation for the carrying capacity of a beam is the ability for every civil engineering major.

3.2. Comprehensive experimental design scheme requirements

The structure design requirements of reinforced concrete rectangular simple supported beam:

Beam length and span: the calculation of the span of 1800mm, the full length of 2000mm. Section height: height (180 + n×10) mm, that is, 180mm is the basic height, according to the design needs, the multiplier of 20mm is increased or reduced, three kinds of beam height: 160mm, 180mm and 200mm choose one of them. Breadth of section is: width (120 + n × 10) mm, that is, 120mm is the basic width. According to the design needs, the multiplier of 20mm is increased or reduced. Three widths: 100mm, 120mm and 140mm choose one of them. Materials: 1) the concrete design is selected in two ways of C20 and C30; 2）The steel bar is HPB300 with circular steel bar, and the diameter of steel bar is 6, 10, and 12.Loading state: the reinforced concrete beam is subjected to the force of the experimental requirement of the bending bearing capacity of the normal section. The loading diagram in the experiment is shown in Figure 1. The design of reinforced concrete beams requires: the bending strength meets the requirement of bearing capacity, and the shear strength can not meet the shear failure before bending failure. To complete the calculation of reinforced concrete beams and the corresponding drawings, drawings requirements: structural diagram of reinforced concrete beams.

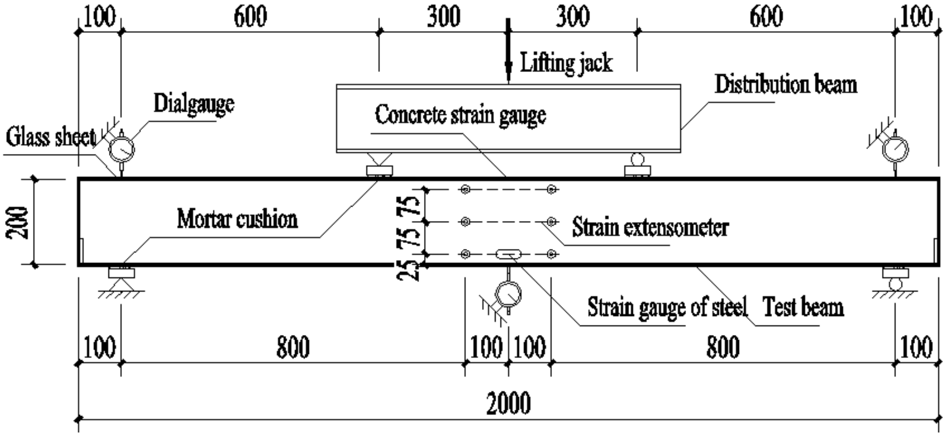

Figure 1. Experimental loading diagram

Concrete mix ratio selection and construction mix ratio determination:

The recommended mix ratio of two kinds of concrete strength: It is adjusted according to the specification "design specification for common mixtures" JGJ 55-2011. C20: Sand: Gravel: water =300: 732: 1193: 170, of which the sand rate is 0.38, the water cement ratio is 0.57, and 32.5 grade ordinary portland cement is used. C30: Sand: Gravel: water =334: 660: 1226: 180, of which the sand rate is 0.35, the water cement ratio is 0.54, and 42.5 grade ordinary portland cement is used.

4. Comprehensive experimental case -- Design of reinforced concrete beam experiment plan

4.1. Design of reinforced concrete section and calculation of reinforcement

According to the requirements of the course experiment, the section size of the concrete beam of group B is b× h=110mm × 200mm , and the concrete strength grade is C25,and its mix proportion is cement: sand: gravel: water =334:660:1226:180, the sand rate is 0.35, the water cement ratio is 0.54, and 32.5 grade ordinary portland cement is used. Rebar uses light round bar HPB300,combined design value of bending moment is $M_d = 10KN{\bullet}m$ at the section of load and size, I class environment conditions. Thesafety level is two. The axial compressive strength is f_{cd}=11.5MPa , and the steel bar tensile strengthdesign value is f_{sd} =270MPa according to the schedule 1-1 of the principle of structural design. It canbe found that the height of the compression zone is ξ_b=0.576 ,the coefficient of structural importance is γ_0=1 , the combination of the bending moment of the section is $M_d = 10KN{\bullet}m$, the calculation value of the bending moment is $M = \gamma_0 M_d = 10KN{\bullet}m$, the one layer of reinforcement, assuming that the distance between the center of the steel bar and the edge of the concrete is $\alpha_s = 40$, the effective height is $h_0 = 160mm$. By replacing the known parameters into the formula (1), the height x of cross section compression zone is 61mm. By replacing the x=61 into the formula (2), the area of the required reinforcement is $A_s = 286mm^2$.

$$M=f_{cd}bx(h_0-\frac{x}{2}) \qquad (1)$$

$$M=f_{sd}A_S(h_0-\frac{x}{2}) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Consider placing a layer of reinforcing bar, two bars per layer, using $2\phi16$ （$A_s=402mm^2$）.

The thickness of the concrete protective layer is 15mm,get $\alpha_s=23$,adopt $\alpha_s=25$, and the effective height is $h_0=175mm$, it meets the requirement of minimum reinforcement ratio. The height x of the actual compression area is 86mm , which meets the requirement of the height of the confined area($\xi_b h_0$=101mm). The actual compression zone height is replaced by the for mula (1), and the flexural capacity is 14.4 kN•m, which meets the design requirement.

4.2. Material statistics of reinforced concrete beams

Through the reinforcement calculation, the reinforced concrete beams on the upper frame are reinforced by two diameters of 6mm, the main reinforcement is two steel bars with diameter 16mm, and the stirrup adopts the single leg hoop with diameter 6mm. Figure 2 shows the reinforcement diagram of the concrete beam. The material of reinforcing steel is like table 1.

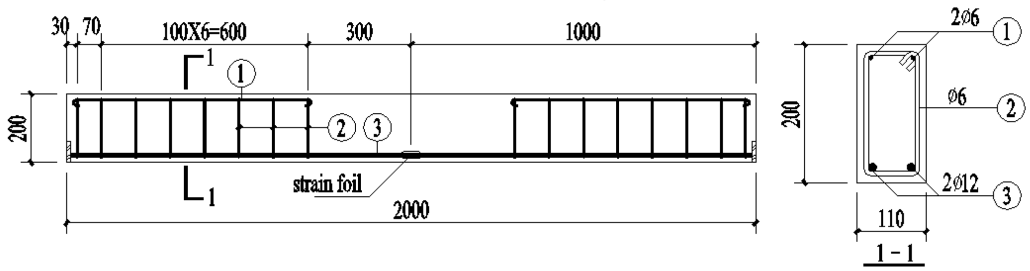

Figure 2. Reinforcement diagram of concrete beams

Table 1. Detail of rebar material

Category	Diameter（mm）	Each length（mm）	Amount（root）	Total length（m）
The main reinforcement	16	2170	2	4.34
Stirrup	6	551	14	7.718
Erection bar	6	675	4	2.700

Through the calculation of the bearing capacity of reinforced concrete, the calculation of reinforcement, the calculation of rebar material, the training of CAD drawing and so on, it exercises the team cooperation ability among the members, the ability of personal professional knowledge, the ability to communicate with each other, and prepare for the next practical exercise.

5. Conclusion

Two conclusions are drawn through the study:

(1) Select a kind of concrete grade to design the mix ratio of concrete and calculate the amount of each material, and according to the stress of the experimental requirement of the flexural bearing capacity of the reinforced concrete beam, the maximum shear force and the maximum bending moment were calculated and the positions of both were determined. The calculation ability of the students was exercised by calculating the corresponding reinforcement according to the stress condition.

(2) According to the calculation of the requirements of reinforcement and the size of the selected section of the beam, the construction drawing of the beam was drawn by CAD. The ability of software drawing was exercised.

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References

[1] Yang Wan-ting. A brief discussion on the reform of higher education in the new era -- Some Thoughts on the current situation and reform measures of the reform of the university education [J]. Journal of Chengdu University (Social Science Edition), 2016 (5): 116-119.

[2] Chen Ping. The concept of professional certification to promote the connotation development of engineering major construction[J]. Chinese University Teaching, 2014 (1): 42-47.

[3] Li Xiao-li, Yuan Zhao-qing, Zhang Yun-feng, et al. Reform and practice of the course design of Civil Engineering Specialty [J]. China Metallurgical Education, 2010 (1): 56-58.

[4] Peng Peng-Ning. Considering curriculum design and graduation design as a whole to improve the practical ability of Civil Engineering Undergraduates [J]. Journal of Guangxi Institute of education, 2011 (2): 156-157.

[5] Zhu Yan-Zhi, Pan Hong-Ke, Zhang Chun-li. The design of civil engineering course and the model of graduation design [J]. Journal of Architectural Education in Institutions of Higher Learning, 2009, 18 (4): 109-112.

[6] Liu Yong-jian, Li You-qun, Liu Guang-jing. Strengthening practical teaching to cultivate the creative ability of civil engineering students [J]. Journal of Architectural Education in Institutions of Higher Learning, 2008, 17 (5): 107-109.

[7] Ye Jian-Shu. Principle of structure design. The third edition [M]. China Communications Press Co.,Ltd, 2014.