Case-Based and Task-Driven Education Improves Students’ Qualities of Bridge Engineering

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Abstract: The teaching contents of bridge engineering were reformed by the teaching cases of bridge selected from outstanding and collapsed bridges in recent years in China. The professional knowledge of bridge engineering was effectively connected with the teaching cases of bridge through task-driven teaching method. Students actively constructed professional knowledge and skills of bridge engineering by solving practical bridge problems. The students’ qualities of bridge engineering, such as communication skills, team-work spirit, professional skills and responsibility, are improved during studying bridge cases and designing bridge process.

Introduction

The industrialization and the development of Chinese national economy are stepping into the key period at the present. The college students graduated from bridge engineering are facing higher requirement from related bridge enterprises than before. It is well known that bridge is the main component of the highway transportation and plays an important role in the society and economy. However, it was reported that bridges were constantly collapsed in recent years in China. It is obvious that the education of bridge engineering in university need to be improved immediately. Engineering is a practical activity in which actual problems are solved and practical buildings or structures are made out. Therefore, engineers must have the ability to accomplish the related engineering [1]. The college students graduated from bridge engineering must have high quality of bridge engineering in order to accomplish the bridge engineering in the future. Some researchers have paid attention to reform the education of bridge engineering [2]. Improving the college students’ communication skills, team-work spirit, professional skills and responsibility [3, 4] will be an important research region. This will be an important way to improve their qualities of bridge engineering. The teaching contents are usually limited by traditional textbook. Therefore, teaching contents need to be reformed to improve the college students’ qualities of bridge engineering.

The case-based and task-driven teaching method is an advanced teaching method which combines the advantages of case-based teaching method [5,6,7] and task-driven teaching method[8]. The main advantages of case-based teaching method is persisted in the case-based and task-driven teaching method, such as deep analysis and explaining the teaching cases, motivate the students to learn professional knowledge of bridge engineering, and reasonably integrates the professional knowledge with teaching case. This method also remains the advantage of the task-driven teaching method, such as clear purpose. The case-based and task-driven teaching method is applied in bridge engineering curriculum since theory and practical skills are all important. Real teaching practice in recent years demonstrates that the case-based and task-driven teaching method is very helpful for improving students’ enthusiasm to learn bridge professional knowledge and their qualities to solve practical bridge engineering.

Reform the Teaching Contents by Using Bridge Cases

Task-driven is the main subject in the whole classroom education and organizes all teaching links
When case-based and task-driven teaching method is used. The teaching cases are not limited by traditional textbook since the case teaching is a real revolution of teaching contents. In this method, a complete bridge is decomposed to a series of bridge cases according to a systematic view at first. Then, the bridge cases are organized and studied in the classroom to help students completely understanding the bridge solution. In this way, students can learn about the whole bridge problem at first. Then, students pay attention to the key knowledge. So, they can learn practical and useful professional knowledge of bridge which can be used to solve practical bridge problems. Of course, bridge cases should be carefully organized and a good experienced storyteller is needed to help students making the connection between theory and practical bridge cases. In general, the teaching material need be provided to students before teaching starts. Many useful resources can be found through network. Therefore, an educational platform based on network was established and all related materials could be shared by students.

In general, continuous beam bridge and arch bridge can be taken as the main bridge cases. The theory for simply supported beam bridge can be integrated with them in a proper way. The outstanding bridges built in recent years and collapsed bridges due to some reasons were selected in my teaching. The outstanding bridges can enhance students’ confidence and good tradition is naturally accepted by students. This is very helpful for promoting students to establish correct ideas of bridge engineering. For example, Lupu Bridge (Fig. 1) in Shanghai city, Dagu Bridge (Fig. 2) in Tianjin city, and WanxianYangtze River Bridge (Fig. 3) in Chongqing city are all outstanding bridges in China and are well suitable for teaching cases of arch bridge. It is well known that Lupu Bridge in Shanghai city and Dagu Bridge in Tianjin city were awarded the famous international Eugene C. Figg Medal in 2004 and 2006, respectively. Lupu Bridge in Shanghai is a typical basket handle bridge which is an important type of bridge in recent years. Two outward inclined arch ribs with different height are adopted in Dagu Bridge in Tianjin city. It is a very beautiful bridge since the design idea is far beyond the traditional bridge design. WanxianYangtze River Bridge in Chongqing city is a typical box arch bridge while the concrete filled steel tube is served as stiff skeleton. Therefore, this bridge can be taken as not only the teaching material of the traditional box arch bridge but also the teaching material of concrete filled steel tube arch bridge. On the other hand, students can get a deep impression when collapsed bridges are studied at the same time. This is also very helpful for improving their serious attitude for work and responsibility for the society. There are many collapsed bridges which can be served as teaching cases of bridge, such as Chuanxi Bridge collapsed in 2013 (Fig. 4) in Sichuan province, Qunli elevated Bridge collapsed in 2011(Fig. 5) in Haerbin city, and Fenghuang Bridge collapsed in 2007(Fig. 6) in Hunan Province. It should be stated that all figures are collected from the web of Baidu. Students can really understand why these bridges are collapsed and what the basic design principles of bridge mean by studying these bridge accidents. In general, taking both of the outstanding bridges and the collapsed bridges as teaching cases of bridge can motivate students to study more bridge knowledge.

Figure 1. Lupu Bridge.
For perfectly decomposing and organizing teaching task, the teaching cases of bridge must be elaborately analysed based on professional knowledge of bridge. Now, students are generally treated as the main body of study based on the constructivism theory [9,10]. So, all teaching activities should be carried out based on the actual condition and enthusiasm of students. This requires that a special teaching environment relevant to the meaning of the professional knowledge
of bridge should be constructed. If a special bridge case and background are successfully connected with professional knowledge of bridge, students can easily constructed the meaning of professional knowledge of bridge based on their prior knowledge and the special bridge cases. Students’ enthusiasm can be effectively promoted by a successful activity. Prior fundamental knowledge can be applied in teaching cases of bridge, such as influence line, classical elastic centre for arch, and analysis of internal forces of continuous beam in structural mechanics. At the same time, new meaning connected with bridge structure can be easily transmitted from teacher to students. Some bridge programs, such as Bridge Doctor, Midas Civil, can be used for making the teaching alive and interesting. The internal forces, such as shear force, axial force, moment, and deformation of continuous beam bridge can be vividly displayed by using Midas Civil software. The arrangement of prestressed tendons in the three-dimensional model of continuous beam bridge is also clearly displayed. The catenary arch bridge model and its internal forces, deformation and stability can be easily displayed. In this way, the enthusiasm of students can be easily activated. The ability of students to analysis the bridge structure can also be enhanced. For excellent students, the collapsed bridge can be used as an example to learn how the collapsed accident happens.

**Improve the Students’ Qualities of Bridge Engineering**

Most of students will take part in the construction of bridge several years later and bridge engineering is a practical activity. The college students should not only master the professional knowledge of bridge but also be capable of dealing with practical bridge engineering. Bridge engineers must be cooperated with each other during constructing period of bridge. Therefore, improving the communication skills, team-work spirit, and responsibility are very important for students in the university. The practice of bridge design for students can be effectively guided by experienced professor of bridge engineering. The curriculum design of bridge can be integrated with theory study of bridge engineering. This is very helpful for actively studying.

Practical bridge design is taken as the teaching task imitating the working pattern of bridge designer in the institute of design. This may help transforming knowledge to practical abilities of students. For successfully organizing so many students, six to eight students are grouped as a team and one of them is elected as their team leader who can organize them to discuss problems. The route, topography, geologic condition and hydrology data provided for students are the same as that in the institute of design. Different design schemes of bridge are compared under the guide of experienced professor. The prestressed concrete simply supported beam bridge is often chosen as the first step of design scheme. Then, students compute the internal force and deformation of beam, arrange the prestressed tendons, and complete the required drawing, et al. Students are organized and guided to discuss different problems which may be encountered during the design process. At the same time, these problems can be taken as teaching cases. This can make the teaching more alive and interesting. For extending the teaching contents, students and professor are encouraged to communicate with each other online. Practice of bridge design demonstrates that the learning effect of students learning from each other is much better than that from professor since they are grown up now and have their own thinking. The students’ confidence for professional knowledge of bridge is gradually improved with their discussion. At the same time, a good relationship environment may be established. The design task is therefore completed by cooperation way. The students not only comprehensively apply fundamental and professional knowledge into practical bridge design but also have a good professional insight in bridge engineering. Finally, communication skills, team-work spirit and responsibility for work are effectively established. In the whole, every teaching task is gradually advanced in following steps: (1) analysis teaching case; (2) complete computation task; (3) solve exist problem. Students usually bring problems into classroom and actively discuss bridge teaching cases since they have actively completed their calculation task. It is well known that a learner actively constructing knowledge rather than passively receiving it from the environment. Therefore, students can effectively construct their systematic, useful, and practical knowledge of bridge and form a systematic thinking style.
Conclusion

Case-based and task-driven teaching method is applied into the teaching of bridge engineering for solving practical design of bridge and improving students’ qualities of bridge engineering. Bridges built in recent years and known by students are selected as teaching cases of bridge. They are used to reform the teaching contents. The learning tasks are effectively driven by practical design of bridge. Generally, the students’ abilities to solve problems of practical bridge engineering are also effectively improved. The students’ qualities of bridge engineering, such as communication skills and team-work spirit, et al., are effectively improved by above presented method.

References


