Practice and Reflection on the Teaching of Case Studies in Theory and Technology of Railway Engineering

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***Abstract*—China's high-speed, heavy-haul, and urban rail transit have been vigorously developed in recent years. Some new technologies, structures, and materials have been widely used in engineering practice. At the same time, the teaching of track engineering theory and technology courses is facing a big challenge. How to combine some typical engineering cases to explain the knowledge points of the course has become an important problem to be solved. In this paper, given the characteristics of the course content of track engineering theory and technology, two typical case groups of high-speed railway longitudinal plate ballastless track interlayer disease and high-speed railway ballast track key technology are set. The teaching effect of the adopted cases is evaluated, and the results show that the teaching effect of adopting the case teaching method is good.**

***Keywords*—case teaching, track structure, teaching practice, evaluation of effectiveness**

I. Introduction

China's high-speed railways, heavy-haul railways, and urban rail transport have been developing rapidly. By the end of September 2022, China's railway mileage had reached 153,000 kilometers, of which the total mileage of high-speed railways in operation had exceeded 40,000 kilometers and the total mileage of urban rail transport had exceeded 9,000 kilometers. All of which ranked among the top in the world, and China has become the country with the most frequent rail transport operations and the largest construction scale in the world. In particular, high-speed railways have become China's national calling card as a landmark achievement of independent innovation.

The rapid development of rail transportation cannot be achieved without the promotion of high-level talent. In recent years, the School of Civil Engineering and Construction of the University has delivered a large number of outstanding talents for the development of China's transportation industry by dovetailing with the major needs of national independent innovation. There is still a large talent gap in the development of the rail transportation industry, especially the need for innovative and high-quality talents with a sense of social responsibility and scientific spirit, rich in innovation and entrepreneurial spirit and practical ability, and with international vision. Especially with the development of high-speed railways, new technologies have been introduced continuously, and the existing curriculum mainly follows the existing system, which can no longer meet the training of top talents in the field of high-speed railway track structure infrastructure in China at this stage, so the State Railway Administration has started a series of books on "High-speed Railway Engineering" and the curriculum. In the course, some typical cases should be set up as soon as possible to carry out thematic analysis, enhance students' in-depth understanding of the core and key issues of high-speed railways, cultivate students' ability to analyze and solve problems and improve students' innovation in research ideas and methods, which is of great significance to the training of industry This is of great significance to the training of top talents in the industry.

Because of the existing problems in the teaching of railway transit engineering, the case teaching method is adopted in the teaching process. The detailed cases are used to explain the problems of the interlayer disease of the longitudinal connecting slab of the ballastless track of the high-speed railway, as well as the splash of the ballast track and the maintenance of the crane. It deepens the engineering understanding of the students. The teaching results of the case teaching method are evaluated through a questionnaire survey and other methods. The statistical results show that the case teaching method can improve students' learning enthusiasm, and also pay attention to the learning of basic knowledge of track structure and the training of practical skills. This method improves students' participation in the course and achieves good teaching results.

II. Case Study Teaching

A. The Meaning of Case Study Teaching

The case-based teaching method is a teaching method with cases as the core. It is a teaching mode in which the

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teacher is the leader, students are the main body and cases are the basic teaching content. By setting engineering problems in the engineering context as cases and restoring real working situations, students stand in the perspective of the principal, analyze and discuss the problems, and then propose solutions in line with the actual situation. The aim is to integrate students into the educational practice, through the form of two-way interaction, to create an atmosphere of independent learning and research-based learning, and to cultivate students' practical ability and comprehensive quality.

The Case Method was pioneered in 1870 by C.C. Langdell, former Dean of Harvard Law School, and later popularised by W.B. Doham, Director of the Harvard Graduate School of Business and Management, and quickly spread from the US to many parts of the world, and is considered to be a successful educational method representing the future direction of education. For example, in 1991, Kowalski [1] proposed that the case method could train students' reasoning, thinking, and problem-solving skills; in 1992, Shulman [2] defined the case method as a teaching method that uses cases as a medium of instruction; in 1996, Merseth [3] proposed that the case method included discussion in large classes and small groups, role-playing in cases or the 1980s, case teaching was introduced to China and gradually became widely used.

III. Track Engineering Theory and Technology Case Set

A. Course Objectives

Track Engineering Theory and Technology is a core course for postgraduate students of railway engineering, which mainly covers the content of track structure theory, including ballast and ballastless track structure, track structure mechanics analysis methods, high-speed railway turnout structure, seamless lines, track vibration, and noise reduction, etc. Through this course, students will be able to: (1) fully grasp the composition and characteristics of ballast and ballastless track structures; (2) be familiar with track structure calculation theory and calculation models, and learn track structure mechanical analysis methods; (3) master the types and technical characteristics of high-speed railway turnout structures, and understand the finite element calculation methods of turnout structures; (4) master the knowledge points related to seamless lines; (5) master track vibration and noise reduction techniques. (5) to master the track vibration and noise reduction technology, including the types and characteristics of vibration and noise reduction track structure, vibration and noise reduction design of track components, etc.; (6) to understand the application of computers in the design and management of track structure.

B. Selection of Cases

High-speed railways should have a high level of safety. As the content in Fig. 1 says. As the lower infrastructure of high-speed train operation, the service condition of the track structure directly determines the operational safety of high-speed trains. The track structure is mainly divided into ballast track structure and ballastless track structure, of which longitudinal plate ballastless track is widely used in China's high-speed railway lines for its high smoothness, high stability, low maintenance, and long life. However, with the operation, the longitudinal plate ballastless track has developed a series of diseases [4], and from sporadic to large-scale emergence, it has become the most relevant issue in the industry for the safety of high-speed railway operation, and every year, a lot of manpower and material resources need to be invested in large-scale maintenance and repair. Therefore, it is not only in line with the current situation of China's high-speed railway operations but also a suitable case for training top talents with a focus on major common engineering problems.

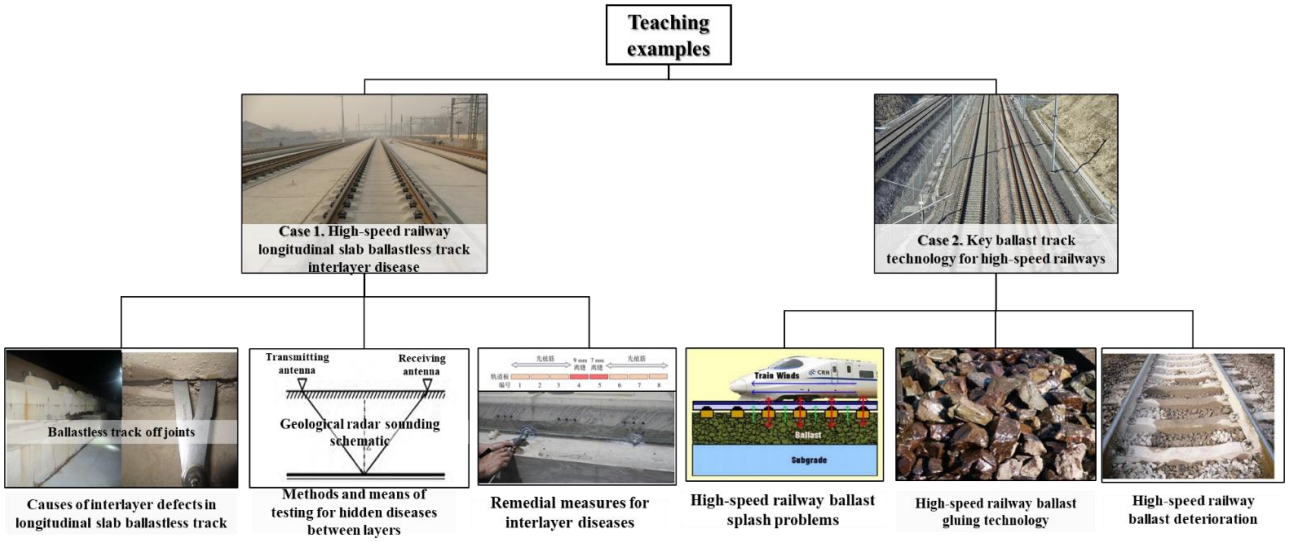

Fig. 1. Teaching case content map.

Although China has conducted long-term research for ballast tracks, almost all high-speed railways opened for construction in recent years have adopted ballastless tracks, making China for high-speed railway ballast track technology accumulation insufficient. It has become China's high-speed railway further developing the bottleneck problem. For example, in the construction of high-speed railways with a speed of 300 km/h or more, the first face is the problem of ballast splash [5], what causes it, and how it should be handled. In addition, ballast deterioration is inevitable under long-term high-frequency train loading. If the mechanism can be revealed and the type of damage can be clarified [6], it will be very helpful to improve the ballast track technology. In addition, there is a widespread problem of ballast-ballastless track transition sections in China, how to make a smooth transition of rigidity is one of the key technical issues to ensure the safe operation of high-speed railways. Therefore, the key technology of ballast track for high-speed railways as a typical case is very helpful for the cultivation of a shortage of talent in the industry [7]. In addition, China's "Generation One" railways are mainly built using ballast track structures. Therefore, it is important for the implementation of the strategy of the railway going global and the construction of a strong transportation country to use it as a case study for in-depth lectures and discussions.

C. Case Identification

Taking into full consideration the fact that at present China's high-speed railway track structure infrastructure has been transferred from large-scale construction to large-scale operation and maintenance, as well as the actual content setting of the course narrative and personnel training objectives, "Track Engineering Theory and Technology" set 2 typical cases to carry out postgraduate teaching, as shown in Fig. 1 below.

The 2 typical cases are as follows.

Case 1: High-speed railway longitudinally connected slab ballastless track interlayer disease

Theme 1: Causes of interlaminar defects in longitudinal slab ballastless track.

Theme 2: Methods and means of testing for concealed interlayer defects.

Theme 3: Remedial measures for interlayer defects.

Case 2: Key ballast track technologies for high-speed railways

Theme 1: Ballast splash problems in high-speed railways [8].

Theme 2: Ballast gluing technology for high-speed railways [9].

Theme 3: Ballast deterioration in high-speed railways [10].

IV. Case Effectiveness Evaluation

To understand the students' feedback on the effectiveness of using case study teaching, an online questionnaire survey was conducted for all students who took the course "Theory and Technology of Rail Engineering".

A total of 50 samples were distributed and 50 valid samples were returned. The results of the survey are as follows.

① The necessity of including typical engineering cases in the teaching content

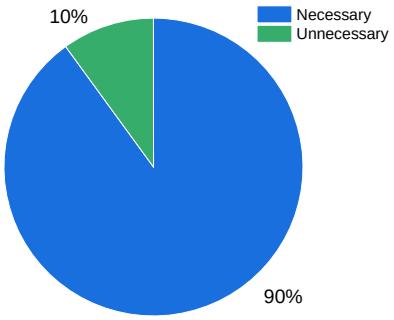

Fig. 2. The necessity of including typical engineering cases.

From the survey data in Fig. 2, it is clear that 90% of the students think it is necessary to include typical engineering cases in the teaching content. Therefore, typical engineering cases can be added continuously for future teaching.

② Typical cases of high-speed railway ballastless track involved in the teaching content

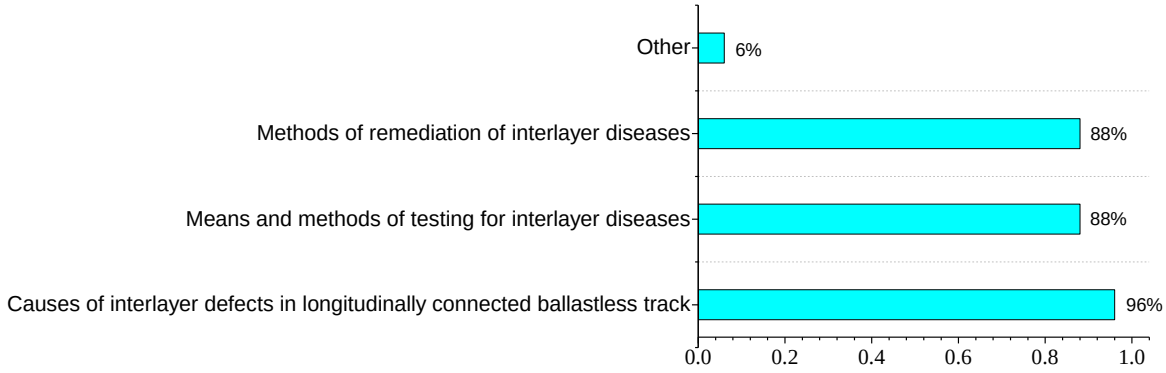

Fig. 3. Typical cases of high-speed railway ballastless track.

As can be seen from the bar chart data in Fig. 3, in terms of ballastless track for high-speed railways, 96%, 88%, and 88% of students thought that the content should include the causes of interlaminar disease in longitudinal slab ballastless track, the means and methods of testing for interlaminar disease and the methods of remediation of interlaminar disease respectively. In addition, 6% of the students suggested that the temperature field, the effect of track irregularities on the structure, and the types of serious diseases should be covered in the teaching case. In summary, student suggestions should be fully considered in the teaching of high-speed railway ballast track cases, and content could be added such as the effect of temperature on ballast track.

③ Typical cases of high-speed railway ballast tracks involve teaching content

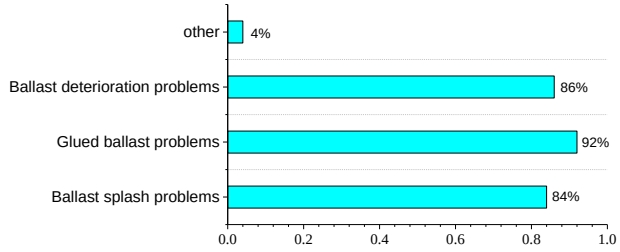

Fig. 4. Typical cases of high-speed railway ballast track.

As the content in Fig. 4 says. As can be seen from the bar chart data, in terms of ballast track for high-speed railways, 92% of students thought that the content should include glued ballast technology, while 86% and 84% of students thought that the content should include ballast deterioration problems and ballast splash problems respectively. In addition, 4% of students thought that the theory of calculating stresses in the roadbed should be covered in the teaching cases, interspersed with a section on basic concepts.

④ The degree of integration of case teaching with engineering practice in the teaching process

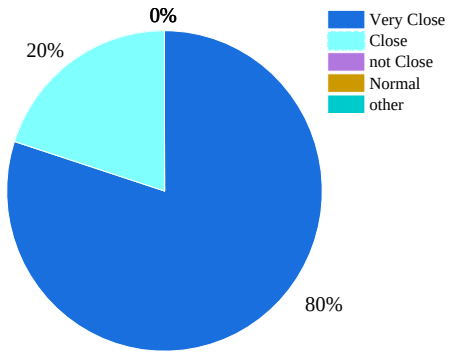

Fig. 5. The degree of integration of case teaching

As the content in Fig. 5 says. The results of the survey showed that 80% of the students thought that the case study of this course was very closely integrated with engineering practice, 20% thought it was closely integrated, and the remaining percentage was 0. Thus, it can be seen that the case study teaching was well integrated with engineering practice.

⑤ Satisfaction with the effect of case teaching

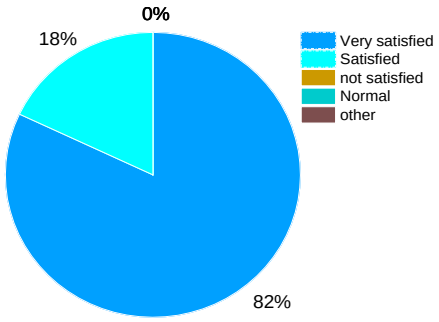

Fig. 6. Satisfaction with the effect of case teaching

As the content in Fig. 6 says. The number of respondents who were very satisfied with the teaching effect accounted for 82%, 18% were satisfied and the rest accounted for 0. This indicates that the course has achieved a good teaching effect by adopting case teaching.

A total of 50 questionnaires were returned for this study. Through comprehensive analysis, the following conclusions and suggestions were drawn: the course has achieved a good teaching effect by adopting the case teaching method, and most students are satisfied with the current teaching content and format. In terms of teaching content, according to students' suggestions, we can continue to increase the number of typical teaching cases and expand the current scope of case content, to better meet the requirements of postgraduate students for knowledge content.

V. Conclusion

Given the rapid development of rail transportation in China, some new technologies, new structures, and new materials are widely used in engineering practice. The thesis introduces the case study teaching method into the core course *Theory and Technology of Rail Engineering* for postgraduate students.

The case teaching practice shows that the use of case teaching can effectively mobilize students' learning enthusiasm, and also take into account the cultivation of track structure knowledge and practical skills, through the practical significance of high-speed railway ballastless track and ballast track key technology project development cases, so that students from passive knowledge receiver, into the active construction of knowledge, and achieved a good teaching effect.

Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Author Contributions

Hong Xiao: Project administration, Supervision. Writin g – review & editing. Shaolei Wei: Conceptualization, W riting – original draft, Methodology, Formal analysis. Ke

Qin: Data collection, statistical analysis. Shaoshuai Qiao: Investigation. All authors had approved the final version.

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