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Teaching Reform and Practice of Soil Mechanics Course in the Context of Emerging Engineering Science

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Abstract: With the accelerated development of scientific and technological progress and industrial upgrading, Emerging Engineering Education has become the key to cultivate high-quality and innovative talents, and the teaching reform of the Soil Mechanics course, as a core basic course of civil engineering, is particularly important for adapting to the engineering needs of the new era. This paper discusses the teaching reform and practice of Soil Mechanics courses in the context of emerging engineering science, and puts forward the introduction of cutting-edge technology, updating course content, innovative teaching methods, the teaching quality of Soil Mechanics courses and the comprehensive quality of students, and other strategies, and seeks to promote the significant improvement of the quality of teaching and the quality of talents. Among them, the application of virtual reality and project-driven learning mode enhances students' practical ability and innovative thinking. The strengthening of practical teaching links and industry-university-research cooperation has enhanced the opportunities for students to participate in actual engineering projects, while the integration of Civic and Political Education has fostered students' professional ethics and sense of social responsibility. In the future, the course of Soil Mechanics will continue to adjust and optimise the teaching mode, cultivate high-quality civil engineering talents adapted to the needs of emerging engineering science, and provide powerful support for modern engineering construction.

Keywords: emerging engineering science; soil mechanics; teaching reform; project-driven learning; industry-university-research cooperation

Introduction

As an important branch of engineering mechanics, Soil Mechanics mainly studies the stress-strain, stress-strain-time relationship and its strength characteristics of soil under the action of external forces. This discipline provides a solid theoretical foundation and technical support for many engineering fields such as civil engineering, traffic engineering, water conservancy engineering, etc., and is the key to ensure the safety and stability of the project. With the increasing complexity of engineering construction, the research methods and applications of Soil Mechanics are constantly expanding. However, the traditional teaching mode of Soil Mechanics courses favours theoretical lectures and the practical aspects are relatively weak, which is difficult to meet the modern engineering needs and student training objectives. Under the background of emerging engineering science, the educational concepts emphasising interdisciplinarity, innovativeness and practicability have become the mainstream, and new technologies and methods are increasingly widely used in engineering. Under this background, traditional engineering education is facing serious challenges, and Soil Mechanics courses urgently need to carry out teaching reforms to adapt to the ever-changing needs of the industry and enhance students' innovative and practical abilities, so as to better serve the modern engineering construction.

1. The Current Situation of Teaching Soil Mechanics Course

With the rapid development of infrastructure

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construction in China, the importance of Soil Mechanics courses in engineering education has become more and more prominent. China's infrastructure construction, including high-speed railways, roads, bridges, water conservancy projects and other fields, has significantly increased the demand for expertise in Soil Mechanics. These projects put forward higher requirements for engineering geology, soil stability, foundation treatment, etc., so the Soil Mechanics course has become a core basic course for training civil engineering students (Li, Liu, & Liu, 2024). Students not only need to master a solid theoretical foundation, but also need to have the ability to solve practical engineering problems.

At present, there are some urgent problems in the teaching of Soil Mechanics course. First of all, the soil mechanics course is theoretical and practical, and it is difficult to learn. The course content covers complex mechanical principles and mathematical calculations, requiring students to have strong experimental ability, which makes students easily confused in the learning process. Secondly, the teaching model is relatively monotonous, primarily relying on traditional lecture methods, and lacks interactivity and innovation, most of the courses rely on the board or PPT, this teaching method is difficult to stimulate the students' learning interest and initiative, and difficult to effectively reflect the actual situation of engineering practice, it is difficult for the students to understand the abstract concept of Soil Mechanics. In addition, the relatively small number of course hours limits the depth and breadth of the teaching content. Due to the limited class time, teachers can only briefly introduce the basic theory, lack of in-depth discussion and case analysis, and the application of actual engineering cases is not strong enough. Finally, the experimental teaching of soil mechanics is weak. Limited experimental equipment and resources, single experimental content, difficult to simulate complex engineering situations, such as Triaxial compression test and other complex experiments are less involved, which restricts the cultivation of students' hands-on ability and innovative thinking (Wang, 2023). In addition, the lagging nature of the existing teaching materials also makes it difficult for students to grasp the latest engineering practices and lack a systematic understanding of new technologies, which limits their ability to quickly adapt to the rapidly changing engineering environment and the application of new technologies after graduation.

Overall, there is a certain gap between the teaching status of Soil Mechanics courses and the needs of China's infrastructure development. Therefore, in order to cultivate civil engineering talents in line with the needs of the times, the reform of the teaching of Soil Mechanics should not only update the content of the teaching materials in a timely manner, but also systematically improve the teaching mode and practical teaching links, so as to better improve the quality of teaching and cultivate the practical ability and innovation ability of students.

2. The Significance of the Emerging Engineering Science Background to the Teaching Reform of Soil Mechanics Courses

2.1. Promote the close integration of Soil Mechanics education and modern engineering needs

With the rapid development and technological innovation in the field of civil engineering, the scale and complexity of engineering projects are increasing, which puts forward higher requirements for the application of Soil Mechanics. If the education of Soil Mechanics can be closely combined with modern engineering needs, it will enable students to better master and apply the latest Soil Mechanics theories and technical means, which will help to improve their ability to solve practical engineering problems. This combination will not only improve students' professionalism and competitiveness, but also ensure that future civil engineering projects will meet higher standards in terms of quality, safety and sustainability. Through the interface between education and engineering practice, students are able to be exposed to the latest industry trends and engineering application scenarios in the course of their studies, thus developing their ability to adapt to the modern engineering environment. In this way, Soil Mechanics education is not limited to traditional theoretical teaching, but is transformed into a comprehensive education mode oriented to practical needs, providing a solid foundation for the cultivation of high-quality and adaptable engineering and technical talents.

2.2. Cultivate compound talents with innovative

ability and practical experience

Modern engineering projects often have a high degree of complexity and diversity, relying solely on traditional theoretical knowledge has been unable to fully solve practical engineering problems. Therefore, it becomes crucial to cultivate engineering talents who can flexibly apply knowledge and propose innovative solutions. By reforming the Soil Mechanics curriculum and enhancing students' innovative thinking and practical ability, we can better meet the social demand for high-quality engineering talents. These composite talents are not only solid and reliable in the basic theories of civil engineering, but also demonstrate strong adaptability and creativity in practical operation. They are able to quickly master new technologies, cope with new challenges, and carry out effective teamwork and project management in complex engineering environments (Xu, 2024). This talent cultivation mode helps to improve the overall quality and efficiency of engineering construction, promotes technological progress, facilitates the sustainable development of engineering projects, and provides a solid talent guarantee for the country's infrastructure construction and economic development.

2.3. Strengthening professional ethics education and enhancing students' sense of social responsibility

As an important basic discipline of civil engineering, the teaching of Soil Mechanics not only focuses on technology and theory, but also needs to guide students to understand the profound impact of engineering on society and the environment. By strengthening professional ethics education, students can recognise the moral responsibility and social impact involved in engineering decisions, and thus adhere to high standards of professional conduct in their future careers. Students will develop a sense of social responsibility so that they will not only focus on technical and economic benefits but also consider environmental protection and social welfare when designing and implementing engineering projects. The cultivation of such a sense of ethics and responsibility will help prevent the occurrence of engineering blunders and ethical problems, and improve the overall quality and social acceptance of engineering projects. Engineers with a strong sense of social responsibility are more capable of making responsible decisions in crises and challenges and contributing to the sustainable development of society. Strengthening professional ethics education is not only necessary for training qualified engineers, but also the key to promoting the healthy development of the industry.

3. Teaching Reform and Practice Strategy of Soil Mechanics Engineering Under the Background of Emerging Engineering Science

3.1. Optimising the course content system, integrating new technologies and interdisciplinary knowledge

Under the background of emerging engineering science, optimising the course content system of Soil Mechanics requires updating the course content by combining the latest engineering technologies and industry demands, and introducing cutting-edge Soil Mechanics knowledge. For example, the introduction of digital measurement technology and intelligent sensing technology should be increased so that students can master the latest means of soil monitoring and analysis. On the other hand, the integration of Soil Mechanics with other related disciplines, such as with intelligent construction and environmental engineering, should be strengthened. Intelligent construction requires students to understand the application of geomechanics in the process of intelligent construction, while environmental engineering focuses on soil pollution prevention and ecological restoration technology, through the integration of these interdisciplinary knowledge, students' vision can be broadened and their adaptability in diversified engineering projects can be enhanced (Dong, Li, Zhang, et al., 2024).

In the specific curriculum, the basic theory part should include traditional core knowledge such as basic physical properties of soil, stress calculation in soil, seepage, deformation and strength. Meanwhile, the course content should increase engineering case studies, especially real projects involving new technologies and techniques, such as the Hong Kong-Zhuhai-Macao Immersed Tube Tunnel and the Qinghai-Tibet Railway and other major projects. Through the explanation of these real cases, students can understand the practical application of complex theories more intuitively. Eventually, by optimising the course content system, the Soil Mechanics course is constructed to be more comprehensive, practical and cutting-edge, so that students not only have a

solid theoretical foundation, but also can flexibly apply what they have learned in modern engineering, and meet the demand for high-quality talents in the context of emerging engineering science.

3.2. Innovative teaching methods, application of virtual reality and project-driven learning mode

Although the traditional "lecture" teaching method can transfer basic theoretical knowledge, it lacks interactivity and practicability, which makes it difficult to stimulate students' interest and initiative. Therefore, the introduction of VR (Virtual Reality) and AR (Augmented Reality) technology can provide a new perspective and experience for the teaching of Soil Mechanics. For example, through VR technology, students can simulate the stress-strain changes and seepage process of soil body in the virtual environment, so as to visually observe and understand the complex mechanical behaviour. In addition, AR technology can superimpose the virtual model on the actual scene, helping students to better combine theoretical knowledge with actual engineering. The application of these technologies makes the abstract concepts of Soil Mechanics concrete and visual, and improves the vividness and effectiveness of teaching.

In addition to the application of advanced technologies, the Project-Based Learning model (PBL) is also an effective teaching method. By introducing real engineering projects into the classroom, students can apply the learned knowledge of Soil Mechanics in the process of solving real problems. This not only cultivates students' innovative thinking and problem-solving ability, but also enhances teamwork and communication skills (Zeng, Liu, Hu, et al., 2023). For example, teachers can organize students to simulate the design of a small civil engineering project, covering the whole process from soil survey, mechanical analysis to the development of construction plans. In this process, students can not only deepen their understanding of the course content, but also appreciate the complexity and diversity of engineering practice. Through the combination of virtual reality technology and project-driven learning mode, the course of Soil Mechanics will be closer to the actual engineering needs, laying a solid foundation for the cultivation of high-quality talents with innovative ability and practical experience.

3.3. Strengthening practical teaching links, increasing experimental courses and engineering internship opportunities

Under the background of emerging engineering science, practical teaching can effectively make up for the shortcomings of traditional classroom teaching and enable students to combine theoretical knowledge with practical application. Therefore, increasing experimental courses and engineering internship opportunities is crucial to cultivate students' hands-on ability and ability to solve practical problems. Colleges and universities should optimise and expand the experimental courses of soil mechanics and increase the diversity and complexity of experimental projects. For example, in addition to the traditional straight shear test and water content test, more complex experimental projects such as Triaxial compression test should be introduced, which can more comprehensively reflect the mechanical behaviour of soil under different conditions. Through the use of modern experimental equipment, such as digital Soil Mechanics testing devices and sensing technology, the accuracy and analysis of experimental data can also be improved, enabling students to access the most cutting-edge technical means. In addition to the experimental courses, it is also key to strengthen the cooperation with enterprises and research institutes to increase the engineering internship opportunities for students. Through school-enterprise cooperation, students can participate in actual engineering projects, from site investigation, soil analysis to construction monitoring, to fully understand the actual application process of Soil Mechanics in engineering. This kind of internship experience can not only consolidate what has been learned in the classroom, but also enable students to cultivate problem-solving ability and teamwork spirit in a real environment (Peng, Li, & Geng, 2023). Through the effective combination of experimental courses and engineering internships, students will be able to quickly adapt to the actual working environment after graduation and meet the demand for high-quality engineering talents in the context of emerging engineering science.

3.4. Promote University-Industry-Research Cooperation to enhance students' participation in actual engineering projects

Under the background of the emerging engineering science, promoting the cooperation between industry, universities and research institutes

can help to enhance students' participation in actual engineering projects and cultivate high-quality engineering talents with innovation ability and practical experience. University-Industry-Research cooperation can effectively integrate academic research, engineering practice and teaching, and provide students with abundant learning resources and practical opportunities. Through the cooperation with famous enterprises, research institutes and engineering projects, the university can invite industry experts and engineers to participate in the teaching of the courses, share the latest industry developments and engineering cases, and bring first-hand engineering experience and practical problem solving ideas to students.

Promoting University-Industry-Research cooperation can also create opportunities for students to directly participate in actual engineering projects. For example, schools can cooperate with enterprises to set up student internship bases and regularly organize students to participate in large-scale engineering projects, such as infrastructure construction and geological disaster management. In these projects, students can apply the knowledge of Soil Mechanics to carry out practical operations such as soil mechanical property testing, soil stability analysis and engineering design optimisation, so as to deepen their understanding of theoretical knowledge (Feng et al, 2023). At the same time, this mode of cooperation can also provide students with more opportunities to participate in scientific research projects, such as innovative experimental projects, engineering simulation and simulation, so that students can get exercise in academic research and technological innovation. Through University-Industry-Research Cooperation, students can not only accumulate practical work experience, but also enhance their innovative thinking, ability to solve practical problems and sense of teamwork. This all-round cultivation mode will provide strong support for the cultivation of civil engineering professionals adapted to modern engineering needs in the context of emerging engineering science.

3.5. Integration of civic and political education to cultivate students' professional ethics and sense of social responsibility

Under the background of emerging engineering science, the teaching of Soil Mechanics, as a basic discipline of civil engineering, should not only focus on the cultivation of theoretical and practical abilities, but also help students to establish correct values and cultivate their professional ethics and sense of social responsibility (Zhou & Hou, 2024). Through the integration of Civic Education, students can deeply understand the social value and moral responsibility of engineering while learning professional knowledge. For example, major engineering cases in history can be introduced into the teaching process to explore the social responsibility and ethical issues involved, such as bridge collapses, tunnel collapses and other events, to help students realise the importance of scientific rigour and professional ethics. In classroom teaching and practical teaching, teachers can guide students to learn about the professionalism and ethics of famous engineers by recounting their careers and contributions. For example, introducing the story of Mao Yisheng and other old-generation engineers who insisted on the quality of engineering in a difficult environment will stimulate students' national pride and sense of responsibility. In the process of experimental teaching and internship, students can also be confronted with the choice of ethical decision-making by setting up relevant situational simulations to enhance their sense of professional ethics. By integrating Civic and Political Education into the teaching of Soil Mechanics, students can not only learn professional skills, but also understand the impact of engineering on society and the environment, and realise their responsibilities in their future careers. This comprehensive education mode not only cultivates students' technical ability, but also shapes their moral character, providing an important guarantee for the country to cultivate engineering talents with comprehensive quality.

Conclusion

By exploring the teaching reform in the context of emerging engineering science, the teaching quality of Soil Mechanics courses and the comprehensive quality of students will be significantly improved. The reform not only updates the course content and introduces the latest engineering technology and interdisciplinary knowledge, but also innovates the teaching methods and applies virtual reality and project-driven learning mode. These initiatives have greatly enhanced students' theoretical understanding and practical ability. By strengthening practical

teaching sessions and industry-university-research cooperation, universities have increased the opportunities for students to participate in actual engineering projects, enabling them to exercise in a real environment. The integration of Civic and Political Education, on the other hand, fosters students‘ professional ethics and sense of social responsibility, and helps to mould students’ moral character and professionalism. Looking into the future, the course of Soil Mechanics will continue to adjust and improve on the teaching mode, keep up with the progress of science and technology and the development needs of the industry, and cultivate more high-quality civil engineering talents adapted to the needs of the emerging engineering science, so as to provide strong support for the engineering construction of the society and the country.

Conflict of Interest

The author declares that she has no conflicts of interest to this work.

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