

# *An Exploration on the Construction of the Textbook "Elastic-Plastic Mechanics" and the Ideological and Political Teaching Reform in Petroleum Colleges*

Chen Yanfei\*, Wang Zhihao, Gao Zhihao, Zhang Zuomin, Yin Yi, Zhong Rongfeng,  
Li Shuopeng, Zhang Weidong

*National Engineering Laboratory of Oil and Gas Pipeline Transportation Safety, China University of Petroleum (Beijing)/Beijing Key Laboratory of Urban Oil and Gas Transmission and Distribution Technology, Beijing, China*

*\*Corresponding author*

**Keywords:** Elastic-plastic mechanics; textbook construction; teaching reform; ideological and political education

**Abstract:** "Elastic-Plastic Mechanics" is a basic course for science and engineering majors, and it is also a required mechanics course for many majors in petroleum colleges and universities. Because this course has many basic theoretical formulas, abstract content, strong logic, and certain requirements for students' mathematics and mechanics, the phenomenon of "difficult for students to learn and difficult for teachers to teach" often occurs. In addition, there is currently a lack of elastoplastic mechanics textbooks that are highly relevant to the petroleum industry, resulting in unsatisfactory teaching results. Combining its own teaching experience and the characteristics of students in petroleum colleges and universities, the teaching team has compiled the book "Basic Theory and Engineering Application of Elastic-Plastic Mechanics" on the basis of fully absorbing domestic and foreign excellent teaching materials for elastic-plastic mechanics. This book has entered the petroleum industry. Typical engineering examples are integrated into ideological and political content; to a certain extent, it has promoted the course construction of elastic-plastic mechanics in petroleum colleges and universities.

## 1. Introduction

Postgraduate education is an important part of higher education. The "Opinions of the Ministry of Education on Improving and Strengthening the Construction of Postgraduate Courses" issued by the Ministry of Education pointed out: attach great importance to the important role of course learning in the training of postgraduates. Curriculum study is an important feature of my country's degree and postgraduate education system. It is a necessary link to ensure the quality of postgraduate training. It has a basic, comprehensive and comprehensive role in the growth of postgraduates. Emphasizing curriculum learning, strengthening curriculum construction, and improving curriculum quality are important and urgent tasks for deepening the reform of postgraduate education [1]. The construction of high-quality courses is inseparable from teaching

materials that are closely integrated with professional characteristics. "Elastic-Plastic Mechanics" is a professional basic compulsory course for postgraduates majoring in offshore oil and gas engineering, petroleum and natural gas engineering, safety science and engineering, etc., China University of Petroleum (Beijing). It has high abstraction, strong logic and complex knowledge points. Features. Therefore, students generally have the phenomenon of "not understanding in class but not understanding in class". In addition, although there are many kinds of current elastoplastic mechanics textbooks, most of them have the characteristics of strong theory and require students to have a certain mechanical foundation; and these textbooks are not closely integrated with petroleum engineering majors. Faced with these problems, the teaching team of the safety course for oil and gas storage and transportation engineering of China University of Petroleum (Beijing) proceeded from the actual situation of students, based on the syllabus of elastic-plastic mechanics, closely related to the engineering characteristics of the petroleum industry, and combined with its own ten years of teaching. Based on his experience, he has compiled a book, "Basic Theory and Engineering Application of Elastoplastic Mechanics", which is suitable for teaching postgraduate elasto-plastic mechanics courses in petroleum universities. This textbook has extensively absorbed the writing experience of excellent textbooks related to elastoplastic mechanics at home and abroad, and on this basis has reorganized the knowledge points of elasto-plastic mechanics, rearranged the elasto-plastic mechanics framework, and integrated it into a large number of petroleum industries. Typical engineering examples make it more in line with the requirements of the petroleum industry for talent training in the context of today's era, and lay a certain foundation for students to engage in related research and work in the future.

## **2. From the point to the surface, the knowledge progresses layer by layer**

Mechanics, as a basic science, is a required basic course for most engineering students. Elastoplastic mechanics is a branch of solid mechanics. The elastoplastic mechanics course is based on theoretical mechanics, structural mechanics, material mechanics, etc., to further systematically learn the basic concepts and research methods of elasto-plastic mechanics, for the follow-up professional course study and scientific research work Carry out the necessary mechanical support. According to the new engineering concept, through course study, students not only need to establish accurate physical concepts, master the analysis methods of elastic-plastic deformation mechanics, but also learn to apply the basic theories and methods of elastic-plastic mechanics to think, analyze and solve practical engineering problems [2]. This requires students to have a solid foundation in mechanics and strong mathematical reasoning ability. However, in actual teaching, there are often some difficulties in order to better complete the teaching tasks of mechanics and achieve the new engineering concept. On the one hand, for postgraduates from engineering colleges and universities with distinctive characteristics in petroleum and other industries, their mathematical foundation and mechanics foundation are relatively weak compared with other engineering students; on the other hand, with the popularization of higher education in my country in recent years, higher education institutions The enrollment scale of postgraduates has been expanding year by year [3], and it is not uncommon for interdisciplinary graduate students to study for postgraduates. A small number of interdisciplinary postgraduates have not studied basic mechanics such as theoretical mechanics and material mechanics during their undergraduate years. Writing presents new challenges. In this regard, the teaching team has fully considered some of the above problems when compiling the textbook, not only focusing on the progressive relationship between the compilation of basic content of elastic-plastic mechanics and the difficulty of knowledge points, but also on the situation of students and the characteristics of the major itself, so that it cannot only be suitable for the major. The study of postgraduates can be combined with the engineering practice of the current industry.

The book is divided into 12 chapters, mainly covering stress analysis, strain analysis, elastic-plastic constitutive relation and yield criterion, solution of plane problem in Cartesian coordinates, solution of plane problem in polar coordinates, elastic-plastic torsion of rod, elastic-plastic of thick-walled cylinder Analysis, elasto-plastic analysis of ultimate internal pressure of thin-walled pipes, elasto-plastic analysis of rectangular beams, elasto-plastic analysis of ultimate bending moment of pipes, elasto-plastic analysis of ultimate bending moment of pipes with corrosion defects, etc. Among them, the basic theoretical knowledge of mechanics accounts for more than one third of the book. In terms of content arrangement, start with any point inside the object, study the stress-strain state of a point, and then expand to study the stress and strain of the plane, and finally further discuss the force of the space body. In the selection of the coordinate system, the derivation process of the equilibrium equations, geometric equations, constitutive equations and other formulas in the plane rectangular coordinate system is studied first, and then it is further extended to the derivation of the formulas in polar coordinates. In the construction of the structure, the basic content of stress theory and strain theory is first taught, followed by a large-scale compilation of elastic mechanics, and then transition to plastic mechanics, and finally the process of components from elastic deformation to elastic-plastic deformation to complete plastic deformation. discussion and conclusion. For example, the typical thick-walled cylindrical structure in the project is selected for force analysis. The elastic problem is analyzed first, and the relevant conclusions are drawn. Then, it is further extended to the plastic problem. Finally, the laws and characteristics of the thick-walled cylinder in the elastic-plastic deformation process are summarized. Achieved knowledge points from simple to difficult, and the content is progressive. In addition, the book also provides detailed explanations of stress tensor, stress concentration phenomenon, inverse solution method and semi-inverse solution method, etc., as well as classical theories in elastic-plastic mechanics such as Saint-Venant's principle, Tresca and Mises yield criterion, etc. A detailed introduction is given, and the detailed derivation process of some more complex formulas is given. It is more suitable for petroleum engineering students with weak mechanics and mathematics foundation.

### **3. In line with the characteristics of the industry, focus on ability training**

Actively serving the society and cultivating outstanding talents is an important mission and responsibility of colleges and universities, and an accurate and in-depth understanding of industry needs is the primary task of the suitability of talent training. As a technology-intensive oil industry, with the in-depth development and transformation and upgrading, the demand for talents is getting higher and higher. It is a major challenge and an important mission for petroleum colleges and universities to improve the social suitability of petroleum engineering and technical personnel and cultivate outstanding engineering and technical personnel needed by the petroleum industry [4]. The cultivation of outstanding talents is inseparable from high-quality curriculum construction. To improve the suitability of talents, the first thing to improve is the suitability of teaching materials. The teaching team found in the process of researching elastoplastic mechanics textbooks that most of the current elastoplastic mechanics textbooks are written by teachers majoring in mechanics. Although these textbooks cover typical engineering structure analysis in engineering, such as analysis of thick-walled cylinders, rotating circles Disk analysis, shaft torsion, thin plate analysis, thermal stress, structural plastic limit analysis and stability, mechanical analysis of metal plastic forming, load-bearing analysis of geotechnical structures, etc. [5] are not well suited to the characteristics of the petroleum industry. . In the oil industry, the most common is the cylindrical structure. Whether it is various oil extraction equipment used in the process of oil and gas extraction, various pipelines for transporting oil and natural gas, and storage tanks for storing and transporting

various petroleum products, they can all be classified as cylindrical (cylindrical) structures. In this regard, the teaching team focused on the elastic-plastic analysis of the force of cylindrical objects in the textbook, and made corresponding simplifications to other contents. In the content design of the textbook, the concept of polar coordinate system is first introduced into the plane problem and the basic equations expressed in polar coordinate system are discussed. Secondly, the elastic-plastic torsion problem of circular shaft rods is studied, and then it is extended to the elastic-plasticity of thick-walled cylinders. Analysis, when writing the chapter on elastoplastic analysis of thick-walled cylinders, the teaching team found that most of the current elastoplastic mechanics textbooks only discuss the analysis of the stress, strain and displacement when the cylinder wall is subjected to uniform internal and external pressures. In the actual engineering of the petroleum industry, it is more common for thick-walled cylinders to bear non-uniform internal pressure. For this part of the content, the superposition principle was introduced when writing the textbook, and the non-uniform pressure was decomposed into uniform pressure, sine and cosine loads, etc., and then based on the elastic-plastic analysis results of the thick-walled cylinder subjected to uniform pressure and the inverse solution (or semi-inverse solution method) to obtain the results of the elastic-plastic analysis of the thick-walled cylinder under the action of trigonometric function loads. Provide solutions for students to encounter such problems in practical engineering in the future. Then, the elasto-plastic analysis of the ultimate internal pressure of thin-walled pipelines, which is closely related to the petroleum industry, is further studied. In the last chapter, the teaching team introduced the basic assumptions and theories of the elastoplastic analysis of the ultimate bending moment of the pipeline with corrosion defects to the students based on the research progress of the ultimate bearing capacity of the pipeline with corrosion defects at home and abroad in recent years and the achievements of the research group in this regard and analytical methods.

#### **4. Integrate ideology and politics into textbooks and cultivate healthy talents**

On October 8, 2019, the Ministry of Education clearly stated that "the ideological and political education should run through the whole process of talent training, and the ideological and political construction of the curriculum should be regarded as a key link in the implementation of the fundamental task of cultivating people by virtue. Education and implicit education should be unified, and the ideological and political education resources contained in various courses and teaching methods should be fully explored." As the highest level of academic education, postgraduate education is an important symbol of a country's development level and development potential. It shoulders the important mission of high-level talent training and innovation and creation, and is an important engine for the construction of a powerful modern socialist country [6]. At present, postgraduate students in colleges and universities are showing a trend of expanding enrollment year by year, and postgraduate education is becoming more and more popular. However, from the current situation, most postgraduates pay attention to professional study and scientific research, and pay less attention to ideological and political study, and ideological and political education is facing new challenges [7].

As a petroleum institution, China University of Petroleum (Beijing), the teaching effect of ideological and political courses is relatively weaker than the main oil courses, and graduates are likely to be engaged in high-tech industries related to national security and social stability, so ideological and political education is more necessary. And important. Mechanics courses based on basic theory and formula derivation have relatively little or no content of "course ideology and politics"; therefore, it is necessary to dig deep into the cultural elements and value models contained in mechanics courses such as "elasto-plastic mechanics" and carry out patriotism. The "course ideology and politics" at the core not only plays an irreplaceable role in deepening the identification of socialism with Chinese characteristics and strengthening the pursuit of China's great rejuvenation, but also in the professional knowledge learning, interest guidance, innovation ability training and

graduate students of mechanics courses. The ability to analyze and solve problems has an immeasurable effect. In this regard, the teaching team selected the deeds of 12 Chinese scientists including Zhou Peiyuan, a master of mechanics education, Li Siguang, a master of geology, Qian Weichang, the father of Chinese mechanics, Deng Jiaxian, the father of China's nuclear bomb, Qian Xuesen, the father of Chinese missiles, and Yu Min, the father of China's hydrogen bomb. , arranged to the ideological and political introduction part of the course at the end of each chapter. By introducing the educational history and scientific research experience of the older generation of scientists, we will carry forward the innovative spirit of the older generation of scientists who are not afraid of difficulties and dare to be the first, the patriotic spirit of cherishing the motherland and serving the people, the truth-seeking spirit of pursuing truth and rigorous scholarship, and being indifferent. Fame and fortune, dedication to research. This will further correct students' attitude towards academics and scientific research, inspire and cultivate students' scientific research spirit of daring to question, dare to explore, not afraid of difficulties, seeking truth and pragmatism, and noble sentiments of being loyal to the motherland, caring for the people, and selfless dedication. Through the in-depth integration of professional knowledge and ideological and political education, we will cultivate students' patriotism and strong national feelings, improve their cultural literacy and scientific research spirit, and lay a solid foundation for cultivating socialist builders and successors with all-round development of morality, intelligence, physique, beauty and labor.

## 5. Conclusions

As an important basic mechanics course in petroleum colleges and universities, elastoplastic mechanics plays an important role in cultivating students' professional mechanics knowledge, exercising students' thinking and innovation ability. In the compilation of the textbook "Basic Theory and Engineering Application of Elastoplastic Mechanics", based on the basic theory of elasto-plastic mechanics, build a textbook framework that fits the characteristics of petroleum colleges and universities, pay attention to sorting out the knowledge context of elasto-plastic mechanics, and teach knowledge that fits the development of the students' industry gist. While highlighting the characteristics of the petroleum industry and based on engineering practice, this book is further integrated into ideological and political education, which can better improve the teaching quality of elastic-plastic mechanics, better cultivate students' engineering practice ability, and better serve the petroleum industry development and modernization of the country.

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