Study on the Content and Implementation of the Ideological and Political Theories Education in Mechanics of Materials

Qiufei Ren[1] and Wenzheng Su[2,*]

[1]School of Marxism, Dalian Vocational and Technical College (Dalian Open University), Dalian, Liaoning, China.
[2]Department of Engineering Mechanics, School of Civil Engineering, Dalian Jiaotong University, Dalian, Liaoning, China

Abstract: The integration of ideological and political education in all courses needs the synergistic combination of professional courses with ideological and political courses. Based on the law of the personnel cultivation process and the nature of *Mechanics of Materials*, this paper proposes that the focus of ideological and political teaching in *Mechanics of Materials* is to guide students to master and apply Marxist standpoints and methodologies consciously to analyze and solve problems and develop noble scientific spirits. Taking the chapter *Bending Stress* as an example, the course design and implementation methods of ideological and political education in Mechanics of Materials are discussed in detail.

1. Introduction

Comprehensively promoting the integration of ideological and political education in all courses is a strategic initiative to implement the fundamental task of establishing moral education, which requires the participation of all the courses and the integration of values into knowledge transfer and ability training to help foster the young the morally sound values and outlook on the world and life [1]. Only when the explicit education of professional courses and the implicit education of ideological and political courses synergize with each other, can we build a full and comprehensive education for all the members. Generally, professional teachers account for 80% of the total number of teachers in a university and students spend 80% of their time on professional courses, so teaching professional courses is the foundation for ideological and political theories teaching in all courses.

Ministry of Education holds that the ideological and political theories taught in all courses should be specifically designed following the characteristics of disciplines and majors, and the Guideline of Ideological and Political Courses in Higher Education Institutions has been issued for different majors accordingly[1]. Only by strengthening the integration of ideological and political theories in all courses, can the overall goal of curriculum ideological and political construction be effectively realized. The Guideline of Ideological and Political Courses in Higher Education Institutions points out that the courses of science and engineering majors should tie Marxist standpoints and methodologies with the cultivation of scientific spirit in the course teaching to improve students' ability to correctly understand, analyze and solve problems.

* Corresponding author: wzhsu@djtu.edu.cn

Mechanics of Materials, characterized by a large number of students and long class hours, is one of the important engineering compulsory courses, covering almost all major engineering categories including mechanical, civil engineering, materials, transportation, etc. Therefore, it is of great significance to integrate ideological and political theories into the courses of *Mechanics of Materials*. However, it is found that there are still no examples to follow for the teaching content and activities of ideological and political education in *Mechanics of Materials*.

The ideological and political education in the *Mechanics of Materials* should be designed with full consideration of the personnel training process and the nature of the course. In terms of the personnel training process, the students who take *Mechanics of Materials* courses are usually sophomores in a four-year higher education system. Before that, they are mainly educated in general studies, while junior and senior students are mainly educated in professional studies, so sophomore year is in the critical period of transition from general education to professional education. In China, sophomore students have already studied the basic standpoints and methodologies of Marxism. However, they still do not know how to apply the methodologies of Marxism to deal with various practical problems. Marxism not only presents a correct worldview but also provides a scientific methodology. As pointed out by President Xi Jinping “Why can the Communist Party of China (CPC) and Socialism with Chinese characteristics be good? In the final analysis, it is because of Marxism” [2]. Only when students are fully aware of the advanced and scientific nature of Marxism can they consciously apply Marxism to guide their study, work, and life, and elevate it to belief. Therefore, the priority of the ideological and political theories teaching in *Mechanics*

© The Authors, published by EDP Sciences. This is an open access article distributed under the terms of the Creative Commons Attribution License 4.0 (https://creativecommons.org/licenses/by/4.0/).

of Materials is to guide students to master and apply Marxist standpoints and methodologies to analyze and solve problems, enhance their consciousness of applying Marxism, lay a solid methodological foundation for the subsequent study and work, continuously improve the level of scientific thinking, and develop noble scientific spirits.

Considering the nature of *Mechanics of Materials* as a basic professional course, it should be clearly distinguished from general courses in terms of the education of ideological and political theories. The general engineering curriculum focuses on cultivating students' engineering ethics and craftsmanship, as well as inspiring students' national sentiment and mission. The ideological and political education of the course can be well achieved by interspersing the world-renowned achievements of China in engineering fields and relevant touching deeds. While the ideological and political teaching in *Mechanics of Materials* should not overemphasize the contribution of the course to modernization. Although many achievements in modernization are inseparable from the ideas and knowledge of *Mechanics of Materials*, it rarely directly solves engineering problems. Even engineering problems that are highly related to mechanics are mainly solved by modern mechanical theories represented by the finite element method. In addition, the ideological and political teaching in the *Mechanics of Materials* must be coordinated with other professional courses. Premature insertion of these outstanding achievements is easy to overlap with the ideological and political teaching in professional courses offered by students in the senior stage, which is not conducive to the integration of ideological and political education. Therefore, considering the characteristics of *Mechanics of Materials* and the work division and cooperation of different courses, the ideological and political education in *Mechanics of Materials* should emphasize the cultivation of students' ability to use Marxist basic standpoints and methodologies.

To sum up, the integration of ideological and political education in *Mechanics of Materials* is supposed to aim at helping students to master and apply the basic Marxist standpoints and methodologies to understand, analyze and solve problems, systematically master scientific methods, and form a correct scientific view. Considering the nature of the *Mechanics of Materials* and taking the chapter *Bending Stress* as an example, the paper discusses the teaching content and implementation methods to integrate ideological and political education in the specialty course.

2. Teaching Content and Implementation Methods of Ideological and Political Education in *Mechanics of Materials*

The philosophical problems embedded behind the professional knowledge such as phenomena, theories, methodology, and models related to *Mechanics of Materials* are expected to be stressed in the integration of ideological and political theories to guide students to correctly understand, analyze and solve problems and to foster in the young the morally sound values and outlook on the world by using the basic Marxist standpoints and methodologies. In its formation and development, Marxism has both criticized and inherited philosophical ideas from different schools. The development of *Mechanics of Materials* is enriched with Marxist dialectical materialist ideas, especially the material dialectics including the law of the unity of opposites, the law of quantitative change and qualitative change, and the law of the negation of the negation, as well as a series of Marxist philosophical categories such as whole and part, form and content, phenomenon and essence, occasionality and inevitability, etc. can all be found in the *Mechanics of Materials.* Therefore, the implementation of ideological and political education in the *Mechanics of Materials* should deeply explore the Marxist philosophical principles behind the specialty theories from the perspective of methodology.

The following principles need to be considered in the actual implementation:

First, the ideological and political content should be consciously screened for simplicity and precision. Things are universally connected, and different philosophical elements may be embedded behind a theory, so it is necessary to capture the most representative one based on the idea of contradiction analysis. Otherwise, it may lead to students' fatigue and even show a negative impact on the education of professional knowledge.

Second, the content should be of moderate difficulty. Consider the fact that the course is intended for sophomore students. Some obvious truths should not be highlighted and Marxist Natural Dialectics, which is difficult for undergraduates to understand, should not also be exaggerated. The content should ideally be within the scope of what students have learned in the course *Basic Principles of Marxism*. In addition, ideological and political teaching should not go any further than necessary to leave enough thinking space for students.

Third, ideological and political theories are supposed to be gradually spread among students. Professional knowledge needs to be stressed in teaching activities, and Marxist standpoints and methodologies should be properly interpreted, which makes the finishing point.

3. Examples of ideological and political teaching in the Chapter *Bending Stress*

Taking the content of *Bending Stress* as an example, the chapter illustrates the methods to integrate Marxist basic standpoints and methodologies with professional knowledge to implement ideological and political teaching.

First, Marxian phenomena and essential categories can be introduced through the plane-section assumption of beam deformation. The plane-section assumption, as an important assumption of beam theory, can be elicited by an experiment, in which, some transverse and longitudinal orthogonal lines are pre-drawn on the

surface of the beam, resulting in a pure bending deformation of the beam. It is observed that the transverse lines remain straight, while the longitudinal lines become curved, and the transverse and longitudinal lines remain orthogonal[3]. Meanwhile, students should be inspired to explore the essence behind the phenomenon, that is, the beam surface deformation lies in the beam cross-section remaining plane, which is called the plane-section assumption. Phenomena and essence are the basic categories of Marxism, and neither one exists without the other [4]. Viewing essence through phenomena is an important part of Marxist methodology.

Second, Dialectical materialist epistemology holds that practice is the sole criterion for testing truth[4]. The verification of the plane-section assumption cannot be done without a lot of practice. Based on the previous work, the beam theory was proposed by the French mechanic Navi in 1826 and has been numerously tested in engineering practice. The results have shown the correctness of the plane-section assumption. But the verification of the plane-section assumption is not compiled in some textbooks, and it is often ignored by young teachers in class.

Third, the determination of the position of the neutral axis shows the law of the negation of the negation. Engels proposed that: “The world is not to be considered as a complexity of ready-made things, but as a complexity made up of processes in which the stable things, no less than the thought pictures in the brain—the idea, cause an unbroken chain of coming into being and passing away, in which, by means of all sorts of seeming accidents, and despite all the temporary setbacks, forward progress will eventually be achieved”[5]. Today, it can be easily concluded that the neutral axis passes through the centroid, but the discovery of the neutral axis has not been smooth in the long history[6]. Starting from Galileo's systematic study of the bending deformation of beams in 1638, a large number of scientists, such as Mariot, Bernoulli, and Navi, have repeatedly denied and revised the theory to find out the correct position of the neutral axis, promoting the human understanding of the theory for nearly 300 years. Finally, in 1826, the correct position of the neutral axis was determined by Navi based on the previous work. It can be said that the development of the beam theory embodies the law of the negation of the negation and it is in the process of repeated affirmation and negation that human understanding of the objective world achieves a spiral upward.

Fourth, the calculation of the normal stress in the cross-section during transverse bending reflects the method of contradiction analysis. *Mechanics of Materials* adopts the formula of normal stress in the cross-section of a pure bending beam to approximately calculate the normal stress during transverse bending. However, using the plane-section assumption and the assumption of no extrusion between longitudinal line segments in the calculation of the normal stress of transverse bending leads to contradictions, which are reflected in the contradiction between material strength and bending normal stress, warping normal stress and extrusion stress between longitudinal line segments. Marxism believes that using the contradiction analysis method to solve problems requires us to constantly strengthen our problem consciousness, adhere to analyze problems on a case-by-case basis, and be good at recognizing and resolving contradictions, especially to give priority to solving the main contradiction as a way to drive the solution of other contradictions [4]. Taking the simply supported beam under uniform pressure shown in Figure 1 as an example, through strict elastic mechanics calculation, the normal stress X of the beam cross-section and the compressive stress Y between longitudinal line segments are as follows [7].

$$\sigma_x = \frac{M}{I} y + q \frac{y}{h}\left(4\frac{y^2}{h^2} - \frac{3}{5} \right) \tag{1}$$

$$\sigma_y = -\frac{q}{2}\left(1+\frac{y}{h} \right)\left(1-\frac{2y}{h} \right)^2 \tag{2}$$

where Formula (1) represents the additional normal stress caused by section warping, which is represented below.

$$\sigma_x^{add} = q \frac{y}{h}\left(4\frac{y^2}{h^2} - \frac{3}{5} \right) \tag{3}$$

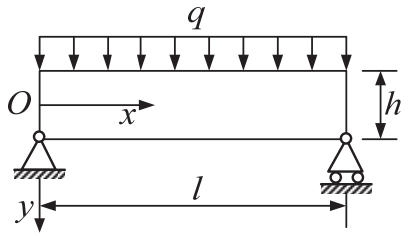

Fig.1 State of samples before and after tests

Figure 2 shows the variation of the values of xadd and y with l/h, in which, xadd represents the upper and lower edge points and y shows the upper edge points of the cross-section of a simply supported beam. Both of them are normalized by x for easy observation. With the increase of l/h, both of them decrease rapidly. When l/h is greater than seven, both of them are lower than 3% of the cross-section normal stress, which can be ignored. Beams studied in the *Mechanics of Materials* are usually slender, and the contradiction between bending normal stress and material strength is the main contradiction of beam transverse bending, so the approximate treatment conforms to the basic laws of Marxism.

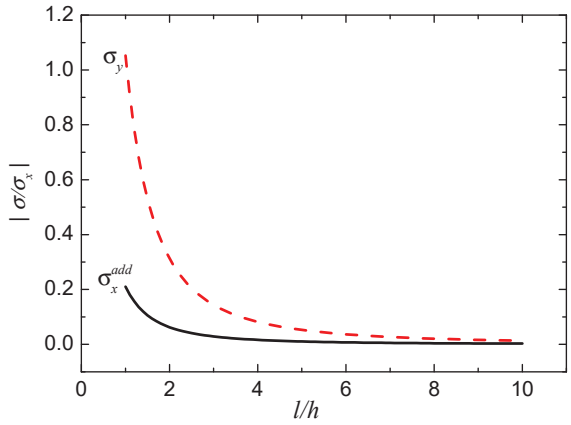

Fig. 2 Variation of the maximum normal stress in the mid-span cross-section and the maximum compressive stress in the longitudinal segment of a simply supported beam under uniform pressure with L/h.

Fifth, contradiction analysis, the core of which is to analyze contradictions on a case-by-case basis, can be elicited by discussing the effect of bending shear stress. As Lenin pointed out that: "A concrete analysis of a concrete situation is the living soul of Marxism"[8]. Usually, the strength of a slender beam is mainly controlled by bending normal stress. Beams that satisfy the bending normal stress can also bear shear stress intensity. Marxism holds that the principal contradiction and the secondary contradiction can be transformed into each other under certain conditions. Accordingly, in some special cases, the contradiction between shear stress and material strength can be transformed into the principal contradiction. Therefore, for these kinds of beams, such as short-span beams, I-beams with thin and high webs, and welded, riveted, or glued beams, the shear strength should be checked [9].

It can be seen that there are rich Marxist basic laws, philosophy, and scientific thinking behind the Mechanics of Material. Fully digesting these ideological and political theories in teaching will benefit students for life, help students to further understand Marxism, and consciously use the standpoints and methodologies in their study and work. There are also a large number of examples of Marxist application in other chapters of the *Mechanics of Materials* and even a professional knowledge point may contain several different basic laws, the selection of teaching content is inseparable from the practice of teachers. Marxism is both a belief and a scientific method, and a full understanding of its scientific nature will help foster in the young morally sound values and outlook on the world and master scientific methodologies.

4. Conclusion

In this paper, the chapter Bending Stress is taken as an example to demonstrate the content design and implementation methods of ideological and political teaching in the *Mechanics of Materials*. It is proposed that the task of ideological and political education in the courses is to improve students' ability to correctly understand, analyze and solve problems by using Marxist basic standpoints and methodologies. The guidance of Marxism is the fundamental reason for our party to strengthen its beliefs and grasp the historical initiative [10]. Considering the nature of the course *Mechanics of Materials* and the process of personnel training, the ideological and political teaching in *Mechanics of Materials* focuses on the improvement of young people's Marxist theoretical literacy and spiritual realm. The proposed methods and strategies for the integration of ideological and political education in *Mechanics of Materials* can also be applied to other courses of engineering majors.

Project funds

1) A phased research result of the project: "The Times Value and Practice Path of the Communist Party of China (CPC) People's Sprits" supported by Dalian Vocational and Technical College (Dalian Open University) in 2022.

2) The Mechanics of Materials (953) supported project of the first-class undergraduate course construction project in Liaoning Province in 2020.

References

1. Notice of the Ministry of Education on the issuance of the Guiding Outline of Curriculum Ideological and Political Construction in Colleges and Universities. Government Portal of the People's Republic of China (PRC) Ministry of Education [EB/OL] (2020–06–01) [2021–08–30]. http://www.moe.gov.cn/srcsite/A08/s7056/202006/t20200603_462437.html.
2. Speech by President Xi Jinping at the celebration of the centenary of the founding of the Communist Party of China (CPC). Xinhuanet [EB/OL] (2021–07–15) [2021–09–06]. http://www.xinhuanet.com//2021-07/15/c_1127658385.htm
3. BEDFORD A, LIECHTI K M. Mechanics of Materials [M/OL].Cham: Springer International Publishing, 2020 [2020-11-08]. http://link.springer.com/10.1007/978-3-030-22082-2.
4. Book Writing Group, Basic Principles of Marxism (2023). Higher Education Press, Beijing.
5. Marx and Engels, Selected Works of Marx and Engels (Volume IV) (2012), People's Publishing House, Beijing.
6. Wu, J. K. Talking about beams in History of Mechanics' Notes XIX. Mechanics and Practice, 2008(06): 106-109.
7. Xu, Z. L. Mechanics of Elasticity (I). Beijing: Higher Education Press, 2016.
8. Lenin, Selected Works of Lenin (Vol. IV) (2012), People's Publishing House, Beijing.
9. Liu, H. W. Mechanics of Materials I (6th edition). Beijing: Higher Education Press, 2017.

10. Hold High the Great Banner of Socialism with Chinese Characteristics and Strive in Unity to Build a Modern Socialist Country in All Respects - Xi Jinping's Report in The 20th National Congress of the Communist Party of China（CPC） (2022), People's Publishing House, Beijing.