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Application of Material Mechanics

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Abstract: *The main task of the course of material mechanics is that when we design components, we not only need to meet the requirements of stiffness, strength and stability, but also reasonably select the required materials and reduce the consumption of required materials as much as possible, so as to reduce the waste of funds or reduce the overall weight of relevant components. The latter often requires less materials, while the former requires more materials. There are contradictions and conflicts between the two. In addition, some problems that need to be solved can not be understood only by existing theories, but also need to be solved by relying on some relevant experiments.*

Keywords: *Mechanics of Materials, Civil Engineering, Axial Compression Principle*

1. Introduction

Mechanics of materials is the backbone of engineering students. In this discipline, the exploration goal is regarded as a linear elastic object with equilibrium, continuity and different homosexuality. However, in fact, the exploration is not enough to produce the required materials for this kind of corresponding premise. Therefore, it is necessary to meet different arguments and actual schemes to carry out experimental exploration as different raw materials for comparison. This discipline is closely related to the combination of society and production practice. Using the relevant knowledge of material mechanics to solve the problems encountered in production practice can be traced back to a very long time. Since people built houses in social life in ancient times, people began to have some ideas and summarized their relevant theories, in order to find a scheme to determine the size of components and reduce accidents. The pyramids built by the ancient Egyptians according to some experience and methods remain today. The ancient Greeks developed statics. For example, Archimedes gave the principle of lever balance and the solution of the center of gravity of objects, which laid the foundation of material mechanics.

Since the 21st century, due to the rapid development of industrial technology such as aviation and aerospace industry, Chinese scientists have made internationally influential achievements in the scientific research and manufacture of new materials and the theory of material mechanics. All these achievements not only enrich and develop the research scope of material mechanics, but also promote the application and development of material mechanics in the field of engineering technology. With the continuous emergence of new materials and new technologies, material mechanics is still a field with broad prospects, and will play a greater role in the development and development of modern industrial technology.

2. Theoretical Research on Material Mechanics

From the perspective of exploration goal, material mechanics, as a discipline to explore the changes of strain force, strength, stiffness and stability of required materials under different external conditions, goes hand in hand with theoretical mechanics and structural mechanics to form mechanical science. In general, the discipline should pay attention to the preparation of theoretical research work in advance, and understand the composition of basic relevant models and simple analysis of their theoretical basis. The general exploration trend of this discipline is divided into four parts: rod, plate and shell, internal force and deformation degree of block.

Compared with other mechanical studies, material mechanics involves the following aspects: first, explore different mechanical properties or mechanical properties of materials;second,Explore the stress

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conditions of different components, and deduce the actual parameters of stress and deformation of corresponding components. Taking the member exploration as a specimen, in structural mechanics, through the correlation of members, explore the force condition of most of the surrounding members and all their structures. In material mechanics, we can explore the different stress forms between members, such as tension, compression, bending and shear. [1] After analyzing the stress conditions of four stress forms, the values of axial force, pressure, tension and bending moment of the corresponding rod are deduced. [2] Secondly, based on the principle of axial compression and bending normal stress in material mechanics, the relevant problems of the rod and all its structures are analyzed, so as to provide the primary argument for the improvement of the rod structure. [3]

3. Development of Material Mechanics

The ancient Romans were also very effective in the application of the knowledge of material mechanics. They built some temples and bridges in their own country and have been preserved to this day. In the development of material mechanics in the middle ages, the Renaissance was the most rapid. For example, the famous artist Mr. Da Vinci described the experimental process of testing the strength of a material in his manuscript. Leonardo da Vinci is the first proponent to use this experimental method to test the strength of materials. Galileo published a book in 1638, which is recognized as the prelude to the discipline of material mechanics.

After the 1880s, scientists who contributed to the development of material mechanics in this era include Coulomb and so on. Coulomb system studies the damage of brittle materials, and determines the important benchmark of material strength. Navier showed the category of stress and strain, gave the generalized Hooke's law to each part of isotropic and anisotropic elastomer, and explored the statically indeterminate of beam and the bending of curved beam. [4] After that, Saint Venant explored the torsion of columns and the bending of general beams, and showed that the well-known Saint Venant theory established an important foundation for the future application of material mechanics in engineering. [5]

In the mid-19th century, with the rapid development of railway engineering, a large number of damage problems caused by fatigue of Locomotive Axles emerged, which promoted the research on material fatigue and structural response under dynamic load. Since the 20th century, some complex mechanical inventions and the construction of new buildings have promoted the development of the gold industry. The main engineering materials are high-strength steel and aluminum alloy materials. In the use of high-strength steel, because there are similar accidents as before, it is because a component has an initial microcrack that leads to accidental fracture. In order to solve this kind of problem, a branch of fracture mechanics has been produced and developed. In short, the problems involved in material mechanics and the scope of research are constantly extending and optimizing with the development of production.

China has also made great contributions to the development history of material mechanics. In the Eastern Han Dynasty, Zheng Xuan, a Confucian scholar, once put forward a description related to the law of elasticity. For example, the well-known Zhaozhou Bridge in Hebei, which has been preserved for more than 1400 years, is the oldest stone arch bridge in global history. In addition, Sichuan Anlan bamboo cable bridge, a suspension bridge built with bamboo cables, fully uses the tensile strength of bamboo. After the 2008 Wenchuan earthquake, it is still complete and intact, and there is no damage or deformity left so far. For another example, in the "construction method" compiled in the Song Dynasty, the height width ratio of the rectangular wooden beam section is 3:2, which is very consistent with the basic principles of today's material mechanics.

4. Application of Axial Compression Principle

The normal stress of the component is directly proportional to the axial force and inversely proportional to its cross-sectional area. [6] When the axial force is constant, the larger the cross-sectional area is, the smaller the normal stress is; [7] On the contrary, the larger the cross-sectional area. When the cross-sectional area of the member is certain, the greater the axial force is, the greater the normal stress is.

Whether the safety factor of the component is affected by the external stress can be judged according to the strength of the component. Applying its axial compression principle to civil engineering construction can better estimate the safety and applicability of different components, and

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deal with the existing problems in the design of engineering structures as soon as possible. The improvement of the engineering structure design plan and the selection of materials are given important arguments to ensure the quality of the project and the use time of the whole life.

4.1 Application of Axis Principle in High-Rise Buildings

The application of axis principle in its project content can implement the improvement object of its structural part. For example, a residential building with a height of more than 27m was built in the 1990s, with a total of 18 floors. The structure of the building with about 9 floors shows a ladder shape, and the steps on both sides appear ray dispersion. Based on the analysis of the relevant contents of the construction of all structures and structures, the weight from the upper end to the lower part is increasing day by day, and its normal stress is certain; In order to ensure its quality and safety, it is the demand of the corresponding structure. The stress of the cross-section material is less than the normal stress of the building, and it should always be kept on the basis of the safe use of engineering materials. Firstly, it combines the properties of all stressed parts of the building. After transforming the surface and cross-sectional area of the building, it ensures that the normal stress corresponding to the engineering materials and components of the high-rise building is sufficient to construct the demand of safety benchmark. At present, most high-rise buildings have roughly the same structural surface and size, so the purpose of ensuring their average stress, improving the material use value of the project and controlling the construction cost can be achieved by transforming the cross-sectional area of their column structure.

What needs to be paid attention to is the demand of transforming the structural cross-sectional area of the column to achieve all the stress states of the building. The top of the column structure needs to withstand different floors and self weight, so it is necessary to ensure its structural safety. In addition to the materials with maximum bearing capacity, the cross section in the column structure needs to be modified. The column structure is modeled as the shape of thick head and thin tail, which ensures the balance of force required, and fully exerts the influence of axial compression principle in high-rise building engineering.

4.2 Application of Arch Rib Shaft Principle

It has a very significant impact on ensuring the quality and life-long service life of the arch bridge. During the construction of arch rib, the principle of axial compression is used to balance the stress state of arch rib structure, which only withstands axial force. Taking a grand canal as an example, the arch rib has the characteristics of parabola, and its section is box type. The section size of the bridge gradually decreases from the middle to both ends. Through the non amateur three-dimensional structure analysis and scientific and technological attributes, it is concluded from the analysis of the axial compression principle that under the condition of certain material performance, its axial force is greater, and the area of its section should be expanded. Therefore, the structure of the arch rib of the arch bridge on the top of the project is not the same. The arch rib in the middle is an important stress area, and the size of the section is larger than the area of the arch rib on both sides; Under the influence of the principle of axial compression, the construction method related to the cutting area of the arch rib is effectively transformed. Effectively improve the material use value of the arch rib structure that needs to be built, and establish a solid foundation for the object of great progress in implementing its economic benefits.

4.3 Bridge Construction Cable Tower Material Mechanics Axis Principle Application

Taking a local bridge as an example, the section shows a box shape, and its code continues to decrease from bottom to top. Because the cross-sectional surface from the upper end to the lower part of the cable tower of the bridge needs to be continuously increased under the influence of the axial force to form the shape of narrow upper part and wide lower part. Taking a bridge as an example, the structure of the Golden Gate Bridge is constructed by using the principle of axial compression for the first time during the surface simulation and its construction. It shows the shape of steps through multi-faceted observation.

To sum up, the structures are rigid towers, and the fundamental properties use the shape of narrow top part and wide bottom part to ensure that the stress part of the structure is average. Except for the secondary beam, the beam of suspension bridge needs to withstand the weight of its object and the live load gravity of the bridge deck. The cable is used to transport the force to the corresponding structure,

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so that the horizontal forces generated by the cables on both sides of the structure can be eliminated from each other, so that the structure can only withstand the vertical upward force.

5. Conclusion

The application of shaft principle with good quality and efficiency in civil engineering can promote and extend the method of engineering material and structure inspection. At the same time, it can deal with the corresponding engineering construction, so as to prevent life danger, abnormal operation of funds and lack of employees with good operation ability during the commencement. Explore the axis principle, and be able to evaluate the performance of the relevant materials of the project construction that are deformed and not easy to break due to the action of external force, and can resist damage and maintain constant performance under the influence of external force, so as to ensure whether the different properties of materials correspond to the structural requirements of the project, and promote the implementation of civil engineering in advance, so as to maximize the efficiency of civil engineering under the condition of sufficient funds; Give people maximum utility in real life; In terms of safety, utility maximization establishes a solid foundation.

References

[1] Chen Mengcheng, Li Qi Elastic mechanical analysis of composite elastic modulus and axial pressure distribution of concrete filled steel tubular columns. Journal of East China Jiaotong University, 2016, (4): 24-30

[2] Fu Qiang, Wang Liping, Fang Changjing Study on mechanical behavior of concrete filled rectangular weather resistant steel tubular short columns under axial compression. Journal of building structure, 2017, (S1): 198-203

[3] Lu Chunling, Wei Feng, Wang Qiang, et al Experimental study on axial compressive behavior of reinforced concrete square section short columns strengthened with prestressed carbon fiber composite sheets. Industrial architecture, 2017, (5): 171-178

[4] Liu Lei, Li Zhongfeng, application analysis of axial compression principle of material mechanics in civil engineering, modern manufacturing technology and equipment, 2019175 + 177

[5] Sun Xunfang, Fang Xiaoshu, Guan Laitai, mechanics of materials [M] 6th Edition, Beijing, higher education press, 2019, 1-4

[6] Wang Xiaoping, Li Zhiqiang, Li Shu Test and analysis of axial compression bearing capacity of composite column with foamed concrete cap and steel keel. Steel structure, 2016, (2): 59-63

[7] Yang Lu, Shang fan, Zhao Menghan, et al Calculation method of overall stable bearing capacity of stainless steel box axial compression members. Journal of Harbin University of technology, 2017, (6): 124-129