力学专业英语

孟庆元 主编

哈尔滨工业大学出版社

A Course for Specialized English of Mechanics

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·哈尔滨·

内 容 简 介

本书从应力和应变的基本概念开始，介绍了有关静力学、动力学、弹性力学、塑性力学、材料力学行为和机理、计算和实验方法、断裂和疲劳、计算机以及民用和空间技术等诸多领域的专业知识，选材广泛，内容精练。

本书适合于工程力学及其他相关专业的大学本科生或研究生作专业英语教材，也可作为科技人员提高英语水平的阅读材料。

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孟庆元，1970年毕业于哈尔滨军事工程学院，1978年考取哈尔滨工业大学工程力学专业研究生。1980年1月由国家公派赴英国曼彻斯特大学留学，并于1984年获得博士学位。1991~1993年在美国加州大学圣巴巴拉分校以高级访问学者和副研究员身份从事智能材料研究工作。现为哈尔滨工业大学航天工程与力学系教授，固体力学学科博士生指导教师，哈尔滨工业大学学报（英文版）主编。目前，在固体材料力学、分子设计与分子模拟以及计算力学方法等领域从事教学和研究工作。

Preface

This book is intended to be written and used to undergraduate students as a specialized English course in the realm of engineering mechanics and its related fields. The texts in this book are concerned with a wide range of subject matters relevant to various topics of mechanics. The typical technical terms, the grammatical structures and sentence patterns commonly used in scientific books and papers frequently occur throughout the book.

The special kind of English which is used only in science and technology has to be learned as a separate language. This is due to the fact that for students who learned English as a language of everyday conversation and of literature, it will be very difficult for them to understand what is written in specialized technical English. Therefore, the purpose of this course is to teach students of scientific subjects the basic language of technical English.

Technical English uses grammatical and syntactic forms and patterns which often occur in a formal style, with a very high concentration of technical terms and a number of mathematical symbols. In fact, many technical English words have been taken from everyday language but given a precise definition for technical use. In this case, the meanings of these words in their technical use are likely to differ from their non-technical meanings. As a result, technical English does differ from everyday English because of the specialized contexts. However, as far as technical English is concerned, the differences will not present any great problems once the features of technical English have been learned and recognized.

The learning approach of the book is recommended to be essentially an oral practice, in view of the fact that oral repetition is the most effective way of fixing material, even for purely recognition purpose. In addition to the purely language-teaching aims outlined above, the book is also recommended to be used to stimulate critical thought and foster the habits of clear exposition of ideas and the impartial assessment of evidence.

Finally, it is hopeful that the texts in this book are shown in such a way that will be of interest to the students who pursue the subject of mechanics for learning both the language of specialized technical English and the knowledge of mechanics.

Q. Meng

序　言

本书是为工程力学及其他相关专业大学本科生专业英语教学而编写的教材。书中的课文涉及到了力学学科中的许多领域。有关的专业术语以及在科学文献中常见的科技英语句型和语法结构都贯穿于本书中。

由于专业科技英语属于科技领域中的专门的语言范畴,具有一定的特殊性,因此,在学习中应把专业英语看做是与一般日常英语不同的另一种形式的语言。事实上,对于学习日常英语和文学的学生来说,他们很难理解专业科技英语的涵义。因此,编写本书的目的就是对科技专业的大学生们进行专业英语知识的基本训练。

专业科技英语的语法和句式往往十分规范和严谨。在科学文献中充满了大量的科技专业术语和数学符号。事实上,许多科技英语词汇来源于日常英语,但在科技文献中却具有十分严格且独立的定义。在这种情况下,这些作为科技专业英语使用的词汇的涵义与作为日常生活用语时的意义截然不同,这完全取决于语言的环境。然而,通过学习只要对科技专业英语的特征有所认识,这种差异将不会成为学习专业英语的困难。

关于本书的学习方法,作者建议以口语训练为主。这是由于不断重复的口语训练可以深入地认知和理解事物。除以上所说的纯粹语言训练外,作者还建议通过本教材的学习,激发学生思维的积极性,培养学生准确表述思想和公正评价某个事物的能力。

最后,希望学习工程力学及其他相关专业的大学生们通过本教材的训练,不仅在科技专业英语学习方面,也同时在有关力学专业知识的学习方面产生浓厚的兴趣。

编　者

2002 年 5 月 30 日

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Lesson 1

Stress and Strain

1. The concepts of stress and strain can be illustrated in an elementary way by considering the extension of a prismatic bar. As shown in Fig. 1, a prismatic bar is one that has constant cross section throughout its length and a straight axis. In this illustration the bar is assumed to be loaded at its ends by axial forces P that produce a uniform stretching, or tension, of the bar.

2. By making an artificial cut (section mm) through the bar at right angles to its axis, we can isolate part of the bar as a free body [see Fig. 1(b)]. At the left-hand end the tensile force P is applied, and at the other end there are forces representing

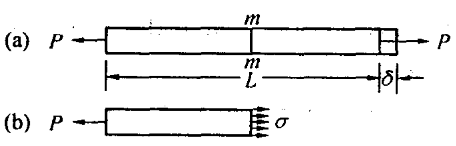

Fig. 1 Prismatic bar in tension

the action of the removed portion of the bar upon the part that remains. These forces will be continuously distributed over the cross section, analogous to the continuous distribution of hydrostatic pressure over a submerged surface.

3. The intensity of force, that is, the force per unit area, is called the stress and is commonly denoted by the Greek letter σ. Assuming that the stress has a uniform distribution over the cross section [see Fig. 1(b)], we can readily see that its resultant is equal to the intensity σ times the cross-sectional area A of the bar. Furthermore, from the equilibrium of the body shown in Fig. 1(b), we can also see that this resultant must be equal in magnitude and opposite in direction to the force P. Hence, we obtain

$$\sigma = \frac{P}{A} \tag{1}$$

4. Eq. (1) can be regarded as the equation for the uniform stress in a prismatic bar. This equation shows that stress has units of force divided by area. When the bar is being stretched by the force P, as shown in the figure, the resulting stress is a tensile stress; if the forces are reversed in direction, causing the bar to be compressed, they are called compressive stresses.

5. A necessary condition for Eq. (1) to be valid is that the stress σ must be uniform over the cross section of the bar. This condition will be realized if the axial force P acts through the centroid of the cross section. When the load P does not act at the centroid, bending of the bar will result, and a more complicated analysis is necessary. At present, however, it is assumed that all axial forces are applied at the centroid of the cross section unless specifically stated to the contrary. Also, unless stated otherwise, it is generally assumed that the weight of the object itself is neglected, as was done when discussing the bar in Fig. 1.

6. The total elongation of a bar carrying an axial force will

be denoted by the Greek letter δ [see Fig. 1(a)], and the elongation per unit length, or strain, is then determined by the equation

$$\varepsilon = \frac{\delta}{L} \tag{2}$$

where L is the total length of the bar. Note that the strain ε is a non-dimensional quantity. It can be obtained accurately from Eq. (2) as long as the strain is uniform throughout the length of the bar. If the bar is in tension, the strain is a tensile strain, representing an elongation or stretching of the material; if the bar is in compression, the strain is a compressive strain, which means that adjacent cross sections of the bar move closer to one another.

7. When a material exhibits a linear relationship between stress and strain, it is said to be linear elastic. This is an extremely important property of many solid materials, including most metals, plastics, wood, concrete, and ceramics. The linear relationship between stress and strain for a bar in tension can be expressed by the simple equation

$$\sigma = E\varepsilon \tag{3}$$

in which E is a constant of proportionality known as the modulus of elasticity for the material.

8. Note that E has the same units as stress. The modulus of elasticity is sometimes called Young's modulus, after the English scientist Thomas Young (1773 ~ 1829) who studied the elastic behavior of bars. For most materials the modulus of elasticity in compression is the same as in tension.

New Words and Expressions

analogous [ə'næləgəs] *adj*. 类似的，相似的

artificial [ˌɑːti'fiʃəl] *adj*. 人工的，人造的，假的

centroid ['sentrɔid] *n*. 质心，形心

ceramic [si'ræmik] *adj*. 陶瓷的；*n*. 陶瓷(制品)

compress [kəm'pres] *v*. 压缩，压紧

compressive [kəm'presiv] *adj*. 压缩的，有压缩力的

concrete ['kɔnkriːt] *n*. 混凝土

contrary ['kɔntrəri] *adj*. 相反的，逆的；*n*. 反面；*adv*. 相反地

distribute [dis'tribjuːt] *vt*. 分布，散布

elasticity [elæs'tisiti] *n*. 弹力，弹性

elongation [ˌiːlɔŋ'geiʃən] *n*. 伸长，延伸

equation [i'kweiʃən] *n*. 方程，等式

equilibrium [ˌiːkwi'libriəm] *n*. 平衡

hydrostatics [ˌhaidrəu'stætiks] *n*. 流体静力学

intensity [in'tensiti] *n*. 强度，强烈

isolate ['aisəleit] *vt*. 使隔离，使绝缘

linear ['liniə] *adj*. 线性的，直线的

modulus ['mɔdjuləs] *n*. 模量，模数

pressure [preʃə] *n*. 压，压力，压迫，强制，紧迫

prismatic [priz'mætik] *adj*. 棱镜的，棱柱形的

proportionality [prəˌpɔːʃə'næliti] *n*. 比例

resultant [ri'zʌltənt] *adj*. 合成的；*n*. 合力

solid ['sɔlid] *n*. 固体；*adj*. 固体的，坚固的，稳固的

strain [strain] *n*. 应变

stress [stres] *n*. 应力

stretch [stretʃ] *vt*. 伸展，伸张，展开，把……拉直(长)

submerge [səb'mə:dʒ] *v*. 浸没,淹没；*vi*. 潜水

tension ['tenʃən] *n*. 张力,拉力，拉紧

Lesson 2

Tensile Stress-strain Behavior

1. The relationship between stress and strain in a particular material is determined by means of a tensile test. A specimen of the material, usually in the form of a round bar, is placed in a testing machine and subjected to tension. The force on the bar and the elongation of the bar are measured as the load is increased. The stress in the bar is found by dividing the force by the cross-sectional area, and the strain is found by dividing the elongation by the length along which the elongation occurs. In this manner a complete stress-strain diagram can be obtained for the material.

2. The typical shape of the stress-strain diagram for structural steel is shown in Fig. 1, where the axial strains are

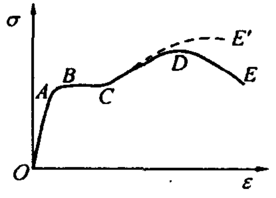

Fig. 1 A typical stress-strain curve

plotted on the horizontal axis and the corresponding stresses are given by the ordinates to the curve *OABCDE*. From *O* to *A* the stress and strain are directly proportional to one another and the diagram is linear. Beyond point A the linear relationship between stress and strain no longer exists, hence the stress at A is called the proportional limit.

3. With an increase in loading, the strain increases more rapidly than the stress, until at point B a considerable elongation begins to occur with no appreciable increase in the tensile force. This phenomenon is known as yielding of the material, and the stress at point B is called the yield point or yield stress. In the region BC the material is said to have become plastic, and the bar may actually elongate plastically by an amount which is 10 or 15 times the elongation which occurs up to the proportional limit.

4. At point C the material begins to strain harden and to offer additional resistance to increase in load. Thus, with further elongation the stress increases, and it reaches its maximum value, or ultimate stress, at point D. Beyond this point further stretching of the bar is accompanied by a reduction in the load, and fracture of the specimen finally occurs at point E on the diagram.

5. During elongation of the bar a lateral contraction occurs, resulting in a decrease in the cross-sectional area of the

Fig.2 Necking of a bar in tension

bar. This phenomenon has no effect on the stress-strain diagram up to about point C, but beyond that point the decease in area will have a noticeable effect upon the calculated value of stress. A pronounced necking of the bar occurs (see Fig.2), and if the actual cross-sectional area at the narrow part of the neck is used in calculating σ, it will be found that the true stress-strain curve follows the dashed line *CE*. Whereas the total load the bar can carry does indeed diminish after the ultimate stress is reached (line *DE*), this reduction is due to the decrease in area and not to a loss in strength of the material itself.

6. The material actually withstands an increase in stress up to the point of failure. For most practical purposes, however, the conventional stress-strain curve *OABCDE*, based upon the original cross-sectional area of the specimen, provides satisfactory information for design purposes.

7. The diagram in Fig.1 has been drawn to show the general characteristics of the stress-strain curve. There is an initial region on the stress-strain curve in which the material behaves both elastically and linearly. The region from *O* to *A* on the stress-strain diagram for steel is an example. The presence of a pronounced yield point followed by large plastic strains is somewhat unique to steel, which is the most common structural metal in use today. Aluminium alloys exhibit a more gradual transition from the linear to the nonlinear region.

8. Both steel and many aluminium alloys will undergo large strains before failure and are therefore classified as ductile. On the other hand, materials that are brittle fail at relatively low values of strain. Examples include ceramics, cast iron, concrete, certain metallic alloys, and glass.