全国普通高等院校土木工程类
实用创新型系列规划教材

土木工程
专业英语

贾艳敏 主编
施 平 主审

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内容简介

本书为土木工程专业英语。内容包括：力学、建筑材料、测量、工程结构荷载、结构设计、钢结构、土木工程施工、高层建筑、道路与桥梁等方面。

本书可作为高等院校土木工程专业本科教材，也可作为土木工程专业技术人员学习专业英语之参考书。

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全国普通高等院校土木工程类实用创新型系列规划教材

前　言

专业英语是大学英语教学的一个重要组成部分，是促进学生们完成从英语学习过渡到实际应用的有效途径。学习专业英语可以培养学生以英语为工具交流专业知识的能力。

本书所涉及的内容包括：力学、建筑材料、测量、工程结构荷载、结构设计、钢结构、钢筋混凝土结构、预应力混凝土结构、土木工程施工、基础工程、高层建筑、道路与桥梁、工程管理、计算机在土木工程中的应用、科技写作等方面。通过学习这本教材，学生们不仅可以熟悉和掌握土木工程专业常用的及与专业有关的单词、词组及其用法，而且可以深化本专业的知识，从而为今后的学习和工作打下良好的基础。

全书由50篇课文组成，其中30篇课文有参考译文。本书选材广泛，内容丰富，语言规范，难度适中，便于自学。

本书由东北林业大学贾艳敏担任主编，参加编写的有郭红雨、徐莲净、郭启臣。本书由哈尔滨工业大学施平担任主审。

由于编者水平有限，书中难免有不足和欠妥之处，恳请广大读者批评指正。

目　录

Lesson 1 Simple Stress and Strain

In any engineering structure the individual components or members will be subjected to external forces arising from the service conditions or environment in which the component works. If the component or member is in equilibrium, the resultant of the external forces will be zero but, nevertheless, they together place a load on the member which tends to deform that member and which must be reacted by internal forces set up within the material.[1]

There are a number of different ways in which load can be applied to a member. Loads may be classified with respect to time:

(1) *A static load* is a gradually applied load for which equilibrium is reached in a relatively short time.

(2) *A sustained load* is a load that is constant over a long period of time, such as the weight of a structure (called dead load). This type of load is treated in the same manner as a static load; however, for some materials and conditions of temperature and stress, the resistance to failure may be different under short time loading and under sustained loading.

(3) *An impact load* is a rapidly applied load (an energy load). Vibration normally results from an impact load, and equilibrium is not established until the vibration is eliminated, usually by natural damping forces.

(4) *A repeated load* is a load that is applied and removed many thousands of times.

(5) *A fatigue or alternating load* is a load whose magnitude and sign are changed with time.

It has been noted above that external force applied to a body in equilibrium is reacted by internal forces set up within the material. If, therefore, a bar is subjected to a uniform tension or compression, i.e. a force, which is uniformly applied across the cross-section, then the internal forces set up are also distributed uniformly and the bar is said to be subjected to a uniform normal stress, the stress being defined as[2]

$$stress(\sigma) = \frac{load}{area} = \frac{P}{A} \tag{1}$$

Stress σ may thus be compressive or tensile depending on the nature of the load and will be measured in units of newtons per square meter (N/m^2) or multiples of this.

If a bar is subjected to an axial load, and hence a stress, the bar will change in length. If the bar has an original length L and changes in length by an amount δL, the strain produced is defined as follows:

$$strain(\varepsilon) = \frac{change\ in\ length}{original\ length} = \frac{\delta L}{L} \tag{2}$$

Strain is thus a measure of the deformation of the material and is non-dimensional, i.e. it has no units; it is simply a ratio of two quantities with the same unit.[3]

Since, in practice, the extensions of materials under load are very small, it is often convenient to measure the strains in the form of strain $\times 10^{-6}$, i.e. microstrain, when the symbol used becomes $\mu\varepsilon$.

Tensile stresses and strains are considered positive in sense.[4] Compressive stresses and strains are considered negative in sense. Thus a negative strain produces a decrease in length.

A material is said to be elastic if it returns to its original, unloaded dimensions when load is removed. A particular form of elasticity which applies to a large range of engineering materials, at least over part of their load range, produces deformations which are proportional to the loads producing them. Since loads are proportional to the stresses they produce and deformations are proportional to the strains, this also implies that, whilst materials are elastic, stress is proportional to strain. Hooke's law therefore states that

$$stress\ (\sigma) \propto strain\ (\varepsilon) \tag{3}$$

This law is obeyed within certain limits by most ferrous alloys and it can even be assumed to apply to other engineering materials such as concrete, timber and non-ferrous alloys with reasonable accuracy.[5]

Whilst a material is elastic the deformation produced by any load will be completely recovered when the load is removed; there is no permanent deformation.

Within the elastic limits of materials, i.e. within the limits in which Hooke's law applies, it has been shown that

$$\frac{stress}{strain} = \text{constant} \tag{4}$$

This constant is given the symbol E and termed the modulus of elasticity or Young's modulus.

Thus
$$E = \frac{stress}{strain} = \frac{\sigma}{\varepsilon} \tag{5}$$

Young's modulus E is generally assumed to be the same in tension or compression and for most engineering materials has a high numerical value.[6] Typically, $E = 200 \times 10^9$ N/m^2 for steel, so that it will be observed from Eq. (5) that strains are normally very small.

In most common engineering applications strains rarely exceed 0.1%. The actual value of Young's modulus for any material is normally determined by carrying out a standard test on a specimen of the material.

Words and Expressions

service condition			使用状况，使用条件
component	[kəm'pəunənt]	*n.*	部件，构件
equilibrium	[ˌi:kwi'libriəm]	*n.*	平衡，均衡
resultant	[ri'zʌltənt]	*a.*	合成的；*n.*合成量,合力,合成
internal force			内力
sustained load			长期(施加的)载荷，持续载荷
resistance	[ri'zistəns]	*n.*	抵抗力，阻力，抗力
impact load			冲击载荷
vibration	[vai'breiʃən]	*n.*	振动
eliminate	[i'limineit]	*v.*	排除，消除，除去
damping force			阻尼力
repeated load			重复载荷
fatigue load			疲劳载荷
alternating load			交变载荷
magnitude	['mægnitju:d]	*n.*	大小，数量，等级
sign	[sain]	*n.*	符号，正负号
uniform	['ju:nifɔ:m]	*a.*	均匀的
tension	['tenʃən]	*n.*	拉力，拉伸；*v.* 拉伸
compression	[kəm'preʃ(ə)n]	*n.*	压力，压缩
stress	[stres]	*n.*	应力
strain	[strein]	*n.*	应变
deformation	[ˌdi:fɔ:'meiʃən]	*n.*	变形
extension	[iks'tenʃən]	*n.*	伸长，延长，延期
microstrain	[ˌmaikrəu'strein]	*n.*	微应变
elastic	[i'læstik]	*a.*	弹性的
ferrous	['ferəs]	*a.*	铁的，含铁的
permanent	['pə:mənənt]	*a.*	永久的，持久的
constant	['kɔnstənt]	*n.*	常数，恒量
specimen	['spesimin, -mən]	*n.*	试件，标本，样品

Notes

[1] external force 意为“外力”。全句可译为：

若构件或杆件处于平衡状态，虽然外力的合力为零，但是，这些外力共同给杆件施加了一个荷载，它将使杆件产生变形，而且一定会产生内力。

[2] normal stress 意为“正应力，法向应力”。全句可译为：
因此，如果一根杆受到均匀拉伸或压缩，即在横截面上受到均匀的轴向力，则称此杆承受均匀的正应力，该应力被定义为：

[3] non-dimensional 意为“无量纲的”。全句可译为：
因此，应变是对材料变形的一个度量，它是没有量纲的，即应变没有单位，它仅仅是两个具有相同单位的量的比值。

[4] sense 这里指“方向”。全句可译为：
拉应力和拉应变的方向被认为是正的。

[5] ferrous alloy 意为“铁基合金，黑色金属合金”，non-ferrous alloy 意为“非铁合金，有色金属合金”。全句可译为：
在一定的限度内，大部分铁基合金符合这个定律，甚至可以假设将此定律应用于诸如混凝土、木材和非铁合金等工程材料时，也有足够的精度。

[6] Young’s modulus 意为“杨氏模量或弹性模量”。全句可译为：
一般认为杨氏模量 E 在受拉或受压时是相同的，对于大部分工程材料，它的数值很大。

Lesson 2 Stress-Strain Relationship of Materials

The satisfactory performance of a structure is frequently determined by the amount of deformation or distortion that can be permitted. A deflection of a few thousandths of an inch might make a boring machine useless, whereas the boom on a dragline might deflect several inches without impairing its usefulness. It is often necessary to relate the loads on a structure, or on a member in a structure, to the deflection the loads will produce. Such information can be obtained by plotting diagrams showing loads and deflections for each member and type of loading in a structure, but such diagrams will vary with the dimensions of the members, and it would be necessary to draw new diagrams each time the dimensions were varied. A more useful diagram is one showing the relation between the stress and strain. Such diagrams are called stress-strain diagrams.

Data for stress-strain diagrams are usually obtained by applying an axial load to a test specimen and measuring the load and deformation simultaneously. A testing machine is used to strain the specimen and to measure the load required to produce the strain. The stress is obtained by dividing the load by the initial cross sectional area of the specimen. The area will change somewhat during the loading, and the stress obtained using the initial area is obviously not the exact stress occurring at higher loads. It is the stress most commonly used, however, in designing structures. The stress obtained by dividing the load by the actual area is frequently called the true stress and is useful in explaining the fundamental behavior of materials. Strains are usually relatively small in materials used in engineering structures, often less than 0.001, and their accurate determination requires special measuring equipment.

True strain, like true stress, is computed on the basis of the actual length of the test specimen during the test and is used primarily to study the fundamental properties of materials. The difference between nominal stress and strain, computed from initial dimensions of the specimen, and true stress and strain is negligible for stresses usually encountered in engineering structures, but sometimes the difference becomes important with larger stresses and strains.

The initial portion of the stress-strain diagram for most materials used in engineering structures is a straight line. The stress-strain diagrams for some materials, such as gray cast iron and concrete, show a slight curve even at very small stresses, but it is common practice to draw a straight line to average the data for the first part of the diagram and neglect the curvature.

The action is said to be elastic if the strain resulting from loading disappears when the load is removed. The elastic limit is the maximum stress for which the material acts elastically.

When the stress exceeds the elastic limit (or proportional limit for practical purposes), it is found that a portion of the deformation remains after the load is removed. The deformation remaining after an applied load is removed is called plastic deformation. Plastic deformation independent of the time duration of the applied load is known as slip. Creep is plastic deformation that continues to increase under a constant stress. In many instances creep continues until fracture occurs; however, in other instances the rate of creep decreases and approaches zero as a limit. Some materials are much more susceptible to creep than the others, but most materials used in engineering exhibit creep at elevated temperatures. The total strain is thus made up of elastic strain, possibly combined with plastic strain that results from slip, creep, or both. When the load is removed, the elastic portion of the strain is recovered, but the plastic part (slip and creep) remains as permanent set.

A precise value for the proportional limit is difficult to obtain, particularly when the transition of the stress-strain diagram from a straight line to a curve is gradual. For this reason, other measures of stress that can be used as a practical elastic limit are required. The yield point and the yield strength for a specified offset are frequently used for this purpose.

The yield point is the stress at which there is an appreciable increase in strain with no increase in stress, with the limitation that, if straining is continued, the stress will again increase.

The yield strength is defined as the stress that will induce a specified permanent set, usually 0.05 to 0.3 percent, which is equivalent to a strain of 0.0005 to 0.003. The yield strength is particularly useful for materials with no yield point.

The maximum stress, based on the original area, developed in a material before rupture is called the ultimate strength of the material, and the term may be modified as the ultimate tensile, compressive, or shearing strength of the material.

Ductile materials undergo considerable plastic tensile or shearing deformation before rupture. When the ultimate strength of a ductile material is reached, the cross sectional area of the test specimen starts to decrease or neck down, and the resultant load that can be carried by the specimen decreases. Thus, the stress based on the original area decreases beyond the ultimate strength of the material, although the true stress continues to increase until rupture.

Words and Expressions

distortion	[dis'tɔːʃən]	*n*.	扭曲，变形
boring machine			镗床
boom	[buːm]	*n*.	悬臂，吊杆，起重杆
dragline	['dræglain]	*n*.	挖掘机，拉铲挖土机
deflect	[di'flekt]	*v*.	产生挠度，偏斜，偏转

impair	[im'pεə]	*v.*	妨碍，损害，减少（量，价值，力等）
plot	[plɔt]	*v.*	绘图，绘制
diagram	['daiəgræm]	*n.*	图表
dimension	[di'menʃən]	*n.*	尺寸，大小，尺度
test specimen			试件
simultaneously	[siməl'teiniəsli]	*ad.*	同时地
fundamental	[ˌfʌndə'mentl]	*a.*	基础的，根本的，基本的
primarily	['praimərili]	*ad.*	主要地，根本上地
property	['prɔpəti]	*n.*	性质，特性
nominal	['nɔminl]	*a.*	名义上的
initial	[i'niʃəl]	*a.*	开始的，最初的
gray cast iron			灰铸铁
curvature	['kə:vətʃə]	*n.*	弯曲，曲率
proportional limit			比例极限
plastic deformation			塑性变形
slip	[slip]	*n.& v.*	滑动，滑移，打滑
creep	[kri:p]	*n.*	蠕变，徐变，蠕动
fracture	['fræktʃə]	*n.*	破裂，断裂
susceptible	[sə'septəbl]	*a.*	易受影响的，敏感的
elevate	['eliveit]	*v.*	提升，提高
yield point			屈服点
yield strength			屈服强度
offset	['ɔ:fset]	*n.*	变形，偏移量
equivalent	[i'kwivələnt]	*a.*	相当的，等效的；
		n.	等价物, 相等物
rupture	['rʌptʃə(r)]	*n.*	断裂，破裂
ultimate strength			极限强度
ductile material			延性材料
neck down			（产生）颈缩

Lesson 3 Beams

The beam, or flexural member, is frequently encountered in structures, and its elementary stress analysis constitutes one of the important facets of mechanics of materials. A beam is a member subjected to loads applied transverse to the long dimension, causing the member to bend. For example, Fig. 1 depicts the shape (exaggerated) of a simply supported beam when loaded at the one-third points.

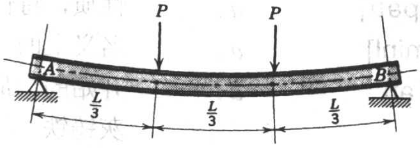
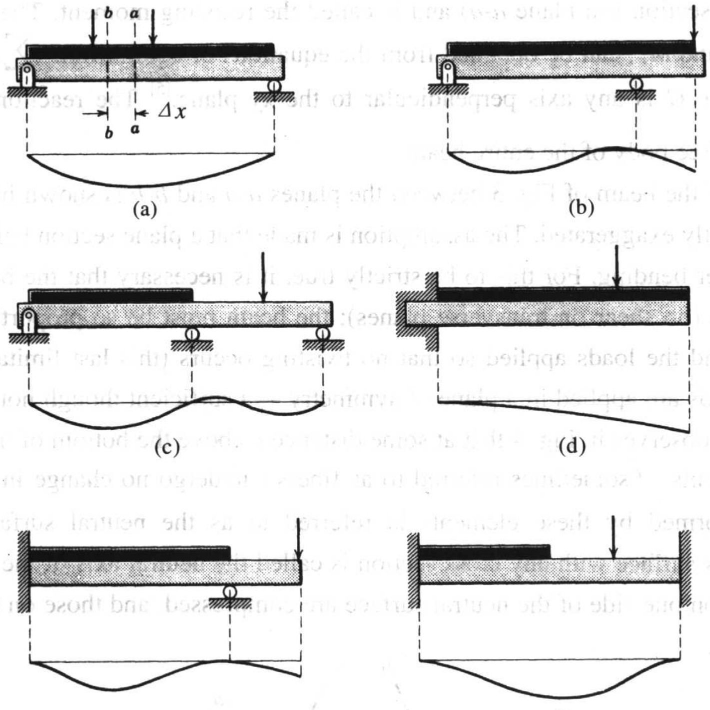


Fig. 1 Simply supported beam loaded at the one-third points

Before proceeding with a discussion of stress analysis for flexural members, it may be well to classify some of the various types of beams and loadings encountered in practice.[1] Beams are frequently classified on the basis of the supports or reactions. A beam supported by pins, rollers, or smooth surfaces at the ends is called a simple beam. A simple support will develop a reaction normal to the beam but will not produce a couple. If either or both ends of a beam project beyond the supports, it is called a simple beam with overhang.[2] A beam with more than two simple supports is a continuous beam. Fig. 2(a), (b), (c) show a simple beam, a beam with overhang, and a continuous beam, respectively. A cantilever beam is one in which one end is built into a wall or other support so that the built-in end cannot move transversely or rotate. The built-in end is said to be fixed if no rotation occurs and restrained if a limited amount of rotation occurs. The supports shown in Figs. 2(d) and (e) represent fixed ends unless otherwise stated.[3] The beams in Figs. 2(d), (e), and (f) are, in order, a cantilever beam, a beam fixed (or restrained) at the left end and simply supported near the other end (which has an overhang), and a beam fixed (or restrained) at both ends.

Cantilever beams and simple beams have only two reactions (two forces or one force and a couple), and these reactions can be obtained from a free-body diagram of the beam by applying the equations of equilibrium. Such beams are said to be statically determinate since the reactions can be obtained from the equations of equilibrium. Continuous and other beams, with only transverse loads, with more than two reaction components are called statically indeterminate since there are not enough equations of equilibrium to determine the reactions.[4]

The beams shown in Fig.2 are all subjected to uniformly distributed loads and to concentrated loads, and, although shown as horizontal, they may have any orientation. The deflection curves shown beneath the beams are greatly exaggerated to assist in visualizing the shape of the loaded beam.



(a) (b) (c) (d) (e) (f)

Fig. 2 Beams and their deflection curves

A free-body diagram of the portion of the beam of Fig. 2(a) between the left end and plane *a-a* is shown in Fig. 3. A study of this diagram reveals that a transverse force V_r and a couple M_r at the cut section and a force R (a reaction) at the left support are needed to maintain equilibrium.

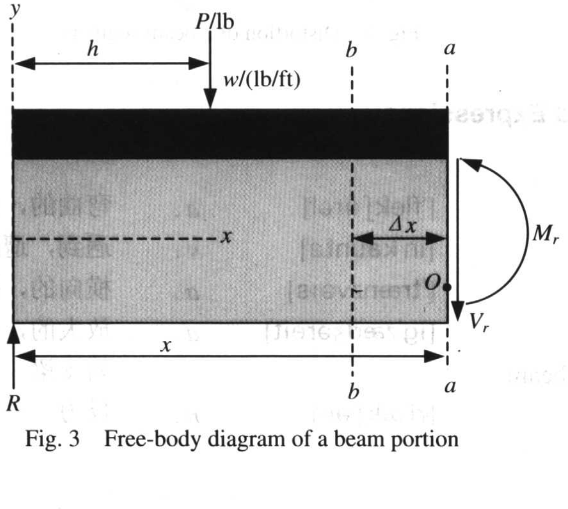


Fig. 3 Free-body diagram of a beam portion

The force V_r is the resultant of the shearing stresses acting on the cut section (on plane *a-a*) and is called the resisting shear. The couple M_r is the resultant of the normal stresses acting on the cut section (on plane *a-a*) and is called the resisting moment. The magnitudes and senses of V_r and M_r, can be obtained from the equations of equilibrium $\sum F_y = 0$ and $\sum M_O = 0$, where *O* is any axis perpendicular to the *xy* plane.[5] The reaction *R* must be evaluated from a free body of the entire beam.

A segment of the beam of Fig. 3 between the planes *a-a* and *b-b* is shown in Fig. 4 with the distortion greatly exaggerated. The assumption is made that a plane section before bending remains plane after bending. For this to be strictly true, it is necessary that the beam be bent only with couples (no shear on transverse planes); the beam must be so proportioned that it will not buckle and the loads applied so that no twisting occurs (this last limitation will be satisfied if the loads are applied in a plane of symmetry —a sufficient though not a necessary condition).[6] One observes in Fig. 4 that at some distance *c* above the bottom of the beam, the longitudinal elements （sometimes referred to as fibers）undergo no change in length. The curved surface formed by these elements is referred to as the neutral surface, and the intersection of this surface with any cross section is called the neutral axis of the section. All elements (fibers) on one side of the neutral surface are compressed, and those on the opposite side are elongated.

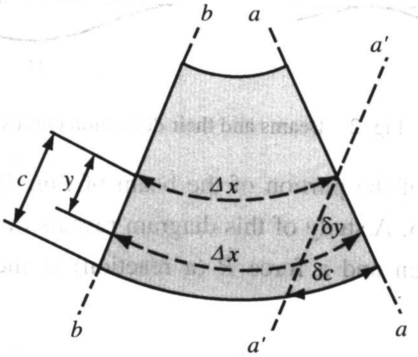


Fig. 4　Distortion of a beam segment

Words and Expressions

flexural	['flekʃərəl]	*a*.	弯曲的，挠性的
encounter	[in'kauntə]	*v*.	遇到，遭遇
transverse	['trænzvəːs]	*a*.	横向的，横断的，横放的
exaggerate	[ig'zædʒəreit]	*a*.	放大的，夸张的，夸大的
simply supported beam			简支梁
reaction	[ri'ækʃən]	*n*.	反力