谢礼立 总主审

建筑与土木工程专业英语系列

建筑工程力学英语

Professional English on Civil Engineering Mechanics

宋天舒 主编

哈尔滨工程大学出版社

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内 容 简 介

本书共分十三个单元,包括了土木工程和力学有关学科的原版教材的节选。为帮助读者对书中内容的理解,每个单元后面都附有词汇表和整篇译文。本书力求少而精,按照由浅入深、循序渐进的原则选编,以便于读者在较短的时间内掌握土木工程及工程力学专业的基本专业词汇及专业英语的表述方法,从而迅速提高专业英语的阅读能力。

本书可作为土木工程专业以及相关专业的大学生的专业英语教材,也可作为工程力学与土木工程专业的教师和工程技术人员自学专业英语的参考书。

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总　　序

按照国家教育部1999年9月颁发的《大学英语教学大纲》(修订本)的规定,大学英语教学分为基础阶段和应用提高阶段。基础阶段的教学主要是公共英语,分为大学英语一至六级。应用提高阶段的教学要求包括专业英语和高级英语两部分。非英语专业的学生在完成基础阶段的学习任务,即通过国家四级、六级考试后,必须学习专业英语。《大学英语教学大纲》不仅强调学习专业英语的重要性,同时对专业英语的词汇和听、说、读、写、译的能力做出了明确的说明。

专业英语与公共英语有着相同的语言系统和语法规则,但也存在很大差别。在专业英语文章中不仅有大量专业词汇和专业术语,还有许多合成新词和缩略词,但两者的主要区别在于文体差异。专业英语主要是对客观事实和客观真理进行论述,逻辑性强,条理规范。另外专业英语的语法结构也有其自身的特性,如长句多、被动语态、非限定动词或非限定定语从句使用频率高等。由于专业英语与专业内容紧密配合,相互一致,懂专业的人用起来得心应手,不懂专业的人用起来则困难重重。因而必须具有一定的相关专业知识基础,才能正确地理解和运用专业英语。

本套建筑与土木工程专业英语系列丛书包括:《建筑工程力学英语》、《土木工程英语》、《建筑环境与设备工程英语》、《给水排水工程英语》、《建筑学英语》。在选材上按照《大学英语教学大纲》要求,注重专业英语的文体特性,在强调专业性的同时,尽量保持内容的基础性和通用性,避免涉及过于深奥的专业理论,同时也不使其成为简单科普书籍。本套丛书80%左右为专业基本内容,20%左右为专业前沿性文献,基本上出自英语原文。通过学习,学生能

够系统地掌握专业英语的文体特征和专业文献的阅读方法，熟练地进行英语资料的阅读、翻译以及英文摘要的写作。

谢礼立

2004年8月

谢礼立，1994年中国工程院首批院士，中国地震局工程力学研究所名誉所长，研究员；现任中国地震局科技委副主任，《中国地震学会》副理事长。

前　　言

本书共包括十三个单元，可作为工程力学和土木工程专业以及相关专业的本科生32学时左右的专业英语教材，包括了土木工程和力学有关学科的原版教材的节选。为使本书更具系统性，编者对英文原文作了必要的删改。本书在编写过程中力求少而精，为帮助读者对书中内容的理解，每个单元后面都附有专业词汇和整篇译文，以便于读者掌握工程力学与土木工程专业的基本专业词汇及专业英语的表述方法。本书同时也可作为工程力学与土木工程专业的教师和工程技术人员自学专业英语的参考书。

本书由宋天舒和杨在林合作编写，其中第一、二、三、九、十、十一、十三单元由宋天舒编写，第四、五、六、七、八、十二单元由杨在林编写。全书由宋天舒统稿。本书在编写过程中参考了有关专家的论著，在此一并表示感谢。限于编者水平，本书一定存在不少缺点和错误，恳请专家和读者给予批评指正。

编　者

2004年8月

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Unit One

Part Ⅰ Engineering Materials

All products that come out of industry consist of at least one—and often many—type of materials. The most obvious example is the automobile. A car contains a wide variety of materials, ranging from glass to steel to rubber, plus numerous other metals and plastics.

The number of materials, which are available to the engineer in industry, is almost infinite. The various compositions of steel alone run into the thousands. It has been said that there are more than 10,000 varieties of glass, and the numbers of plastics are equally great. In addition, several hundred new varieties of materials appear on the market each month. This means that individual engineers and technicians cannot hope to be familiar with all the properties of all types of materials in their numerous forms. All he can do is try to learn some principles to guide him in the selection and processing of materials.

The properties of a material originate from the internal structure of the material. This is analogous to saying that the operation of a TV set depends on the components and circuits within that set. The internal structures of materials involve atoms, and the way atoms are associated with their neighbors into crystals, molecules, and microstructures.

It is convenient to divide materials into three main types: (1) metals, (2) plastics or polymers and (3) ceramics.

Characteristically, metals are opaque, ductile, and good conductors of heat and electricity. Plastics (or polymers) which usually contain light elements, and therefore have relatively low density, are generally insulators, and are flexible and formable at relatively low temperatures. Ceramics, which contain compounds of both metallic and nonmetallic elements, are usually relatively resistant to severe mechanical, thermal, and chemistry conditions.

Metals are divided into ferrous and nonferrous metals. The former contains iron and the latter does not contain iron. Certain elements can improve the properties of steel and are therefore added to it. For example, chromium may be included to resist corrosion and tungsten to increase hardness. Aluminum, copper, and their alloys, bronze and brass, are common nonferrous metals.

Plastics and ceramics are nonmetals; however, plastics may be machined like metals. Plastics are classified into two types: thermoplastics and thermosets. Thermoplastics can be shaped and reshaped by heat and pressure but thermosets cannot be reshaped because they undergo chemical changes as they harden. Ceramics are often employed by engineers when materials are needed which can withstand high temperature.

词　汇

analogous	*a*.类似的
molecule	*n*.分子
microstructure	*n*.微结构
polymer	*n*.聚合物
ceramics	*n*.陶瓷
opaque	*a*.不透明的
ductile	*a*.韧性的
insulator	*n*.绝缘体

flexible	*a*.易弯曲的,柔软的
formable	*a*.易成型的
compound	*n*.化合物
metallic	*a*.含金属的
thermal	*a*.热的
ferrous	*a*.含铁的
chromium	*n*.铬
corrosion	*n*.腐蚀
tungsten	*n*.钨
aluminum	*n*.铝
thermoplastic	*n*.热塑塑料
thermoset	*n*.热固塑料
bronze	*n*.青铜
brass	*n*.黄铜

Part Ⅱ　Strength of Materials

Strength of materials is a branch of applied mechanics concerned with the behavior of materials under load, relationships between externally applied loads and internal resisting forces, and associated deformation. Knowledge of properties of materials and analysis of the force involved are fundamental to the investigation and design of structures and machine elements. Mathematical application of principles of mechanics is supplemented by experimentally determined properties of materials and other empirical constants.

Investigation of the resistance of a member, dealing with internal forces, is called free-body analysis. In it, principles of statics are applied to imaginary isolated segments of the loaded member. Determination of the distribution and intensity of the internal forces and the associated deformation is called stress analysis.

Internal reactive forces developed in response to straining actions depend on the magnitude and nature of the loads. The possible straining actions are: (1) tension or compression, which lengthens or shortens the members; (2) shearing, which produces sliding or angular distortion along the plane of applied tangential forces; (3) bending, in which couples or bending moments produce change in curvature; and (4) torsion. In which couples acting normal to axis twist the member.

A material offers resistance to external load only in so far as the component elements can furnish cohesive strength, such as resistance to compaction, and resistance to sliding. The relations developed in strength of materials analysis evaluate the tensile, compressive, and shear stresses that a material is called upon to resist. The most important factors in determining the suitability of a structural or machine element for a particular application are strength and stiffness.

Applications fundamentals can be broadly classified as: (1) investigation of members with known dimensions and materials to determine their ability to resist prescribed loads without excessive deformation, instability, or fracture; and (2) selection of suitable materials and determination of shape and dimensions of a member to perform a prescribed function involving known or estimated external loads. Design is the prediction of suitability for a prescribed function.

词　　汇

strength	*n*.强度,力量
deformation	*n*.变形
empirical	*a*.根据经验的
free-body	自由(分离)体
segment	*n*.段,线段

reactive	*a*.反作用的
magnitude	*n*.大小,幅值
compression	*n*.压缩
shearing	*n*.剪切
distortion	*n*.失真,扭曲
tangential	*a*.切向的
bending	*n*.弯曲
couple	*n*.力偶
moment	*n*.矩,力矩
curvature	*n*.曲率
torsion	*n*.扭转,扭矩
cohesive	*a*.内聚的,粘着的
compaction	*n*.压紧,压缩
sliding	*n*.滑移
tensile	*a*.拉伸的
stiffness	*n*.刚度
instability	*n*.不稳定性
fracture	*n*.断裂
twist	*v*.扭转
normal	*a*.垂直的,法向的

译　文

第一部分　工程材料

所有来自工业的产品至少由一种——常常由许多种——形式的材料组成。最明显的例子是汽车。一辆轿车由多种不同材料组成,从玻璃、钢材到橡胶,加上许多其他金属和塑料。

在工业中对工程师有用的材料数量几乎是无限的。各种钢材

单独的合成物达数千种。据说有超过 10 000 种不同的玻璃,而塑料的数目也有这么多。另外,每个月都在市场上出现几百种不同的新材料。这意味着不能指望单独的工程师和技术人员在材料的众多种形态范围内对材料的所有性能与形式都了如指掌。一个人所能做的只能是试图掌握一些原理以指导其进行材料的选择和加工。

材料的性质缘于其内部结构。这就好比像电视机的操作依赖其内部的元件和电路一样。材料的内部结构包括原子、相邻原子构成晶体的方式、分子和微结构。

材料可以简单地分为三种主要形式:(1)金属;(2)塑料或聚合物;(3)陶瓷。

按其性质划分,金属是不透明的、有韧性的,而且有良好的导热性和导电性。塑料(或聚合物)通常包含轻的元素,因而密度相对较低,它们一般是绝缘的,而且在较低的温度下容易弯曲和成型。陶瓷是既包含金属元素也包含非金属元素的化合物,它们通常对较强的机械的、热的和化学的条件有相当的抵抗力。

金属分为含铁金属和不含铁金属,即前者含铁而后者不含铁。在钢中加入某些元素能改善其性能。例如,含铬的钢可以抗腐蚀,而含钨钢可以增加硬度。铝、铜及它们的合金,青铜和黄铜都是不含铁的金属。

塑料和陶瓷是非金属,但塑料可以像金属一样被加工。塑料可分为两种形式——热塑塑料和热固塑料。热塑塑料可以通过加热和加压进行成型与再成型,而热固塑料不能进行再成型,因为热固塑料硬化时发生化学变化。当需要承受高温材料的时候,工程师们常常用到陶瓷。

第二部分　材料力学

材料力学是应用力学的一个分支,它与材料在受力情况下的

行为、外部施加的载荷与内部承受的力，以及相关的变形有关。材料的性质和力的分析包含的知识是结构与机械零件研究及设计的重要基础。通过实验方法确定的材料性质和其他根据经验得到的常数是对用数学方法解决力学问题的补充。

对一个构件的抵抗力的研究，涉及内力，称为自由分离体分析。在构件内部，应用静力学原理设想将受力构件分割为若干孤立的段。确定内力与相关变形的分布和密集度的过程称为应力分析。

由变形行为导致的构件内部的反作用力依赖于载荷的大小及性质。可能的变形形式为：(1)拉伸或压缩，也就是使构件伸长或缩短；(2)剪切，即沿施加的切向力平面发生滑移或角的扭曲；(3)弯曲，其中力偶或弯矩引起曲率的变化；(4)扭转，其中力偶平面垂直于轴线，使构件发生扭转。

材料仅在各构件能够满足粘着强度的范围内提供对外部载荷的抵抗力，如对压缩的抵抗力，以及对滑移的抵抗力。一种材料所承受的拉伸应力、压缩应力和剪切应力可以利用材料强度分析中导出的关系式进行估算。确定某个结构或机械的构件对某个特定的应用是否合适的最重要因素是强度和刚度。

我们可以将基本应用的分类扩展为：(1)已知构件的尺寸和材料，在不考虑大变形、不稳定性和断裂的基础上，确定构件抵抗预定的载荷的能力；(2)选择合适的材料并确定构件的形状和尺寸，以适应预定的载荷函数，包括已知的或估算的外部载荷。设计就是对一个指定的函数的合适性的预测。

Unit Two

Part Ⅰ Structural Analysis

Structural analysis involves the determination of the forces acting within a structures or components of a structure. The term force meant to include bending moment, shear, axial compression or tension, and torsional moment. Components of a structure are elements such as beams (members subjected primarily to bending moment with little axial compression or tension), columns (members subjected primarily to axial compression with relatively little bending moment), tension member (members subjected primarily to axial tension with relatively little bending moment), and beam-columns (members subjected to significant magnitudes of bending moment as well as axial compression). In addition, components may refer to integral system, such as an entire floor, a roof, a multistory wall, or even the entire structure.

Structural analysis and structural design are interlocked subjects. The structural engineering has the objective of proportioning a structure such that it can safely carry the loads to which it may be subjected. Structural analysis provides the internal forces and structural design utilizes those forces to proportion the members or systems of members. Sometimes the laws of statics are sufficient to determine the internal forces from known applied loads and structural configuration; such structures are said to be statically determinate. More frequently, the internal forces are dependent on the relative stiffness of members in addition to the laws of statics; such structures are said to be statically indeterminate. For statically indeterminate structures, the design process involves iteration: the relative sizes must be systems of members proportional for the internal forces, the stiffness of members or systems of members evaluated, the structural analysis performed to determine the internal forces, the stiffness of members or systems of members evaluated, and the structural analysis repeated. Without structural analysis, design is impossible.

Structural design has been defined as "a mixture of art and science, combining the experienced engineers' intuitive feeling for the behavior of a structure with sound knowledge of the principles of statics, dynamics, mechanics of materials, and structural analysis, to produce a safe economical structure which will serve its intended purpose."

For many centuries, structures were designed solely as an art. Early Roman and Greek structures were proportioned with the said of structural analysis to determine the internal forces. When the proportioning was incorrect, the structures collapsed and for most, no historical reference remains. Some structures were overdesigned; some might be found to have been correctly designed if reviewed according to twentieth-century accepted procedures.

Structural analysis, as it is recognized today, began about 130 years ago with the publication by Squire Whipple of a rational discussion of the determination of forces in trusses. For the elastic theory relation to flexural members, Navier is generally regarded as the founder of the modern theory of elastic solids, with his published memoir of 1827. This theory has essentially provided the differential equation method for the analysis of statically indeterminate beams.

Practical treatment of statically indeterminate analysis may be considered to have originated with the French civil engineer Clapeyron, who in 1857 published his "theorem of three moments" for the analysis of continuous beams. During the period from 1860 to 1900, structural