

“十三五”国家重点出版物出版规划项目
面向可持续发展的土建类工程教育丛书

土木工程专业英语

合肥工业大学 王静峰 主编

SPECIALIZED ENGLISH FOR
CIVIL ENGINEERING



配套教师课件

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本书是“十三五”国家重点出版物出版规划项目面向可持续发展的土建类工程教育丛中教材之一。“土木工程专业英语”课程是高等院校土木工程专业的主要专业课之一。本书根据土木工程专业指导委员会的课程要求和国家专业认证(评估)的要求,结合了作者多年的教学经验,吸纳了国内外最新研究成果和发展动态,主要内容包括土木工程概论、土木工程材料、钢筋混凝土结构、钢结构、地震工程和结构抗震分析、高层建筑、桥梁工程、道路和交通工程、岩土和地下工程、计算机辅助设计和建筑信息模型、现代预制结构、工程施工和管理等。本书内容涵盖建筑、土木和交通工程领域的主要知识,共12个单元,每个单元包括正文、词汇和习题。

本书可作为高等院校土木工程专业本科生或土建类专业高职高专、成人教育的教材,也可作为土木工程技术人员和研究生的参考书。

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前言

在国际经济一体化的环境下,国际交流与合作日益广泛和频繁。科学技术快速发展,科技信息日新月异,熟练掌握英语,及时获取专业发展动态信息是工程技术人员和科研人员必备的基本能力。专业英语作为拓展大学生和研究生专业知识的有效工具,使得专业英语教学成为大多数高校开展科学研究和实现国际化教育的重要途径之一。

2015年,教育部颁布了《普通高等学校本科专业目录》,各个专业基本都对大学英语水平提出了明确要求。根据大学英语教学大纲要求,大学英语分为基础英语和专业英语两个学习阶段。专业英语是继基础英语学习之后,将专业技术与英语知识紧密结合在一起的一门交叉性课程,是对专业知识的拓展与发展。

目前,很多大学生和研究生的专业英语知识匮乏。强化他们的专业英语学习,将为其专业文献阅读和高水平英文写作打下良好的基础。专业英语教学强调专业性、应用性和灵活性,其目的是以大学英语为基础,进行专业方向的实践应用,进一步提高学生的专业英语技能。

本书不仅包括土木工程领域的专业基础知识,还包括科学前沿和研究热点,知识全面、深度适宜,既注重知识结构的完整性,又突出内容的新颖性和趣味性,同时注重引导学生关注土木工程各领域的核心内容。

本书共12个单元,每个单元有2~3小节,每小节的主要内容围绕单元主题展开。每个单元由正文、词汇和习题三部分组成。正文包括土木工程概论、土木工程材料、钢筋混凝土结构、钢结构、地震工程和结构抗震分析、高层建筑、桥梁工程、道路和交通工程、岩土和地下工程、计算机辅助设计和建筑信息模型、现代预制结构、工程施工和管理等内容。习题注重引导学生进一步理解章节内容,培养学生课外学习能力。

本书由合肥工业大学王静峰担任主编。第1、4、6单元由王静峰编写;第2、3单元由合肥工业大学丁兆东编写;第7、11、12单元由福建农林大学廖飞宇编写;第5、10单元由合肥工业大学赵春风编写;第8、9单元由上海大学胡宝琳编写。合肥工业大学夏竟成、汪皖黔、郭磊、徐秋雨对全书的英文进行了校对。

本书编写过程中参考了一些国内外已出版的教材和论著,外版资料的引用部分尽量保持原有风格,让学生全面了解英语语言的风格。在此,谨向相关编著者一并致以诚挚的谢意。

限于编写时间和编者水平,书中难免有疏漏与不妥之处,敬请广大同行及读者批评和指正。

编者

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Unit 1

Introduction to Civil Engineering

本单元第1部分系统地介绍了土木工程专业所研究和服务的领域，重点介绍了结构工程、地下工程、环境工程、水资源工程、交通工程和建筑施工等方面的内容；第2部分结合现阶段社会经济环境，具体介绍了对将来土木工程师所需要掌握的技能，对学生和执业工程师面临的问题给予了具体的建设性指导。

1.1 Civil Engineering

1.1.1 Overview

Civil engineering is the oldest engineering discipline. From the pyramids in Egypt, the Roman aqueduct and roads, to the Great Wall and the Grand Canal of China, ancient civil engineers left their imprint on human history on a grand scale. While the basic needs for civil engineering have not changed throughout the ages, the content and level of expectation of civil engineering work have certainly changed with the time because the tools available to civil engineers are changing with the time.

土木工程是最古老的工程学科。从埃及的金字塔、罗马的渡槽和道路，到中国的长城和大运河，古代的土木工程师大张旗鼓地在人类历史留下了他们的印记。虽然土木工程的基本需求在各个时代都没有改变，但土木工程工作的内容和期望水平，却随着时间的推移和可用工具的变化而产生了变化。

Civil engineering is a branch of engineering that deals with providing people with a livable built environment consistent with the standards and expectations of modern living through the applications of mathematics, science, and human experience. Some of the contributions of civil engineering are visible and obvious: buildings, bridges, highways, railways, airports, and dams and levees. Some are less commonly known as the product of civil engineering: offshore platforms, cell phone towers, power transmission lines and substations, drinking

water and wastewater treatment plants, traffic signals, air pollution control, International Space Station, and many more. In short, civil engineering deals with people's everyday needs and more.

土木工程是工程的一个分支,通过数学、科学和人类经验的应用,为人们提供符合现代生活标准和期望的宜居建筑环境。一些土木工程的贡献是显而易见的,如建筑、桥梁、高速公路、铁路、机场、水坝和堤坝。一些土木工程的贡献不太常见,如海上平台、手机信号塔、输电线路和变电站、饮用水和污水处理厂、交通信号灯、空气污染控制、国际空间站等。简而言之,土木工程涉及人们的日常需求及诸多其他需求。

Civil engineering's progress throughout time introduces new contributions to people's daily lives. Twenty greatest engineering achievements of the 20th century are:

- (1) Electrification.
- (2) Automobiles.
- (3) Airplanes.
- (4) Water supply and distribution.
- (5) Electronics.
- (6) Radio and television.
- (7) Agricultural mechanization.
- (8) Computers.
- (9) Telephones.
- (10) Air conditioning and refrigeration.
- (11) Highways.
- (12) Spacecraft.
- (13) Internet.
- (14) Imaging.
- (15) Household appliances.
- (16) Health technologies.
- (17) Petroleum and petrochemical technologies.
- (18) Laser and fiber optics.
- (19) Nuclear technologies.
- (20) High-performance materials.

土木工程在时间进程中的进步为人们的日常生活带来了新的贡献。20世纪20项伟大的工程成就是:

- (1) 电气化。
- (2) 汽车。
- (3) 飞机。
- (4) 供水和配水。
- (5) 电子产品。

- (6) 广播电视。
- (7) 农业机械化。
- (8) 计算机。
- (9) 电话。
- (10) 空调和制冷。
- (11) 高速公路。
- (12) 航天器。
- (13) 互联网。
- (14) 成像。
- (15) 家用电器。
- (16) 卫生技术。
- (17) 石油和石化技术。
- (18) 激光和光纤。
- (19) 核技术。
- (20) 高性能材料。

Among the twenty, clearly (4) and (11) are the contributions of civil engineering. Even (1) the generation and transportation of electrical power, cannot be achieved without the civil engineering contribution to the designing and constructing power transmission towers and lines. Same is true for (2) and (3).

在这 20 项中, 显然 (4) 和 (11) 是土木工程的贡献。如果没有土木工程对设计和建造输电塔和线路的贡献, 即使是 (1), 电力的产生和运输也不可能实现。(2) 和 (3) 也是如此。

As already indicated in Table 1-1, civil engineering includes several very different technical specialty areas. By describing these technical areas, it is hoped that a clearer picture of what civil engineering entails may emerge. Eight civil engineering technical areas are described below. Each technical area has its own sub-areas of specialty. They are described following the short overview of each technical area. When you begin to take civil engineering courses, you may identify each course with some of these technical areas. A student is not expected to be exposed to all the technical areas but at least four are included in the curriculum of any civil engineering degree program. Three contemporary issues confronting civil engineers are described following a description of other areas closely related to civil engineering. Personal attributes of a typical civil engineer is portrayed near the end. The chapter ends with a brief mentioning of all the steps leading to a civil engineering degree and career.

如表 1-1 所示, 土木工程包括几个截然不同的技术专业领域。通过描述这些技术领域, 希望读者可以更清楚地了解土木工程的内容。下面介绍 8 个土木工程技术领域。每个技术领域都有自己的专业子领域。我们将按

照每个技术领域的简短概述描述它们。当你开始学习土木工程课程时，你可以确定每个课程涉及的一些技术领域。预计学生不会接触所有技术领域，但至少要有4类包含在土木工程学位课程里。在描述与土木工程密切相关的其他领域之后，描述了土木工程师面临的3个当代问题。典型土木工程师的个人特征在最后有提及。本章最后还简要提到了通往土木工程学位和职业生涯的所有步骤。

Table 1-1 Basic needs and civil engineering

Human Needs	Specific Nature of Needs	Civil Engineering Technical Areas
Breath	Clean air	Environmental Engineering
Drink	Safe water	Environmental Engineering
Sleep	Livable shelter	Structural/Construction Engineering
Move around	Ways to travel	Transportation/Construction Engineering
Safe from disaster	Earthquake mitigation	Structural/Geotechnical Engineering
	Flood mitigation	Hydraulic Engineering/Water Resources
	Wind mitigation	Structural Engineering
	Fire resistant	Structural Engineering

1.1.2 Structural Engineering

Structural engineering is the technical specialty that deals with the analysis and design of constructed structures. From spacecraft to deep sea submarines, from tiny micro-electro-mechanical system (MEMS) devices to long bridges and tall buildings, these are all human-made structures that serve specific functions. A structure is always subjected to the many "loads" the environment forces upon it. These loads include the omnipresent gravitational load of its own weight (called the dead load), the weight of things moving about in or upon the structure (the live load), and event-driven loads originated from the occurrence of earthquakes, strong wind, or heavy snow. Structural design aims at providing a structure with sufficient level of resistance against these loads with minimum cost. Within structural engineering, there are several technical sub-areas. Some are named according to the type of structure. Some are named according to the type of load.

(1) Earthquake engineering. The suddenness of earthquakes and the damage they could cause in a matter of seconds inspired the study of the nature of earthquakes and the effects they inflict on structures. The effects of earthquake ground motion create vertical and horizontal forces that change violently within a short duration. The time-varying nature and the multi-directional nature of the earthquake-induced load require special design and analysis considerations. The fundamental approach in earthquake engineering is not to design a

structure to withstand any earthquake at all costs but to design a structure that will not inflict injury to human lives at a reasonable cost.

(2) Wind engineering. Strong wind caused by a hurricane, a tornado, or a storm creates effects on structures that are also time-varying and multi-directional. Strong wind around a structure may push against a surface while creating a partial vacuum behind another structural surface. Unlike earthquakes, which occur infrequently, especially the damaging ones, strong wind in some areas occurs frequently and so is the damage it incurs. Design against such wind-related effects is the realm of wind engineering. Here again, the design approach is to protect human lives with a reasonable cost.

(3) Fire engineering. In the event of a fire in a building, the high temperature created by the fire may cause the building material to lose its strength and eventually fail under the weight of the building. Fire engineering in the context of structural engineering deals with the effective application of protective materials to the structural components such as steel beams and columns such that sufficient time is provided for the occupants to escape and the firefighters to arrive. The research in fire engineering provides data to be incorporated into design and construction codes and specifications.

(4) Structural reliability. The many loads a structure must withstand during its life span are mostly of a “random” nature, meaning it cannot be defined precisely with respect to its magnitude and time of occurrence. So are the resistance provided by the size and material of structural components. Design in the face of uncertainty requires the application of probability and statistics. **Structural reliability** is the methodology applying these mathematical tools to the load-resistance analysis in structural design. It is used in the development of design codes and specifications that are followed by designers to provide acceptable levels of safety against all loads.

(5) Building engineering. Structural engineers often become building design specialists because building design is more frequently in demand than bridge or dam designs, especially in urban centers. Building engineers also design special buildings such as stadiums and large dome structures.

(6) Bridge engineering. Some structural engineers specialize in bridge design and construction. Bridge design can be categorized according to material and bridge type. One unique feature of bridge design is it is closely integrated with construction. From the bridge foundation to the superstructure, the process of construction and erection often requires detailed analysis by the design engineers and likely dictates the designers’ choice of bridge type.

(7) Dam engineering. The design of dams requires detailed study of the geological characteristics of the site and the mechanical properties of the founda-

tion before the dam type is selected. For some types of dams, it is necessary to ensure the dam material is placed in such a manner that seepage of water through and under the dam body is within acceptable limits. Dam engineers also design all details on how to divert water during construction and specify maintenance and operations procedures post construction.

(8) Forensic engineering. Forensic engineering refers to the study of causes of an engineering event, usually a disaster or failure of some kind. In the context of structural engineering, it refers to the investigation of a structural failure. There are no courses or programs for structural forensic engineering training, but experienced structural engineers who have investigated past failures are often called upon to investigate a new event. In case of major disasters, often a team of experts are assembled to study the cause of the disaster and to make recommendations to prevent future disasters. Even when the cause of disaster is terrorism, forensic engineering would reveal the weakness in design and provide guidance for future designs. A good example is the 1995 bombing of the Alfred P. Murrah Federal Building in Oklahoma City. The collapse of the building was caused by the bombing that destroyed ground-level columns in the front of the building. Experts recommended that future buildings should have sufficient redundancy in the design of supporting columns so that the damage of one or more columns would not lead to the collapse of the whole building.

In structural design in the context of civil engineering, there are three construction materials that are dominant: steel, reinforced concrete, and timber. Each has its own design specifications. Thus, steel structure design, reinforced-concrete structure design, and timber structure design are three main design disciplines.

1.1.3 Geotechnical Engineering

Most civil engineering structures are earthbound. They sit on soil and rock ground directly or on constructed foundations that transfer the load to the soil or rock below. Geotechnical engineering is the technical specialty that deals with soil and rock as supporting materials for structures. It deals with the various foundation types that work between the structure and the ground. In addition it deals with the stability of soil or rock slopes whose failure may cause loss of human lives or damage to property. There are several technical areas of study that are pertinent to geotechnical engineering.

(1) Engineering geology. While geology is a basic science that is concerned with macroscopic earth structures or movements, engineering geology provides geological data pertinent to constructed structures. One obvious example of the application of engineering geology is the mapping of active seismic

faults that are to be avoided when making plans for human habitat development, roadway construction, or power plant construction. At a more fundamental level, understanding various geological formation and rock types provides geotechnical engineers the knowledge necessary in assessing the suitability of a site for human activities.

(2) Soil mechanics. Most people would not consider soil as an engineering material, but it is, because most constructed structures are situated on it by necessity. Without due consideration of soil's bearing capacity under various circumstances, a structure built over it may sink, tilt, or outright turn over. Soil mechanics is a branch of mechanics that studies the mechanical properties of various types of soil and its strength at different moisture-content levels. It provides the scientific base upon which design formulas and codes are developed for everyday engineering design practice.

(3) Rock mechanics. The properties of rock become relevant when it is used as the foundation of a high-rise building or a large dam. It is also relevant when one examines the stability of the slope of a mountain or a tunnel. It is also the subject of study for the occurrence of earthquakes.

(4) Foundation engineering. A foundation is the interface between a superstructure and its supporting soil. A common type of foundation for single-family homes consists of strip footings placed under loadbearing basement walls. Another common practice is to use a concrete slab to spread the weight of the building over the soil underneath. Foundation engineering is the study of different types of foundation and their proper applications. Depending on the properties of soil at a site, shallow or deep piles may be deployed. The construction of a bridge over water may require the use of deep caissons on which piers are constructed. To stabilize an excavated slope, various types of methods may be used including retaining walls and slope-protection vegetation growth.

(5) Soil improvement. When a structure must be placed at a site with very weak soil, various techniques can be used to improve the soil properties. These typically involve the use of replacement material through excavation or the injection of special material (grouts) into the original soil to change its properties. Another special technique is to place geo-synthetic fabrics or textiles in horizontal layers to strengthen the soil or to limit soil's permeability, which is essential in the design for landfill and hazardous material deposit sites.

(6) Tunnel engineering. Tunneling through soil or rock is sometimes necessary in the construction of roadways or special storage spaces. Tunnel engineering deals with the route determination, selection of tunneling machines, and the analysis and design of the tunnel structure.

Most of the things designed by geotechnical engineers are not as visible as

those by structural engineers because they are underground or under the superstructure above. But, it is safe to state that no civil engineering work can be constructed without the contribution of geotechnical engineers.

1.1.4 Environmental Engineering

Environmental engineering is the application of engineering means to protect human health and to preserve the natural environment by managing and developing water, air, and land resources. The application of environmental engineering relies on the fundamental sciences of chemistry, biology, ecology, and health sciences. Most modern environmental engineering projects are planned and implemented under the auspices of the *Clean Water Act*, *Safe Drinking Water Act*, *Clean Air Act*, and other federal and state environmental legislation. Several technical areas in environmental engineering are described below.

(1) Water treatment and supply. Before water is consumed, it has to be collected first from either underground or above-ground sources. Therefore, source control is one of the most important tasks of water supply. Except for a few municipalities where the source water derived from deep aquifers, source water has to be treated to remove contaminants such as pathogenic bacteria, heavy metals, and pesticide residues. The process of treatment involves the removal of suspended solids and the use of chemicals or ultraviolet (UV) radiation to disinfect unwanted organisms so that the effluent water satisfies quality requirements dictated by the *Federal Safe Drinking Water Act*. For water used by industrial plants such as paper mills or nuclear power plants, special treatment is needed and its discharge is regulated.

(2) Wastewater treatment and disposal. In a modern municipality, household wastewater is collected through underground pipelines to a treatment plant. The wastewater treatment process is very different from drinking water treatment and is classified into primary treatment, secondary treatment, and tertiary advanced treatment. Primary treatment removes suspended solids from wastewater by a sedimentation process. Secondary treatment is to remove dissolved organic wastes from wastewater by biochemical decomposition followed by further sedimentation. The *Federal Clean Water Act* establishes nationwide minimum treatment requirements for all wastewater. For municipal wastewater discharge, the minimum treatment is the secondary treatment, which removes 85% of biochemical oxygen demand (BOD) and total suspended solids (TSS). BOD is a measurement of oxygen-demanding organic wastes. In situations in which these minimum treatment levels are not sufficient, the *Clean Water Act* requires additional treatment, which is accomplished by membrane filtration and

other physical-chemical processes.

The outcomes of the wastewater treatment are solid **sludge** and effluent water. The solid sludge sometimes can be used for landfill or even as **fertilizers**. The effluent water can be used for irrigation or groundwater recharge or may be directly discharged into river, stream, lake or sea. For a municipality, the amount of rainfall determines the ways of collecting and treating wastewater. Obviously if a large amount of rainfall is expected, especially when storm water comes in a very short period of time, rainwater runoff should be separated or diverted either temporarily or permanently from household wastewater in order to avoid overwhelming the treatment plant. Thus, a wastewater collecting system can either be combined (for more arid areas) or separated. Some industrial plants produce special wastewater that requires the removal of heavy metal or hazardous chemicals before being discharged.

(3) Air pollution. Environmental engineers monitor, analyze, and assess the air quality around municipalities. Air pollution comes from natural and human-activity sources. Volcanic eruption is a major natural source of air pollution. The gaseous and particulate contents of a volcanic eruption are often studied by scientists rather than engineers. Around a large municipality, however, air pollutants come from automobile emissions, nearby industrial plant emission, and even from faraway sources. Health science advances have discovered that tiny solid particles in the air such as soot are hazardous to human health. The monitoring of these particles is as important as that for gases. Tracing plant emission in the atmosphere, called plume analysis, is important in the assessment of the environmental impact of a plant. Another form of air pollution is sand storm. Monitoring of sand storms may lead to the sources of the storm and policy for conservation or planting of new vegetation.

(4) Solid waste disposal. Solid wastes, commonly known as trash and garbage, from domestic, commercial, and industrial sources are to be collected, separated, and partially recycled, and disposed of in landfills and special disposal sites. Environmental engineers, working with other civil engineers, select, design, and construct sanitary landfill sites. Water percolating through a sanitary landfill is intercepted, collected, and treated in order to prevent the seepage of hazardous materials into ground water strata. Some solid waste may be burned by specially designed incinerating plants.

(5) Nuclear waste disposal. Nuclear waste comes from used **fuel rods** in **nuclear power plants**. Though the degree of radiation from these spent fuel rods is low, long-term exposure to low-level radiation is hazardous to human health. Disposal of these wastes has few options. The basic approach is to store them in places far from human habitat. Furthermore, it must be assured that the storage

containers will not leak to the environment in any way. Leakage to underground water would be disastrous because the contaminants can travel far and reach sources for human water consumption.

(6) Noise pollution. In modern municipalities, human activities often generate sustained high levels of sound that are hazardous to the physical and mental wellbeing of habitants. Sound barriers are often needed to shield neighborhoods from highway traffic noises. Power plants or air-conditioning plants on large campuses produce high levels of noises that also require containment and shielding. Environmental engineers monitor the noise levels and design and implement mitigation strategies.

(7) Environmental impact assessment. Environmental engineers are often called upon to assess the impacts on human health and the natural environment by a new development, a new industrial plant, or even a new commercial establishment such as a large shopping mall. Such assessment may entail the study of noise, traffic, water consumption and discharge, power requirements, air pollution potential, and other factors.

Environmental engineering as a part of civil engineering is unique in its extensive applications of knowledge from health sciences and biology and chemistry. Its practice is also very much impacted by environmental laws enacted at the state and national levels.

1.1.5 Water Resources Engineering

Water resources engineering is a specialty dealing with the use of water in support of modern living, including the agricultural, industrial, domestic, recreational, and environmental needs. Its scope includes the finding and preservation of above and underground water sources, understanding the movement of water in nature, engineering the transport of water, and managing erosive effects of water wave and current on shorelines. Some core and related specialties are described below.

(1) Water resources system engineering. The understanding of the circulation of water on the earth and managing the sources of water in a region requires a system approach. Decision on the water supply for a city or a region requires the knowledge of water sources and the quality and quantity of each source. The application of system analysis in water resources management and the design and operations of multipurpose reservoir and river systems is at the core of water resources system engineering.

(2) Hydraulic engineering. Hydraulic engineers design artificial waterways such as canals, channels, and aqueducts as well as manage water movement by designing and constructing dams, levees, canal locks, and other wa-



ter-regulating devices. For many regions a major task of hydraulic engineers is flood prevention and control, which entails the assessment of potential rainfall quantity, prediction of water levels along natural rivers, streams, or channels, and strategies to mitigate flooding hazards by improving the natural topography. Hydraulic engineering is also fundamental to hydraulic-power generation. In hydraulic-power generation a prerequisite is a high water-level differential (water head). When water moves from a high level to a lower level, the difference in the water levels provides the energy potential for power generation. Some dams are constructed mainly for power generation although usually a dam also has the potential to be used for flood control. The stored water in a dam's reservoir can be used for agricultural, industrial, and domestic consumption as well as recreational sports.

(3) Coastal engineering. The movement of water in oceans and lakes has erosive effects on their shorelines. The preservation of wetland for flood mitigation or marine ecology requires the knowledge of such effects. Use of artificial barriers such as breakwaters or dikes at a shore or a harbor can result in reducing the water wave level within protected areas, eliminate or reduce the effects of shoreline erosion, and redirect natural sediment so that new land can be created over time.

(4) Ocean engineering. Ocean engineering deals with the effects of ocean currents and waves on ocean-bound structures and the analysis and design of such structures to withstand the wave forces. The most prominent ocean-bound structures are offshore platforms for oil exploration and production. Ocean engineers provide estimates of forces generated from waves and currents and the interaction of wave and structure so that structural engineers can design a platform to withstand such forces. Other ocean-bound structures include offshore wind farms and pipelines to transport materials from offshore to shore. While ships are obvious ocean-bound structures, their design usually falls in the realm of naval architecture, which integrates several engineering disciplines: structural, ocean, mechanical, and electrical for the design of ships. Naval architecture is not considered as a part of civil engineering.

1.1.6 Transportation Engineering

Transportation engineering deals with the efficient transport of people and goods. The content of transportation engineering changes whenever a new mode of transportation becomes viable. For example the advent of airplanes and air travel led to new technical fields such as airport design and air traffic control. Several sometimes overlapping technical specialties are part of transportation engineering: