21世纪全国本科院校土木建筑类创新型应用人才培养规划教材

土木工程专业英语

主　编　宿晓萍　赵庆明

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内 容 简 介

本书共 26 课，每课包括正文和参考译文两大部分，每课编配生词表和常用词组与专业短语，并配有练习题、必要的翻译注释，以及专业基础知识的相关扩展内容和阅读材料，便于学生更好地掌握本书的教学内容，在学习专业知识的同时，可积累大量的相关专业英语词汇，了解科技文章的语法特点与翻译技巧。

本书选材范围涉及建筑工程、道路与桥梁工程、岩土工程、地下工程、建筑设计与构造、工程管理等方面的内容，与土木工程专业课程的基本教学内容结合紧密。全书以文字为主，适当配图，选取的英文文章专业性强，内容浅显易懂，专业词汇丰富。

本书适合作为建筑工程、道路桥梁工程、岩土工程、管理工程等专业的中外合作办学项目、“卓越计划”及应用型本科的教材。

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Ⅰ．①土… Ⅱ．①宿… ②赵… Ⅲ．①土木工程—英语—高等学校—教材 Ⅳ．①TU

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前　言

中国目前正在进行大规模的基础设施建设，一批大型、复杂、高端的工程项目吸引了国外建筑公司或事务所参与设计、施工与管理等，同时，越来越多的中国建筑企业也涌向国际建筑市场，积极拓展国际工程承包业务。随着国际合作工程项目的日益增多，这对中国土木工程专业人才的质量及其国际合作能力与竞争力提出了新的考验。同时，随着我国“卓越工程师培养计划”的不断推进，高等工程教育已逐渐趋于国际化，高等院校也在不断开展国际合作办学，通过借鉴和利用国外高等教育的优质资源与成功经验，培养具有国际化高素质的专业人才，以增强我国人才在国际工程市场上的竞争能力。

本书从培养应用型国际化土木工程专业人才的目标出发，结合学生出国进修学习及毕业后的工作实际，通过一定数量的土木工程类英语原文文章，训练学生阅读与翻译本专业英文资料的初步能力，掌握一定量的专业英语词汇，为学生出国进修学习夯实专业英语应用基础，提高学生未来工作岗位所需要的专业英语知识和技能。

本书由宿晓萍、赵庆明担任主编，由沙勇、李莹担任副主编，吴春利、常虹参编。本书共分 26 课，具体编写分工如下：长春工程学院宿晓萍编写第 1、2、3、4、5 课，长春工程学院赵庆明编写第 7、9、15、16、20 课，长春工程学院沙勇编写第 10、11、12、13、14、17、18、19 课，长春工程学院李莹编写第 21、22、23、24、25、26 课，吉林大学吴春利编写第 6 课，吉林建筑大学常虹编写第 8 课。

本书的编写得到了长春工程学院外国语学院高岩松老师的大力支持与帮助，在此表示衷心的感谢。

由于编者水平有限，书中难免有不妥之处，恳请广大读者批评指正。

编　者

2016 年 12 月

目　录

Lesson 1

Civil Engineering

Civil engineering, the oldest of the engineering specialties, is the planning, design, construction, and management of the built environment.① This environment includes all structures built according to scientific principles, from irrigation and drainage systems to rocket-launching facilities.

Civil engineers build roads, bridges, tunnels, dams, harbors, power plants, water and sewage systems, hospitals, schools, mass transit, and other public facilities essential to modern society and large population concentrations. They also build privately owned facilities such as airports, railroads, pipelines, skyscrapers, and other large structures designed for industrial, commercial, or residential use. In addition, civil engineers plan, design, and build complete cities and towns, and more recently have been planning and designing space platforms to house self-contained communities.

The word "civil" derives from the Latin for citizen. In 1782, an Englishman John Smeaton used the term to differentiate his nonmilitary engineering work from that of the military engineers who predominated at the time②. Since then, the term civil engineering has often been used to refer to engineers who build public facilities, although the field is much broader.

1. Scope

Because it is so broad, civil engineering is subdivided into a number of technical specialties③. Depending on the type of project, the skills of many kinds of civil engineer specialists may be needed.

When a project begins, the site is surveyed and mapped by civil engineers who locate utility placement water, sewer, and power lines. Geotechnical specialists perform soil experiments to determine if the earth can bear the weight of the project. Environmental specialists study the project's impact on the local area: the potential for air and groundwater pollution, the project's impact on local animal and plant life, and how the project can be designed to meet government requirements aimed at protecting the environment. Transportation specialists determine what kind of facilities is needed to ease the burden on local roads and other transportation networks that will result from the completed project.④ Meanwhile, structural specialists use preliminary data to make detailed designs, plans, and specifications for the project. Supervising and coordinating the work of these civil engineer specialists, from the beginning to the end of the project, are

the construction management specialists. Based on information supplied by the other specialists, construction management civil engineers estimate quantities and costs of materials and labor, schedule all work, order materials and equipment for the job, hire contractors and subcontractors, and perform other supervisory work to ensure the project is completed on time and as specified.

Throughout any given project, civil engineers make extensive use of computers. Computers are used to design the project's various elements (computer-aided design, or CAD) and to manage it. Computers are a necessity for the modern civil engineer because they permit the engineer to efficiently handle the large quantities of data needed in determining the best way to construct a project.

2. Structural engineering

In this specialty, civil engineers plan and design structures of all types, including bridges, dams, power plants, supports for equipment, special structures for offshore projects, the United States space program, transmission towers, giant astronomical and radio telescopes, and many other kinds of projects. Using computers, structural engineers determine the forces a structure must resist: its own weight, wind and hurricane forces, temperature changes that expand or contract construction materials, and earthquakes. They also determine the combination of appropriate materials, steel, concrete, plastic, stone, asphalt, brick, aluminum, or other construction materials.

3. Water resources engineering

Civil engineers in this specialty deal with all aspects of the physical control of water. Their projects help prevent floods, supply water for cities and for irrigation, manage and control rivers and water runoff, and maintain beaches and other waterfront facilities. In addition, they design and maintain harbors, canals, and locks, build huge hydroelectric dams and smaller dams and water impoundments of all kinds, help design offshore structures, and determine the location of structures affecting navigation.

4. Geotechnical engineering

Civil engineers who specialize in this field analyze the properties of soils and rocks that support structures and affect structural behavior. They evaluate and work to minimize the potential settlement of buildings and other structures that stems from the pressure of their weight on the earth. These engineers also evaluate and determine how to strengthen the stability of slopes and fills and how to protect structures against earthquakes and the effects of groundwater.

5. Environmental engineering

In this branch of engineering, civil engineers design, build, and supervise systems to provide safe drinking water and to prevent and control pollution of water supplies, both on the surface and underground. They also design, build, and supervise projects to control or eliminate pollution of the land and air. These engineers build water and wastewater

treatment plants, and design air scrubbers and other devices to minimize or eliminate air pollution caused by industrial processes, incineration, or other smoke-producing activities. They also work to control toxic and hazardous wastes through the construction of special dump sites or the neutralizing of toxic and hazardous substances. In addition, the engineers design and manage sanitary landfills to prevent pollution of surrounding land.

6. Transportation engineering

Civil engineers working in this specialty build facilities to ensure safe and efficient movements of both people and goods. They specialize in designing and maintaining all types of transportation facilities, highways and streets, mass transit systems, railroads and airfields, ports and harbors. Transportation engineers apply technological knowledge as well as consideration of the economic, political, and social factors in designing each project. They work closely with urban planners, since the quality of the community is directly related to the quality of the transportation system.

7. Pipeline engineering

In this branch of civil engineering, engineers build pipelines and related facilities which transport liquids, gases, or solids ranging from coal slurries (mixed coal and water) and semi-liquid wastes, to water, oil, and various types of highly combustible and noncombustible gases. The engineers determine pipeline design, the economic and environmental impact of a project on regions it must traverse, the type of materials to be used — steel, concrete, plastic, or combinations of various materials — installation techniques, methods for testing pipeline strength, and controls for maintaining proper pressure and rate of flow of materials being transported. When hazardous materials are being carried, safety is a major consideration as well.

8. Construction engineering

Civil engineers in this field oversee the construction of a project from beginning to end. Sometimes called project engineers, they apply both technical and managerial skills, including knowledge of construction methods, planning, organizing, financing, and operating construction projects. They coordinate the activities of virtually everyone engaged in the work: the surveyors, workers who lay out and construct the temporary roads and ramps, excavate for the foundation, build the forms and pour the concrete, and workers who build the steel framework. These engineers also make regular progress reports to the owners of the structure.

9. Community and urban planning

Those engaged in this area of civil engineering may plan and develop communities within a city, or entire cities. Such planning involves far more than engineering consideration; environmental, social, and economic factors in the use and development of land and natural resources are also key elements. These civil engineers coordinate planning of public works along with private development. They evaluate the kinds of facilities needed,

including streets and highways, public transportation systems, airports, port facilities, water-supply and wastewater-disposal systems, public buildings, parks, and recreational and other facilities to ensure social and economic as well as environmental well-being.

10. Photogrametry, surveying, and mapping

The civil engineers in this specialty precisely measure the Earth's surface to obtain reliable information for locating and designing engineering projects. This practice often involves high-technology methods such as satellite and aerial surveying, and computer processing of photographic imagery. Radio signals from satellites, scans by laser and sonic beams, are converted to maps to provide far more accurate measurements for boring tunnels, building highways and dams, plotting flood control and irrigation projects, locating subsurface geologic formations that may affect a construction project, and a host of other building uses.

11. Other specialties

Two additional civil engineering specialties that are not entirely within the scope of civil engineering but are essential to the discipline are engineering management and engineering teaching. ⑤

1) Engineering management

Many civil engineers choose careers that eventually lead to management. Others are able to start their careers in management positions. The civil engineer-manager combines technical knowledge with an ability to organize and coordinate worker power, materials, machinery, and money. These engineers may work in government—municipal, county, state, or federal; in the U. S. Army Corps of Engineers as military or civilian management engineers; or in semiautonomous regional or city authorities or similar organizations. They may also manage private engineering firms ranging in size from a few employees to hundreds.

2) Engineering teaching

The civil engineer who chooses a teaching career usually teaches both graduate and undergraduate students in technical specialties. Many teaching civil engineers engage in basic research that eventually leads to technical innovations in construction materials and methods. Many also serve as consultants on engineering projects, or on technical boards and commissions associated with major projects.

Ⅰ. New Words

1. irrigation *n.* 灌溉
2. drainage *n.* 排水，排水系统，污水
3. sewage *n.* 污水，下水道，污物
4. predominate *vt.* 居支配地位，统治，（数量上）占优势
5. subdivide *vt.* 把……再分，把……细分
6. geotechnical *adj.* 岩土工程技术的

7. specification *n*. 规格，说明书，技术要求
8. supervise *vt*. 监督，管理，指导
9. coordinate *vt*. 协调，调整，整合
10. subcontract *vt*. 转包，分包；*n*. 转包合同，分包合同
11. subcontractor *n*. 转包商，分包者
12. supervisory *adj*. 监督的，管理的
13. asphalt *n*. 沥青，柏油；*vt*. 铺沥青于……
14. aluminum *n*. [化] 铝
15. impoundment *n*. 蓄水，贮水量，围住，扣留
16. scrubber *n*. 洗涤器，滤清器，刷子，擦洗者
17. incineration *n*. 焚化，烧尽，火葬
18. toxic *adj*. 有毒的，中毒的
19. slurry *n*. 泥浆，水泥浆，煤泥
20. combustible *adj*. 易燃的，燃烧性的；*n*. 可燃物，易燃物
21. ramp *n*. 斜坡，坡道，斜面
22. excavate *vt*. 挖掘，开凿
23. aerial *adj*. 空气的，大气的，航空的
24. sonic *adj*. 声音的，音速的，声波的
25. plotting *vt*. 测绘，标图，标航路；*n*. 测绘，标图
26. municipal *adj*. 市政的，市立的，地方自治的

Ⅱ. Phrases and Expressions

1. civil engineering 土木工程
2. structural engineering 结构工程
3. water resources engineering 水利资源工程
4. geotechnical engineering 岩土工程
5. environmental engineering 环境工程
6. transportation engineering 交通（运输）工程
7. pipeline engineering 管道工程
8. construction engineering 建筑工程，施工工程
9. engineering management 工程管理
10. drainage system 排水系统

Ⅲ. Notes

① “the oldest of the engineering specialties” 在句中的成分是 civil engineering 的主语补足语。另外，科技文章常用一般现在时表述，注重的是客观事实与真理。

② “differentiate... from” 译为 “与……相区别，不同于……”。句中的 that 指代 work，以避免用词重复。

③ 主句采用被动语态。被动语态的使用是专业英语中常见的语法特点，因为科技人员往往更关心事实和行为，而不是行为者；而且被动语态比主动语态简短，将最重要的信息放在句首，一下就可抓住读者的注意力。

④ “what kind of . . . project” 是 determine 的宾语从句。在此宾语从句中，“that will result from the completed project” 是 burden 的定语从句。复杂长句多是科技文章的一个显著特点，如主从句、一主多从、并列句应用较多，不仅包含的信息量大，也是为了达到准确描述事物的目的。

⑤ “. . . not . . . but. . . ” 意为 “不是……而是……”，带有选择的意思。

Ⅳ. Exercises

Fill in the blanks with the information given in the text.

1. Two additional civil engineering specialties that are not entirely within the scope of civil engineering but are essential to the discipline are _____ and _____.

2. Translate the following expressions into English.

(1) 土木工程_____ (2) 结构工程 _____ (3) 岩土工程 _____

(4) 管理工程_____ (5) 建筑设计 _____ (6) 民用建筑 _____

Ⅴ. Expanding

Remember the following terms related to the type of engineering.

1. residential building 居住建筑
2. public building 公共建筑
3. heating and ventilating and air-conditioning engineering/HVAC engineering 采暖与通风工程
4. water and sewerage engineering 给排水工程
5. municipal project 市政工程
6. subway engineering 地铁工程

Ⅵ. Reading Material

Becoming a Civil Engineer

In the English-speaking countries, unlike Continental Europe, a professional engineer who wishes to be fully qualified, must join at least one engineering institution. All these institutions require candidates for admission to prove that they have some years of useful practical experience as an engineer. Each institution is a learned society not unlike a club except that the candidate's strict examination for membership is based mainly on his engineering knowledge, and all institutions publish engineering literature in their own subjects, usually in their own subjects, usually in their monthly journal. Each has several grades of membership, from the highest, full Member, down through the usual grade,

Associate-Member, to the grades of Student or Graduate for younger people up to about twenty-five or thirty years old.

In Britain it has always been possible for a boy on leaving school at fifteen to start work in the drawing office of a civil engineer, whether contractor or consultant, and eventually after many years of study in his spare time, to become a qualified civil engineer. This is becoming less easy and may soon become impossible. The recommended method of study for the ICE (Institution of Civil Engineers) examinations is now by full-time or sandwich study for a degree or diploma. Sandwich study is full-time work at a college interrupted by periods of full-time work with an employer.

Modern engineering requires more and more science, and to make use of its scientific theories, a civil engineer should study full-time for some years after leaving school. Therefore a university degree in civil engineering may soon become essential for membership of the ICE or any of the other civil engineering institutions (Institutions of Highway Engineers, Municipal Engineers, Public Health Engineers, Structural Engineers, Water Engineers, or the Permanent Way Institution, etc.).

To qualify for Associate-Membership of the ICE, a person must be at least twenty-six years old and working as a civil engineer. He must also pass certain examinations, satisfy ICE that he has had several years of useful engineering experience under the supervision of qualified civil engineers, both in the drawing office and on the site, and finally he must pass a mainly oral examination called the professional interview, before a group of qualified civil engineers. This is generally the only part of the examination from which candidates are never excused, whatever their civil engineering degree.

In general education, the minimum requirements, before a man may be accepted even as a candidate for the ICE examinations are as follows: five passes in the General Certificate of Education, (a) at advanced level in physics, (b) at advanced level in either pure or applied mathematics, (c) at ordinary level in English, and (d) at ordinary level in two other subjects. Detailed information is issued free by the ICE on all matters including the parts of the examination a candidate need not take as well as on the number of years and the types of civil engineering experience which are accepted.

In Britain the thirteen main engineering institutions were formally joined for examination purposes in 1965 in the Council of Engineering Institutions in London. A similar arrangement was made a few years earlier in the Unite Engineering Center, 345 East 47th Street, New York, for the United States institutions. In Britain all professions now take the Part 1 examination set by the Council of Engineering Institutions. This includes the five subjects of engineering drawing, mathematics, applied mechanics, principles of electricity, heat light and sound.

参考译文

第1课 土木工程

土木工程学，作为最古老的工程专业，是对建筑环境的规划、设计、施工和管理。这一环境包括从灌溉和排水系统到火箭发射设施的所有根据科学原理建造的建筑物。

土木工程师修筑道路、桥梁、隧道、大坝、海港、电厂、给排水系统、医院、学校、公交及其他现代社会和大量人口集中地所必需的基本公共设施；他们也修筑私有设施，诸如机场、铁路、管线、摩天大楼和其他为工业、商业或居住用途而设计的大型结构。此外，土木工程师还规划、设计和建造完整的城市与乡镇，最近已经开始规划和设计可容纳设备齐全的社区空间平台。

“土木”一词起源于拉丁语“citizen”。1782年，英国人约翰·史密顿采用这一术语来区分他所从事的非军事工程的工作与在当时占主导地位的军事工程师的工程项目。从那时起，“土木工程”这个术语就经常用来指那些建造公共设施的工程师们，尽管该词所包含的范围更为广泛。

1. 范围

由于土木工程包含的范围如此广泛，所以它被细分为许多技术专业。根据工程类型的不同，需要多种土木工程专业人员。

当一个工程项目开始，土木工程师要进行场地的勘测和地形图的绘制，他们还要确定有效的给水、排水和电力线路的位置。岩土工程专家要进行土壤试验以确定土体是否能承受工程的荷载。环境工程专家要研究工程对当地环境的影响：对空气和地下水的潜在污染，对当地动植物的影响，以及工程如何设计才能满足政府针对环境保护的要求。交通工程专家要确定需要采用哪种设施来减轻因整个工程对当地道路和其他交通网造成的负担。同时，结构工程专家运用初始数据来对工程进行详细的设计、规划和说明。从项目开始到结束，监督和协调上述土木工程专家工作的是施工管理专家。根据其他专家提供的信息，施工管理专家估计所需的材料和人工的数量与造价，确定所有工作的进度，订购施工材料和设备，雇用承包商和分包商，并执行其他监督工作以确保工作按时且按规定完成。

在任何给定项目的整个过程，土木工程师都大量运用计算机。计算机被用来设计和管理工程的多种要素（计算机辅助设计，或CAD）。对现代土木工程师来说，计算机是个必需品，因为它们可以使工程师高效地处理大量的数据，而这些数据是确定工程的最佳建造方法所必需的。

2. 结构工程学

在这一专业领域，土木工程师规划和设计各种类型的结构，包括桥梁、大坝、电厂、设备支架、海上工程的特种结构、美国太空计划、发射塔、巨型天文和射电望远镜以及许多其他种类的工程。结构工程师用计算机确定结构所必须承受的力：自重、风（飓风）荷载、温度变化引起的建筑材料的膨胀和收缩，以及地震荷载。他们还需确定合适的材料组合，如钢、混凝土、塑料、石材、沥青、砖、铝或其他建筑材料。

3. 水力工程学

这个专业的土木工程师要处理水的物理控制的各个方面。他们的项目有助于预防洪

水、为城市供水和灌溉用水、管理和控制河流和水径流、维护海滩及其他滨水设施。另外，他们还设计和维护港口、运河与水闸，建造大型水力发电大坝与小型坝及各种蓄水设施，帮助设计海域构筑物，并确定导航构筑物的位置。

4. 岩土工程学

专攻这一领域的土木工程师要分析支承结构并影响结构性能的岩土的性质。他们计算建筑和其他结构由于自重压力可能引起的沉降，并采取措施使之减少到最小。他们也评估和确定如何加强边坡和填充物的稳定性，以及如何保护结构免受地震和地下水的影响。

5. 环境工程学

在这一工程学分支中，土木工程师设计、建造和监督系统以提供安全的饮用水，防止和控制地面和地下供水的污染。他们还设计、建造和监督工程以控制或减轻对土壤和空气的污染。这些工程师建造供水和污水处理厂，设计空气净化器和其他设施把由于工业生产、焚化或其他排烟生产活动引起的空气污染减到最小或消除。他们还通过建造特殊倾倒场所或中和有毒有害物质来控制有毒有害废物的危害。此外，工程师还对垃圾掩埋进行设计和管理，以预防其对周围环境造成污染。

6. 交通工程学

从事这一专业的土木工程师建造设施以确保人和货物被安全高效地运输。他们精于设计和维护各种类型的交通设施，如高速公路和街道、公共交通系统、铁路和机场、港口和海港。交通工程师在设计每个项目中运用科技知识，并考虑经济、政治和社会方面的因素。他们与城市规划师紧密合作，因为社区的质量与交通系统的质量休戚相关。

7. 管道工程学

在土木工程学的这个分支中，工程师们建造管道和相关设施来输送液体、气体或固体，从煤浆（煤与水的混合）和半液态废物，到水、油和各种类型的高燃烧性和非燃烧性气体。工程师们决定管道设计，管道工程对它所必须通过地区的经济和环境的影响，所用材料类型——钢材、混凝土、塑料或多种材料的组合——的安装技术、测试管道强度的方法，以及控制所运送的流体材料保持适当的压力和流速。当输送有害物质时，安全也是一个主要的考虑因素。

8. 建造工程学

这一领域的土木工程师要从头到尾监督工程的施工。他们有时也被称为项目工程师，他们运用技术和管理技能，包括施工方法、规划、组织、财务以及运作施工项目方面的知识。事实上，他们协调参与工程的每一个人的行动：测量员，铺设和修筑临时道路和坡道、开挖基坑、支模和浇筑混凝土的工人，以及建造钢骨架的工人。这些工程师还要向工程业主做常规进度报告。

9. 社区和城市规划

从事这一领域工作的土木工程师为市内社区或整个城市进行规划和开发。此规划所包含的远不止工程方面，在使用和发展土地和自然资源中的环境、社会、经济因素也是重要因素。这些工程师要协调公共工程的规划和私人建筑发展之间的关系。他们评估所需的各类设施，包括街道和公路、公交系统、机场、港口设施、供水和废水处理系统、公共建筑、公园、休闲和其他保证社会、经济以及环境健康的设施。

10. 摄影、测量与绘图

该专业的土木工程师精确地测量地球表面以获得可靠信息来定位和设计工程项目。这一工作经常涉及高科技方法，诸如卫星和航空测量、摄影图像的计算机处理等。从卫星传来的无线电信号通过激光和声束扫描被转换成图形，为以下方面提供更精确的测量：隧道钻孔、修建高速公路和大坝、绘制洪水控制和灌溉工程图、定位可能影响建筑项目的地下岩石构成，以及其他许多建筑的使用。

11. 其他专业

另外两个工程专业虽不完全包含在土木工程的范围内，但对该学科很重要，它们就是工程管理和工程教育。

1）工程管理

许多工程师最终选择管理作为职业，而其他人可从管理这一位置开始他们的职业生涯。土木工程管理者综合了技术知识和组织协调劳动力、材料、机械和资金的能力。这些工程师可能在市、村镇、州或联邦政府工作；或在美国陆军工程兵团担任军事或民用管理工程师；或在半自治地区或城市权力机关或类似机构工作。他们也可能管理着规模由几个到数百人的私营工程公司。

2）工程教育

选择教育事业的土木工程师通常教授技术专业的研究生和本科生。许多土木工程教育者从事基础研究并引导建筑材料和施工方法的技术创新。许多人也担任工程项目顾问或与重要项目相关的技术部门或委员会的顾问。

Lesson 2

Basic Knowledge of Drawing①

1. Drawling tools and their utilization②

In order to improve the quality and efficiency in producing drawings, all tools must be used correctly.

1) Drawing board

A drawing board is used to fix drawing sheet and produce drawings on the sheet. The surface of the board should be flat and smoothy. The left side is the lead side and should be straight for guiding rulers as shown in Fig. 2-1.

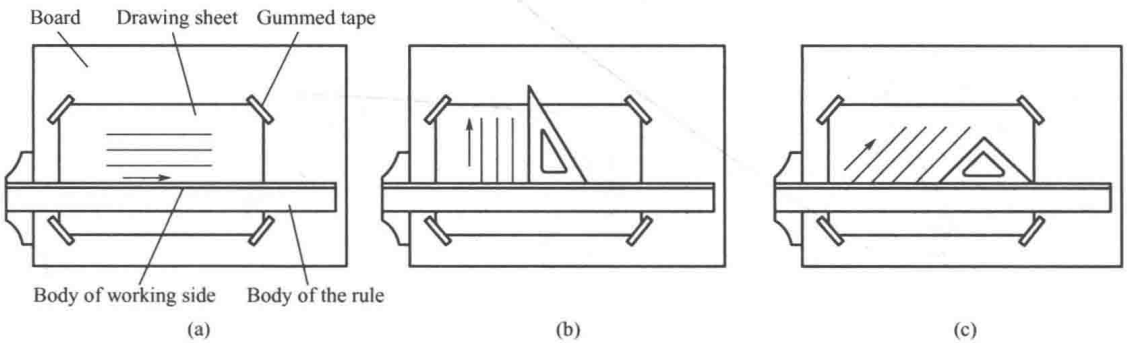

Fig. 2 - 1 The use of drawing board and T-square

(a) To fix paper and draw horizontal lines; (b) To draw vertical lines; (c) To draw parallel lines

2) T-square

A T-square is mainly used to draw horizontal lines. It can also be used to draw vertical lines in combination with a triangle as shown in Fig. 2 - 1(a). To draw horizontal lines, it needs to place the head of the T-square in contact to the left edge of the drawing board with left hand and move the T-square to the desired position. Then it needs to hold the pencil and draw the line from its left end to the right end. One should not directly use a T-square to draw vertical lines and should not use the lower edge of a T-square to draw horizontal lines either.

3) Triangles

A triangle is often used in combination with a T-square to draw vertical lines, lines with an inclination angle of 30°, 45° or 60° to horizontal lines as shown in Fig. 2 - 1(b) and (c). One can also use two triangles to draw parallel lines and perpendicular lines of any