普通高等教育“十二五”规划教材

土木水利专业英语

彭辉　编著

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内 容 提 要

本书以土木工程、水利工程为主线，系统地介绍了土木工程、水利工程及其所包含的有关分支学科的基本内容和历史概况，如：建筑材料、桥梁、道路、岩土、大坝、渡槽、力学、生态等，特别增加了三峡工程、南水北调工程等世界瞩目的大型工程的介绍，共编排32篇课文作为课堂教学与课后阅读。每篇课文附上关键的词语解释，供教师指导学生阅读和学习。

本书是为高等学校土木工程专业、水利工程专业类本科学生和研究生选编的专业英语教材。本书也可作为从事土木工程、水利工程的专业人员了解专业知识、提高英语水平的辅助阅读材料。

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前言

专业英语是大学英语教学的一个重要组成部分，是促进学生完成从英语学习过渡到实际应用的有效途径。教育部颁布的《大学英语教学大纲》以及全国硕士研究生教学指导委员会制定的工科硕士研究生培养方案中明确规定专业英语为必修课，要求从大学阶段到研究生阶段，不断培养学生的英语交流和使用能力，以应对日趋国际化的学术交流和经济社会发展。

目前我国土木工程、水利工程行业与国外有许多交流，并参与国际市场的竞争，急需大量既懂专业又能熟练掌握专业外语的技术人员投身土木、水利国际市场，因此许多的专业技术人员希望有一本既包括土木类知识又涉及水利类知识的专业外语参考书籍。为此，本书的编写尽可能做到内容的系统性、知识性和实用性，使本书除可用做本科、研究生教材外，也可供土木、水利专业的教师、研究人员和工程技术人员参考。

专业英语与普通英语并无实质的不同。因此，学习普通英语的方法仍适合于学习专业英语。听、说、读、写、译五种语言技巧仍适用于专业英语的学习和使用。随着国际交流的逐渐增强，专业外语的听、说和读变得越来越重要，因此鼓励加强专业外语的听说训练和撰写能力，特别是广大专业技术人员经常在工作、学习上用到专业外语，如何在较短时间内掌握各自专业领域的专业英语成为广大专业技术人员十分关心的问题。为此本书精选土木工程、水利工程领域有关分支学科目前较为关心的研究内容和工程介绍，以提高教材的针对性。

本书第一部分16篇课文主要涉及土木工程领域的专业知识；第二部分16篇课文主要涉及水利工程领域的专业知识。每篇课文配有词汇注释，便于阅读学习。

本书由三峡大学水利与环境学院彭辉编著，在编写中得到三峡大学研究生处、重点学科建设办公室和水利与环境学院各位领导的关心和支持。由于编写时间紧迫，及限于编者的学识，书中难免会有不足之处。敬请读者批评指正。

作 者

2012年10月

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Part One Civil Engineering Specialty

Lesson One Durability of Concrete

Besides its ability to sustain loads, concrete is also required to be durable. The durability of concrete can be defined as its resistance to deterioration resulting from external and internal causes. The external causes include the effects of environmental and service conditions to which concrete is subjected, such as weathering, chemical actions and wear. The internal causes are the effects of salts, particularly chlorides and sulphates, in the constituent materials, interaction between the constituent materials, such as alkali – aggregate reaction, volume changes and absorption permeability.

In order to produce a durable concrete, care should be taken to select suitable constituent materials. It is also important that the mix contains adequate quantities of materials in proportions suitable for producing a homogeneous and fully compacted concrete mass.

Weathering

Deterioration of concrete by weathering is usually brought about by the disruptive action of alternate freezing and thawing of free water within the concrete and expansion and contraction of the concrete. Under restraint, resulting from variations in temperature and alternate wetting and drying.

Damage to concrete from freezing and thawing arises from the expansion of pore water during freezing; in a condition of restraint, if repeated a sufficient number of times, this results in the development of hydraulic pressure capable of disrupting concrete. Road kerbs and slabs, dams and reservoirs are very susceptible to frost action.

The resistance of concrete to freezing and thawing can be improved by increasing its impermeability. This can be achieved by using a mix with the lowest possible water – cement ratio compatible with sufficient workability for placing and compacting into a homogeneous mass. Durability can be further improved by using air – entrainment, an air content of 3 to 6 per cent of the volume of concrete normally being adequate for most applications. The use of air – entrained concrete is particularly useful for roads where salts are used for deicing.

Chemical Attack

In general, concrete has a low resistance to chemical attack. There are several chemical agents that react with concrete but the most common forms of attack are those associated with leaching, carbonation, chlorides and sulphates. Chemical agents essentially react with certain compounds of the hardened cement paste and the resistance of concrete to chemical attack therefore can be affected by the type of cement used. The resistance to chemical attack improves with increased impermeability.

Wear

The main causes of wear of concrete are the cavitation effects of fast-moving water, abrasive material in water, wind blasting and attrition and impact of traffic. Certain conditions of hydraulic flow result in the formation of cavities between the flowing water and the concrete surface. These cavities are usually filled with water vapour charged with extraordinarily high energy and repeated contact with the concrete surface results in the formation of pits and holes, known as cavitation erosion.

Since even a good-quality concrete will not be able to resist this kind of deterioration, the best remedy is therefore the elimination of cavitation by producing smooth hydraulic flow. Where necessary, the critical areas may be lined with materials having greater resistance to cavitation erosion.

In general, the resistance of concrete to erosion and abrasion increases with increase in strength. The use of a hard and tough aggregate tends to improve concrete resistance to wear.

Alkali-Aggregate Reactions

Certain natural aggregates react chemically with the alkalis present in Portland cement. When this happens these aggregates expand or swell resulting in cracking and disintegration of concrete.

Volume Changes

Principal factors responsible for volume changes are the chemical combination of water and cement and the subsequent drying of concrete, variations in temperature and alternate wetting and drying. When a change in volume is resisted by internal or external forces this can produce cracking, the greater the imposed restraint, the more severe the cracking. The presence of cracks in concrete reduces its resistance to the action of leaching, corrosion of reinforcement, attack by sulphates and other chemicals, alkali-aggregate reaction and freezing and thawing, all of which may lead to disruption of concrete. Severe cracking can lead to complete disintegration of the concrete surface particularly when this is accompanied by alternate expansion and contraction.

Volume changes can be minimised by using suitable constituent materials and mix proportions having due regard to the size of structure. Adequate moist curing is also essential to minimise the effects of any volume changes.

Permeability and Absorption

Permeability refers to the ease with which water can pass through concrete. This should not be confused with the absorption property of concrete and the two are not necessarily related. Absorption may be defined as the ability of concrete to draw water into its voids. Low permeability is an important requirement for hydraulic structures and in some cases water - tightness of concrete may be considered to be more significant than strength although, other conditions being equal, concrete of low permeability will also be strong and durable. A concrete which readily absorbs water is susceptible to deterioration.

Concrete is inherently a porous material. This arises from the use of water in excess of that required for the purpose of hydration in order to make the mix sufficiently workable and the difficulty of completely removing all the air from the concrete during compaction. If the voids are interconnected, concrete becomes pervious, although with normal care concrete is sufficiently impermeable for most purposes. Concrete of low permeability can be obtained by suitable selection of its constituent materials and their proportions followed by careful placing, compaction and curing. In general, for a fully compacted concrete, the permeability decreases with decreasing water - cement ratio. Permeability is affected by both the fineness and the chemical composition of cement. Coarse cements tend to produce pastes with relatively high porosity. Aggregates of low porosity are preferable when concrete with a low permeability is required. Segregation of the constituent materials during placing can adversely affect the impermeability of concrete.

Words and Expressions

1. sustain [sə'stein] *vt.* 支撑，承担
2. deterioration [ditiəriə'reiʃən] *n.* 恶化；退化；堕落
3. external [ik'stəːnəl] *a.* 外部的；表面的
4. internal [in'təːnəl] *a.* 内部的；内在的；国内的
5. chloride ['klɔːraid] *n.* 氯化物
6. sulphate ['sʌlfeit] *n.* 硫酸盐；硫酸酯
7. interaction [intər'ækʃən] *n.* 相互作用，相互影响
8. permeability [pəːmiə'biliti] *n.* 渗透性；透磁率，导磁系数
9. homogeneous [həmə'dʒiːniəs] *a.* 均匀的，同性质的，各向同性的
10. disruptive [dis'rʌptiv] *a.* 破坏性的；分裂性的
11. hydraulic [hai'drɔːlik] *a.* 液压的；水力的；水力学的
12. kerb [kəːb] *n.* 街头的边石，路边
13. impermeability [impəːmiə'biləti] *n.* 不渗透性；不透过性；不能渗透的性质或状态

14. compatible [kəmˈpætəbl] *a.* 兼容的；能共处的；可并立的
15. deicing [diːˈaisiŋ] *n.* 除冰；碎冰装置
16. leaching [ˈliːtʃiŋ] *n.* 溶析；沥滤；浸出，浸析作用
17. carbonation [kɑːbəˈneiʃən] *n.* 碳酸化作用
18. compound [ˈkɔmpaund] *n.* 化合物
19. cavitation [kæviˈteiʃən] *n.* 气蚀，空蚀，空化作用
20. abrasive [əˈbreisiv] *a.* 粗糙的；有研磨作用的
21. remedy [ˈremidi] *n.* 补救办法；药品，治疗法
22. abrasion [əˈbreiʒən] *n.* 磨损；磨耗；擦伤
23. disintegration [disintiˈgreiʃən] *n.* 瓦解，崩溃；分解
24. severe [siˈviə] *a.* 严重的；严厉的；剧烈的
25. moist [mɔist] *a.* 潮湿的，湿润的
26. voids [vɔidz] *n.* 空隙，孔洞；空隙率
27. porous [ˈpɔːrəs] *a.* 可渗透的，多孔的
28. workable [ˈwəːkəbl] *n.* 和易性
29. fineness [ˈfainnis] *n.* 细度
30. segregation [segriˈgeiʃən] *n.* 离析
31. alkali – aggregate 碱集料
32. air – entrained concrete 引气混凝土

Lesson Two . Steel Structures

Multi - story Buildings

Multi - story buildings are buildings of several floors in which the floor height remains more or less constant as you proceed upwards, and in which this height is usually no more than 3 - 4m. Thus, multi - storied buildings are office buildings, residential buildings, etc. , anywhere from two floors high to high rises. Structurally, the approach to such buildings is frequently a question of studying column/beam systems with regard to column distances and placement, shaping and dimensioning of steel sections, and principles for placing the bracing system. The higher the building, the more important and more dominant a factor will be the bracing system.

One of the advantages of a steel skeleton is that long beam spans can be combined with small column sections. Moreover, the low weight of the structure itself provides a more accessible loading capacity. By its openness, the structure also allows for simple, straightforward installations. When it comes to construction, a steel skeleton, or steel frame, is highly prefabricated and therefore, short on construction time, a feature that also positively affects the economics of the given building project. Another advantage is that steel can be produced with very small dimensional tolerances, guaranteeing a high precision building that, for example, will facilitate the fitting of the façade. The steel frame is also flexible in the sense that it can be changed according to its application. Such an adaptation prolongs the life of a steel building, and in the event of future razing, the steel structure can be easily dismantled and the steel reused.

The vertical load in a steel structure is transported through the columns down to the foundation. The most suitable structural layout for a steel frame is a square or rectangular orthogonal grid. The rectangular bay may often be the most economical solution because the decking then usually spans only in one direction. The columns are placed in the grid's points of intersection.

A bearing system often consists of continuous columns and beams spanning between the columns. The system has simple details and few elements. What is more, its assembly is easy and the column - to - column distance often fits the standard section lengths. In most instances, the bearing elements are not pure steel structures. The floor slabs are generally done in concrete, either as precast floor slabs, such as spancrete, or as precast concrete formwork that require additional insitu concrete. The use of corrugated steel sheets as permanent formwork for a concrete deck is also common. In addition to the vertical load, the deck also bears the horizontal wind loads, and has the task of transferring them from the facades to the building's bracing system. The bracing system, in turn, transfers the loads downward. Frequently, a bracing system in steel is preferable to, for example, concrete slabs in stairwells. Steel angles are generally used as wind braces, either alone or joined, with screwed or welded connections. The steel weight per square meter/foot of floor area is an important economic factor in a bearing system. For example, the weight of the steel for a 4 – 6 – story steel – frame office building is on the order of 20 – 25kg/m^2. Although the material costs make up only about one – third of the cost of the completed steel structure in a building, and the total bearing system only constitutes 6%–10% of the total construction cost, it is good practice to strive for economical use of materials, and for simple, functional and, above all, production – friendly details.

The most common column sections are the W – shaped sections and several shapes of joined sections. In multi – storied buildings, the slenderness ratio of columns is not an important factor because we can expect lateral support from each floor deck. Thus, the steel stiffness is effective with slender column sections. In general, hollow sections have a lower steel weight than W – shapes, but the material cost is higher.

As beams, S (I – beams) are most common. The easiest approach is to lay the floor deck on top of the I – beams and to avoid underlying beams. This solution is best for dividing walls or outer walls that must hide the beams. W and M – shapes are also used, and C or MC – shapes are used where the floor deck comes only from one side. Inside, it may be advantageous to build the beams into the floor deck and weld. T – shapes are commonly used.

Long – span Structures

Steel is especially well – suited for building types requiring moderate to very large column – free space. It has the greatest strength per unit area of any material and a favorable relationship between strength and weight, making it possible to construct buildings with large spans not only economically, but also with a visually light, elegant appearance.

This section features buildings that demonstrate steel's potential for long spans, beginning with a brief overview of the purest structural systems for horizontal loadbearing.

Let us consider large halls, i. e. , single – story buildings with large, free spans that are not braced by intermediate elements or interior walls. Therefore, it is the horizontal structure that is of greatest interest to us, especially when it comes to frames and connections between horizontal and vertical bearing elements. In this type of building, the figure of the structural system complements the building's total form. Thus the relationship of structure to form is especially obvious in this type of architecture. This means that all structural choices take on a design significance, and vice versa, and that the design of details and individual elements takes on special importance.

Many researches show the rules of thumb which are suggested for the relationship between structural height and related span. The suggested factors must be regarded as a kind of more lenient load that is evenly distributed. For more complex load situations and bigger loads, the stated factors may be deceptive. In any case, the rules of thumb are only for help in the early stages of the design process. Keep in mind that they can never replace statistical calculations. In order to increase the span while keeping the dimension of the steel beam at a minimum, the beam can be supported at one or several places along the span, thereby forming a trussed beam. The posts set - in under the beam become compression members, united by a continuous tension member that is either a wire or a thin steel member. With such a structural approach, the beam must be dimensioned to withstand compression loads in addition to bending.

Greater load - bearing capacity and an increase in span can be achieved with the use of trussed structures. The truss can be planar or spatial, and is formed by staves joined in rigid triangles. Compared to pure beam construction, trussed structures are visually lighter and of greater bearing capacity, but require a deeper section.

If the architectural plan allows, additional supports can be located in a square or rectangular grid in which the difference between the sides is not greater than 1 : 1. 5. In this case a two - way structure of beams might be suitable. For maximum rigidity, it is advantageous to make the orthogonal joints moment - connections. If the beams have a cross - section that works well against torsion, as in rectangular sections, the two - way system will have great load - bearing capacity.

The same grid construction can be done with crossing trusses. If the trusses in this type of system are closely spaced, running in the same direction, and interconnected in the other direction with additional steel members, then we have a spatial system called a space frame. Space frames have a large two - way loadbearing capacity and are extremely light - weight.

Used in situation with individual column support, all these types of horizontal structural systems require separate bracing systems. In principle, this can be achieved in a steel building with cross bracing. The bracing system must respond to compression and suction forces along the two main plan directions, and must be placed in such a way that the braced wall areas do not have a common point of intersection. In practice, this means that at least three different column areas must be braced.

When using frame construction, bracing for horizontal loads can be taken care of by the main structural system itself. Structural frames are designed for lateral bracing, which is achieved by the joint action between the horizontal and vertical members. If a corner can be made a moment connection, so that it will not change its angle under load, the structure will also be able to withstand lateral loads in its own plane. A structural frame can have a maximum of three connections that are not moment connections - in other words, it can only have three pin connections. Like with beams and columns, the frame can also be made of trusses.

The arched structure with three pin connections has the same capacity for lateral stability that a frame has. The arch will function structurally only when its endpoints are prevented from being displaced outward. The arch can consist of steel sections or be made up of individual steel staves. An arch carries its load when compression forces are generated in its cross - section to a greater or lesser degree, depending on how close the shape of the arch matches the compression curve of the load in question. Normally there will be bending moments in the arch in addition to compression forces.

Thus, frames and arches have the capacity of withstanding lateral forces acting on their own plane. To withstand lateral forces acting on the direction perpendicular to the structure's plane, several frames or arches in a series must be braced among themselves.

Arches and frames can be juxtaposed to form spatial structural systems such as cupolas or structural grids of frames. A suspended steel cable is a kind of reverse or up - side - down arch that can only withstand tension stresses. While the arch will tend to splay its endpoints, the endpoints for the cable will tend to be drawn in toward one another. This can be counteracted, for example, by using a combination of columns and backstays. The use of backstays can also provide lateral bracing in such cable structures.

A fundamental problem with the use of cable structures is the cables pliancy, which causes the cable to change shape every time the load changes. To avoid this, the cable must be stiffened either by increasing the loads on the cable through pretensioning, or by constructing an inverted bowstring truss. The principle here is that the suspended main cable is connected to another cable of opposing curvature. This secondary cable is pretensioned and transfers the resultant force to the main cable putting it under tension. The system will then become rigid along its own plane. Cable trusses can also be grouped together to form multi - bay spatial structures.

Another method of bracing a cable roof is by using double - curved structures. One set of cables is suspended in one direction, while another pretensioned set arches in the opposite direction and holds the main cables taut.

Words and Expressions

1. dimensioning [di'menʃəniŋ] *n.* 尺寸标注，量尺寸
2. openness ['əupənnis] *n.* 直率，公开，开放，空旷
3. prefabricate ['priː'fæbrikeit] *vt.* 预先建造组合
4. prolong [prə'lɔŋ] *vt.* 延长，拉长，拖延
5. raze [reiz] *vt.* 铲平，夷为平地
6. dismantle [dis'mæntl] *vt.* 拆开，拆卸；废除，取消
7. orthogonal [ɔː'θɔgənl] *a.* 直角的，直交的

8. intersection [intə'sekʃən] *n.*	交叉；十字路口；交集；交叉点
9. precast [priː'kaːst] *v.*	预浇铸，预制
a.	预浇铸的，预制的
10. formwork ['fɔːmwəːk] *n.*	样板，模壳，支模
11. stairwell ['stɛəwel] *n.*	楼梯井
12. weld [weld] *v.*	焊接；*n.* 焊接，焊缝
13. stiffness ['stifnis] *n.*	硬度；刚度
14. hollow ['hɔləu] *a.*	空的，空洞的，凹陷的
n.	山谷，洞，窟窿
15. moderate ['mɔdərit] *a.*	适度的，温和的，中等的
v.	节制，使……稳定；使……缓和
16. complement ['kɔmplimənt] *vt.*	补足，补助
n.	补足物，补语，余角
17. deceptive [di'septiv] *a.*	骗人的，造成假象的，靠不住的
18. stave [steiv] *n.*	梯级横木
19. orthogonal [ɔː'θɔgənl] *a.*	直角的，直交的
20. torsion ['tɔːʃən] *n.*	扭转
21. spatial ['speiʃəl] *a.*	空间的；存在于空间的；受空间条件限制的
22. juxtapose [dʒʌkstə'pəuz] *vt.*	并列；并置
23. cupolas ['kjuːpələz] *n.*	化铁炉；圆屋顶；圆顶的塔
24. counteract [kauntə'rækt] *vt.*	抵消；中和；阻碍
25. backstay ['bækstei] *n.*	背撑，拉索
26. pliancy ['plaiənsi] *n.*	柔软；柔顺；适应性
27. pretensioning ['priː'tenʃəniŋ] *n.*	先张拉；先张技术；[力] 预拉伸
28. taut [tɔːt] *a.*	拉紧的；弹性的
29. corrugated steel sheet	压型钢板，波纹钢板
30. trussed structure	桁架结构
31. two - way system	双向体系
32. bowstring truss	弓弦桁架

Lesson Three Bridge Structures

Birth of Bridges

The first man - made bridge was probably a tree trunk or flat stone laid across a stream. No doubt it was made many thousands of years before the birth of Christ. Even before that, primitive man must have wondered at natural arches such as the Pont d'Arc at Ardeche that has a span of 194 feet rising 111 feet over the river. But ages would have passed before some pioneer jammed two stones together like an inverted "V" across a narrow brook and so built the first arch bridge.

According to Degrand, the earliest bridge on record is that built on the Nile by Menes, the first King of the Egyptians, about 2650 B. C. ; but no details are forthcoming. A detailed description of another bridge built about five centuries later is given by Diodorus Siculus - the fabulous bridge built by Semiramis, Queen of Babylon, over the Euphrates. Herodotus ascribes this bridge to Queen Nitocris who ruled five generations later. First the river was diverted well above the city into an artificial lake, so that the piers of the bridge could be built in the dry in the river bed. The stones of the piers were bonded together by iron bars soldered in with lead. The deck was of timber, cedar, cypress, and palm, and was no less than 30 feet wide; part of it was removable and was taken up each night to afford protection from robbers. When the bridge was finished, the river was brought back into its original channel. So the record reads today; how much is true and how much due to embellishment through the ages we shall never know; but there is no doubt that a remarkable bridge was built 4,000 years ago in Babylon.

Bridge Types

We can only speculate on these beginnings. We see primitive suspension bridges made of twisted creepers or lianas tied to tree trunks on either side of a gorge and spanning it like a perilously hung cobweb. But when these bridges were evolved or which came first we cannot say with certainty. We only know that the three types, beam or girder bridges (typified by a tree trunk across a stream), arch bridges, and suspension bridges, have been known and built from the earliest times of which we have any record. In their simplest form, beam or girder bridges are called simple spans. If two or more are joined together over the piers they become continuous, or they may be built to form cantilever bridges. These, however, are only varieties of girder bridges and do not constitute a different type. The three types, girder, arch, and suspension, may be varied and combined to assist each other in the same structure, and down the years materials of construction have evolved from those ready to hand, such as timber and stone, to manufactured materials such as brick, concrete, iron, and steel.

Beam Bridges

A simple single - span bridge may be of steel (probably a plate girder), reinforced concrete or prestressed concrete. In steel the maximum span for a simple beam bridge is usually about 100 ft (although bridges with longer spans have been built) . When, however, the spans are large, a continuous girder is usually adopted. A plate - girder bridge in Germany has a central span of 354 ft and side spans of 295 ft.

For spans between supporting piers above about 150 ft, the truss is often used and the material is invariably steel. A bridge over the Ohio in Illinois, completed in 1917, has a simply supported span of 720 ft.

The principle of the cantilever bridgeis with and without a suspended span. The piers having been built, the bridge is built out from each pier, and the middle portion of the bridge, called the suspended span, which is usually in one prefabricated unit, is then placed in position. The bridge therefore consists of two anchored cantilevers supporting a beam "suspended" from the ends of the cantilevers. The maximum bending moments and shear forces occur at middle piers, and at these points the bridge is usually of greater depth.

When spans are large, thus requiring a great depth of bridge, cantilever bridges are usually constructed of steel trusses (trussed girders) . It is possible in this way to have spans of up to about 1,800 ft between piers. Although this bridge may look like an arch, it is in fact a double - cantilever trussed beam. It may be noted that in cantilever bridges the greatest depth of truss occurs at the main piers because it is at these points that the greatest stresses occur.

Arch Bridges

In an arch bridge the arch is the main structural member and transmits the loads imposed on it to the abutments at the springing points. The part of the construction above the arch ring, where the roadway or railway is at a higher level than the crown of the arch, is called the spandrel.

Since steel and reinforced concrete are capable of taking tension, the arch rings can be very much thinner than masonry construction. The braced spandrel bridge is usually constructed in steel, as it is also the bridge where the roadway is supported by hangers from the structural arch.

Another type of arched bridge is the stiffened tied arch, which is often called a bow - string girder. In an archery bow the string prevents the bow from flattening out. In a simi-