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高等学校教材

# 科技英语阅读与写作

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中国铁道出版社

2002年·北京

(京)新登字 063 号

## 内 容 简 介

本书由 16 个既相互联系、又相对独立的单元组成,每个单元包括阅读课文、生词和短语、难句分析、练习题、阅读翻译和写作指导五部分。本书选题广泛,涉及建筑材料、道路与铁道工程、地基基础、隧道施工、经济学、工程管理、计算机应用、运筹学等学科。每个单元的课文均精选自国外英文原著,语言规范,内容新颖。每个单元的阅读、翻译与写作指导为读者有效阅读、翻译和写作科技英语提供了实务性的指导,具有很高的实用价值。

本书可作为高等院校土木工程专业英语系列课程中"科技英语阅读与写作"和工程管理专业英语系列课程中"专业英语阅读与写作"两门课的教材。对于有志提高自身科技英语阅读、翻译和写作水平的科技工作者和理工科其他专业学生,本书亦有重要参考价值。

**图书在版编目(CIP)数据**

科技英语阅读与写作/宇德明编著.-北京:中国铁道出版社,2002.3
高等学校教材
ISBN 7-113-04546-4

Ⅰ.科… Ⅱ.宇… Ⅲ.①科学技术-英语-阅读教学-高等学校-教材 ②科学技术-英语-写作-高等学校-教材 Ⅳ.H31

中国版本图书馆 CIP 数据核字(2002)第 006108 号

书　　名:科技英语阅读与写作
作　　者:宇德明
出版发行:中国铁道出版社(100054,北京市宣武区右安门西街 8 号)
责任编辑:程东海
编辑部电话:路电(021)73135　市电(010)51873135
封面设计:马　利
印　　刷:中国铁道出版社印刷厂
开　　本:787×1092　1/16　印张:14.5　字数:360 千
版　　本:2002 年 3 月第 1 版　2002 年 3 月第 1 次印刷
印　　数:1~3 000 册
书　　号:ISBN 7-113-04546-4/H·52
定　　价:20.20 元

# 前　　言

为了保证大学生在四年大学学习期间英语学习“不断线”，不断提高他们学习英语和应用英语的能力，各高等院校除了在第一学年和第二学年为大学生开设必修课“基础英语”外，还要在第三学年和第四学年为他们开设选修课或必选课“科技英语阅读”、“专业英语阅读”和“科技英语写作”等性质的课程。四年以来，作者一直承担中南大学土木建筑学院的“科技英语阅读”、“科技英语写作”和“工程管理专业英语阅读”三门课程的教学任务。在教学实践过程中，我和我的同事们遇到了不少困难，其中最大的困难是没有合适的教材。

没有合适的教材给教师的课堂教学和学生的课后自学带来了诸多不便，制约了教学效率和教学效果的提高。因此，多年来作者一直希望编写一本能同时供土木工程和工程管理专业使用的“科技英语阅读与写作”教材，并着手系统地收集和整理有关材料。作者经过将近一年的辛勤工作，终于在年底前按时完成了本书的写作计划。

本书由16个既相互联系、又相对独立的单元组成，每个单元包括阅读课文、生词和短语、难句分析、练习题、阅读翻译和写作指导五部分。各单元的阅读课文选材广泛，涉及建筑材料、道路与铁道工程、地基基础、隧道施工、经济学、工程管理、计算机应用、运筹学等学科。这些阅读课文均精选自国外英文原著，语言规范，内容新颖。其中前六个单元的阅读课文主要介绍土木工程技术方面的知识，包括钢筋混凝土和预应力混凝土、铁路横断面、柔性路面的结构、扩展基础和打入桩基础、新奥法隧道施工、隧道施工中甲烷的危害等方面的知识。后十个单元的阅读课文主要介绍工程管理方面的知识，包括管理与工程管理、组织垂直结构、FIDIC合同条件、招标文件的编制、评标与授予合同、项目经理、通货膨胀的性质和影响、折旧方法、计算机模拟、排队论等方面的知识。

每个单元的阅读、翻译与写作指导集中论述与科技英语阅读、翻译与写作有密切关系的一个主题，目的是向我国理工科专业的大学生和青年科技工作者介绍科技英语阅读、翻译与写作的基本知识，为他们进行有效的科技英语阅读、翻译与写作提供实务性的指导，其中使用的例句和例文绝大多数属于日常科技英语，从而减轻了读者阅读理解时的难度。在阅读、翻译与写作指导部分，第一单元对汉语和英语的语法进行对比分析，第二单元讨论英语的构词法，第三单元介绍英语的基本句型，第四单元讨论科技英语的文体，第五单元介绍科技英语的阅读方法与技巧，第六单元介绍科技英语翻译的基本知识，第七单元介绍科技英语中专业术语和固定词组的翻译技巧，第八单元介绍科技英语中表示比较意义的结构和词组的翻译方法，第九单元讨论科技英语的写作要求和程序，第十单元介绍科技英语写作中造句的要求以及主语和谓语的确定方法，第十一单元讨论科技英语写作中如何正确使用动词，第十二单元讨论科技英语写作

中的一致关系，第十三单元介绍科技英语写作中的常用句型与结构，第十四单元介绍科技论文的写作要求和分类方法，最后两个单元介绍科技论文的组成部分以及写作科技论文时需要注意的有关问题。

书后提供了三套模拟试卷，其中模拟试卷一主要根据前面八个单元的内容编写，模拟试卷二主要根据后面八个单元的内容编写，模拟试卷三则根据全书的内容编写。每个单元的练习题和三套模拟试卷的参考答案也在书后给出，目的是减轻授课老师的备课负担，并方便读者的自学。

建议本教材的总教学时数为60～80学时。如果教学时数不够，授课老师可根据实际教学时数和教学大纲的要求，灵活选择教学内容。

在本书的形成和出版过程中，中南大学土木建筑学院周继祖教授和余浩军讲师为本书阅读课文的选材提供过很好的建议和意见，本书的写作出版得到了中南大学土木建筑学院的大力支持。作者对上述个人和单位表示衷心感谢。本书参考了大量的文献资料，作者对这些文献的作者表示感谢。

作者水平有限，书中如有错误和不妥之处，欢迎读者指正。

宇德明

2001年12月

# 目　录

# Unit 1 Reinforced Concrete and Prestressed Concrete

## 1. Reinforced concrete

Concrete and reinforced concrete are used as building materials in every country. In many, including the United States and Canada, reinforced concrete is a dominant structural material in engineered construction. The universal nature of reinforced concrete construction stems from the wide availability of reinforcing bars and the constituents of concrete, gravel, sand, and cement, the relatively simple skills required in concrete construction, and the economy of reinforced concrete compared to other forms of construction. Concrete and reinforced concrete are used in bridges, buildings of all sorts, underground structures, water tanks, television towers, offshore oil exploration and production structures, dams, and even in ships.

Reinforced concrete structures may be cast-in-place concrete, constructed in their final location, or they may be precast concrete produced in a factory and erected at the construction site. Concrete structures may be severe and functional in design, or the shape and layout can be whimsical and artistic. Few other building materials offer the architect and engineer such versatility and scope.

Concrete is strong in compression but weak in tension. As a result, cracks develop whenever loads, or restrained shrinkage or temperature changes, give rise to tensile stresses in excess of the tensile strength of the concrete. In the plain concrete beam, the moments about the neutral axis due to applied loads are resisted by an internal tension-compression couple involving tension in the concrete. Such a beam fails very suddenly and completely when the first crack forms. In a reinforced concrete beam, steel bars are embedded in the concrete in such a way that the tension forces needed for moment equilibrium after the concrete cracks can be developed in the bars.

The construction of a reinforced concrete member involves building a form or mold in the shape of the member being built. The form must be strong enough to support both the weight and hydrostatic pressure of the wet concrete, and any forces applied to it by workers, concrete buggies, wind, and so on. The reinforcement is placed in this form and held in place during the concreting operation. After the concrete has hardened, the forms are removed. As the forms are removed, props or shores are installed to support the weight of the concrete until it has reached sufficient strength to support the loads by itself.

The designer must proportion a concrete member for adequate strength to resist the loads, and adequate stiffness to prevent excessive deflections. In addition, the beam must be proportioned so that it can be constructed. For example, the reinforcement must be detailed so that it can be assembled in the field, and since the concrete is placed in the form after the reinforcement is in place, the concrete must be able to flow around, between, and past the reinforcement to fill all parts of the form completely.

Reinforced concrete structures consist of a series of individual "members" that interact to support the loads placed on the structure. Although these are considered separately in developing the design theory and in the design process, their interaction must also be taken into account. This is done in the overall analysis of the structure and in the design of joints and connections.

Precast concrete buildings generally follow one of two patterns: frames composed of precast beams and columns with channel elements for floor members are widely used for offices, schools, and similar buildings; for apartment and hotel structures, one-way precast floor slabs supported by precast walls are frequently used.

The choice of whether a structure should be built of concrete, steel, masonry, or timber depends on the availability of materials and on a number of value decisions. The choice of structural system is made by the architect or engineer early in the design, based on the following considerations:

(1) **Economy.** Frequently, the foremost consideration is the overall cost of the structure. This is, of course, a function of the costs of the materials and the labor necessary to erect them. Frequently, however, the overall cost is affected as much or more by the overall construction time since the contractor and owner must borrow or otherwise allocate money to carry out the construction and will not receive a return on this investment until the building is ready for occupancy. In a large typical apartment or commercial project, the cost of construction financing will be a significant fraction of the total cost. As a result, financing savings due to rapid construction may more than offset increased material costs. For this reason, any measures the designer can take to standardize the design and forming will generally pay off in reduced overall costs.

(2) **Suitability of material for architectural and structural function.** A reinforced concrete system frequently allows the designer to combine the architectural and structural functions. Concrete has the advantage that it is placed in plastic condition and is given the desired shape and texture by means of the forms and the finishing techniques. This allows such elements as flat plates or other types of slabs to serve as load-bearing elements while providing the finished floor and/or ceiling surfaces. Similarly, reinforced concrete walls can provide architecturally attractive surfaces in addition to having the ability to resist gravity, wind, or seismic loads. Finally, the choice of size or shape is governed by the designer and not by the availability of standard manufactured members.

(3) **Fire resistance.** The structure in a building must withstand the effects of a fire and remain standing while the building is evacuated and the fire is extinguished. A concrete building inherently has a 1-to-3-hour rating without special fireproofing or other details. Structural steel or timber building must be fireproofed to attain similar fire ratings.

(4) **Low maintenance.** Concrete members inherently require less maintenance than do structural steel or timber members. This is particularly true if dense, air-entrained concrete has

been used for surfaces exposed to the atmosphere, and if care has been taken in the design to provide adequate drainage off and away from the structure. Special precautions must be taken for concrete exposed to salts such as deicing chemicals.

(5) **Availability of materials.** Sand, gravel, cement, and concrete mixing facilities are very widely available, and reinforcing steel can be transported to most job sites easily than structural steel. As a result, reinforced concrete is frequently used in remote areas.

## 2. Prestressed concrete

Methods of inducing compression in a concrete member before it is loaded, known as prestressing, are used to great advantage for precast concrete beams of long span in which the dead load forms a high proportion of the total load. The use of high-strength concrete and hightensile steel is the most effective way of reducing the dead load, and consequently the bending moment, of a beam, but high-tensile steel cannot be used at a high working stress without excessive cracking of the concrete and deflection of the beam unless the concrete is prestressed. When a load is applied to a prestressed beam a greater increase in the compressive stress in the concrete can take place before failure, so that when failure is due to crushing of the concrete a prestressed beam can resist a higher bending moment than an ordinary beam of the same size and concrete strength. The effect of prestressing may be regarded as increasing the ultimate moment of resistance of the concrete by lowering the neutral-axis for the stresses produced by bending after cracking has occurred. Prestressing also increases the resistance to shearing forces, and in some cases reduces the amount of reinforcement required to resist shear.

Prestressing is more reliably carried out and high-strength concrete is best made in factories. Prestressed concrete is therefore becoming increasingly used for precast members which might otherwise develop serious cracks during handling or under load, especially if they are designed for high stresses in order to reduce the weight. Prestressing is being successfully used in the manufacture of concrete sleepers. Ordinary reinforced concrete sleepers quickly fail in service due to the rapid opening and closing of cracks when loads are applied and removed in rapid succession. It has been found that some prestressed sleepers do not crack, and disintegration due to the opening and closing of cracks is therefore avoided. Hollow beams for bridges and concrete piles constructed of precast blocks are other examples of the use of prestressed members. It is not often possible to predict the length required for a pile, and it is a great convenience to be able to extend a pile during driving by adding blocks; the handling of long piles is avoided and, provided the lateral support of the ground is adequate, the prestressing cables can be removed upon completion of driving and used again. Other examples of the application of prestressed concrete are dams, caissons, and runways. Prestressing is also used in the construction of tanks, the elimination of ring tension and shrinkage stress in the wall of a cylindrical tank preventing cracks and ensuring liquid-tightness. Prestressed concrete thin-slab shell roofs have also been constructed. Steel-lined prestressed concrete nuclear pressure-vessels are now widely used. The uncracked concrete provides biological shielding and, when subjected to overloading, the vessels lose pressure without the risk of explosion which is possible with steel-plate construction. The design must permit an adequate rate of leakage at the ultimate limit-state.

Another advantage of prestressed concrete is that the concrete and the steel are severely tested during the prestressing operation, and a lower factor of safety is justified. The permissible working stress in the concrete is generally one-third of the compressive strength, thus allowing a margin to cover the risk of poor concrete at a critical section. The risk is reduced by prestressing, because the stress induced in the concrete during the prestressing operation may be 50 percent to 75 percent of its compressive strength.

There are three principal ways in which concrete is prestressed, namely, by tensioned wires fixed at their ends, by tensioned wires gripped by the concrete, and by applying an external load; experiments are also being made with expanding-cement concrete.

End-anchored wires are used in long-span concrete beams. The reinforcement is separated from the surrounding concrete by a sheath or other wrapping which allows the wires to move freely during stressing. The wires are anchored at the ends of the beam either by fixing to an anchor plate, or other devices such as wedging with concrete cones. Since the steel is stressed after the concrete is cast and hardened this method of prestressing is known as post-tensioning. A disadvantage of this method is that the wires must be protected against corrosion by forcing cement grout into the sheath. The grout provides protection against corrosion and also provides a bond between the wires and the sheath and thus with the concrete; it also supplements the resistance of the wires to slip, without which the security of the wires would depend entirely on the permanence of the end anchorages. With proper care these disadvantages do not involve serious risk. The object of allowing the wires to move while the prestress is being established is to make it possible to prestress the beam after most of the shrinkage of the concrete has taken place, and so reduce the loss of prestress due to shrinkage and to eliminate loss of prestress due to elastic contraction of the concrete. In some cases it is possible to increase the prestress when the beam begins to carry its own weight, the prestress thus relieving the member of a considerable proportion of compressive stresses due to its weight.

In the concrete-gripped type of prestressed concrete, the wires are stretched before concreting; the method is consequently referred to as pretensioning. When it has hardened the concrete grips the wires as in reinforced concrete, except that the grip may be increased slightly when the wires are released from the stretching device on account of a slight shortening and swelling of the wires that occur as the concrete member shortens under compression. The shortening of the concrete member is also a slight disadvantage of this method of prestressing, since the consequent shortening of the tensioned wires is accompanied by a reduction in the prestress. On the other hand it is not necessary to provide anti-corrosion treatment, the wires are gripped throughout their length, and the security of the beam is not dependent upon anchorage of the wires at the ends. Prestressing may increase the ultimate moment of resistance of the concrete in a beam; failure generally occurs by the yielding of the wires. If, therefore, sufficient prestress can be induced by this method to eliminate cracking under a small overload, it is probably better than the post-tensioning method, since there are no anchorages to fail. The application of the post-tensioning method when prestressing by compressing together precast blocks is often simpler to carry out on site than pretensioning. It is important to use a strong concrete with pretensioning since the wires have been known to slip in concrete of average strength.

An example of a concrete member being prestressed by the application of an external load is the jacking of an arch during construction. Otherwise there are few opportunities of adopting this method, which entails prestressing an arch slab or arch rib spanning between two unyielding abutments. A loaded column can be regarded as being prestressed against stresses due to bending moments, as also can an arch if it is uniformly compressed by a large dead load.

The use of expanding-cement concrete for inducing a prestress was introduced by M. Lossier and is still in experimental stage. The prestress is caused by the concrete swelling instead of shrinkage during setting and hardening. If this process can be developed so that the initial prestresses are sufficiently high to prevent cracking occurring under load, it may become a useful method of construction.

## New Words and Expressions

abutment 桥台,拱座
anchor plate 紧固板
arch 拱形结构,拱架结构
artistic 艺术的,美化的
blocks 段,节,组,套
buggy 手推小车
cable 钢丝,钢索
caissons 沉箱(桥梁工程)
cast-in-place 现浇的
cement 水泥
channel 沟道
concreting 凝固
couple 力偶
dead load 固定载荷
deice 防止结冰,防冻
detail 详细说明
end anchorage 端部锚固,端锚墩
erect 安装,装配
fire ratings 防火等级
form 模板
frame 框架
gravel 卵石,砾石
grout 浆
jacking 张拉
margin 富余(量)
masonry 砖石建筑,圬工
moment 力矩
one-way 单向的
overload 超载
post-tensioning 后张法
precast 预制的
press 压力
prestressing 预加应力
pretensioning 先张法
prop 支撑,支柱
*proportion* 详细说明,使成比例
reinforced concrete 钢筋混凝土
runways 跑道
security 安全,可靠,稳定
setting 凝结,凝固
sheath 外壳,金属套管
shell roofs 薄壳屋顶
shore 斜撑
stretching device 拉伸装置
supplement 补充,增强
texture 质地,结构,构造
whimsical 奇想的

### Analysis of Difficult Sentences

1. Reinforced concrete structures may be cast-in-place concrete, constructed in their final location, or they may be precast concrete produced in a factory and erected at the construction site.

   这是一个由连词“or”连接的并列复合句。过去分词短语“constructed in their final location”、“produced in a factory”和“erected at the construction site”作后置定语，其中第一个分词短语修饰“cast-in-place concrete”，后两个分词短语修饰“precast concrete”。全句可翻译为：钢筋混凝土结构可以是在最终现场施工的现浇混凝土，也可以是在工厂生产并在施工现场安装的预制混凝土。

2. In the plain concrete beam, the moments about the neutral axis due to applied loads are resisted by an internal tension-compression couple involving tension in the concrete.

   这是一个被动语态的简单句，主语和谓语分别为“moments”和“are resisted”。介词短语“about the neutral axis”和“due to applied loads”作主语“moments”的定语，介词短语“in the plain concrete beam”、“by an internal tension-compression couple”和现在分词短语“involving tension in the concrete”作状语。全句可翻译为：在素混凝土梁中，作用载荷产生的相对于中性轴的力矩为内部的拉力-压力力偶所平衡，必然在混凝土中引起拉力。

3. The reinforcement must be detailed so that it can be assembled in the field, and since the concrete is placed in the form after the reinforcement is in place, the concrete must be able to flow around, between, and past the reinforcement to fill all parts of the form completely.

   这是一个三重复合句，第一重由连词“and”连接，第二重分别由连词“so that”和“since”连接，第三重由连词“after”连接。全句可翻译为：必须对钢筋配置情况作详细说明，以便现场安放作业。同时，由于只有在钢筋安放好以后才能往模板中浇混凝土，因此，要使混凝土完全充填模板的各个部分，混凝土必须能够绕钢筋、在钢筋之间流动，能够流到钢筋的后面去。

4. The overall cost is affected as much or more by the overall construction time since the contractor and owner must borrow or otherwise allocate money to carry out the construction and will not receive a return on this investment until the building is ready for occupancy.

   这是一个三重复合句，第一重由连词“since”连接，第二重由连词“and”连接，第三重由连词“until”连接。全句可翻译为：总成本受总施工时间的影响同样大(甚至更大)，因为承包商和业主必须借款或以其他方式筹措资金才能进行施工，同时，建筑物只有已经竣工可供人使用以后，他们才能够得到投资的回报。

## Exercises

1. Fill in the blanks with the words or phrases given in the bracket.

   (after, that , due to, As a result, in)

   Concrete is strong __(1)__ compression but weak in tension. __(2)__, cracks develop whenever loads, or restrained shrinkage or temperature changes, give rise to tensile stresses in excess of the tensile strength of the concrete. In the plain concrete beam, the moments about the neutral axis

___(3)___ applied loads are resisted by an internal tension-compression couple involving tension in the concrete. Such a beam fails very suddenly and completely when the first crack forms. In a reinforced concrete beam, steel bars are embedded in the concrete in such a way ___(4)___ the tension forces needed for moment equilibrium ___(5)___ the concrete cracks can be developed in the bars.

2. Translate the following into English.

(1)预应力梁　　(2)压应力
(3)中性轴　　(4)裂纹
(5)弯矩　　(6)混凝土
(7)跑道　　(8)薄壳屋顶
(9)框架　　(10)圬工
(11)先张法　　(12)后张法
(13)端部锚固　　(14)水泥浆

3. Translate the following into Chinese.

(1) prestress　　(2) abutment
(3) opportunity　　(4) sheath
(5) tensioned wire　　(6) thin-slab
(7) ring tension　　(8) high-tensile steel
(9) plain concrete　　(10) liquid-tightness

## 阅读、翻译与写作指导:(一)汉英语法对比

当今世界有五十多亿人口,使用四千多种不同的语言。其中,使用人数最多的语言依次是汉语和英语。世界上最大的发展中国家和最大的发达国家的官方语言也分别是汉语和英语。英语还是一种国际公认的世界通用语言。因此,汉英两种语言在全球人际交流中非常重要。但汉语和英语的语法既有相同之处,又有不同之处。汉语使用者和英语使用者之间要进行有效的沟通,必须了解两种语言在语法方面的异同。下面依次讨论汉语和英语中词类和复合句方面的异同。其他方面的语法异同请读者参阅相关文献。

### 1. 词类对比

汉语将词分为 11 类,英语将词分为 10 类。汉语没有冠词,英语没有量词和助词。其对应关系见表 1。

**表 1　汉英词类对照**

| | 汉语词类及举例 | | 英语词类及举例 | |
|---|---|---|---|---|
| 实　　词 | 名词 | (水泥) | noun | (cement) |
| | 形容词 | (美丽) | adjective | (beautiful) |
| | 代词 | (我们) | pronoun | (we, us) |
| | 动词 | (驾驶) | verb | (drive) |
| | 副词 | (很) | adverb | (very) |
| | 数词 | (三) | numeral | (three) |
| | 量词 | (个) | — | |

续上表

| | 汉语词类及举例 | 英语词类及举例 |
|---|---|---|
| 虚　　词 | 介词　　　　(在) | preposition　　　　(at, in) |
| | 连词　　　　(但是) | conjunction　　　　(but) |
| | 叹词　　　　(啊) | interjection　　　　(aha) |
| | 助词(了) | — |
| | — | article　　　　(the, a, an) |
| 说明:括号内的词为例词,"—"号说明对应的语言中没有该词类 | | |

汉语词大部分是一词一类,有少量兼类词,一般只兼两类。例如,"报告"一词在汉语中既可以作动词,又可以作名词。英语常用词有许多是一词多类,而且可以兼两类、三类、四类甚至于五类。例如,在不同的上下文中,英语单词"round"可以分别用作形容词、副词、名词、介词和动词,分别表示"圆的、球形的"、"周转地、循环地"、"圆的东西"、"环、绕"和"使成为圆形"等意思。

汉语的一个词能充当的句子成分较多,一般不必转换词类。以"讨论"一词为例:

(1)我们讨论了这个问题。　　　(谓语)

(2)讨论开始了。　　　(主语)

(3)这是一次重要的讨论。　　　(宾语)

(4)首先确定讨论的内容。　　　(定语)

相反,英语一个词能充当的句子成分较少,充当不同成分时一般需要转换词类。例如:

(1)She got a fright.　　　(名词"fright"作宾语)

(2)The noise frightened me.　　　(动词"frightened"作谓语)

(3)It was a frightful storm.　　　(形容词"frightful"作定语)

(4)It was frightfully dangerous.　　　(副词"frightfully"作状语)

**2. 复合句对比**

汉语复合句分为联合复句、偏正复句、多重复句和紧缩复句。联合复句由两个以上的分句连接起来,各分句之间的地位是平等的,不分主从,每个分句在意义上没有说明另一分句的作用。根据分句之间的不同关系,联合复句又可分为并列复句、承接复句、递进复句和选择复句四种。选择复句又包括商选句、限选句和取舍句三种。联合复句的例句有:

(1)他既懂汉语,又懂英语。　　　(并列复句)

(2)客人一时没有听懂,接着明白过来了。　　　(承接复句)

(3)这种桥不但形式优美,而且结构坚固。　　　(递进复句)

(4)与其等死,不如起来反抗。　　　(选择复句中的取舍句)

偏正复句的分句不是平等联合,而是有主有从,主要的分句是全句的正意所在,叫正句。另外的分句从种种关系上去限制它,说明它,叫偏句。偏正复句又可分为因果复句、假设复句、条件复句、转折复句、让步复句、目的复句和连锁复句七种。因果复句又包括因果句和推断句两种,条件复句又包括特定条件句、唯一条件句和无条件句三种,转折句又包括重转句和轻转句两种。偏正复句的例句有:

(1)因为天气不好,所以我们没去爬山。　　　(因果复句中的因果句)

(2)如果天气好，我们就去爬山。 (假设句)

(3)只要你努力，就一定能学好英语 (条件复句中的特定条件句)

(4)尽管天气很冷，可他还是忙得出了一身汗。 (转折复句中的重转句)

(5)他固然不对，你的态度也不好。 (让步复句)

(6)为着民族的解放，他们不惜牺牲宝贵的生命。(目的复句)

(7)一般情况下，学习越努力，学习成绩越好。 (连锁复句)

一般复句所包括的分句都是单句。如果分句本身又是由复句构成，便形成了多重复句。例如：

如果没有氧，只有氢；或者没有氢，只有氧，都不能形成水。

这是一个包含三个层次的多重复句。第一层"如果……都……"是条件复句，第二层"……或者……"是选择复句，第三层"……没有氧，只有氢……"与"……没有氢，只有氧……"是并列复句。

紧缩复句就是分句中关联词或主语省略，使句子更紧凑。例如，"坐着听听也长见识。"是一个紧缩复句，它实际上是省略了关联词"只要"和主语的条件复句。

英语复合句可以分成并列复合句和主从复合句。主从复合句中的从句又可分成名词性从句、定语从句和状语从句。名词性从句包括主语从句、宾语从句、表语从句和同位语从句四种。定语从句包括限制性定语从句和非限制性定语从句两种。状语从句包括时间状语从句、地点状语从句、原因状语从句、结果状语从句、条件状语从句、让步状语从句、比较状语从句、方式状语从句和目的状语从句九种。英语复合句的例句有：

(1)It has been found that some prestressed sleepers do not crack.(主语从句)
(已经发现有些混凝土轨枕不开裂。)

(2)The computers can only do what they are told to do.(宾语从句)
(计算机只能做人们让它做的事。)

(3)One of the most important facts about light is that it travels in straight line.(表语从句)
(光最重要的特性之一是直线传播。)

(4)The question whether there is life on Mars is still disputable.(同位语从句)
(火星上是否有生命这个问题仍有争论。)

(5)Any measures the designer can take to standardize the design will generally pay off in reduced overall costs.(限制性定语从句)
(设计师采取的使设计标准化的任何措施一般会产生降低总造价的回报。)

(6)The most familiar ferrous alloy is steel, which contains iron and a very small proportion of carbon.(非限制性定语从句)
(钢是人们最熟悉的黑色合金，它含有铁和极少量的碳。)

(7)The risk is reduced by prestressing, because the stress induced in the concrete during the prestressing operation may be 50 percent to 75 percent of its compressive strength.(原因状语从句)
(预加应力使风险降低，因为施加预应力过程中在混凝土中引起的应力可能达到混凝土抗压强度的50～75%。)

(8)Where pipelines cross swamps, rivers, or lakes they must be encased in concrete.(地点状语从句)

(管道通过沼泽、河流或湖泊时,必须用混凝土包起来。)

(9) If two separate forces are applied in the same direction, it is easy to find out the resultant.(条件状语从句)

(如果两个单独的力作用在同一方向上,那么容易求其合力。)

(10) After the concrete has hardened, the forms are removed.(时间状语从句)

(混凝土硬化以后,再将模板撤去。)

(11) The beam must be proportioned so that it can be constructed.(目的状语从句)

(梁必须均衡以便能够施工)

(12) The inside of the earth is so hot that the rock has melted like ice.(结果状语从句)

(地球内部如此之热,以至于岩石都像冰一样熔化了。)

(13) Although these are considered separately in developing the design theory and in the design process, their interaction must also be taken into account.(让步状语从句)

(尽管在提出设计理论和设计过程中这些构件是单独考虑的,对于它们的相互作用也必须加以考虑。)

(14) Concrete members inherently require less maintenance than do structural steel or timber members.(比较状语从句)

(混凝土构件的固有性质决定了它需要的维修量比结构钢或木构件需要的维修量要小。)

(15) Solids expand and contract as liquids do.(方式状语从句)

(固体像液体一样膨胀和收缩。)

# Unit 2 The Railway Cross Section

The railway cross section of today is the result of more than a century of evolutionary change. In the early days of railroading, both the longitudinal-tie-track and the crosstie-track were used. For the U.S. intercity railroad system, the crosstie-track has prevailed and, predominantly, wood crossties have been used.

The cross-sectional area of the rail has been increased continuously, and the tie spacing has been decreased to accommodate increasing wheel loads. However, the spacing of the ties cannot be reduced indefinitely , nor can the rail section be increased without limit. For these reasons, some thought now is being given to eliminating the tie spaces altogether by using instead a continuous reinforced concrete slab. In this design, the rails would be secured by fasteners that are anchored in the slab.

The paragraphs that follow describe the various components of a railroad cross section. Looking to the future, it should be remembered that other design concepts and approaches to track design may be needed to serve heavier loads and increased traffic and to adapt to technological change.

Standards for the width of the subgrade are determined for mainline, secondary line, and light traffic branch lines and spurs. Many railroads have adopted 20 ft as the width of single-lane main lines. This width will also vary according to the height of fill. A width of 22 ft has been used for fills under 20ft; 24 ft for fills 20 to 50 ft; and 26 ft for fills over 50 ft. Standard width in cuts including side ditches is 30 ft. In some locations 40 ft is used to permit the use of off-track equipment for maintenance purposes. Common widths of rights-of-way in open country are 50, 60, 80, 100, and sometimes 200 and 400 ft.

There are seven main elements of a railroad cross section: (1) ballast, (2) crossties, (3) rails, (4) tie plates, (5) fastenings, (6) rail anchors, and (7) rail joints. In the following sections, they will be discussed in order.

## 1. Ballast

Ballast is a key structural element of the railroad permanent way. Its prime function is to transmit and distribute the wheel loadings from the base of the crossties to the subgrade at pressures that will not cause subgrade failure. In addition, ballast serves to anchor the track, preventing longitudinal and transverse track movements under dynamic train loading, to provide immediate drainage of the permanent way under the ties, and to provide a road material that inhibits vegetation growth and minimizes dust.

Open graded materials that can perform satisfactorily the required functions of ballast are crushed stones, washed river or pit run gravel, and furnace slags. Typically, material varies in grain size from 1.5 to 1.75 in. Where ballast material is expensive or in short supply, or where subgrade strength is sufficiently low that excessive depth of ballast would be required, a layer of sub-ballast frequently is used. Material for the sub-ballast layer of the permanent way can be a less openly graded material meeting less stringent quality requirements.

The depth of the ballast may vary from 6 to 30 in. or more depending on wheel loads, traffic density and speed, and the type and condition of the foundation. The thickness of the sub-ballast may also vary, but excellent results have been obtained with a thickness of about 12 in.

The AREA has set quality standards on ballast with reference to the following criteria:

(1) **Wear resistance**. Under the Los Angeles abrasion test, percentage of wear of any ballast material is limited normally to 40 percent.

(2) **Cleanliness**. Deleterious substances are limited in prepared ballasts to the following amounts:

| | |
|---|---|
| soft and friable pieces | 5 percent |
| material finer than No. 200 Sieve | 1 percent |
| clay lumps | 0.5 percent |

(3) **Frost resistance**. Ballast must be capable of resisting freeze-thaw cycles. AREA requires an average weight loss of not more than 7 percent after 5 cycles of the sodium sulfate soundness test.

(4) **Unit weight**. Specifications require compacted weights of not less than 70 and 100 $lb/ft^3$ for blast furnace and open hearth slags, respectively.

## 2. Crossties or sleepers

The crosstie serves several functions, including (1) spreading horizontal and vertical loadings to the ballast; (2) maintaining the correct gage between the rails; (3) providing, in conjunction with the ballast, a means of anchoring the track against longitudinal and lateral movements; and (4) providing a convenient means for making needed adjustments of the vertical profile of the track.

Vertical loadings are applied to the ties by the train weight. Horizontal longitudinal loadings occur as trains accelerate or decelerate, while transverse loadings are applied as the vehicles transverse curved sections. Additional transverse loads are present due to the "barreling" effect of locomotives at high speed. To permit the horizontal transfer of forces from the tie, the ballast is tamped mechanically between the ties.

Typically, ties are made of wood which is treated with both preservatives and coating materials for protection against weathering and splitting while in service. Tie sections vary from 6 in. thick ×6 in. wide to 7 in. thick ×9 in. wide. Tie lengths also vary. Standard sizes are 8, 8.5, and 9 ft long. Tie replacement, which averages 3 percent of all ties yearly, accounts for a large proportion of total track maintenance.

Many railroads have had satisfactory experience with concrete crossties (or sleepers as they are sometimes called). It is reported that there are more than 3 000 million sleepers in the world of