应用型本科院校土木工程专业系列教材

YINGYONGXING BENKE YUANXIAO
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土木工程专业英语

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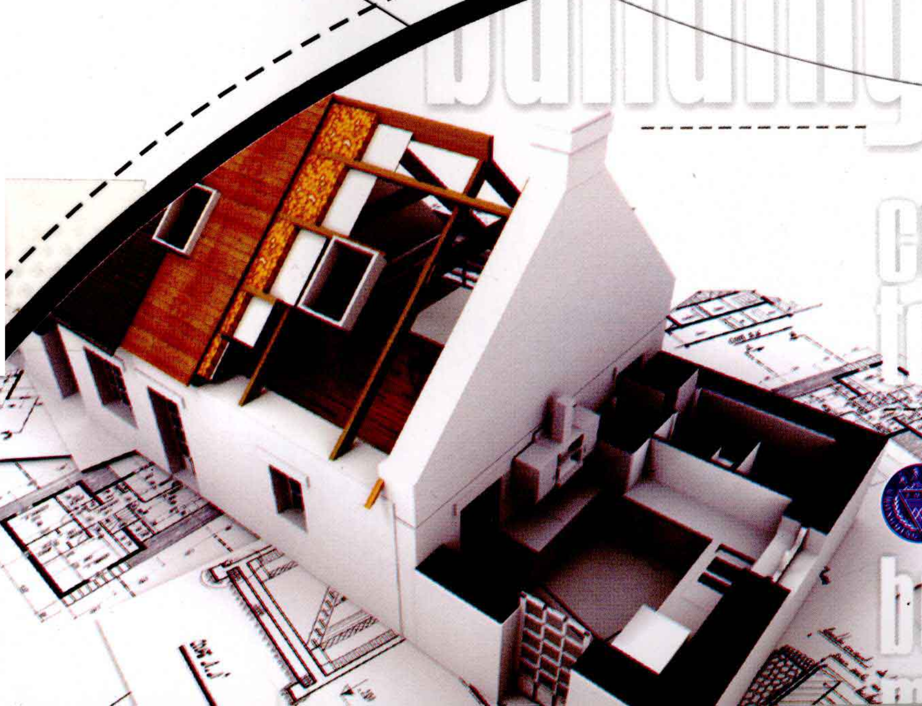

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内容提要

本书是应用型本科院校土木工程专业系列教材之一。教材共有4大部分,13个单元,35课。有结构设计、建筑施工、工程管理和阅读材料,内容涉及力学、结构分析与设计安全、建筑材料、结构物设计、基础施工、逆作法施工、混凝土结构物施工、预制件工程、隧道工程、道桥工程、工程招投标、工程管理、项目管理等。

本书可作为应用型本科院校土木工程专业教学用书,也可供学生自学使用。

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前　言

土木工程专业英语是土木工程专业本科教学的重要组成部分，是促进学生完成从大学基础英语向专业外语和外向型交流过渡的有效途径。结合土木工程专业应用型人才培养和实际工程施工中需要的专业内容，编写了这本选材广泛、内容丰富、难度适中、语言规范的教科书，课后配有适量实用的练习和答案，阅读材料选材更拓宽了与课文相关的内容、技术，以及工程管理方面的知识，同时辅以必要的单词短语翻译和提示，非常适合土木工程专业教学特别是学生自学的需要。

教材内容共 4 大部分，13 个单元，35 课。有结构设计、建筑施工、工程管理和阅读材料，涉及力学、结构分析与设计安全、建筑材料、结构物设计、基础施工、逆作法施工、混凝土结构物施工、预制件工程、隧道工程、道桥工程、工程招投标、工程管理、项目管理等。

本书由白越任主编（负责 Unit 1、Unit 8、Unit 9 和 Part Ⅲ）；冯震（负责 Unit 4、Unit 5、Unit 6）和李瑞璟（负责 Unit 2、Unit 3、Unit 7）任副主编；张瑛（负责 Part Ⅱ的序言）参编。

由于编者水平有限，书中难免有不足之处，恳请广大读者给予指正。

编　者

2011 年 4 月

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PART I

BUILDING STRUCTURES

Unit 1

Structural Analysis and Safety

Text 1 Structural Analysis

Structural analysis is the process of determining the forces and deformations in structures due to specified loads so that the structure can be designed rationally, and so that the security status of existing structures can be checked.

In structural design, it is necessary to start with a concept leading to a configuration which can then be analyzed. This is done so that members can be sized and the needed reinforcing could be determined, in order to:

(1) carry the design loads without excessive deformations (serviceability or working condition).

(2) prevent collapse before a specified overload has been placed on the structure (safety or ultimate condition).

Since normally elastic conditions will prevail under working loads, a structural theory based on the assumption of elastic behavior is appropriate for determining serviceability conditions. Collapse of a structure will usually occur only long after the elastic range of the materials has been exceeded at critical points, so that an ultimate strength theory based on the inelastic behavior of the materials is necessary for a rational determination of the safety of a structure against collapse. Nevertheless, an elastic theory can be used to determine a safe approximation to the strength of ductile structures, and this approach is customarily followed in reinforced concrete practice.

All structures are assemblies of three-dimensional members, the exact analysis of which is a forbidding task even under ideal conditions and is impossible to contemplate under conditions of professional practice. For this reason, an important part of the analysis work is the simplification of the actual structure and loading conditions to a model that is susceptible to rational analysis.

Thus, a structural framing system is decomposed into a slab and floor beams that in turn frame into girders carried by columns that transmit the loads to the foundations. Since traditional structural analysis has been unable to cope with the action of the slab, this has often been idealized into a system of strips acting as beams. Also, longhand methods have been unable to cope with three-dimensional framing systems, so that the entire structure has been modeled by a system of planar subassemblies, to be analyzed one at a time. The modern computing methods have revolutionized structural analysis by making it possible to analyze entire systems, thus leading to more reliable predictions about the behavior of structures under loads.

Actual loading conditions are also difficult both to determine and to express realistically, and must be simplified for the purpose of analysis. Thus, traffic loads on a bridge structure, which are essentially both of dynamic and random nature, are usually idealized into statically moving standard trucks, or distributed loads, intended to simulate the most severe loading conditions occurring in practice.

Similarly, continuous beams are sometimes reduced to simple beams, and rigid joints to pin joints; filler walls are neglected; shear walls are considered as beams. In deciding how to model a structure so as to make it reasonably realistic but at the same time reasonably simple, the analyst must remember that each such an idealization will make the solution more suspect. The more realistic the analysis, the greater will be the confidence it inspires, and the smaller may be the safety factor.

The most important use of structural analysis is as a tool in structural design. As such, it will usually be a part of a trial-and-error procedure, in which an assumed configuration with assumed dead loads is analyzed, and the members are designed in accordance with the result of the analysis. This phase is called the preliminary design; since this design is still subject to change, usually a crude fast analysis method is adequate. At this stage, the cost of the structure is estimated, loads and member properties are revised, and the design is checked for possible improvements. The changes are now incorporated in the structure, a more refined analysis is performed, and the member design is revised.

An efficient analyst must be able to reduce these to shortcut methods by appropriate assumptions, and must be aware of available design and analysis aids, as well as simplifications permitted by applicable building codes. An up-to-date analyst must likewise be versed in the bases of matrix structural analysis and its use in digital computers as well as in the use of available analysis programs or software.

New Words and Expressions

configuration	[kənˌfigjuəˈreiʃən]	*n.* 结构，构造，外形
prevail	[priˈveil]	*vi.* 流行，盛行，获胜，成功
collapse	[kəˈlæps]	*n.* 倒塌，毁坏，断裂

overload	[ˈəuvəˈləud]	*n.* 超载,超重
critical point		临界点
approximation	[əˌprɔksiˈmeiʃən]	*n.* 接近,近似,大致估计,大约
ductile	[ˈdʌktail]	*adj.* 可延展的,延性的
customarily	[ˈkʌstəmərəli]	*adv.* 通常地
assemble	[əˈsembl]	*v.* 组合,集合,聚集
contemplate	[ˈkɔntempleit]	*v.* 思考,设想
decompose	[ˌdiːkəmˈpəuz]	*v.* 分解
slab	[slæb]	*n.* 平板,板梁
girder	[ˈgəːdə]	*n.* 梁,大梁
strip	[strip]	*n.* 条板,带,条
planar	[ˈpleinə]	*adj.* 平面的,平坦的
subassembly	[ˈsʌbəˈsembli]	*n.* 部件,组件
reliable	[riˈlaiəbl]	*adj.* 可靠的,可信赖的
simplify	[ˈsimplifai]	*v.* 简化,简单化,单一化
simulate	[ˈsimjuleit]	*v.* 模拟,模仿
rigid joint		刚性节点,刚性连接
pin joint		铰结,销钉连接
filler wall		柱间墙,填充墙
shear wall		剪力墙
inspire	[inˈspaiə]	*v.* 鼓励,激励,赐给灵感
preliminary design		初步设计
incorporated	[inˈkɔpəreitid]	*adj.* 合并的,一体化的
up-to-date		*adj.* 现代的,最新的,当今的
matrix	[ˈmeitriks]	*n.* 矩阵

Exercises

1. Fill in the blanks with the proper words, according to the text.

(1) Structural analysis is the (　　) of determining the forces and deformations in structures due to specified loads so that the structure can be designed rationally, and so that the security status of existing structures can be checked.

(2) This is done (　　) members call be sized and the needed reinforcing could be determined,…

(3) (　　) normally elastic conditions will prevail under working loads, a structural theory based on the assumption of elastic behavior is appropriate for determining serviceability conditions.

(4) (　　), an elastic theory can be used to determine a safe approximation to the strength of ductile structures, and this approach is customarily followed in reinforced concrete practice.

(5) For this reason, an important part of the analysis work is the simplification of the actual structure and loading conditions to a model that is susceptible (　　) rational analysis.

(6) Thus, a structural framing system is decomposed into a slab and floor beams that (　　) frame into girders carried by columns that transmit the loads to the foundations.

(7) The modem computing methods have revolutionized structural analysis by making it possible to analyze entire systems, thus leading (　　) more reliable predictions about the behavior of structures under loads.

(8) Actual loading conditions are also difficult (　　) to determine and to express realistically, and must be simplified for purposes of analysis.

(9) The (　　) realistic the analysis, the greater will be the confidence it inspires, and the smaller may be the safety factor.

(10) As such, it will usually be a part of a trial-and-error procedure, in which an assumed configuration with assumed dead loads is analyzed, and the members are designed in accordance (　　) the result of the analysis.

2. **Translate the following phrases into English.**

(1)实用性	(2)结构垮落
(3)可延展结构	(4)静荷载
(5)更可靠的预测	(6)桥结构上的运输荷载
(7)结构设计	(8)试算法
(9)简捷法	(10)矩阵结构分析

3. **Translate the following sentences into Chinese.**

(1) Carry the design loads without excessive deformations (serviceability or working condition).

(2) In the design of structures, it is necessary to start with a concept leading to a configuration which can then be analyzed.

(3) Collapse of a structure will usually occur only long after the elastic range of the materials has been exceeded at critical points, so that an ultimate strength theory based on the inelastic behavior of the materials is necessary for a rational determination of the safety of a structure against collapse.

(4) All structures are assemblies of three-dimensional members, the exact analysis of which is a forbidding task even under ideal conditions and impossible to contemplate under conditions of professional practice.

(5) Actual loading conditions are also difficult both to determine and to express realistically, and must be simplified for the purpose of analysis.

(6) Similarly, continuous beams are sometimes reduced to simple beams, and rigid joints to pin joints; filler walls are neglected; shear walls are considered as beams.

(7) As such, it will usually be a part of a trial-and-error procedure, in which an assumed configuration with assumed dead loads is analyzed, and the members are designed in accordance with the result of the analysis.

(8) An efficient analyst must be able to reduce these to shortcut methods by appropriate assumptions, and must be aware of available design and analysis aids, as well as simplifications permitted by applicable building codes.

Reading Materials (Ⅰ)

Structure of Buildings

Considering only the engineering essentials, the structure of a building can be defined as the assemblage of those parts which exist for the purpose of maintaining shape and stability. Its primary purpose is to resist any loads applied to the building and to transmit those to the ground.

In terms of architecture, the structure of a building is and does much more than that. It is an inseparable part of the building form and to varying degrees is a generator of that form. Used skilfully, the building structure (see in Fig. 1-1) can establish or reinforce orders and rhythms (规律、旋律) among the architectural volumes and planes. It can be visually dominant or recessive (逆行的、退行的). It can develop harmonies (协调) or conflicts. It can be both confining and emancipating (使不受束缚). And, unfortunately in some cases, it cannot be ignored that it is physical.

The structure must also be engineered to maintain the architectural form. The principles and tools of physics and mathematics provide the basis for differentiating between rational and irrational forms in terms of construction. Artists can sometimes generate shapes that obviate any consideration of science, but architects cannot.

Fig. 1-1 The building structure

There are at least three items that must be present in the structure of a building:

- stability.
- strength and stiffness.
- economy.

Taking the first of the three requirements, it is obvious that stability is needed to maintain shape. An unstable building structure implies unbalanced forces or a lack of equilibrium and a consequent acceleration of the structure or its pieces.

The requirement of strength means that the materials selected to resist the stresses generated by the loads and shapes of the structure must be adequate. Indeed, a "factor of safety" is usually provided so that under the anticipated loads, a given material is not stressed to a level even close to its rupture (断裂, 破裂) point. The material property called stiffness is considered with the requirement of strength. Stiffness is different from strength in that it directly involves how much a structure strains or deflects under load. A material that is very strong but lacking in stiffness will deform too much to be of value in resisting the forces applied.

Economy of a building structure refers to more than just the cost of the materials used. Construction economy is a complicated subject involving raw materials, fabrication, erection, and maintenance. Design and construction labor cost and the cost of energy consumption must be considered. Speed of construction and the cost of money (interest) are also factors. In most design situations, more than one structural material requires consideration. Competitive alternatives almost always exist, and the choice is seldom obvious.

Apart from these three primary requirements, several other factors are worthy of emphasis. First, the structure or structural system must relate to the building's function. It should not be in conflict in terms of form. For example, a linear function demands a linear structure, and therefore it would be improper to roof a bowling alley (保龄球场) with a dome (圆屋顶). Similarly, a theater must have large, unobstructed spans, but a fine restaurant probably should not. Stated simply, the structure must be appropriate to the function it is to shelter.

Secondly, the structure must be fire-resistant. It is obvious that the structural system must be able to maintain its integrity at least until the occupants (居住者) are safely out. Building codes specify the number of hours for which certain parts of a building must resist the heat without collapse. The structural materials used for those elements must be inherently (内在地、固有地) fire-resistant or be adequately protected by fireproofing materials. The degree of fire resistance to be provided will depend on a number of items, including the use and occupancy load of the space, its dimensions, and the location of the building.

Thirdly, the structure should integrate well with the buildings circulation systems. It should not be in conflict with the piping systems for water and waste, the ducting systems for air, or (most important) the movement of people. It is obvious that the various building systems must be coordinated with the design progresses. One can design in a sequential step-by-step manner within any one system, but the design of all of them should move in a parallel manner toward completion. Spatially, all the various parts of a building are interdependent.

Fourthly, the structure must be psychologically as well as physically safe. A high-rise frame that sways (摆动) considerably in the wind might not actually be dangerous but may make the building uninhabitable just the same. Lightweight floor systems that are too "bouncy" (富有活力) can make the users very uncomfortable. Large glass windows, uninterrupted by dividing mullions (门窗的直棂), can be quite safe but will appear very insecure to the occupant standing next to one 40 floors above the street.

Sometimes the architect must make deliberate attempts to increase the apparent strength or solidness of the structure. This apparent safety may be more important than honestly expressing the building's structure, because the untrained viewer cannot distinguish between real safety and perceived safety.

Reading Materials (Ⅱ)

Design of Simple Structures

As any structure is designed to carry some external forces in the form of applied loads, local codes or ordinances (条例、法令) which prescribe loads must be followed in assessing loading conditions. In all cases, the code requirements are considered to be the minimum legal requirements.

Buildings

Structurally, buildings can be divided into three major groups:

(1) Shell or Surface Structures: These consist of a "skin" which is functional—that is, which encloses a space and at the same time acts as a main load—carrying element.

(2) Framed Structures: These usually consist of planar systems which are combined into three-dimensional configurations. This type of steel skeleton or beam-and-column construction call be used for residences, high-rise or low-rise apartment buildings, public buildings, and industrial buildings (workshops, warehouses, factories).

(3) Suspended Structures: These usually involve large clear spans (净跨) which are achieved by the use of cables as main supporting elements. This type of structure was originated in 1896 by the Russian engineer Shookhov for special structures such as sport or exhibition arenas (竞技场).

Before starting to calculate loads and their "actions" or stresses and deflections, the designer must select the materials to be used and have a clear concept of the way in which the transfer of vertical and horizontal loads from the point of their application to the ground will take place. The soundness of this structural concept actually determines the success or the failure of a design, with respect to not only its safety, but also its economy. In any actual design situation, the feasibility of various systems and the extent to which they reduce or increase the cost of other elements of the structure must be established first. The intelligent selection of the best concept can only be made after the criteria for a particular problem have been thoroughly investigated and defined.

In any flaming system, a deck element is supported by regularly spaced beams, which in turn are supported by other beams or directly by columns or walls. Vertical loads thus carried by these elements are finally transmitted to columns and to their foundations. Horizontal loads, wind forces, or dynamic forces are usually transferred by rigid floor or roof diaphragms (隔板、薄板) directly to flames, provided that the diaphragm capabilities of the deck and the adequacy of the assembly details make this possible.

Bridges

Bridges can be classified in several ways. Often a bridge structure represents some combination of two or more types. First, a classification according to the traffic load can be made under which there are highway, railway, or pedestrian bridges, with the understanding that very often any combination of these three is possible. According to the bridge axis, there are straight and curved bridges. According to the position of the floor carrying the traffic, there are deck bridges, with the floor on top of the main members, or through bridges, with the deck connected to the bottom chord of the main supporting members. Bracing is provided on the plane of the top chord above the traffic, but if the height is not sufficient, the space above is left open; such structures are called semithrough(中承式) or pony truss(小型桁架) bridges. Sometimes combination in the form of double-deck bridges is used. According to the makeup of the web of the main load-carrying members we can recognize full web-girder or beam or box-girder bridges and open-web truss bridges. If the system line of the bridge structure is straight and horizontal, the bridge is of the girder type; with a curved line, it is an arch bridge. Further subdivisions within each of the above groups can be made. Older steel bridges were riveted(铆接) while newer ones are welded and/or bolted. Finally, some bridges are movable either vertically or horizontally to allow traffic flow underneath if the available clearance is not sufficient.

Which type of bridge is to be used is a major design decision, and local conditions—traffic, site, geological, geographical, and aesthetic(美学的)—are to be considered. Available clearances, erection possibilities, and foundation construction are also the major factors affecting decisions concerning the type and span length of a bridge.

Text 2 Structural Safety

The principal scope of specifications is to provide general principles and computational methods in order to verify the structural safety. The "safety factor", which according to the modern trend is independent of the nature and combination of the materials used, can usually be defined as the ratio between the conditions which yield failure of the construction and the worst predictable working conditions. This ratio is also proportional to the inverse of the probability (risk) of failure of the structure.

Failure has to be considered not only as overall collapse of the structure but also as unserviceability or according to a more precise, common definition, as the reaching of a "limit state" which causes the construction not to accomplish the task designed for.

There are two categories of limit state:

(1) Ultimate limit state, which corresponds to the highest value of the load-bearing capacity.

Examples include local buckling or global instability of the structure; failure of some sections and subsequent transformation of the structure into a mechanism; failure by fatigue; elastic or plastic deformation or creep that causes a substantial change of the geometry of the structure; and sensitivity of the structure to alternating loads, to fire and to explosions.

(2) Service limit states, which are functions of the use and durability of the structure. Examples include excessive deformations and displacements without instability, early or excessive cracks, large vibrations, and corrosion.

Computational methods used to verify structures with respect to the different safety conditions can be separated into:

(1) Deterministic methods, in which the main parameters are considered as nonrandom parameters.

(2) Probabilistic methods, in which the main parameters are considered as random parameters.

Alternatively, with respect to the different use of factors of safety, computational methods can be separated into:

(1) Allowable stress method, in which the stresses computed under maximum loads are compared with the strength of the material reduced by given safety factors.

(2) Limit states method, in which the structure may be proportioned on the basis of its maximum strength. This strength, as determined by rational analysis, shall not be less than that required to support a factored load equal to the sum of the factored live load and dead load (ultimate state).

The stresses corresponding to working (service) conditions with unfactored live and dead loads are compared with the prescribed values (service limit state). From the four possible combinations of the first two and second two methods, we can obtain some useful computational methods. Generally, two combinations prevail:

(1) Deterministic methods, which make use of allowable stresses.

(2) Probabilistic methods, which make use of limit states.

The main advantage of probabilistic approaches is that, at least in theory, it is possible to scientifically take into account all random factors of safety, which are then combined to define the safety factor. Probabilistic approaches depend upon:

(1) Random distribution of strength of materials with respect to the conditions of fabrication and erection (scatter of the values of mechanical properties through out the structure).

(2) Uncertainty of the geometry of the cross-sections and of the structure (faults and imperfections due to fabrication and erection of the structure).

(3) Uncertainty of the predicted live loads and dead loads acting on the structure.

(4) Uncertainty related to the approximation of the computational method used (deviation of the actual stresses from computed stresses).

Furthermore, probabilistic theories mean that the allowable risk can be based on several factors, such as:

(1) Importance of the construction and gravity of the damage by its failure.