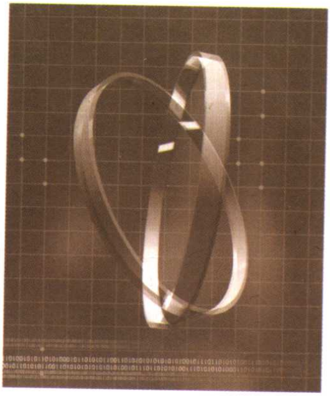

建筑工程专业英语

孙爱荣　刘晚成　陆万宗　编

English in Architectural Engineering

哈爾濱工業大學出版社

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内容提要

本书以培养学生的专业英语阅读能力为主要目标，内容涉及钢筋混凝土结构、预应力混凝土结构、计算机应用、钢结构、结构可靠度、建筑结构荷载、建筑学、建筑施工、建筑材料等。本书既注重学生专业英语学习又考虑介绍有关的专业知识。

本书可作为高等院校建筑工程专业的教材，也可供土建类专业技术人员学习、参考之用。

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再版前言

从1996年开始，我国对全国的建筑工程本科专业进行严格的专业评估。《全国高等学校建筑工程专业本科教育（评估）标准（试行）》中，明确规定建筑工程专业应开设基础外语、专业外语等课程，总计不少于20学分（314学时），要求学生能够比较顺利地阅读本专业的外文书刊。再有，国家教育部颁布的《大学英语教学大纲》也把专业英语阅读列为必修课而纳入英语教学计划，强调通过四年不断线的英语教学使学生能顺利阅读英文专业书刊。根据以上文件的精神，我们于1997年编写了《建筑工程专业英语》，以满足高等院校建筑工程专业的专业英语教学需要。经过多年使用，本书内容受到许多学校认可，在此经过部分内容调整修改予以再版，以满足专业教学的需求。

全书内容共分30课，涉及钢筋混凝土结构、预应力混凝土结构、计算机应用、钢结构、结构可靠度、建筑结构荷载、建筑学、建筑施工、建筑材料等内容。编写时，注重在使学生既提高专业英语阅读能力的同时，还扩大专业知识面。

本书由孙爱荣、刘晚成、金殿龙和陆万宗编写。孙鸿剑、曹炳政等为本书的计算机文字排版、编辑校对等做了大量工作。在本书编写过程中参考了有关文献的部分资料。在此一并表示衷心感谢！对书中的不足之处，恳请广大读者和同行专家批评指正。

编　者

2005.8

CONTENTS

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Loads

The accurate determination of the loads to which a structure or structural element will be subjected is not always predictable. Even if the loads are well-known at one location in a structure, the distribution of load from element to element throughout the structure usually requires assumptions and approximations. Some of the most common kinds of loads are discussed in the following sections.

Dead Load

Dead load is a fixed position gravity service load, so called because it acts continuously toward the earth when the structure is in service. The weight of the structure is considered dead load, as well as attachments to the structure such as pipes, electrical conduit, air – conditioning and heating ducts, lighting fixtures floor covering, roof covering, and suspended ceilings; that is, all items that remain throughout the life of the structure.

Dead loads are not usually known accurately until the design has been completed. Under steps 3 through 6 of the design procedure discussed in Sec. 1.2, the weight of the structure or structural element must be estimated, preliminary section selected, weight recomputed, and member selection revised if necessary. The dead load of attachments is usually known with reasonable accuracy prior to the design.

TABLE 1: Typical Minimum Uniformly Distributed Live Loads

Occupancy or Use	Liveload	
	psf	Pa
1. Hotel guest rooms School classrooms Private apartments Hospital private rooms	40	1900
2. Offices	50	2400
3. Assembly halls, fixed seat Library reading rooms	60	2900
4. Corridors, above first floor in schools, libraries, and hospitals	80	3800
5. Assembly areas; theater lobbies Dining rooms and restaurants Office building lobbies Main floor, retail stores Assembly hall, movable seats	100	4800
6. Wholesale stores, all floors Manufacturing, light Storage warehouses, light	125	6000
7. Armories and drill halls Stage floors Library stack rooms	150	7200
8. Manufacturing, heavy Sidewalks and driveways subject to trucking Storage warehouse, heavy	250	12000

Live Load

Gravity loads acting when the structure is in service, but varying in magnitude and location, are termed live loads. Examples of live loads are human occupants, furniture, movable equipment, vehicles, and stored goods. Some live loads may be practically permanent, others may be highly transient. Because of the unknown nature of the magnitude, location, and density of live load items, realistic magnitudes and the positions of such loads are very difficult to determine.

Because of the public concern for adequate safety, live loads to be taken as service loads in design are usually prescribed by state and local building codes. These loads are generally empirical and conservative, based on experience and accepted practice rather than accurately computed values. Wherever local codes do not apply, or do not exist, the provisions from one of several regional and national building codes may be used. One such widely recognized code is the American National Standard Mihijum Design Loads for Buildings and Other Structures ANSI A58.1 of the American National Standards (ANSI), from which some typical live loads are presented in Table 1. The code will henceforth be referred to as the ANSI Standard. This Standard is updated from time to time, most recently in 1982.

Live load when applied to structure should be positioned to give the maximum effect, including partial loading, alternate span loading, or full span loading as may be necessary. The simplified assumption of full uniform loading everywhere should be used only when it agrees with reality or is an appropriate approximation. The probability of having the prescribed loading applied uniformly over an entire floor, or over all floors of a building simultaneously, is almost nonexistent. Most codes recognize this by allowing for some percentage reduction from full loading. For instance, for live loads of 100 psf or more ANSI standard allows members having an influence area of 400 sq ft or more to be designed for a reduced live load according to Eq. 1, as follows

$$L = L_0\left[0.25 + \frac{15}{\sqrt{A_I}}\right] \tag{1}$$

where

L ——reduced live load per sq ft of area supported by the member

L_0——unreduced live load per sq ft of area supported by the member (from Table 1)

A_I——influence area, sq ft

The influence area A_I area is four times, the tributary area for a column two times, the tributary area for a beam, and is equal to the panel area for a two – way slab. The reduced live load L shall not be less than 50% of the live load L_0 for members supporting one floor, nor less than 40% of the live load L_0 otherwise.

The live load reduction referred to above is not permitted in areas to be occupied as places of public assembly and for one – way slabs, when the live load L is 100 psf or less. Reductions are permitted for occupancies where L_0 is greater than 100 psf and for garages and roofs only under special circumstances(ANSI – 4.7.2).

Snow Load

The live loading for which roofs are designed is either totally or primarily a snow load. Since snow has a variable specific gravity, even if one knows the depth of snow for which design is to be made, the load per unit area of roof is at best only a guess.

The best procedure for establishing snow load for design is to follow the ANSI Standard. This Code uses a map of the United States giving isolines of ground snow corresponding to a 50 – year mean recurrence interval for use in designing most permanent structures. The ground snow is then multiplied by a coefficient that includes the effect of roof slope, wind exposure, nonuniform accumulation on pitched or curved roofs, multiple series roofs, and multilevel roofs and roofs areas adjacent to projections on a roof level.

It is apparent that the steeper the roof the less snow can accumulate. Also partial snow loading should be considered, in addition to full loading if it is believed such loading can occur and would cause maximum effects. Wind may also act on a structure that is carrying snow load. It is unlikely, however, that maximum snow and wind loads would act simultaneously.

In general, the basic snow load used in design varies from 30 to 40 psf (1400 to 1900 MPa) in the northern and eastern states to 20 psf (960 MPa) or less in the southern states. Flat roofs in normally warm climates should be designed for 20 psf (960 Mpa) even when such accumulation of snow may seem doubtful. This loading may be thought of as due to people gathered on such a roof. Furthermore, though wind is frequently ignored as a vertical force on a roof , nevertheless it may cause such an effect . For these reasons a 20 psf (960 MPa) minimum loading , even though it may not always be snow, is reasonable. Local codes, actual weather conditions, ANSI, or the Canadian Structural Design Manual, should be used when designing for snow. Other snow load information has been provided by investigators.

Wind Load

All structures are subject to wind load , but they are usually only those more than three or four stores high , other than long bridges, for which special consideration of wind is required.

On any typical building of rectangular plan and elevation, wind exerts pressure on the windward side and suction on the leeward side, as well as either uplift or downward pressure on the roof. For most ordinary situations vertical roof loading from wind is neglected on the assumption that snow loading will require a greater strength than wind loading does. This assumption is not true for southern climates where the vertical loading, due to, wind must be included. Furthermore, the total lateral wind load, windward and leeward effect, is commonly assumed to be applied to the windward face of the building.

In accordance with Bernoulli's theorem for an ideal fluid striking an object, the increase in static pressure equals the decrease in dynamic pressure, or

$$q = \frac{1}{2}\rho v^2 \tag{2}$$

where q is the dynamic pressure on the object, p is the mass density of air (specific weight $w = 0.076\,51$ pcf at sea level and 15℃), and v is the wind velocity. In terms of velocity v in miles per hour, the dynamic pressure q (psf) would be

$$q = \frac{1}{2}\left(\frac{0.076\,51}{32.2}\right)\left(\frac{5\,280v}{3\,600}\right)^2 = 0.002\,6\ v^2 \tag{3}$$

In design of usual types of buildings, the dynamic pressure q is commonly converted into equivalent static pressure p, which may be expressed

$$p = qC_eC_gC_p \tag{4}$$

where C_e is a exposure factor that varies from 1.0 (for 0 – 40-ft height) to 2.0 (for 740 – 1200-ft height); C_g is a gust factor, such as 2.0 for structural members and 2.5 for small elements including cladding; and C_p is a shape factor for the building as a whole. Excellent details of application of wind loading to structures are available in the ANSI Standard and in the National Building Code of Canada.

The commonly used wind pressure of 20 psf , as specified by many building codes, corresponds to a velocity of 88 miles per hour (mph) from Eq. 3. An exposure factor C_e of 1.0 , a gust factor C_g of 2.0 , and a shape factor C_q of 1.3 for an airtight building, along with a 20 psf equivalent static pressure p, will give from Eq 4 a dynamic pressure q of

7.7 psf, which corresponds, using Eq.3 to a wind velocity of 55 mph. For all buildings having nonplanar surfaces, plane surfaces inclined to the wind direction or surfaces having significant openings, special determination of the wind forces should be made using such sources as the ANSI Standard, or as the National Building Code of Canada. For more extensive treatment of wind loads, the reader is referred to the Task Committee on Wind Force, Lew, Simiu, and Ellingwood in the Building Structural Design Handbook, and others.

Earthquake Load

An earthquake consists of horizontal and vertical ground motions, with the vertical motion usually having much smaller magnitude. Since the horizontal motion of the ground causes the most significant effect, it is that effect which is usually thought of as earthquake load. When the ground under an object (structure) having a certain mass suddenly moves, the inertia of the mass tends to resist the movement. A shear force is developed between the ground and the mass. Most building codes having earthquake provisions require the designer to consider a lateral force CW that is usually empirically prescribed. The dynamics of earthquake action on structures is outside the scope of this text, and the reader is referred to Chopra, and Clough and Penzien.

In order to simplify the design process, most building codes contain an equivalent lateral force procedure for designing to resist earthquakes. One of the most widely used design recommendations is that of the Structural Engineers Association of California (SEAOC), the latest version of which is 1974. Since that time, the Applied Technology Council (ATC) prepared a set of design provisions. Some recent rules for the equivalent lateral force procedure are those given by the ANSI Standard. In ANSI the lateral seismic forces V, expressed as follows, are assumed to act nonconcurrently in the direction of each of the main axes of the structure

$$V = ZIKCSW \tag{5}$$

where

Z——seismic zone coefficient, varying from 1/8 for the zone of lowest seismicity, to 1 for the zone of highest seismicity

I——occupancy importance factor, varying from 1.5 for buildings designated as "essential facilities," and 1.25 for buildings where the primary occupancy is for assembly for greater than 300 persons, to 1.0 for usual buildings

K——horizontal force factor, varying from 0.67 to 2.5, indicating capacity of the structure to absorb plastic deformation (low values indicate high ductility) the seismic coefficient, equivalent to the maximum acceleration in terms of acceleration due to gravity

$$C = \frac{1}{15\sqrt{T}} \leqslant 0.12 \tag{6}$$

T——fundamental natural period, i.e., time for one cycle of vibration, of the building in the direction of motion

S——soil profile coefficient, varying from 1.0 rock to 1.5 for soft to medium – stiff clays and sands

W——total dead load of the building, including interior partitions

When the natural period T cannot be determined by a rational means from technical data, it may be obtained as follows for shear walls or exterior concrete frames utilizing deep beam or wide piers, or both

$$T = \frac{0.05h_n}{\sqrt{D}} \tag{7}$$

where D is the dimension of the structure in the direction of the applied forces, in feet, and h_n is the height of the building.

Once the base shear V has been determined, the lateral force must be distributed over the height of the building.

More details of the ANSI Standard procedure are available in the Building Structural Design Handbook. Various building code formulas for earthquake – resistant design are compared by Chopra and Crux . Many states have adopted the Uniform Building Code(UBC), the most recent version of which is 1985, which contains provisions for design to resist earthquake generally based on the ANSI Standard .

Words and Expressions

distribution	*n*.	分配,分布
conduit	*n*.	管道,导线管
duct	*n*.	(输送)管道
transient	*a*.	无常的,短期的
empirical	*a*.	经验的
retial	*a*.	零售的
panel		(嵌)板
isoline	*n*.	(等值)线
suction	*n*.	吸收
windward side		迎风面
leeward side		背风面
gust	*n*.	阵风
cladding	*n*.	覆盖,包层
nonplanar	*a*.	非平面的
seismic	*a*.	地震的
nonconcurrently	*adv*.	非共点地
soil profile		土(壤)剖面

2

Probabilities of Occurrence of Tornado Winds

Consider an area A_0, say, a one – degree longitude – latitude square, and let the tornado frequency in that area (i. e., the average number of tornado occurrences per year) be denoted by $\bar{n}$. The probability that a tornado will strike a particular location during one year is assumed to be

$$P(S) = \bar{n} \frac{\bar{a}}{A_0} \qquad (1)$$

where $\bar{a}$ is the average individual tornado area. In certain applications, for example, the design of nuclear power plants, rather than the probability $P(S)$, it is of interest to estimate the probability $P(S, V_0)$ that a tornado with maximum wind speeds higher than some specified value V_0 will strike a location in any one year. This probability can be written as

$$P(S, V_0) = P(V_0) P(S) \qquad (2)$$

where $P(V_0)$ is the probability that the maximum wind speed in a tornado will be higher than V_0.

Probabilities $P(S)$ in the United States were estimated, based on Eq. 1 in which $\bar{n}$ was estimated from 13 – year frequency data, $\bar{a} = 2.82$ sq. miles and $A_0 = 4780 \cos\varphi$, where φ is the latitude at the center of the one-degree square considered. Estimated probabilities $P(V_0)$ are shown in the map of the United States. These estimates are based upon observations of 1612 tornadoes during 1971 and 1972. It is noted that in estimating the probabilities, it was assumed that tornado path areas are the same throughout the contiguous United States.

The maximum speed of the tornado corresponding to a specified probability of occurrence can be estimated. According to Technical Basis for Interim Regional Tornado Criteria (WASH-1300(UC-11)), "In order to adequately protect public health and safety, the determination of the design basis tornado is based on the premise that the probability of occurrence of a tornado that exceeds the Design Basis Tornado (DBT) should be on the order of 10^{-7} per nuclear power plant." The required probability P(V_0) is then determined from the relation

$$P(V_0)P(S) = 10^{-7} \tag{3}$$

where the value of $P(S)$ for the location considered is taken from the above estimated probabilities. The wind speed corresponding to the probability $P(V_0)$ so determined can be then obtained. The average tornado intensity with a 10^{-7} probability per year for each 5-degree square in the contiguous United States, based on Eq. 3 and Figs. 1 and 2, is obtained.

For nuclear power plant design purposes, the contiguous United States are divided into three tornado intensity regions. The corresponding tornado winds are given in Table 1.

The pressure drop due to the passage of tornadoes can be estimated from the equation for the cyclostrophic wind. Using the relation = dr/dt, Eq. 2 can be written as

$$\frac{\mathrm{d}p}{\mathrm{d}t} = \frac{V_{tr}}{R_m}\rho V_t^2 \tag{4}$$

where p is the pressure, t is the time, V_{tr} is the translational speed, ρ is the air density, R_m is the radius of maximum rotational wind speed, and