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（下册）

苏小卒 主编

同济大学出版社

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Civil Engineering Speciality English

（下册）

Volume 2

苏小卒　主编

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序　言

在土木工程类专业合并成一个土木工程专业后的大土木环境下，许多课程的设置和内容都进行了调整。原来分门别类的专业英语课程也合并成一门“土木工程专业英语阅读”课，本书就是为该课程编写的教材。

目前我国土木工程行业与国外有许多交流，并参与国际市场的竞争，许多专业技术人员希望有系统的土木工程专业英语参考书。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，使本书除可用作教材外，也可供土木工程专业的教师、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也适用于学习专业英语。听、说、读、写、译这五种语言技能是互相联系的。过去一般认为专业英语以读、写、译为主，然而现在随着国际交流和全球化市场经济的发展，需要听和说的场合也越来越多了。故也应鼓励进行听说方面的练习。经验表明，英语听力的熟练对于提高阅读能力也是大有帮助的。由于语言的技能性重于其知识性，经常使用英语以加强练习是非常重要的。除了阅读本书之外，如能结合学习和工作经常阅读专业英语文献，对提高专业英语水平是大有好处的。

本书分上下两册，上册为基本部分，下册则涵盖土木工程的各个领域。

下册的内容见本书的目录，共有 18 个单元，每单元分为课文和阅读材料两部分。书后附有课文的总词汇索引，其中不包括上册课文词汇表中已出现的词汇。

本书由同济大学土木工程学院专业教师编写。下册第一单元的课文由周克荣编写，第一单元的阅读材料由顾祥林编写；第二单元由罗永峰编写；第三单元和第十六单元由苏小卒编写；第四单元由韩兵康编写；第五单元由叶为民编写；第六单元由赖允瑾编写；第七单元由高广运编写；第八单元的课文由汤永净编写，第八单元的阅读材料由王璇编写；第九单元由葛耀君编写；第十单元由郑步全编写；第十一单元由李修刚编写；第十二单元由郭忠印编写；第十三单元由祁德庆编写；第十四单元由郑永来编写；第十五单元由叶勤编写；第十七单元的课文由苏小卒编写，第十七单元的阅读材料由葛耀君编写；第十八单元由谢步瀛编写。全书由苏小卒统一修订定稿。

本书是同济大学土木工程学院教材编写计划项目的一部分。副院长陈以一教授对本书的编写给予了很大支持和帮助。朱合华、叶为民、郭忠印、程效军、刘国彬等有关的系、室领导都给予了支持和帮助。

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。

苏小卒

土木工程专业英语

Civil Engineering Speciality English

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Preface

After the transformation of the various specialities in the civil engineering field into a single civil engineering speciality, the so-called "big civil" environment has been formed under which the curriculums of many courses have been adjusted in both layout and content. As a result, the previous Speciality English courses in the various civil engineering fields have also been combined into one "Civil Engineering Speciality English" course. It is for this course that this book has been compiled and written as a textbook.

At present, there has been much technological exchange between the civil engineering profession in this country and that overseas. Civil engineering companies in this country are increasingly involved in the competition of the international market. In all these activities, many professionals feel the need to improve their speciality English level. Therefore, this book has been written with due consideration to try to make its content systematic in knowledge and suitable for practical use. It is hoped that this book, apart from being used as a textbook, can also serve as a speciality English reference for the teachers, researchers and engineering professionals in civil engineering who feel such a need.

It is believed that there is no essential difference between speciality English and ordinary English. Therefore, the methods suitable for studying ordinary English are still suitable for studying speciality English. The five language skills, namely, listening, speaking, reading, writing, and translation/interpretation, are interconnected. Somehow it has been held that speciality English is mainly used in reading, writing and translation. However, with the present development of international exchange and globalized market economy, the situations in which English listening and speaking are required have become more frequent. It follows that the practice on aural and oral abilities should be encouraged. Previous experience has shown that listening proficiency is of much help in developing reading skills. Since English is more of a skill than a knowledge, constant exposure to speciality English is very important. It is recommended that, besides reading this book, speciality English be actually used in daily study and work especially in the form of reading. This habit is very effective for improving one's speciality English level.

This book is in two volumes: volume one is the fundamental part; volume two is on the various fields of civil engineering.

The scope of volume two can be readily seen from the table of contents of this volume. There are altogether eighteen units in volume two, and each unit has two parts: text and reading material. An index of vocabulary and expressions which are new in the texts of volume two is appendixed at the end of this volume.

The material selection and writing of the book is carried out by the academic staff of the College of Civil Engineering, Tongji University. Volume two is written by: Zhou Kerong (text of unit 1), Gu Xianglin (reading material of unit 1), Luo Yongfeng (unit 2), Su Xiaozu (unit 3, unit 16, and text of unit 17), Han Bingkang (unit 4), Ye Weimin (unit 5), Lai Yunjin (unit 6), Gao Guangyun (unit 7), Tang Yongjing (text of unit 8), Wang Xuan (reading material of unit 8), Ge Yaojun (unit 9, and reading material of unit 17), Zheng Buquan (unit 10), Li Xiugang (unit 11), Guo Zhongyin (unit 12), Qi Deqing (unit 13), Zheng Yonglai (unit 14), Ye Qin (unit 15), and Xie Buying (unit 18), where the units in the parentheses are written by the respective writers. The book is finally edited, revised and unified by Su Xiaozu.

The writing of this book has been a part of the textbook project of the College of Civil Engineering, Tongji University. Here thanks are given to Deputy Dean Professor Chen Yiyi for his encouragement and help; and Zhu Hehua, Ye Weimin, Guo Zhongyin, Cheng Xiaojun, Liu Guobin, and others for their administrative help.

Due to tight schedule and limited knowledge, there could be imperfections in this book. Criticisms and suggestions are welcome for future improvement.

Su Xiaozu
College of Civil Engineering, Tongji University
August 2001

Civil Engineering Speciality English

Contents of Volume 2

Unit 1

RC Floor Systems and Single-Storey Structures

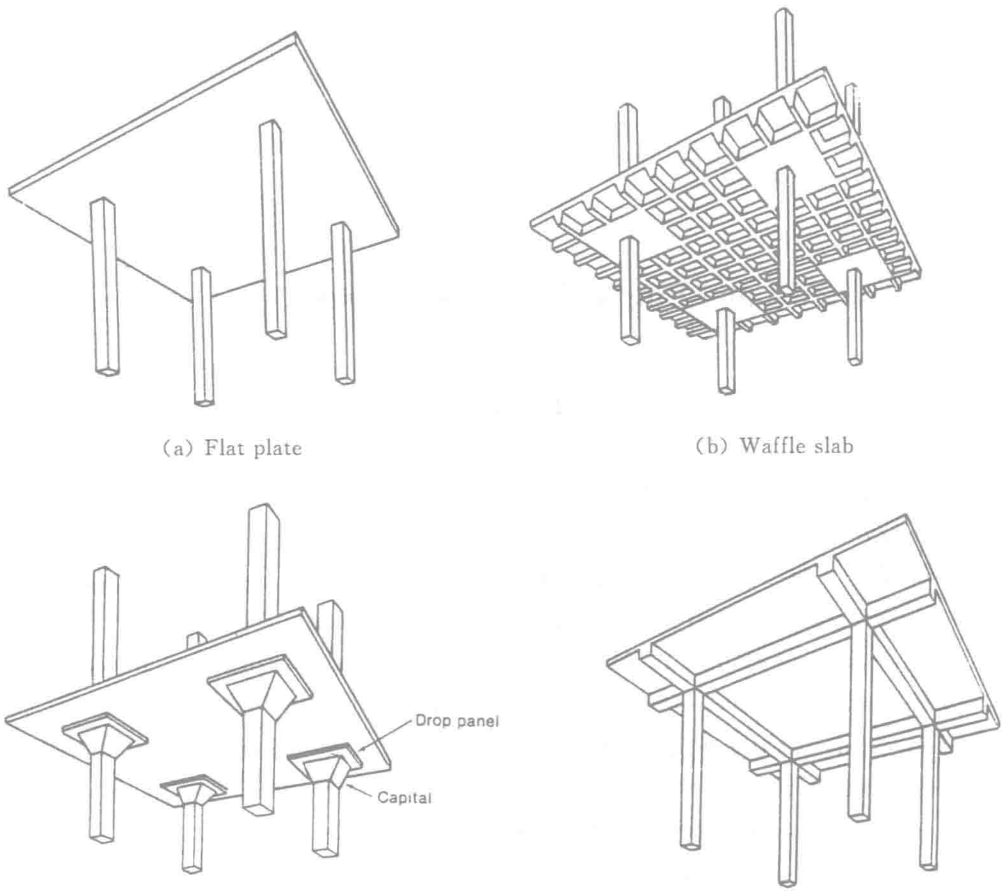
Types of Two-Way Slabs

Two-way slabs are a form of construction unique to reinforced concrete, among the major structural materials[1]. It is an efficient, economical, and widely used structural system. In practice, two-way slabs take various forms. For relatively light loads, as experienced in apartments or similar buildings, *flat plates* are used. As shown in Fig. 1-1(a), such a slab is simply a slab of uniform thickness supported on columns. In an apartment building, the top of the slab would be carpeted and the bottom of the slab would be finished as the ceiling for the story below. Flat plates are most economical for spans from 15 to 20 ft (4.5 to 6 m).

For larger spans, the thickness required to transmit the vertical loads to the columns exceeds that required for bending[2]. As a result, the concrete at the middle of the panel is not efficiently used. To lighten the slab, reduce the slab moments, and save material, the slab at midspan can be replaced by intersecting ribs, as shown in Fig. 1-1(b). Note that near the columns, the full depth is retained to transmit loads from the slab to the columns. This type of slab is known as a *waffle slab* or a two-way joist system, and is formed with fiberglass or metal "dome" forms. Waffle slabs are used for spans from 25 to 40 ft (7.5 to 12 m).

For heavy industrial loads, the *flat slab* system shown in Fig. 1-1(c) may be used. Here the load transfer to the column is accomplished by thickening the slab near the columns, using *drop panels* and/or by flaring the top of the column to form a *column capital*. The drop panel commonly extends about one-sixth of the span each way from each column, giving extra strength in the column region while minimizing the amount of concrete at midspan. *Flat slabs* are used for loads in excess of 100 psf (5 kPa) and for spans of 20 to 30 ft (6 to 9 m). Capitals of the type shown in Fig. 1-1(c) are less common today than they were in the 1920s and 1930s due to the costs of forming the capitals.

Sometimes a slab system will incorporate beams between some or all of the columns. If the resulting panels are roughly square, the structure is referred to as a two-way slab with beams (Fig. 1-1(d)).



(a) Flat plate (b) Waffle slab

(c) Flat slab (d) Two-way slab with beams

Fig. 1-1 Types of two-way slabs

History of Two-Way Slabs

One of the most interesting chapters in the development of reinforced concrete structures concerns the two-way slab. Because the mechanics of slabs action were not understood when the first slabs were built, a number of patented systems developed together with a number of semiempirical design methods. The early American papers on slabs attracted copious and very colorful discussion, each patent holder attempting to prove that his theories were right and all others were wrong.

The early slab buildings were built at the risk of the designer, who frequently had to put up a bond for several years and often had to load test the slabs before the owners would accept them. Turner based his designs on analyses carried out by Professor H. T. Eddy, which were based on an incomplete plate analysis theory. During this period, the use of the crossing beam analogy in design led to a mistaken feeling that only part of the load had to be carried in each direction, so that statics somehow did not apply to slab construction.

In 1914, J. R. Nichols used statics to compute the total moment in a slab panel. This analysis forms the basis of slab design in the current ACI Code. The first sentence of his stated: "Although statics will not suffice to determine the stresses in a flat slab floor of reinforced concrete, it does impose certain lower limits on these stresses." Eddy attacked this concept, saying: "The fundamental erroneous assumption of this paper appears in the first sentence." Turner thought the paper "to involve the most unique combination of multifarious absurdities imaginable from either a logical, practical or theoretical standpoint." A. W. Buel stated that he was "unable to find a single fact in the paper nor even an explanation of facts." Rather, he felt it was "contradicted by facts." Nichols' analysis suggested that the then current slab designs underestimated the moments by 30% to 50%. The emotions expressed by the discussers appear to be inversely proportional to the amount of underdesign in their favorite slab design system.

Although Nichols' analysis was generally accepted as being correct by the mid-1920s, it was not until 1971 that the ACI Code fully recognized it and required flat slabs to be designed for 100% of statics.

Behavior of a Slab Loaded to Failure in Flexure

There are four or more stages in the behavior of a slab loaded to failure:

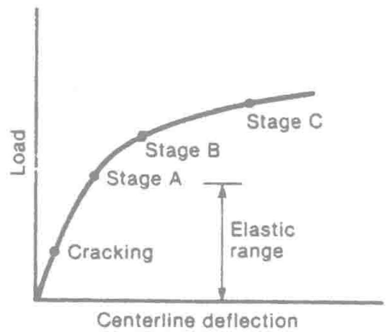
(1) Before cracking, the slab acts as an elastic plate and, for short-time loads the deformations, stresses, and strains can be predicted from an elastic analysis.

(2) After cracking and before yielding of the reinforcement, the slab is no longer of constant stiffness, since the cracked regions have a lower flexural stiffness, EI, than the uncracked regions; and the slab is no longer isotropic since the crack pattern may differ in the two directions. Although this violates the assumptions in the elastic theory, tests indicate that the elastic theory still predicts the moments adequately. Normal building slabs are generally partially cracked at service loads.

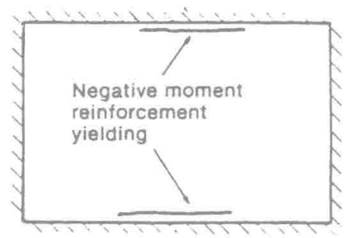
(3) Yielding of the reinforcement eventually starts in one or more regions of high moment and spreads through the slab as moments are redistributed from yielded regions to areas that are still elastic. The progression of yielding through a slab fixed on four edges is illustrated in Fig. 1-2. In this case the initial yielding occurs due to negative moments which form localized plastic hinges at the centers of the long sides (Fig. 1-2(b)). These hinges spread along the long sides and eventually, new hinges form at the ends of the slab (Fig. 1-2(c)). Meanwhile, the positive moments increase in strips across the center of the slab in the short direction because of the moment redistribution caused by the plastic hinges at the ends of these strips. Eventually, yielding occurs due to positive moments in

these strips, as shown in Fig. 1-2(c). With further load, the regions of yielding, known as yield lines, divide the slab into a series of trapezoidal or triangular elastic plates, as shown in Fig. 1-2(d). The loads corresponding to this stage of behavior can be estimated using a yield line analysis.

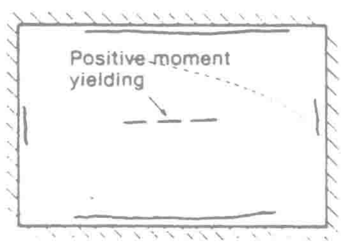
(4) Although the yield lines divide the plate to form a plastic mechanism, the hinges jam with increased deflection and the slab forms a very flat compression arch. This assumes that the surrounding structure is stiff enough to provide reactions for the arch. This stage of behavior is not counted on in design at present.



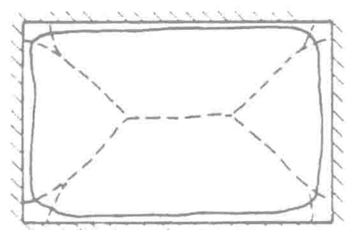
(a) Load-deflection diagram



(b) Initial yielding-Stage A



(c) Onset of positive moment yielding-Stage B



(d) Yield line mechanism-Stage C

Fig. 1-2 Inelastic action in a slab fixed on four sides

Types of Single-Storey Structural Frames

During the last two or three decades, rapidly changing social circumstances have led to a rather uncontrolled and uncoordinated expansion and development of prefabrication. From the experience gained and analyses made during that period, some general conclusions can now be drawn for the guidance of designers. Such a review leads first to a clear distinction between single-storey and multi-storey structures. Secondly marine structures, whether maritime or offshore, involve certain differences which are not encountered when building on land.

With regard to single-storey frames an ambitious enquiry was undertaken by the Fédération Internationale de la Précontrainte (FIP)[3] in collaboration with the Comité Européen du Béton (CEB)[4]. Each member country was asked for details of the types of elements used for various kinds of buildings—garages, farms, stables, factories, offices, supermarkets, laboratories, and so on. The results were published at the FIP congress at Prague in 1970, under the title of *The Philosophy of Prefabrication*. The conclusions included the following:

(1) Five types of structural frames were widely used in different countries (Fig. 1-3).

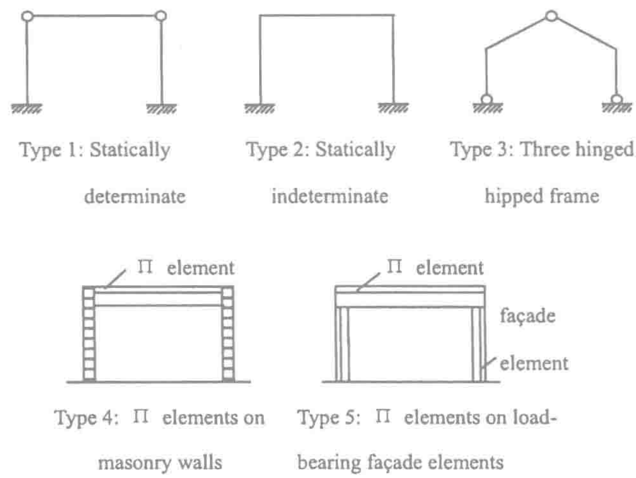


Fig. 1-3 Types of structural frames

(2) In general the frames were provided with restraint at the footings, giving a good degree of stability. In general also, the foundation is cast in place.

(3) The enquiry also showed there was a strong tendency to use a 5—6 m spacing of the structural frames. The head room ranged from 3 to 5 m, with the exception of factory halls which ranged from 6 to 10 m.

(4) Types of structural members:

(a) Main girders built up from separate elements are now rarely used; nor are trusses of reinforced concrete. In all countries the general systems employ rectangular, I or T-shaped cross-sections for most applications and for various types of building.

In roof slabs there is a definite trend towards direct spans from girder to girder, whereby secondary beams are omitted. Expressed as percentages, this simple and direct bearing concept was used in 95% and 70% of cases in the USA and the Netherlands, respectively.

(b) Double T-beams are used in many countries. The spans range between 10m and 25 m. In the USA double T-beams (45%) and single T-beams (20%) are used. In general the single T-beam is not applied so widely as the double T-beam.

(c) Channel elements are used mostly for spans between 6 and 12 m. It is expected that they will be more frequently used in the future, particularly for smaller spans.

(5) For the cladding brickwork, concrete facing elements and concrete blocks were employed.

(6) Mobile cranes were widely used, with a preference for a maximum capacity of 500 kN • m.

(7) Most transportation is done by road; a small percentage is moved by rail.

Conceptual Design for a Single-Storey Building

From the results of the FIP/CEB enquiry a conceptual design has been developed for a single-storey building; in this the data have been assimilated and the use of only a few elements has been applied. Distinctions are made between office buildings, laboratories, and buildings for light industry. Factories for heavy industry, with or without traveling cranes, have been excluded. The design concept consists of two sets of elements, one placed vertically and the other horizontally. Differential horizontal deformations between the roof and the foundation can be resisted in one of two ways: by restraining the column at the footing, or by restraining the column at top and bottom. Temperature changes can give rise to substantial deformations, especially when a roof of double T-beams acts as a stiff slab.

In general any glazing required in the vertical elements will be installed before the structural assembly takes place. For simple workshops, the facade elements can have their window frames fitted in advance.

When a single masonry wall is chosen (Fig. 1-4), a concrete capping beam over the brickwork is recommended in order to reduce uneven stress distributions and to avoid cracks in the wall. When the roof construction incorporates a topping layer and is thus stiffened in the horizontal plane, expansion may cause serious problem. In such cases it will be better to move separately at their longitudinal joints, without damaging the overlying waterproof layer. The use of small sliding devices (see Fig. 1-5) is recommended. A variant of the precast cornice is shown in Fig. 1-6. This is used in connection with masonry walls.

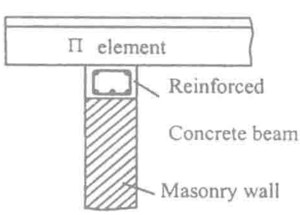


Fig. 1-4 Concrete capping beam

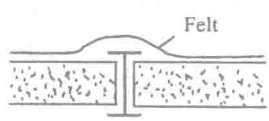


Fig. 1-5 Sliding connection