高等学校试用教材

建筑类专业英语

建筑工程 （第一册）

English in A chitecture

and ruction

卢世伟　孟祥杰　主编

中　国　建　筑　工　业　出　版　社

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史冰岩　齐秀坤　李　飏　编
李晶纯　南敬石　屠永清　黄　红　编
刘建理　主审

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本书即《建筑类专业英语 工业与民用建筑》第一册，系根据国家教委印发的《大学英语专业阅读阶段教学基本要求》编写的。内容包括：材料力学、结构力学、结构动力学、弹性力学、结构分析、结构材料的特性、混凝土、砂浆、房屋建筑学、有限元法等。全书安排 16 个单元，每个单元除正课文外，还配有两篇阅读材料，并配有必要的注释。正课文还配有词汇表和练习，书后附有总词汇表、参考译文和练习答案。本书供建筑工程专业学生使用，也可供土建人员自学专业英语之用。

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《建筑类专业英语》编审委员会

前 言

经过几十年的探索，外语教学界许多人认为，工科院校外语教学的主要目的应该是："使学生能够利用外语这个工具，通过阅读去获取国外的与本专业有关的科技信息。"这既是我们建设有中国特色的社会主义的客观需要，也是在当前条件下工科院校外语教学可能完成的最高目标。事实上，教学大纲规定要使学生具有"较强"阅读能力，而对其他方面的能力只有"一般"要求，就是这个意思。

大学本科的一、二年级，为外语教学的基础阶段。就英语来说，这个阶段要求掌握的词汇量为2400个（去掉遗忘，平均每个课时10个单词）。加上中学阶段已经学会的1600个单词，基础阶段结束时应掌握的词汇量为4000个。仅仅掌握4000个单词，能否看懂专业英文书刊呢？还不能。据统计，掌握4000个单词，阅读一般的英文科技文献，生词量仍将有6%左右，即平均每百词有六个生词，还不能自由阅读。国外的外语教学专家认为，生词量在3%以下，才能不借助词典，自由阅读。此时可以通过上下文的联系，把不认识的生词猜出来，那么，怎么样才能把6%的生词量降低到3%以下呢？自然，需要让学生增加一部分词汇积累。问题是，要增加多少单词？要增加哪一些单词？统计资料表明，在每一个专业的科技文献中，本专业最常用的科技术语大约只有几百个，而且它们在文献中重复出现的频率很高。因此，在已经掌握4000个单词的基础上，在专业阅读阶段中，有针对性地通过大量阅读，扩充大约1000个与本专业密切有关的科技词汇，便可以逐步达到自由阅读本专业科技文献的目的。

早在八十年代中期，建设部系统院校外语教学研究会就组织编写了一套《土木建筑系列英语》，分八个专业，共12册。每个专业可选读其中的3、4册。那套教材在有关院校相应的专业使用多年，学生和任课教师反映良好。但是，根据当时的情况，那套教材定的起点较低（1000词起点），已不适合今天学生的情况。为此，在得到建设部人事教育劳动司的大力支持，并征得五个相关专业教学指导委员会同意之后，由建设部系统十几所院校一百余名外语教师和专业课教师按照统一的编写规划和要求，编写了这一套《建筑类专业英语》教材。

《建筑类专业英语》是根据国家教委颁发的《大学英语专业阅读阶段教学基本要求》编写的专业阅读教材，按照建筑类院校共同设置的五个较大的专业类别对口编写。五个专业类别为：建筑学与城市规划；建筑工程（即工业与民用建筑）；给水排水与环境保护；暖通、空调与燃气；建筑管理与财务会计。每个专业类别分别编写三册专业英语阅读教材，供该专业类别的学生在修完基础阶段英语后，在第五至第七学期专业阅读阶段使用，每学期一册。

上述五种专业英语教材语言规范，题材广泛，覆盖相关专业各自的主要内容：包括专业基础课、专业主干课及主要专业选修课，语言材料的难易度切合学生的实际水平；语汇

以大学英语“通用词汇表”的4000个单词为起点，每个专业类别的三册书将增加1000～1200个阅读本专业必需掌握的词汇。本教材重视语言技能训练，突出对阅读、翻译和写作能力的培养，以求达到《大学英语专业阅读阶段教学基本要求》所提出的教学目标：“通过指导学生阅读有关专业的英语书刊和文献，使他们进一步提高阅读和翻译科技资料的能力，并能以英语为工具获取专业所需的信息。”

《建筑类专业英语》每册16个单元，每个单元一篇正课文（TEXT），两篇副课文（Reading Material A & B），每个单元平均2000个词，三册48个单元，总共约有十万个词，相当于原版书三百多页。要培养较强的阅读能力，读十万个词的文献，是起码的要求。如果专业课教师在第六和第七学期，在学生通过学习本教材已经掌握了数百个专业科技词汇的基础上，配合专业课程的学习，再指定学生看一部分相应的专业英语科技文献，那将会既促进专业课的学习，又提高英语阅读能力，实为两得之举。

本教材不仅适用于在校学生，对于有志提高专业英语阅读能力的建筑行业广大在职工程技术人员，也是一套适用的自学教材。

建设部人事教育劳动司高教处和中国建设教育协会对这套教材的编写自始至终给予关注和支持；中国建筑工业出版社第五编辑室密切配合，参与从制定编写方案到审稿各个阶段的重要会议，给了我们很多帮助。

本书为《建筑类专业英语》建筑工程专业第一册。本册书在编写过程中承蒙哈尔滨建筑大学高伯阳教授、庄重教授、吉林建筑工程学院苗若愚教授、尹德生教授在选材、译文加工等方面给予大力帮助，并提出宝贵意见，谨此致谢。

《建筑类专业英语》是我们编写对口专业阅读教材的又一次尝试，由于编写者水平及经验有限，教材中不妥之处在所难免，敬请广大读者批评指正。

《建筑类专业英语》
编审委员会

Contents

UNIT ONE

Text Introduction to Mechanics of Materials

[1] Mechanics of materials is a branch of applied mechanics that deals with the behavior of solid bodies subjected to various types of loading. It is a field of study that is known by a variety of names, including "strength of materials" and "mechanics of deformable bodies." The solid bodies considered in this book include axially-loaded bars, shafts, beams, and columns, as well as structures that are assemblies of these components. Usually the objective of our analysis will be the determination of the stresses, strains, and deformations produced by the loads; if these quantities can be found for all values of load up to the failure load, then we will have obtained a complete picture of the mechanical behavior of the body.

[2] Theoretical analyses and experimental results have equally important roles in the study of mechanics of materials. On many occasions we will make logical derivations to obtain formulas and equations for predicting mechanical behavior, but at the same time we must recognize that these formulas cannot be used in a realistic way unless certain properties of the material are known. These properties are available to us only after suitable experiments have been made in the laboratory. Also, many problems of importance in engineering can not be handled efficiently by theoretical means, and experimental measurements become a practical necessity. The historical development of mechanics of materials is a fascinating blend of both theory and experiment, with experiments pointing the way to useful results in some instances and with theory doing so in others.① Such famous men as Leonardo da Vinci (1452—1519) and Galileo Galilei (1564—1642) made experiments to determine the strength of wires, bars, and beams, although they did not develop any adequate theories (by today's standards) to explain their test results. By contrast, the famous mathematician Leonhard Euler (1707—1783) developed the mathematical theory of columns and calculated the critical load of a column in 1744, long before any experimental evidence existed to show the significance of his results. Thus, Euler's theoretical results remained unused for many years, although today they form the basis of column theory.

[3] The importance of combining theoretical derivations with experimentally determined properties of materials will be evident as we proceed with our study of the subject. In this article we will begin by discussing some fundamental concepts, such as stress and strain, and then we will investigate the behavior of simple structural elements subjected to tension, compression, and shear.

[4] The concepts of stress and strain can be illustrated in an elementary way by considering the extension of a prismatic bar (see Fig1-1a). A prismatic bar is one that has constant cross section throughout its length and a straight axis. In this illustration the bar is assumed to be loaded at its ends by axial forces P that produce a uniform stretching, or tension, of the bar.

By making an artificial cut (section mm) through the bar at right angle to its axis, we can isolate part of the bar as a free body(Fig. 1-1b). At the right -hand end the tensile force P is applied, and at the other there are forces representing the action of the removed portion of the bar upon the part that remains. These forces will be continuously distributed over the cross section, analogous to the continuous distribution of hydrostatic pressure over a submerged surface. The intensity of force, that is, the force per unit area, is called the stress and is commonly denoted by the Greek letter σ. Assuming that the stress has a uniform distribution over the cross section(see Fig. 1-1b), we can readily see that its resultant is equal to the intensity σ times the cross-sectional area A of the bar. Furthermore, from the equilibrium of the body shown in Fig. 1-1b, we can also see that this resultant must be equal in magnitude and opposite in direction to the force P. Hence, we obtain as the equation for the uniform stress in a prismatic bar. This equation shows that stress has units of force divided by area—for example, pounds per square inch(psi) or kips per square inch(ksi). When the bar is being stretched by the force P, as shown in the figure, the resulting stress is a tensile stress; if the forces are reversed in direction, causing the bar to be compressed, they are called compressive stresses.

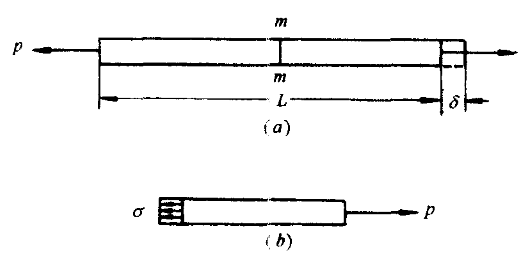

Fig. 1-1 Prismatic bar in tension

$$\sigma = \frac{P}{A} \tag{1-1}$$

[5] A necessary condition for Eq. (1-1) to be valid is that the stress σ must be uniform over the cross section of the bar②. This condition will be realized if the axial force P acts through the centroid of the cross section, as can be demonstrated by statics. ③ When the load P does not act at the centroid, bending of the bar will result, and a more complicated analysis is necessary. Throughout this book, however, it is assumed that all axial forces are applied at the centroid of the cross section unless specifically stated to the contrary. Also, unless stated otherwise,④ it is generally assumed that the weight of the object itself is neglected, as was done when discussing the bar in Fig. 1-1.

[6] The total elongation of a bar carrying an axial force will be denoted by the Greek letter δ(see Fig. 1-1a), and the elongation per unit length, or strain, is then determined by the equation

$$\in = \frac{\delta}{L} \tag{1-2}$$

where L is the total length of the bar. [5] Note that the strain $\in$ is a nondimensional quantity. It can be obtained accurately from Eq. (1-2) as long as the strain is uniform throughout the length of the bar. If the bar is in tension, the strain is a tensile strain, representing an elongation or stretching of the material; if the bar is in compression, the strain is a compressive strain, which means that adjacent cross sections of the bar move closer to one another.

New Words and Expressions

(be) subjected to		承受，经受
deformable * [di'fɔ:məbl]	*a.*	可变形的
axially * ['æksiəli]	*ad.*	轴向地
shaft * [ʃɑ:ft]	*n.*	轴，杆状物
derivation * [ˌderi'veiʃən]	*n.*	推导
realistic * [riə'listik]	*a.*	现实的，实际的
fascinate * ['fæsineit]	*v.*	迷住，强烈吸引
blend [blend]	*n.*	混合，融合
prismatic [priz'mætik]	*a.*	等截面的
tensile * ['tensail]	*a.*	拉力的，拉伸的
sectional * ['sekʃənəl]	*a.*	截面的，部分的
hydrostatic * ['haidrəu'stætik]	*a.*	静力学的
analogous * [ə'næləgəs]	*a.*	类似的
analogous to		类似于
submerged [səb'mə:dʒd]	*a.*	浸在水中的
uniform ['ju:nifɔ:m]	*a.*	均匀的
denote * [di'nəut]	*v.*	指示，表示
equilibrium * [ˌi:kwi'libriəm]	*n.*	平衡
resultant * [ri'zʌltənt]	*n.*	合力
magnitude ['mægnitju:d]	*n.*	大小，尺寸
equation =Eq. [i'kweiʃən]	*n.*	方程
kip [kip]	*n.*	千磅
tensile ['tensail]	*a.*	拉力的
compressive * [kəm'presiv]	*a.*	压力的，压缩的
centroid ['sentrɔid]	*n.*	矩心，形心
specifically [spi'sifikəli]	*ad.*	具体地，特定地
elongation * [ˌi:lɔŋ'geiʃən]	*n.*	伸长，拉长
nondimensional ['nʌndi'menʃənəl]	*a.*	无量纲的
adjacent * [ə'dʒeisənt]	*a.*	相邻的

Notes

1) 两个 with 引出各自的独立结构，用 and 连结。doing 是代动词，指 pointing。第二个独立结构的完整形式是 with theory pointing the way to useful results in other instances。

2) 从 for 开始是动词不定式的复合结构，作 condition 的后置定语，for 引出动词不定式的逻辑主语 Eq(1-1)。

3) as 是关系代词，引出非限定性定语从句，as 代表整个主句所讲的内容，并在从句中作主语。

4) unless 引出省略的条件句，等于 unless it is stated…。

5) where 是关系副词，引导非限定性定语从句。

Exercises

Reading Comprehension

I. Choose the most suitable alternative to complete the following sentences.

1. The objective of our analysis will be the determination of the stresses, strains and deformations produced ____________.
   A. with the stretching
   B. in the tension
   C. by the loads
   D. on the equation

2. Galilei made experiments to determine the strength of wires, bars, and beams, although he ____________.
   A. advanced a new theory
   B. did not develop any adequate theories
   C. developed any theory of experiments
   D. calculated the critical load

3. A prismatic bar is one that ____________.
   A. has constant cross section only
   B. we can isolate part of the bar as a free body
   C. has constant cross section throughout its length and a straight axis
   D. has a straight axis

4. A necessary condition for equation to be valid is that ________.
   A. the experiment must be uniform over the bar
   B. the strain must be uniform throughout the bar
   C. the stress must be uniform over the cross section of the bar

D. the equilibrium must be over the cross section of the bar

5. It can be obtained from Eq. (1-2)as long as ______.

A. the load is uniform across the whole bar

B. the distribution has been done throughout the length of the bar

C. the strain is uniform throughout the length of the bar

D. the axial force has been done across the whole bar

II. From the list below choose the most appropriate headings for each of the paragraphs in the text, then put the paragraph numbers in the brackets.

A. The importance of the derivation and experiment ( )

B. The illustration of the concepts of stress and strain ( )

C. The importance of theoretical analyses and experimental results ( )

D. The illustration of useful condition for Eq(1-2) to be valid ( )

E. The definition of mechanics of materials and the range of study ( )

F. The stress is a necessary condition for Eq. (1-1)to be valid ( )

III. Complete the following sentences with the information given in the text.

1. The solid bodies considered in this book include ______ as well as ______.

2. These properties are ______ only after suitable experiments.

3. We will begin by discussing some fundamental concepts, such as ______.

4. This condition will be realized if ______ the centroid of the cross section, as ______.

5. If the bar is in tension, the strain is ______, if the bar is in compression, the strain is ______.

Vocabulary

I. Choose the word or expression which is the most similar in meaning to the word underlined in the given sentence.

1. A compressive strain means that adjacent cross sections of the bar move closer to one another.

A. closing B. bordering C. adjoining D. resembling

2. In algebra, the sign "X" usually denotes an unknown quantity.

A. symbolizes B. indicates C. expresses D. implies

3. These properties are available to us only after suitable experiments have been made in the laboratory.

A. qualities B. features C. quantities D. attributes

4. The historical development of mechanics of materials is a fascinating blend of both theory and experiment.

A. drawing B. attractive C. familiar D. charming

5. These forces will be analogous to the continuous distribution of hydrostatic pressure over a

submerged surface.

A. alike B. like C. similar D. parallel

II. Match the words in Column A with their corresponding definitions or explanations in Column B.

A	B
1. resultant	a. state of being balanced
2. elongation	b. next(to), lying near(to) but not necessarily touching
3. adjacent	c. deriving or being derived; origin
4. equilibrium	d. as the total outcome of forces or tendencies from different directions
5. derivation	e. the part (of a line etc.) produced by making longer
	f. turn in another direction
	g. statement of how a word was formed and how it changed
	h. must be met with minimum expenditure of a given material

Reading Material A

Shear Center

Consider a beam whose cross section is a channel, Fig. 1-2(a). The walls of this channel are assumed to be so thin that all computations may be based on the dimensions to the center line of the walls. Bending of this channel takes place around the horizontal axis and although this cross section does not have a vertical axis of symmetry, it will be assumed that the bending stresses are given by the usual flexure formula. Assuming further that this channel resists a vertical shear, the bending moments will vary from one section through the beam to another. ①

By taking an arbitrary cut as c-c in Fig. 1-2(a), q and τ may be found in the usual manner. Along the horizontal legs of the channel, these quantities vary linearly from the free edge, just as they do for one side of the flange in an I-beam. ② The variation of q and τ is parabolic along the web. The variation of these quantities is shown in Fig. 1-2 (b) where they are plotted along the center line of the channel's section.

The average shearing stress $\tau_a/2$ multiplied by the area of the flange gives a force $F_1 = (\tau_a/2)b \cdot t$, and the sum of the vertical shearing stresses over the area of the web is the shear $V = \int_{-h/2}^{+h/2} \tau_t \, dy$. These shearing forces acting in the plane of the cross section are shown in Fig. 1-2(c) and indicate that a force V and a couple $F_1 h$ are developed at the section through the channel. ③ Physically there is a tendency for the channel to twist around some longitudinal axis. To prevent twisting and thus maintain the applicability of the initially assumed bending stress distribution, the externally applied forces must be applied in such a manner as to balance the internal couple F_1h. For example, consider the segment of a cantilever beam of negligible weight, to which a vertical force P is applied parallel to the web at a distance e from the web's center line. To maintain this applied force in equilibrium, an equal and opposite shearing force V must be developed in the web.

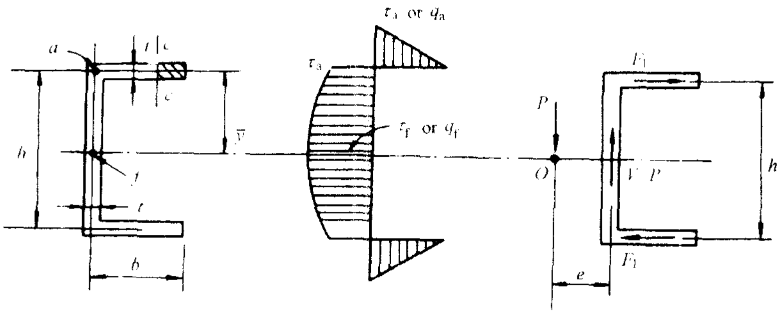

Fig. 1-2 Deriving the location of the shear center for a channel

Likewise, to cause no twisting of the channel, the couple Pe must equal the couple. F_1h. At the same section through the channel, the bending moment PL is resisted by the usual flexural stresses (these are not shown in the figure).

An expression for the distance e, locating the plane in which the force P must be applied so as to cause no twist in the channel, may now be obtained. Thus, remembering that $F_1h = Pe$ and $P = V$,

$$e=\frac{F_1h}{p}=\frac{(1/2)\tau_a bth}{p}=\frac{bth}{2p}\frac{VQ}{It}=\frac{bth}{2p}\frac{Vbt(h/2)}{It}=\frac{b^2h^2t}{4I}$$

Note that the distance e is independent of the magnitude of the applied force P, as well as of its location along the beam. [4] The distance e is a property of a section and is measured outward from the center of the web to the applied force.

A similar investigation may be made to locate the plane in which the horizontal forces must be applied so as to cause no twist in the channel. However, for the channel considered, by virtue of symmetry, it may be seen that this plane coincides with the neutral plane of the former case. The intersection of these two mutually perpendicular planes with the plane of the cross section locates a point which is called the shear center. The shear center is designated by the letter O in Fig. 1-2(c). The shear center for any cross section lies on a longitudinal line parallel to the axis of the beam. Any transverse force applied through the shear center causes no torsion of the beam. [5] A detailed investigation of this problem shows that when a member of any cross-sectional area is twisted, the twist takes place around the shear center, which remains fixed. For this reason, the shear center is sometimes called the center of twist.

For cross-sectional areas having one axis of symmetry, the shear center is always located on the axis of symmetry. For those which have two axes of symmetry, the shear center coincides with the centroid of the cross-sectional area. This is the case for the I-beam that was considered in the previous article.

The exact location of the shear center for unsymmetrical cross sections of thick material is difficult to obtain and is known only in a few cases. If the material is thin, as has been assumed in the preceding discussion, relatively simple procedures may always be devised to locate the shear center of the cross section. The usual method consists of determining the shearing forces, as F_1 and V above, at a section, and then finding the location of the external force necessary to keep these forces in equilibrium.

Notes

(1) 假如槽型截面承受竖向剪力,则弯矩将沿梁的长度方向发生变化。

(2) 正如工字型截面梁的一个翼缘板,槽型截面梁水平翼缘上的 和 从其自由边开始按直线规律变化。

(3) 作用在横截面平面内的各剪力表示在图1-2(c)中,在槽型截面产生的一个力 V 和一个力偶 Fh_1 也表示在该图中 。

(4) 应注意距离 e 与外力的大小及其沿梁长度方向的位置无关 。

(5) 任何通过剪切中心的横向外力不引起梁的扭转 。

Reading Material B

Allowable Stress Design and Strength Design

Structural problems are basically of two types: analysis or design. Analysis (sometimes called review) is the process of determining the types and magnitudes of stresses and deformations in a given structure when it is subjected to known or assumed loads. Most of the problems in this chapter have been of the analysis type. The process of design has quite a different goal. In a design situation we are trying to proportion the size and shape of a structure so that it can carry the known or assumed loads in a safe manner.

These two attitudes are not as distinct and separate as they might appear at first glance, because often the design process becomes an analytical trial-and-error procedure in order to determine the "best" size or configuration for a structure. (The phrase "trial and error," while much used and generally understood, can be misleading, as there really is no "error" involved. The writer prefers" trial-and-check " or " select-and-try" as being more descriptive terminology.)

What determines the "best" structure for a given architectural and construction endeavor is quite an impossible question to answer definitively. In pure structural design terms, the word "best" can sometimes be interpreted as "efficiency," that is, efficient use of the material (s) involved through (a) optimum manipulation of the geometry or statics present, and (b) loading the materials with types of stress which they can most easily "take" or resist. Here the word "efficiency" is used, in a narrow sense, to mean just enough material to do the job without waste. Too much material would be "overdesign" and not enough for proper safety would be "underdesign."

As with any type of design, many orders and sequences of compromises are involved and it is a rare (or nonexistent) effort in which the structural, constructional, and functional considerations become coincident.[1] The structural design process can never be accomplished in isolation and becomes a mixture of efficiency and compatibility determinations.

There are two different approaches to structural design currently in use. One is called the allowable stress method, in which the structure is shaped and the elements are proportioned so that certain "allowable" stresses are not exceeded.[2] (This approach is also referred to as the working stress method or service load method.) These allowable stresses are determined as percentages of the failure strengths of materials under various kinds of stress. For example, the allowable stress in shear for a certain species and grade of wood might be 500kPa, whereas its failure stress in shear might be 1000kPa. The allowable bending stress in structural steel might be determined as two-thirds of its yield value[3] (i.e., steel that has a yield strength of 250MPa can be safely stressed to 165MPa). The difference between the two values in each case constitutes a "margin of safety" or factor of safety obtained by dividing the failure stress by the allowable stress. This design method is used for wood structures and for most steel structures. Elements are proportioned so that the computed stresses present under the expected loads (both dead and live) will be less than the allowable stresses. The behavior of the structure under overload or failure load is not considered. Representative allowable stresses for several types of wood are given in Appendix P. Allowable stresses for different steels are given as required in various chapters.

The other approach to design is called strength design, in which the factor of safety is applied in a manner quite different from the allowable stress concept. In the strength design method, various factors of safety are applied directly to the loads which are known or assumed to be acting on the structure. Thus, we conceptually increase the loads that the structure must be proportioned to take by multiplying those loads by specific factors. Such increased or factored loads are called ultimate loads and we then design the member or structure to fail under the application of these increased loads[4]. (This approach is also called ultimate strength design or ultimate load design.)

Strength design is quite distinct from allowable stress design in that the strength approach proportions a structure to fail under a specified overload and the actual stresses present in the structure under normal loads are not computed. The margin of safety is present in the degree of overload specified. Strength design is widely used for reinforced concrete structures, and overload load factors of 1.4 for dead loads and 1.7 for live loads have been specified by the American Concrete Institute.[5]