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Theory of Structures

Second Edition

结构理论

第2版

S. P. Timoshenko D. H. Young

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THEORY OF STRUCTURES

Second Edition

S. P. TIMOSHENKO

Emeritus Professor of Engineering Mechanics
Stanford University

D. H. YOUNG

Silas H. Palmer Professor of
Civil Engineering
Stanford University

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McGraw-Hill

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[1] IE=International Edition

Theory of Structures

(Second Edition)

影 印 版 序

S. P. Timoshenko 教授和 D. H. Young 教授合作的“结构理论”（第 2 版），是 Timoshenko 教授 1926 年在原苏联列宁格勒出版的“结构理论”和 1945 年在美国 McGraw-Hill 出版的“结构理论”（第 1 版）的延续和发展。由于目前我国工科高等教育教材改革的需要，这本书由清华大学出版社再次影印出版。

在科技迅猛发展的大半个世纪里，一本高等教育的工科教科书在国际范围内得到活跃的教学界如此广泛的推崇和认可，这样的经典之作必有其奥妙之处。作为一名结构力学教师，我愿将如下体会与大家分享，以供参考。

这本书原来是为土木工程系写的关于结构分析的教科书，主要用作本科生和一年级研究生的教材。该书最大的优点在于：首先，它十分理解读者的状态，循循善诱、深入浅出。与有些书总是把简单问题复杂化的做法恰好相反，作者力图把一些十分复杂的问题用简单的方法描述清楚。作者在从力学的基本原理到各种结构分析方法的过渡上，在从结构分析方法到解决各种变化莫测的工程问题的过渡上，都写得非常自然。各章的安排似乎大多在讲不同的结构，实际上却有很清晰的理论系统。这不能不归结于作者丰富的教学经验和出色的表达艺术。因此，这本书也十分适合自学。其次，作者在 1926 年完成了这本书的编写框架，随着科技的发展，他不断地对原著进行修改、补充。以“结构理论”（第 2 版）为例：关于拱和框架的第 8、9 章几乎按弹性核的概念完全重写；由于结构和计算机的发展，增加了结构矩阵方法和结构动力学两章。Timoshenko 教授从来没有满足于已有的成果，从来不认为他的书已达到完美的境地，他一直在与时俱进。最后，特别应该指出的是：作者的写作十分严格，反映了作者严谨的治学精神。难怪人们说：在 Timoshenko

的书里很难找到错误。

可以说，Timoshenko 教授不仅是一位出色的结构工程学者，更是一位优秀的教师。循循善诱、不断进取、严谨治学是他的特点，也是我们在编写教材时应特别向他学习的地方。

刘西拉

于北京

Preface

This second edition of "Theory of Structures," like the first, is intended primarily as a textbook for undergraduate and first-year graduate courses in structural analysis for civil engineers. To serve this purpose, every effort has been made to maintain a close connection between the methods that are developed for the analysis of various types of structures and the fundamental principles of mechanics on which they are based. It is only through a sound understanding of these principles that the engineer can successfully adapt his methods of analysis to the ever-changing problems that will confront him in this modern era.

The book may be roughly divided into two parts: the first part dealing with statically determinate structures, and the second part dealing with statically indeterminate structures. On this plan, the first four chapters deal successively with a review of statics (primarily graphic statics), statically determinate plane trusses, influence lines for beams and trusses, and statically determinate space trusses. Following this, Chapters 5 and 6 treat the fundamental theorems relating to elastic systems and their applications to the calculation of deflections of beams and trusses. In turn, there are chapters dealing with the analysis of statically indeterminate trusses, arches, and frames. The final chapters are devoted to an introduction to matrix methods in structural analysis, the analysis of stiffened suspension bridges, and an introduction to the dynamics of structures.

The first seven chapters in this second edition of "Theory of Structures" remain essentially the same as in the first edition. Chapters 8 and 9, dealing with arches and frames, have been completely rewritten. The present treatment of arches has been simplified by basing it on the theorem of least work and using the concept of elastic center. Several articles on the analysis of portal-type frames, using the elastic-center concept, have also been added. In rewriting the chapter on the uses of slope-deflection equations in the analysis of continuous beams and frames, we have extended the treatment to include systems with nonprismatic members and have included many examples of this kind.

Since the first appearance of this book (1945), two new aspects of structural analysis have become very important, namely, the use of matrix methods of formulating problems and the analysis of structures under dynamic loading. These are both very extensive subjects, and a number of complete books on each are now available. Chapters 10 and 12 here are intended only as introductions to these topics, but we hope that they will encourage the reader to continue his studies in these directions.

In the preparation of the first edition of this book, the senior author's Russian book "Theory of Structures" (Leningrad, 1926) was extensively used. Acknowledgment is also due to Otto Mohr's "Abhandlugen aus dem Gebiete der technischen Mechanik" and to H. Müller-Breslau's "Die graphische Statik der Baukonstruktionen." The authors also wish to give special thanks to Mr. P. Rabcevich of New York City for the use of a number of examples and problems appearing in Chapters 8 and 9 and to Miss Rose Marie Stampfel and Miss Martha Lee Young for their careful typing of the new portions of the manuscript.

S. P. Timoshenko

D. H. Young

内 容 提 要

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Chapter 1

Elements of plane statics

1.1 CONCURRENT FORCES IN A PLANE

The *theory of structures* is based to a large extent upon the principles of statics with which the reader is assumed to be familiar. However, we shall review here some parts of statics that are most useful in the analysis of engineering structures. We begin with the principle of the parallelogram of forces as follows: *Two forces P_1 and P_2, as represented by the vectors $\overrightarrow{OA}$ and $\overrightarrow{OB}$ in Fig. 1.1a, are equivalent in action to a single resultant force R obtained as the diagonal $\overrightarrow{OC}$ of the parallelogram formed on the given vectors as shown.* The same resultant force can be obtained also from the *triangle of forces* shown in Fig. 1.1*b*. This follows from the fact that the triangle ABC in Fig. 1.1*b* is identical with the triangle OAC in Fig. 1.1*a*.

If several forces in a plane act at a single point O (Fig. 1.2*a*), they can always be reduced to one resultant force which also acts through that point. This resultant force can be found by successive applications of the parallelogram of