



Roark's Formulas for Stress and Strain
(Seventh Edition)

Roark 应力应变公式 (第7版)

Warren C. Young Richard G. Budynas



清华大学出版社

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WARREN C. YOUNG
RICHARD G. BUDYNAS

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Original English Language Edition Published by McGraw-Hill Companies, Inc.

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图书在版编目 (CIP) 数据

Roark 应力应变公式=Roark's Formulas for Stress and Strain: 第 7 版/
(美)杨, (美)巴蒂纳斯著. —影印本. —北京: 清华大学出版社, 2003
(国际著名力学图书. 影印版系列)

ISBN 7-302-06265-X

I. R… II. 纳… III. ①工程结构—应力—公式—教学参考资料—
英文 ②工程结构—应变—公式—教学参考资料—英文 IV. TU311.4

中国版本图书馆 CIP 数据核字 (2003) 第 004466 号

出版者: 清华大学出版社 (北京清华大学学研大厦, 邮编 100084)

[http:// www.tup.tsinghua.edu.cn](http://www.tup.tsinghua.edu.cn)

印刷者: 北京市清华园胶印厂

发行者: 新华书店总店北京发行所

开 本: 787×960 1/16 印张: 54.5

版 次: 2003 年 3 月第 1 版 2003 年 3 月第 1 次印刷

书 号: ISBN 7-302-06265-X/O · 279

印 数: 0001~3000

定 价: 89.00 元

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¹ IE=International Edition

Roark's Formulas for Stress and Strain

(Seventh Edition)

影 印 版 序

《应力应变公式》是一本在美国和国际上久负盛名的应力分析实用参考手册。本书是2002年刚出版的最新(第7)版。

随着近代工业不断向大型、复杂、高速、高压、高温等方向发展,要求工程设计不断实现材料省、重量轻、成本低、施工快、结构多样等目标,因而对工程结构部件的应力分析提出了越来越高的要求。为了给工程设计和应力分析人员提供一本精确而实用的应力分析参考手册,美国威斯康辛大学的力学教授 Raymond J. Roark 于1938年把材料力学的理论、方法、公式和数据汇编成《应力应变公式》,出版后深受欢迎。直至1966年去世前他不断加以修订和扩充,并于1943、1954和1965年先后再版。1975年美国威斯康辛大学机械系力学教授 Warren C. Young 继承 Roark 的指导思想和风格,在第5版中对原书内容进行了系统地修订和扩充。1989年再度修订为第6版,并开始以 Roark 冠名,称为《罗氏应力应变公式》。今年出版的第7版又有洛切斯特工业大学机械系力学教授 Richard G. Budynas 加盟,他是《高等材料力学和实用应力分析》一书的作者*。

本手册在我国也有很大影响,除影印版外,汪一麟和汪一骏曾将其第5版翻译成中文,于1985年由中国建筑工业出版社出版。

本书共分3部分。第1部分(即第1章)为引言,简述状态性质,单位制及其转换,老版中有关名词术语的定义已经后移到附录B中。第2部分对应力分析的基本概念、基本原理和基本方法作了总结,为正确应用第3部分的公式打好基础。本部分共含5章:第2章讲应力、应变及应力-应变关系,新版对应力、应变的坐标转换公式作出了更为成熟和现代的表述;第3章讲物体受载后的性质,包括弹性、塑性、蠕变、疲劳、脆性断裂、应力集中、预应力、弹性稳定性等;第4章讲原理和方法,包括运动方程和平衡方程、迭加原理、互易原理、应变协调、各种能量原理、量纲分析等。第5章介绍数值方法,包括有限差分法、有

* 该书1999年第2版已由清华大学出版社于2001年影印出版。

限元法和边界元法；第6章是新加的，介绍实验方法，重点讲电阻应变片法，包括其常用公式，也对脆漆法、光弹性法、光栅应变片和莫瑞技术、激光干涉与全息技术、X射线衍射法等作了简介。第3部分“公式和算例”是手册的主体，共含11章，每章先叙述基本理论公式，并通过算例讲解公式的应用，最后采用列表格式汇总了大量具体结构的计算公式，该格式特别适合于可编程计算器和个人电脑（PC机）的计算。各章内容是：第7章，拉伸、压缩、剪切和复合应力；第8章，梁和直杆的弯曲；第9章，曲梁的弯曲；第10章，扭转；第11章，平板；第12章，柱和其他受压部件；第13章，旋转壳、压力容器和管道；第14章，承受挤压应力和剪应力的接触问题；第15章，弹性稳定性；第16章，动载应力和温度应力；第17章，应力集中系数。本书另有附录A：平面图形性质；附录B：名词术语的定义；附录C：复合材料。全书每章后面均提供了大量参考文献。

第7版同时采用国际单位制(SI)和美国通用单位制(USCU)。公式表格中的系数均为无量纲数，适用于各种单位制。

本书是一本内容丰富、方便实用的应力分析手册，是从事应力分析和强度设计的科技人员、研究人员以及高校教师和研究生首选的参考书。

陆明万
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Preface to the Seventh Edition

The tabular format used in the fifth and sixth editions is continued in this edition. This format has been particularly successful when implementing problem solutions on a programmable calculator, or especially, a personal computer. In addition, though not required in utilizing this book, user-friendly computer software designed to employ the format of the tabulations contained herein are available.

The seventh edition intermixes International System of Units (SI) and United States Customary Units (USCU) in presenting example problems. Tabulated coefficients are in dimensionless form for convenience in using either system of units. Design formulas drawn from works published in the past remain in the system of units originally published or quoted.

Much of the changes of the seventh edition are organizational, such as:

- Numbering of equations, figures and tables is linked to the particular chapter where they appear. In the case of equations, the section number is also indicated, making it convenient to locate the equation, since section numbers are indicated at the top of each odd-numbered page.
- In prior editions, tables were interspersed within the text of each chapter. This made it difficult to locate a particular table and disturbed the flow of the text presentation. In this edition, all numbered tables are listed at the end of each chapter before the references.

Other changes/additions included in the seventh addition are as follows:

- Part 1 is an introduction, where Chapter 1 provides terminology such as state properties, units and conversions, and a description of the contents of the remaining chapters and appendices. The defini-

tions incorporated in Part 1 of the previous editions are retained in the seventh edition, and are found in Appendix B as a glossary.

- Properties of plane areas are located in Appendix A.
- Composite material coverage is expanded, where an introductory discussion is provided in Appendix C, which presents the nomenclature associated with composite materials and how available computer software can be employed in conjunction with the tables contained within this book.
- Stress concentrations are presented in Chapter 17.
- Part 2, Chapter 2, is completely revised, providing a more comprehensive and modern presentation of stress and strain transformations.
- Experimental Methods. Chapter 6, is expanded, presenting more coverage on electrical strain gages and providing tables of equations for commonly used strain gage rosettes.
- Correction terms for multielement shells of revolution were presented in the sixth edition. Additional information is provided in Chapter 13 of this edition to assist users in the application of these corrections.

The authors wish to acknowledge and convey their appreciation to those individuals, publishers, institutions, and corporations who have generously given permission to use material in this and previous editions. Special recognition goes to Barry J. Berenberg and Universal Technical Systems, Inc. who provided the presentation on composite materials in Appendix C, and Dr. Marietta Scanlon for her review of this work.

Finally, the authors would especially like to thank the many dedicated readers and users of *Roark's Formulas for Stress & Strain*. It is an honor and quite gratifying to correspond with the many individuals who call attention to errors and/or convey useful and practical suggestions to incorporate in future editions.

Warren C. Young
Richard G. Budynas

Preface to the First Edition

This book was written for the purpose of making available a compact, adequate summary of the formulas, facts, and principles pertaining to strength of materials. It is intended primarily as a reference book and represents an attempt to meet what is believed to be a present need of the designing engineer.

This need results from the necessity for more accurate methods of stress analysis imposed by the trend of engineering practice. That trend is toward greater speed and complexity of machinery, greater size and diversity of structures, and greater economy and refinement of design. In consequence of such developments, familiar problems, for which approximate solutions were formerly considered adequate, are now frequently found to require more precise treatment, and many less familiar problems, once of academic interest only, have become of great practical importance. The solutions and data desired are often to be found only in advanced treatises or scattered through an extensive literature, and the results are not always presented in such form as to be suited to the requirements of the engineer. To bring together as much of this material as is likely to prove generally useful and to present it in convenient form has been the author's aim.

The scope and management of the book are indicated by the Contents. In Part 1 are defined all terms whose exact meaning might otherwise not be clear. In Part 2 certain useful general principles are stated; analytical and experimental methods of stress analysis are briefly described, and information concerning the behavior of material under stress is given. In Part 3 the behavior of structural elements under various conditions of loading is discussed, and extensive tables of formulas for the calculation of stress, strain, and strength are given.

Because they are not believed to serve the purpose of this book, derivations of formulas and detailed explanations, such as are appropriate in a textbook, are omitted, but a sufficient number of examples

are included to illustrate the application of the various formulas and methods. Numerous references to more detailed discussions are given, but for the most part these are limited to sources that are generally available and no attempt has been made to compile an exhaustive bibliography.

That such a book as this derives almost wholly from the work of others is self-evident, and it is the author's hope that due acknowledgment has been made of the immediate sources of all material here presented. To the publishers and others who have generously permitted the use of material, he wishes to express his thanks. The helpful criticisms and suggestions of his colleagues, Professors E. R. Maurer, M. O. Withey, J. B. Kommers, and K. F. Wendt, are gratefully acknowledged. A considerable number of the tables of formulas have been published from time to time in *Product Engineering*, and the opportunity thus afforded for criticism and study of arrangement has been of great advantage.

Finally, it should be said that, although every care has been taken to avoid errors, it would be oversanguine to hope that none had escaped detection; for any suggestions that readers may make concerning needed corrections the author will be grateful.

Raymond J. Roark

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Part

1

Introduction

