

时代教育 · 国外高校优秀教材精选

 CENGAGE
Learning™

英文版 · 原书第8版

基础工程

[美] 布雷杰 M. 达斯 (Braja M. Das) 著

Foundation Engineering

 双色印刷



机械工业出版社
CHINA MACHINE PRESS

时代教育·国外高校优秀教材精选

基础工程

(英文版·原书第8版)

Foundation Engineering

[美] 布雷杰 M. 达斯 (Braja M. Das) 著



机械工业出版社

本书是结合我国基础工程课程的教学内容与特点,由加利福尼亚州立大学的布雷杰 M. 达斯 (Braja M. Das) 所著的《基础工程原理》第 8 版缩编而成。本书覆盖面广,内容丰富,图文并茂,可读性、系统性强。主要内容包括绪论、浅基础的地基极限承载力、浅基础沉降、板式基础、桩基础、挡土墙、板桩墙、内支撑开挖、土质改良和地基处理。

本书可以作为土木工程专业本科生、研究生教材,也可以作为大学教师和工程技术人员的参考书。

Principles of Geotechnical Engineering

Braja M. Das

Copyright© 2014, 2012 by Cengage Learning.

Original edition published by Cengage Learning. All Rights reserved. 本书原版由圣智学习出版公司出版。版权所有,盗印必究。

China machine Press is authorized by Cengage Learning to publish and distribute exclusively this custom reprint edition. This edition is authorized for sale in the People's Republic of China only (excluding Hong Kong, Macao SAR and Taiwan). Unauthorized export of this edition is a violation of the Copyright Act. No part of this publication may be reproduced or distributed by any means, or stored in database or retrieval system, without the prior written permission of the publisher.

此客户定制影印版由圣智学习出版公司授权机械工业出版社独家出版发行。此版本仅限在中华人民共和国境内(不包括香港、澳门特别行政区及台湾地区)销售。未经授权的本书出口将被视为违反版权法的行为。未经出版者预先书面许可,不得以任何方式复制或发行本书任何部分。

Cengage Learning Asia Pte. Ltd.

151 Lorong Chuan, #02-08 New Tech Park, Singapore 556741

本书封面贴有 Cengage Learning 防伪标签,无标签者不得销售。

北京市版权局著作权合同登记 图字:01-2016-3274 号

图书在版编目(CIP)数据

基础工程:第8版:英文/(美)布雷杰·M. 达斯(Braja M. Das)著. —北京:机械工业出版社,2016.9

(时代教育·国外高校优秀教材精选)

书名原文:Principles of foundation Engineering

ISBN 978-7-111-54911-6

I. ①基… II. ①布… III. ①基础(工程)—高等学校—教材—英文 IV. ①TU47

中国版本图书馆 CIP 数据核字(2016)第 227115 号

机械工业出版社(北京市百万庄大街 22 号 邮政编码 100037)

策划编辑:马军平 责任编辑:马军平 李 帅

封面设计:张 静 责任印制:李 洋

保定市中国画美凯印刷有限公司印刷

2016 年 11 月第 1 版第 1 次印刷

184mm × 260mm · 34.25 印张 · 827 千字

标准书号:ISBN 978-7-111-54911-6

定价:89.00 元

凡购本书,如有缺页、倒页、脱页,由本社发行部调换

电话服务

网络服务

服务咨询热线:010-88379833

机工官网:www.cmpbook.com

读者购书热线:010-88379649

机工官博:weibo.com/cmp1952

教育服务网:www.cmpedu.com

封面无防伪标均为盗版

金书网:www.golden-book.com



影印版序

布雷杰 M. 达斯 (Braja M. Das) 教授是加利福尼亚州立大学工程与计算机学院的名誉院长。他是美国土木工程师协会的终身会员、美国工程教育协会终身会员、美国国家科学研究委员会 (华盛顿特区) 交通科学研究分会力学和化学稳定研究委员会的名誉会员。达斯教授的主要研究领域包括浅基础、土层锚杆和土工合成材料, 他已经发表了 250 多篇岩土工程方面的论文。同时, 达斯教授教学经验丰富, 教学成果卓著, 曾获 AMOCO 基金会奖, 美国工程教育协会为卓越教学颁发的 AT&T 奖, 自动化协会颁发的 Ralph Teetor 奖, 得克萨斯大学埃尔帕索分校为卓越教学颁发的杰出成就奖。达斯教授著有多本岩土工程方面的教材和参考书, 其中《岩土工程原理》《基础工程原理》《土动力学原理》等是其经典著作, 在美国高校土木工程专业得到广泛使用。

《基础工程原理》是为土木工程专业本科生编写的, 于 1983 年首次出版, 2014 年出版第 8 版。这本教材被翻译成多种语言, 在世界各地得到了广泛使用。第 8 版保持了前几版的逻辑结构体系, 结合近年来读者的建议和基础工程的发展对相关内容进行了修订, 分为岩土性质和勘探、基础分析、侧向土压力和挡土墙、土质改良四部分。为了让我国读者能够顺利阅读到达斯教授的著作, 机械工业出版社适时引进了这本优秀教材。根据我国高校基础工程课程的实际教学内容, 本缩编影印版删除了与同批引进的达斯教授所著《岩土工程原理》第 8 版 (缩编后为《土力学》) 中重复的内容 (第 1 部分、第 6 章土中的竖向应力及第 12 章侧向土压力), 以及第 5 章特殊状态下浅基础的极限承载力、第 10 章钻孔桩基础和第 11 章特殊土基础, 缩编后以《基础工程》的名称出版。

本书强调对基础工程基本原理的理解和工程实践的应用, 总结起来, 有以下几个特点:

1) 以原理-设计为主线, 详细介绍了基础工程设计中岩土、结构和施工各专业的特点, 以及它们之间的相关性。

2) 附有大量的例题和习题, 例题都给出了解答步骤, 便于学生自学。

3) 与工程实践紧密结合, 案例丰富。自然界的土体多数情况下是非均质的, 它们在基础工程中的变形与学生所学的理想状态的土力学知识是有差别的, 在本书第2、4、6、7、8、9章中讲解了相关案例。

4) 参考了近年来大量期刊和会议中有关基础工程的文献, 紧密结合国际上基础工程方面的新经验、新技术和新工艺, 便于学生能在未来的工程实践中学以致用。

5) 配有可供教师使用的配套资源 (含教案和 PPT), 便于我国高校教师开展双语课教学使用。

总之, 本书具有良好的系统性、可读性和较高的权威性, 覆盖面广, 内容丰富, 是一本优秀的原版教材, 不但可以作为土木工程专业本科生、研究生教材, 也是一本极好的大学教师和工程技术人员的参考书。

梁发云

同济大学地下建筑与工程系

*In the memory of my mother and
to Janice, Joe, Valerie, and Elizabeth*



Preface

Soil mechanics and foundation engineering have developed rapidly during the last fifty plus years. Intensive research and observation in both the field and the laboratory have refined and improved the science of foundation design. Originally published in the fall of 1983 with a 1984 copyright, this text on the principles of foundation engineering is now in the eighth edition. It is intended primarily for use by undergraduate civil engineering students. The use of this text throughout the world has increased greatly over the years. It has also been translated into several languages. New and improved materials that have been published in various geotechnical engineering journals and conference proceedings that are consistent with the level of understanding of the intended users have been incorporated into each edition of the text.

Based on the useful comments received from the reviewers for preparation of this edition, changes have been made from the seventh edition. There is a small introductory chapter (Chapter 1) at the beginning. The text has been divided into three major parts for consistency and continuity, and the chapters have been reorganized.

Part 1—Foundation Analysis (Chapters 2 through 5)

Part 2—Earth-Retaining Structures (Chapters 6 through 8)

Part 3—Soil Improvement (Chapter 9)

A number of new/modified example problems have been added for clarity and better understanding of the material by the readers, as recommended by the reviewers. Listed here are some of the significant additions/modifications to each chapter.

- In Chapter 2 on Shallow Foundations: Ultimate Bearing Capacity, the laboratory test results of DeBeer (1967) have been incorporated in a nondimensional form in order to provide a general idea of the magnitude of settlement at ultimate load in granular soils for foundations. The general concepts of the development of Terzaghi's bearing capacity equation have been further expanded. A brief review of the bearing capacity factor N_γ obtained by various researchers over the years has been presented and compared. Results from the most recent publications relating

to “reduction factors” for estimating the ultimate bearing capacity of continuous shallow foundations supported by granular soil subjected to eccentric and eccentrically inclined load are discussed.

- Chapter 3 on Settlement of Shallow Foundations has solutions for the elastic settlement calculation of foundations on granular soil using the strain influence factor, as proposed by Terzaghi, Peck, and Mesri (1996) in addition to that given by Schmertmann et al. (1978). The effect of the rise of a water table on the elastic settlement of shallow foundations on granular soil is discussed.
- The example for structural design of mat foundation in Chapter 4 is now consistent with the most recent ACI code (ACI 318-11).
- Discussions have been added on continuous flight auger piles and wave equations analysis in Chapter 5 on Pile Foundations.
- In Chapter 8 on Braced Cuts, principles of general wedge theory have been added to explain the estimation of active thrust on braced cuts before the introduction of pressure envelopes in various types of soils.
- Chapter 9 on Ground Improvement and Modification now includes some recently developed empirical relationships for the compaction of granular and cohesive soils in the laboratory. New publications (2013) related to the load-bearing capacity of foundations in stone columns have been referred to. A brief introduction on deep mixing has also been added.
- A new Appendix A has been added to illustrate reinforced concrete design principles for shallow foundations using ACI-318-11 code (ultimate strength design method).

Natural soil deposits, in many cases, are nonhomogeneous. Their behavior as related to foundation engineering deviates somewhat from those obtained from the idealized theoretical studies. In order to illustrate this, several field case studies have been included in this edition similar to the past editions of the text.

- Foundation failure of a concrete silo and a load test on small foundations in soft Bangkok clay (Chapter 2)
- Settlement observation for mat foundations (Chapter 4)
- Performance of a cantilever retaining wall (Chapter 6)
- Field observations for anchored sheet-pile walls at Long Beach Harbor and Toledo, Ohio (Chapter 7)
- Subway extension of the Massachusetts Bay Transportation Authority (MBTA), construction of National Plaza (south half) in Chicago, and the bottom heave of braced cuts in clay (selected cases from Bjerrum and Eide, 1963) (Chapter 8)
- Installation of PVDs combined with preloading to improve strength of soft soil at Nong Ngu Hao, Thailand (Chapter 9)

Instructor Resource Materials

A detailed *Instructor's Solutions Manual* and PowerPoint slides of both figures and examples from the book are available for instructors through a password-protected Web site at www.cengagebrain.com.

Acknowledgements

Thanks are due to:

- The following reviewers for their comments and constructive suggestions:

Mohamed Sherif Aggour, University of Maryland, College Park
Paul J. Cosentino, Florida Institute of Technology
Jinyuan Liu, Ryerson University
Zhe Luo, Clemson University
Robert Mokwa, Montana State University
Krishna R. Reddy, University of Illinois at Chicago
Cumaraswamy Vipulanandan, University of Houston

- Henry Ng of hkn Engineers, El Paso, Texas, for his help and advice in completing the reinforced concrete design examples given in Appendix A.
- Dr. Richard L. Handy, Distinguished Professor Emeritus in the Department of Civil, Construction, and Environmental Engineering at Iowa State University, for his continuous encouragement and for providing several photographs used in this edition.
- Dr. Nagaratnam Sivakugan of James Cook University, Australia, and Dr. Khaled Sobhan of Florida Atlantic University, for help and advice in the development of the revision outline.
- Several individuals in Cengage Learning, for their assistance and advice in the final development of the book—namely:

Tim Anderson, Publisher
Hilda Gowans, Senior Development Editor

It is also fitting to thank Rose P. Kernan of RPK Editorial Services. She has been instrumental in shaping the style and overseeing the production of this edition of *Principles of Foundation Engineering* as well as several previous editions.

For the past thirty-five years, my primary source of inspiration has been the immeasurable energy of my wife, Janice. I am grateful for her continual help in the development of the original text and its seven subsequent revisions.

Braja M. Das



目 录

影印版序

前言

第1章 绪论 1

- 1.1 岩土工程 1
- 1.2 基础工程 1
- 1.3 教材的基本体系 2
- 1.4 设计方法 2
- 1.5 岩土工程数值方法 4
- 参考文献 4

第1部分 基础分析 5

第2章 浅基础的地基极限承载力 6

- 2.1 概述 6
- 2.2 基本概念 6
- 2.3 太沙基地基承载力理论 11
- 2.4 安全系数 16
- 2.5 地基承载力公式的地下水位修正 18
- 2.6 通用地基承载力公式 19
- 2.7 承载力系数 N_γ 、形状系数和深度系数的其他确定方法 26
- 2.8 极限承载力案例分析 29
- 2.9 地基土压缩性的影响 35

- 2.10 偏心荷载作用下的基础 39
- 2.11 单向偏心荷载作用下地基的极限承载力 40
- 2.12 双向偏心荷载作用下地基的极限承载力 47
- 2.13 倾斜荷载作用下连续基础的地基极限承载力 56
- 习题 59
- 参考文献 62

第3章 浅基础沉降 64

- 3.1 概述 64
- 3.2 饱和黏土地基 ($\mu_s = 0.5$) 浅基础的弹性沉降 64
- 3.3 基于弹性理论的基础沉降公式 67
- 3.4 弹性沉降的改进公式 75
- 3.5 使用应变影响系数计算砂土地基的沉降 80
- 3.6 基于标准贯入阻力计算砂土地上基础的沉降 89
- 3.7 基于旁压试验参数计算粒状土地基的沉降 93
- 3.8 地下水位上升对弹性沉降的影响 99
- 3.9 主固结沉降 101
- 3.10 主固结沉降的三维效应 102
- 3.11 次固结沉降 107
- 3.12 现场载荷试验 109
- 3.13 假定承载力 111
- 3.14 建筑物允许沉降 112
- 习题 114
- 参考文献 116

第4章 板式基础 118

- 4.1 概述 118
- 4.2 联合基础 118
- 4.3 板式基础的常见类型 123
- 4.4 板式基础的承载力 125
- 4.5 板式基础的不均匀沉降 129
- 4.6 板式基础现场沉降观测实例 129
- 4.7 补偿式基础 131
- 4.8 板式基础结构设计 134
- 习题 153
- 参考文献 155

第 5 章 桩基础 156

- 5.1 概述 156
- 5.2 桩的类型及其结构特性 158
- 5.3 长螺旋钻孔压注桩 (CFA 桩) 166
- 5.4 桩长的估算 167
- 5.5 沉桩 168
- 5.6 桩的荷载传递机理 171
- 5.7 桩的承载力估算公式 175
- 5.8 梅耶霍夫法估算桩端承载力 Q_p 178
- 5.9 魏锡克法估算桩端承载力 Q_p 181
- 5.10 科伊尔和卡斯特罗法估算砂土中的桩端承载力 Q_p 185
- 5.11 采用颗粒土的标准贯入试验 (SPT) 和圆锥动力触探试验结果 (CPT) 计算桩端承载力 Q_p 的经验公式 188
- 5.12 砂土中的桩侧摩阻力 (Q_s) 190
- 5.13 黏土中的桩侧摩阻力 197
- 5.14 长螺旋钻孔压注桩的极限承载力 202
- 5.15 嵌岩桩的桩端承载力 205
- 5.16 桩的静载荷试验 212
- 5.17 桩的弹性沉降 217
- 5.18 横向受荷桩 220
- 5.19 打桩公式 234
- 5.20 采用振动沉桩法施工的桩的承载力 240
- 5.21 波动方程分析 241
- 5.22 负表面摩阻力 245
- 5.23 群桩效应 249
- 5.24 饱和黏土中群桩的极限承载力 253
- 5.25 群桩的弹性沉降 256
- 5.26 群桩的固结沉降 257
- 5.27 嵌岩桩 260
- 习题 261
- 参考文献 267

第2部分 挡土结构 271

第6章 挡土墙 272

- 6.1 概述 272
- 6.2 挡土墙截面尺寸 274
- 6.3 采用侧向土压力理论进行挡土墙设计 275
- 6.4 挡土墙的稳定性和倾覆验算 277
- 6.5 倾覆验算 279
- 6.6 基底滑动验算 281
- 6.7 地基承载力失效验算 285
- 6.8 挡土墙施工接头和墙后填土排水 293
- 6.9 挡土墙设计说明及实例 296
- 6.10 加筋土 299
- 6.11 加筋土注意事项 300
- 6.12 加筋土挡墙设计的基本要点 302
- 6.13 金属带材加筋土挡墙 303
- 6.14 逐步设计金属带材加筋土挡墙 310
- 6.15 土工布加筋土挡墙 315
- 6.16 土工格栅加筋土挡墙简介 322
- 6.17 土工格栅加筋土挡墙的设计过程 322
- 习题 327
- 参考文献 329

第7章 板桩墙 331

- 7.1 概述 331
- 7.2 施工方法 334
- 7.3 悬臂式板桩墙 336
- 7.4 打入砂性土中的悬臂式板桩 336
- 7.5 打入砂性土中的悬臂式板桩的特例 343
- 7.6 打入黏性土中的悬臂式板桩 317
- 7.7 打入黏性土中的悬臂式板桩的特例 352
- 7.8 锚拉式板桩墙 356
- 7.9 打入砂性土中的锚拉式板桩墙的自由端法 357
- 7.10 打入砂性土中的锚拉式板桩墙的自由端法设计图 361
- 7.11 打入砂性土中的锚拉式板桩墙的弯矩减少 365

- 7.12 打入砂性土中的锚拉式板桩墙的计算压力图法 368
- 7.13 锚拉式板桩墙的现场观测 372
- 7.14 打入黏性土中的锚拉式板桩墙的自由端法 374
- 7.15 土锚 381
- 7.16 砂性土中锚定板的极限承载力 381
- 7.17 黏性土中 ($\Phi = 0$) 锚定板的极限承载力 390
- 7.18 锚杆的极限抗力 391
- 习题 392
- 参考文献 395

第 8 章 内支撑开挖 396

- 8.1 概述 396
- 8.2 基于一般楔体理论的内支撑开挖分析 397
- 8.3 内支撑开挖设计的土压力包络线 402
- 8.4 成层土开挖的土压力包络线 404
- 8.5 内支撑开挖各组成部分的设计 405
- 8.6 内支撑开挖实例 415
- 8.7 黏性土中的基底隆起 420
- 8.8 砂性土中的基底稳定性 424
- 8.9 板桩的侧向位移和地表沉降 429
- 习题 431
- 参考文献 433

第 3 部分 土质改良 435

第 9 章 土质改良和地基处理 436

- 9.1 概述 436
- 9.2 压实的基本原理 437
- 9.3 压实的经验公式 440
- 9.4 现场压实 443
- 9.5 黏性土水力屏障的压实控制 446
- 9.6 振冲 449
- 9.7 爆破 455
- 9.8 预压 457
- 9.9 砂井排水 461
- 9.10 预制竖向排水管 472

- 9.11 石灰加固 478
- 9.12 水泥加固 480
- 9.13 粉煤灰加固 482
- 9.14 碎石桩 483
- 9.15 挤密砂桩 488
- 9.16 动力压实 490
- 9.17 喷射注浆 492
- 9.18 深层搅拌 494
- 习题 497
- 参考文献 499

附录 A 浅基础的钢筋混凝土结构设计 502

- A.1 钢筋混凝土结构设计基础 502
- A.2 钢筋 505
- A.3 钢筋锚固长度 506
- A.4 连续墙基础设计实例 507
- A.5 柱下方形基础设计实例 511
- A.6 柱下矩形基础设计实例 516
- 参考文献 520
- 部分习题参考答案 521



Contents

Preface xii

7

Introduction 1

- 1.1 Geotechnical Engineering 1
- 1.2 Foundation Engineering 1
- 1.3 General Format of the Text 2
- 1.4 Design Methods 2
- 1.5 Numerical Methods in Geotechnical Engineering 4

References 4

PART 1 Foundation Analysis 5

2

Shallow Foundations: Ultimate Bearing Capacity 6

- 2.1 Introduction 6
- 2.2 General Concept 6
- 2.3 Terzaghi's Bearing Capacity Theory 11
- 2.4 Factor of Safety 16
- 2.5 Modification of Bearing Capacity Equations for Water Table 18
- 2.6 The General Bearing Capacity Equation 19
- 2.7 Other Solutions for Bearing Capacity $N\gamma$, Shape, and Depth Factors 26
- 2.8 Case Studies on Ultimate Bearing Capacity 29
- 2.9 Effect of Soil Compressibility 35
- 2.10 Eccentrically Loaded Foundations 39
- 2.11 Ultimate Bearing Capacity under Eccentric Loading—One-Way Eccentricity 40

- 2.12 Bearing Capacity—Two-Way Eccentricity 47
- 2.13 Bearing Capacity of a Continuous Foundation Subjected to Eccentrically Inclined Loading 56

Problems 59

References 62

3 Settlement of Shallow Foundations 64

- 3.1 Introduction 64
- 3.2 Elastic Settlement of Shallow Foundation on Saturated Clay ($\mu_s = 0.5$) 64
- 3.3 Settlement Based on the Theory of Elasticity 67
- 3.4 Improved Equation for Elastic Settlement 75
- 3.5 Settlement of Sandy Soil: Use of Strain Influence Factor 80
- 3.6 Settlement of Foundation on Sand Based on Standard Penetration Resistance 89
- 3.7 Settlement in Granular Soil Based on Pressuremeter Test (PMT) 93
- 3.8 Effect of the Rise of Water Table on Elastic Settlement 99
- 3.9 Primary Consolidation Settlement Relationships 101
- 3.10 Three-Dimensional Effect on Primary Consolidation Settlement 102
- 3.11 Settlement Due to Secondary Consolidation 107
- 3.12 Field Load Test 109
- 3.13 Presumptive Bearing Capacity 111
- 3.14 Tolerable Settlement of Buildings 112

Problems 114

References 116

4 Mat Foundations 118

- 4.1 Introduction 118
- 4.2 Combined Footings 118
- 4.3 Common Types of Mat Foundations 123
- 4.4 Bearing Capacity of Mat Foundations 125
- 4.5 Differential Settlement of Mats 129
- 4.6 Field Settlement Observations for Mat Foundations 129
- 4.7 Compensated Foundation 131
- 4.8 Structural Design of Mat Foundations 134

Problems 153

References 155