

时代教育·国外高校优秀教材精选

Mc
Graw
Hill Education

(英文版·原书第3版)

土木工程概论

Basic Civil Engineering

(印度) M S 帕拉理查米(M S Palanichamy) 著



机械工业出版社
CHINA MACHINE PRESS



时代教育·国外高校优秀教材精选

土木工程概论

(英文版·原书第3版)

Basic Civil Engineering

(印度) M S 帕拉理查米 (M S Palanichamy) 著



机械工业出版社

M S Palanichamy: **Basic Civil Engineering**

ISBN: 0-07-463818-1

Copyright 2000 by the Tate McGraw-Hill Publishing Company Limited

Original language published by the McGraw-Hill Companies, Inc. All rights reserved. No part of this publication may be reproduced or distributed in any means, or stored in a database or retrieval system, without the prior written permission of the publisher.

Authorized English language reprint edition jointly published by McGraw-Hill Education(Asia) Co. and China Machine Press. 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. Violation of this Law is subject to Civil and Criminal Penalties.

本书英文影印版由机械工业出版社和美国麦格劳-希尔教育出版(亚洲)公司合作出版。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)销售。未经许可之出口,视为违反著作权法,将受法律之制裁。

未经出版者预先书面许可,不得以任何方式复制或抄袭本书的任何部分。

本书封面贴有 McGraw-Hill 公司激光防伪标签,无标签者不得销售。

北京市版权局著作权合同登记号: 01-2004-6848

图书在版编目(CIP)数据

土木工程概论 = Basic Civil Engineering: 第3版/(印度)
帕拉理查米著. —北京:机械工业出版社, 2005. 1

时代教育·国外高校优秀教材精选

ISBN 7-111-15841-5

I. 土... II. 帕... III. 土木工程—高等学校—教材—英文 IV. TU

中国版本图书馆 CIP 数据核字(2004)第 132687 号

机械工业出版社(北京市百万庄大街 22 号 邮政编码 100037)

责任编辑:马军平 封面设计:饶薇 责任印制:施红

北京铭成印刷有限公司印刷·新华书店北京发行所发行

2005 年 1 月第 1 版第 1 次印刷

1000mm × 1400mmB5 · 13 印张 · 500 千字

定价: 32.00 元

凡购本书,如有缺页、倒页、脱页,由本社发行部调换

本社购书热线电话(010)68993821、88379646

68326294、68320718

封面无防伪标均为盗版

国外高校优秀教材审定委员会

主任委员：

杨叔子

委员(按姓氏笔画为序)：

丁丽娟	江见鲸	王先逵	王大康
白峰衫	石德珂	史荣昌	孙洪祥
朱孝禄	陆启韶	张润琦	张策
张三慧	张福润	张延华	吴宗泽
吴麒	宋心琦	李俊峰	余远斌
陈文楷	陈立周	单辉祖	单仁亮
俞正光	赵汝嘉	郭可谦	翁海珊
龚光鲁	章栋恩	黄永畅	谭泽光
郭鸿志			

序

土木工程概论是土木工程专业新入学学生的一门必修专业基础课程,主要阐述本学科的重要性及其所含的大致内容,介绍国内外最新技术成就和信息,展望未来。本书是 M S Palanichamy 教授《Basic Civil Engineering》的第 3 版,系统明确,内容全面,有利于学生全面了解土木工程的广阔领域。

本书内容简明扼要,涉及到土木工程材料、基础、上部结构、应力一应变关系、水坝、桥梁、工程勘察、公路与铁路、环境工程、机场、港口及高层结构等土木工程的各分支领域,在同类图书(如结构系统、建筑师用结构等)中,本书是比较优秀的,具有较高的权威性。其中,在环境工程及各种结构型式中介绍了近代的一些先进建筑,内容具有先进性。

本书采用大量实例和原理图来阐明土木工程领域的基本概念,每章后均附有大量的习题,便于使用者理解和掌握。本书不但可以作为土木工程专业本科生的教材,也可作为大学教师和工程技术人员的英文参考书。

清华大学
江见鲸

出版说明

随着我国加入 WTO，国际间的竞争越来越激烈，而国际间的竞争实际上也就是人才的竞争、教育的竞争。为了加快培养具有国际竞争力的高水平技术人才，加快我国教育改革的步伐，国家教育部近来出台了一系列倡导高校开展双语教学、引进原版教材的政策。以此为契机，机械工业出版社陆续推出了一系列国外影印版教材，其内容涉及高等学校公共基础课，以及机、电、信息领域的专业基础课和专业课。

引进国外优秀原版教材，在有条件的学校推动开展英语授课或双语教学，自然也引进了先进的教学思想和教学方法，这对提高我国自编教材的水平，加强学生的英语实际应用能力，使我国的高等教育尽快与国际接轨，必将起到积极的推动作用。

为了做好教材的引进工作，机械工业出版社特别成立了由著名专家组成的国外高校优秀教材审定委员会。这些专家对实施双语教学做了深入细致的调查研究，对引进原版教材提出了许多建设性意见，并慎重地对每一本将要引进的原版教材一审再审，精选再精选，确认教材本身的质量水平，以及权威性和先进性，以期所引进的原版教材能适应我国学生的外语水平和学习特点。在引进工作中，审定委员会还结合我国高校教学课程体系的设置和要求，对原版教材的教学思想和方法的先进性、科学性严格把关。同时尽量考虑原版教材的系统性和经济性。

这套教材出版后，我们将根据各高校的双语教学计划，举办原版教材的教师培训，及时地将其推荐给各高校选用。希望高校师生在使用教材后及时反馈意见和建议，使我们更好地为教学改革服务。

机械工业出版社
高等教育分社

Preface

This book has been written to provide a concise textbook covering the revised syllabus of all universities in Tamil Nadu for the Civil Engineering part of the Basic Civil and Mechanical Engineering course. It will be useful not only to the first year B.E. students, but also to the Diploma and A.M.I.E. students. It will also serve as a good reference material for those preparing for competitive examinations.

The book is presented in a simple, but comprehensive manner. Solved problems and illustrative diagrams have been included to explain the various concepts. Exercises are appended at the end of each chapter to provide adequate practice to the students and to help them comprehend the subject.

I consider it a great honour to have the foreword written by Prof. N A Gnanam, Director of Technical Education, Tamil Nadu.

I am thankful to the Principal and Management of Mepco Schlenk Engineering College, Sivakasi for their encouragement in completing this project. I express my gratitude to the faculty of Civil Engineering Department for the help extended to me at various stages of the project.

M S PALANICHAMY

Contents

序	iv
出版说明	v
<i>Preface</i>	vii
Chapter 1 Civil Engineering and Materials	1
1.1 Introduction	1
1.2 Civil Engineering	2
1.3 Construction Materials—Bricks	5
1.4 Stones	7
1.5 Cement	9
1.6 Cement Concrete	16
1.7 Steel Sections	28
1.8 Wood	36
1.9 Plastics	42
1.10 Properties of Building Materials	44
<i>Short Questions</i>	48
<i>Exercises</i>	50
Chapter 2 Foundation	52
2.1 Selection of Site	52
2.2 Substructure	53
2.3 Objectives of a Foundation	54
2.4 Site Inspection	54
2.5 Soils	54
2.6 Loads on Foundations	58
2.7 Essential Requirements of a Good Foundation	59
2.8 Types of Foundation	59
2.9 Failure of Foundations and Remedial Measures	63
2.10 Foundations for Machinery	64
2.11 Foundations for Special Structures	68
<i>Short Questions</i>	78
<i>Exercises</i>	79

Chapter 3 Superstructure

80

- 3.1 Introduction 80
- 3.2 Brick Masonry 80
- 3.3 Stone Masonry 87
- 3.4 Beams 91
- 3.5 Columns 92
- 3.6 Lintels 94
- 3.7 Roofing 96
- 3.8 Flooring 101
- 3.9 Plastering 109
- 3.10 Valuation 113
 - Illustrative Examples 117
 - Short Questions 120
 - Exercises 121

Chapter 4 Simple Stresses and Strains

124

- 4.1 Definition of Mechanics 124
- 4.2 Units 124
- 4.3 External Forces 126
- 4.4 Internal Forces—Stress 127
- 4.5 Strain 129
- 4.6 Elasticity 131
- 4.7 Compound Member 137
- 4.8 Torsion 139
 - Illustrative Examples 142
 - Short Questions 165
 - Exercises 165

Chapter 5 Geometric Properties of Sections

169

- 5.1 Centre of Gravity 169
- 5.2 Moment of Inertia of Plane Areas 171
- 5.3 Perpendicular Axis Theorem 172
- 5.4 Parallel Axis Theorem 172
- 5.5 Radius of Gyration of Plane Areas 173
 - Illustrative Examples 174
 - Short Questions 196
 - Exercises 196

Chapter 6 Dams	200
6.1 Introduction	200
6.2 Purpose of Dams	201
6.3 Components of a Reservoir	201
6.4 Selection of Site	202
6.5 Classification of Dams	203
6.6 Geological Effects	211
<i>Short Questions</i>	211
<i>Exercises</i>	212
Chapter 7 Bridges	213
7.1 Introduction	213
7.2 Necessity of Bridges	213
7.3 Site Investigation	214
7.4 Preliminary Data to be Collected	214
7.5 Components of a Bridge	216
7.6 Technical Terms	218
7.7 Classification of Bridges	219
7.8 Arch Bridge	222
7.9 Slab Bridge	223
7.10 T-Beam and Slab Bridge	224
7.11 Bow String Girder Bridge	224
7.12 Suspension Bridge	224
7.13 Steel Bridges	226
7.14 Culverts	231
7.15 Causeways	233
<i>Short Questions</i>	234
<i>Exercises</i>	235
Chapter 8 Surveying	236
8.1 Introduction	236
8.2 Objectives of Surveying	236
8.3 Types of Surveying	236
8.4 Classification of Surveys	237
8.5 Principles of Surveying	238
8.6 Measurement of Distances	239
8.7 Measurement of Angles	244

xii Contents

8.8	Levelling	250	
8.9	Determination of Areas	258	
8.10	Contouring	261	
	Illustrative Examples	264	
	Short Questions	269	
	Exercises	269	
Chapter 9 Roads			272
9.1	Introduction	272	
9.2	Road Transport Characteristics	272	
9.3	Benefits of a Good System of Roads	273	
9.4	Classification of Roads	274	
9.5	Traffic Signs	281	
	Short Questions	288	
	Exercises	288	
Chapter 10 Environmental Engineering			289
10.1	Introduction	289	
10.2	Elements of Protected Water Supply	289	
10.3	Sewage Treatment	296	
10.4	Septic Tank	300	
10.5	Oxidation Ponds	301	
10.6	Plumbing	304	
	Short Questions	317	
	Exercises	317	
Chapter 11 Railways			319
11.1	Introduction	319	
11.2	Comparison of Railways and Roadways	320	
11.3	Advantages of Railways	320	
11.4	Railway Track (Permanent Way)	321	
11.5	Components of a Railway Track	322	
11.6	Basics of Points and Crossings	330	
	Short Questions	336	
	Exercises	337	

Chapter 12 Airports**338**

- 12.1 Introduction 338
- 12.2 Functions of Air Transport 338
- 12.3 Airports 339
- 12.4 Airport Planning 339
- 12.5 Selection of Site 339
- 12.6 Classification of Aerodromes 340
- 12.7 Components of an Aircraft 341
- 12.8 Characteristics of an Aircraft 342
- 12.9 Components of an Airport 344
- 12.10 Lighting Arrangement at Runways, Taxiways and Apron 350
- 12.11 Windrose Diagram 351
- 12.12 Airport Zoning 352
- 12.13 Airport Capacity 352
- 12.14 Imaginary Surfaces 353
- 12.15 Fillets 354
- 12.16 Blast Pad 354
- 12.17 Helipad 356
- 12.18 Landing Aids 357
- 12.19 Standards 358
- Short Questions 361*
- Exercises 361*

Chapter 13 Docks and Harbours**362**

- 13.1 Waterways 362
- 13.2 Functions of Water Transport 362
- 13.3 Coastal Structures 363
- 13.4 Classification of Ships 363
- 13.5 Seaports 363
- 13.6 Port Structures 368
- 13.7 Berthing Structure 368
- 13.8 Docks 370
- 13.9 Transit Sheds 372
- 13.10 Warehouses 373
- 13.11 Dolphins 374
- 13.12 Fenders 376
- 13.13 Mooring Accessories 377

xiv Contents

- 13.14 Buoys 378
- 13.15 Navigational Aids 380
 - Short Questions* 382
 - Exercises* 382

Chapter 14 Tall Structures

383

- 14.1 Introduction 383
- 14.2 Need for Tall Structures 383
- 14.3 Material Used in Construction of Tall Structures 384
- 14.4 Practical Applications 384
- 14.5 Basic Design Features 387
 - Short Questions* 391
 - Exercises* 391

Index

393

Civil Engineering and Materials

1.1 INTRODUCTION

Engineers have probably contributed more to the shaping of civilisation than any other professional group. In every society, the role of engineers is to develop the technological application to meet practical needs. For example, the application of an electrical system is to provide power to a city, a water wheel is to run a mill, an artificial heart is to prolong life, etc. The systems that supply our food, water, fuel, power, transportation network, communication and other conveniences are the products of engineering skill. Despite the essential part engineers play in the above progress and in the well-being of humanity, their exact role is imperfectly understood.

Engineering is the art of converting knowledge into useful practical applications. An engineer is a person, who plays the key role in this process of conversion. Since engineering is the profession which serves people, their environment is an important consideration. Often, there have been difficulties in distinguishing engineers from scientists. It is difficult to determine where the work of the scientist ends and that of the engineer begins.

The basic distinction between the linked professions of science and engineering lies in their goals. Scientists aim to invent while engineers strive to use the inventions effectively to cater to the needs of mankind. For example, the German physicist Heinrich Hertz discovered radio waves while Guglielmo Marconi developed wireless telegraphy using radio waves, a feat of engineering. And after the scientific principles of nuclear fission were established, the hard work of creating atomic weapons and useful power plants was accomplished by electrical, chemical and mechanical engineers.

2 Basic Civil Engineering

1.2 CIVIL ENGINEERING

Civil engineering is that branch of engineering which aims to provide a comfortable and safe living for the people. Shelter, one of the primary needs of mankind, is provided by civil engineers. The efficient planning of water supply and irrigation systems increases the food production in a country. Shelters, apart from just being shelters, have been constructed by civil engineers to provide a peaceful and comfortable life. The engineering marvels of the world, starting from the pyramids to today's thin shell structures, are the results of the development in civil engineering. Communication lines like roads, railways, bridges, etc. without which development is impossible, are fruits of civil engineers' work.

1.2.1 Scope of Civil Engineering

Any discipline of engineering is a vast field with various specialisations. The major specialisations of civil engineering are listed below:

1. Structural engineering
2. Geotechnical engineering
3. Fluid mechanics, hydraulics and hydraulic machines
4. Transportation engineering
5. Water supply, sanitary and environmental engineering
6. Irrigation engineering
7. Surveying, levelling and remote sensing

1.2.2 Structural Engineering

Structural engineering is the most important specialisation in civil engineering. The construction of a structure needs efficient planning, design and method of construction to serve the purpose fully. Generally there are five major steps in any construction project. These include the following:

1. Positioning and arranging the various parts of the structure into a definite form to achieve best utilisation.
2. Finding out the magnitude, direction and nature of various forces acting on the structure.
3. Analysing the structure to know the behaviour of the various parts of the structure subjected to the above forces.
4. Designing the structure such that its stability under the action of various loads is ensured.
5. Executing the work with selected construction materials and skilled workers.

1.2.3 Geotechnical Engineering

For the efficient functioning of any structure built on earth, the behaviour of soil must be known. Geotechnical engineering gives the basic idea about the soil. This branch also deals with the following aspects:

1. The properties and behaviour of soil as a material under “soil mechanics”.
2. The various types of foundations for a structure, for a machine, etc. and their suitability.

Geotechnical Engineering also deals with the analysis, design and construction of foundation.

1.2.4 Fluid Mechanics, Hydraulics and Hydraulic Machines

Fluid mechanics deals with the properties and behaviour of fluids at rest or in motion. The principles of fluid mechanics can be applied to daily life as in the case of the flight of planes, the movement of fish in water, and the circulation of blood in the veins.

The design of hydraulic structures, such as dams and regulators, require the force exerted by water and the behaviour of water under pressure.

Machines which utilise the hydraulic energy are called hydraulic machines. For example, turbines use potential energy of water to generate power. Pumps are devices which utilise mechanical energy to lift water. The efficient working of the above machines depends upon the fluid behaviour which is dealt with in this discipline.

1.2.5 Transportation Engineering

The development of a nation mainly depends on the communication facilities available. A nation’s wealth is measured in terms of the road and railway facilities available. There are three modes of transportation viz., land, water and air. This specialisation deals with the design, construction and execution of the communication routes.

The different branches of transportation engineering include the following: highway engineering deals with the planning and designing of roads, railway engineering deals with the railway tracks, harbour engineering deals with the harbours and airport engineering deals with the airports.

1.2.6 Water Supply, Sanitary and Environmental Engineering

Without food man can survive for days but not without water. The responsibility of providing potable (drinking) water to the public and disposing the waste water safely is that of a civil engineer. The sources of water are precipitation and underground water.

4 Basic Civil Engineering

Water supply engineering deals with the location, collection of water, its treatment methods, tests for standard limits and efficient supply of water.

Used water, solid wastes, toxic wastes, etc. cannot be disposed directly since these affect the environment. Hence these have to be treated and tested for the standard limits and then disposed. Sanitary engineering deals with the collection of used water, their treatment methods and effective disposal which safeguards the whole world. The natural and artificial wastes generated and released into the atmosphere have upset the natural equilibrium. Anthropogenic or human-induced pollutants have overloaded the system.

The role of an environmental engineer is to build a bridge between biology and technology by applying all the techniques to the job of cleaning the debris. Environmental engineering deals with the methods of protecting the environment from the deleterious effects of human activity which would result in the improvement of environmental quality for the well being of mankind.

1.2.7 Irrigation Engineering

Irrigation may be defined as the process of supplying water by man-made methods for the purpose of land cultivation. Irrigation engineering includes the study and design of works related to the control of river water and the drainage of waterlogged areas. Thus, irrigation engineering deals with the controlling and harnessing of various resources of water, by constructing dams, reservoirs, canals, head works and distribution channels to the cultivable land.

1.2.8 Surveying, Levelling and Remote Sensing

Before starting any important civil engineering project, such as the construction of railways, highways, dams and buildings, it becomes necessary to have a detailed survey map showing accurate boundary of the project area. Surveying is defined as an art of collecting data for mapping the relative positions of points on the surface of the earth. Levelling is the process of determining the relative heights of the points on the surface of earth in a vertical plane.

The main purpose of the survey work is to prepare the plan of the object to be surveyed. Various instruments are used to measure and collect the necessary information to draw the plan. Remote sensing uses the technique of obtaining the data about an area by taking aerial photographs. The intelligent interpretation gives a clear picture of the terrain.

1.2.9 Functions of Civil Engineer

Civil engineering incorporates activities such as construction of structures like buildings, dams, bridges, roads, railways, hydraulic structures, water supply and sanitary engineering.

Various functions of a civil engineer are listed below.