

Revised Edition

CONCRETE TECHNOLOGY

THEORY AND PRACTICE



M.S. SHETTY

S.CHAND

CONCRETE TECHNOLOGY

THEORY AND PRACTICE

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*Dedicated
To
My Beloved Father*
V. VENKAPPA SHETTY

FOREWORD

As one who has closely watched the author's interest and involvement in concrete technology for the past several years, I have great pleasure in writing this foreword.

Concrete is by far the most widely used construction material today. The versatility and mouldability of this material, its high compressive strength, and the discovery of the reinforcing and prestressing techniques which helped to make up for its low tensile strength have contributed largely to its widespread use. We can rightly say that we are in the age of concrete.

It is easy to make concrete. There is an old saying that broken stone, sand, and cement make good concrete. But the same proportion of broken stone, sand and cement also make bad concrete. This is mainly because the quality of the end product depends as much, and perhaps more, on the man on the job as on the constituent materials. The difference between good concrete and bad concrete lies in quality control. Extensive research work was, therefore, carried out almost from the beginning of this century not only on the materials but also on the methods used for concrete making. Still, not many men on the job seem to make use of the known techniques for making good concrete which is necessary for achieving strong, durable, and economical construction. This textbook by Prof. M.S. Shetty will, therefore, help to generate a better awareness of the potential of concrete.

The book deals with several aspects of concrete technology and also covers the latest developments that have taken place in India and abroad. The coverage is comprehensive and complete. The properties of the constituent materials of concrete have been explained very lucidly in the text. The information on admixtures and on special concretes, such as air-entrained concrete, vacuum concrete, light-weight concrete, and gap-graded concrete, will be very useful to concrete engineers and those engaged in precast concrete construction. At many places in the text, the author touches upon some important, down-to-earth problems and gives specific recommendations based on his own knowledge and vast experience. The chapter on mix design gives simple and scientific procedures for the benefit of practising engineers and concrete technologists.

One of the welcome features of this book is the inclusion of detailed information on recent developments relating to fibre-reinforced concrete, sulphur-impregnated concrete, and different types of polymer concrete. The author has highlighted the potential of these new materials and has laid emphasis on the need for further research.

The text has been written in simple language and is supplemented by numerous illustrative examples, charts, and tables. The author has succeeded in presenting all the relevant information on concrete technology in a very effective manner. I am sure the book will be well received by students of concrete technology as well as practising engineers and research workers.

M. RAMAIAH

Director,
Structural Engineering
Research Centre
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What made me interested in concrete technology was my association with Shri M.R. Vinayaka of Associated Cement Company, when he was working at Koyna Dam Concrete Research Laboratory. My interest was further enhanced while teaching this fascinating subject to the graduate and postgraduate students at the College of Military Engineering. I am grateful to them.

I gratefully acknowledge the following institutions and societies in the reproduction of certain tables, charts and information in my book:

The American Concrete Institute, the American Society for Testing and Materials, the Cement and Concrete Association, the Portland Cement Association, the Institute of Civil Engineers, London, Department of Mines, Ottawa, Canada, the Concrete Association of India, the Cement Research Institute of India, the Central Building Research Institute, Roorkee, the Structural Engineering Research Centre, Madras, the Central Road Research Institute, Delhi, and the Bureau of Indian Standards.

A book of this nature cannot be written without the tremendous background information made available by various research workers, authors of excellent books and articles which have been referred to and listed at the end of the chapters and at the end of this book. I am thankful to them.

I also wish to express my sincere thanks to the Commandant, College of Military Engineering for extending all facilities and words of encouragement while working on this book.

My special gratefulness is due to Smt. Brinda Balu and Dr. Balasubramanian for going through the manuscript with such diligence as to bring it into the present state.

My special thanks are due to Dr. M. Ramaiah, Director, Structural Engineering Research Centre, Madras, who obliged with a foreword to this book.

Lastly I am grateful to M/s S. Chand and Company Pvt. Ltd., New Delhi for taking the responsibility of publishing this book.

Place: Pune, 1982

M.S. SHETTY

PREFACE TO THE SEVENTH EDITION

I am pleased to present the seventh edition of Concrete Technology to my readers. First published in 1982, the book has seen more than thirty-five reprints. It has found favor with students, practicing and consultant engineers, and architects, in short, with all closely involved with concrete – the most important, versatile, and global construction material.

The first multi-coloured edition of Concrete Technology appeared seven years ago. Since then the construction scene has changed in significant ways and so too has concrete technology. Many new materials and new technologies have been introduced. Very tall, large, deep, and interesting constructions are on the rise in cities such as Mumbai, Ahmedabad, Gurgaon, and other metropolitan areas of India. The skylines of these and other cities have changed dramatically, and hundreds more tall structures are on the anvil in Mumbai and Ahmedabad. Concrete is the material at the centre of these rapid and visible changes we have witnessed recently.

I have been fortunate to have had many opportunities to lecture and conduct training programmes at several engineering colleges across the country and in the course of these visits, I have met large groups of students and practicing civil engineers who have all shown tremendous interest in the subject of concrete technology. Their professional passion and commitment to advancing their knowledge of concrete in order to participate in our nation-building activities is impressive. This Seventh edition acknowledges the work of many: In addition to civil engineering students, structural designers, consultants, architects and builders, all these active and committed individuals working meticulously at construction sites or producing concrete at Ready Mixed Concrete plants day and night deserve special mention as well. Concrete Technology is dedicated to them all and my hope is that they will find in this book material to help them produce better concrete and concrete structures in the future.

In the preface to the sixth edition, I wrote that although India was lagging behind the west and the far east in concrete technology, it was nevertheless doing a good job of catching up with the rest of the world. Today, it is definitely the case that we have made great strides towards excellence. The strength of concrete used today has gone up from M 75 to the M 95 grade. The number of storeys in high-rise buildings has gone up to 117 from around 40 to 50 in 2005. Modern formwork systems like Mivan, self-climbing Doka and Pranav shuttering systems are helping fast track construction. 800 RMC plants have been established and they are supplying quality concrete even to second-tier cities; self-compacting concrete introduced in 2004 has now become a commonly used material. The use of admixtures has percolated down to common contractors. These developments signal that Indian construction practices have in fact caught up with the rest of the developed world.

I am happy to state that I have added a few more important topics to enlarge the scope and content of this seventh edition. Firstly, I have included the amendment clauses issued from time to time to IS 456:2000. Secondly, the contents of chapter five focused on admixtures has been expanded and brought up-to-date. In particular, I have provided more information on Fly Ash and Ground Granulated Blast Furnace Slag (GGBS) both of which are being increasingly used within the concrete industry to enhance sustainability.

Some of the latest tests, such as RCPT and Water Penetration test, for assessing durability of concrete as per ASTM and DIN standards have also been added.

This seventh edition of Concrete Technology also provides a substantial discussion of mass concreting practices. This new material is particularly valuable because structural elements in today's high-rise buildings as well as in Metro Railway, flyover and bridge construction projects are massive in nature and demand a thorough understanding of mass concrete practices. Aspects of mass concrete practices such as adiabatic temperature development, fresh concrete temperature, peak temperature development, its adverse effect on structural integrity and control of temperature gradient in mass concrete (such as raft foundations and other massive structural members) have been dealt with through a number of live examples adopted in actual structures in Mumbai. These fresh additions should prove especially useful to all concerned with mass concrete.

Furthermore, on account of revisions to IS 456:2000, the guidelines to concrete Mix-Design in IS 10262:1982 have become outdated. The Bureau of Indian Standards has brought out a revised concrete Mix-Design code (IS 10262:2009) which has not yet been disseminated to many engineering colleges or practicing engineers. In this new edition, the revised method of concrete Mix-Design has been explained in great detail in relation to worked out examples. In addition Mix-Design incorporating fly ash in concrete has also been worked out.

This book also provides a CD containing lectures on the different topics of the subject. The topics covered in the CD are indicated in the contents.

I trust this revised and expanded seventh edition will be very useful to all civil engineers in India and abroad, especially to students of civil engineering. If this proves to be the case, my efforts will have been well rewarded.

Finally, I would like to thank the management and the editorial team of S. Chand & Company Pvt. Ltd., New Delhi. I am grateful for their assistance and cooperation in helping me bring this edition of Concrete Technology, one of the few and probably the only multi-coloured textbooks on the subject.

M.S. SHETTY

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PREFACE TO THE FIRST EDITION

Cement mortar and concrete are the most widely used construction materials. It is difficult to point out another material of construction which is as versatile as concrete. It is the material of choice where strength, permanence, durability, impermeability, fire resistance and abrasion resistance are required. It is so closely associated now with every human activity that it touches every human being in his day to day living.

Cement concrete is one of the seemingly simple but actually complex materials. Many of its complex behaviours are yet to be identified to employ this material advantageously and economically. The behaviour of concrete with respect to long-term drying shrinkage, creep, fatigue, morphology of gel structure, bond, fracture mechanism and polymer modified concrete, fibrous concrete are some of the areas of active research in order to have a deeper understanding of the complex behaviour of these materials.

In any country, construction accounts for about 60 per cent of the plan outlay. Out of this, cement and cement product would account for more than 50 per cent. Today in India the annual consumption of cement is in the order of 22 million tonnes. It is estimated that the cost of mortar and concrete made from 22 million tons of cement would work out to about Rs. 4,000 crores which is about 1/5 of the plan outlay for the year 1982–83. It is in this context that the knowledge of concrete technology assumes importance.

Concrete is a site-made material unlike other materials of construction and as such can vary to a very great extent in its quality, properties and performance owing to the use of natural materials except cement. From materials of varying properties, to make concrete of stipulated qualities, an intimate knowledge of the interaction of various ingredients that go into the making of concrete is required to be known, both in the plastic condition and in the hardened condition. This knowledge is necessary for concrete technologists as well as for site engineers.

This book is written mainly to give practical bias into concrete-making practices to students of engineering and site engineers. Practical bias needs good theoretical base. Approach to practical solution should be made on the basis of sound theoretical concept. Sometimes, theory, however good, may not be applicable on many practical situations. This is to say, that particularly in concrete-making practices both theory and practice go hand in hand more closely than in many other branches of Engineering mainly because it is a site made material.

There are many good books written on this subject. But there are only a few books dealing with conditions, practice and equipment available in this country. Moreover, most of the books refer to only British and American standards. It has been the endeavour of the author to give as much information as possible about the Indian practice, Indian standard specifications and code of practices for concrete making. If this book helps the reader to make better concrete in the field, my efforts, I feel, are rewarded.

Place: **Pune**

M.S. SHETTY

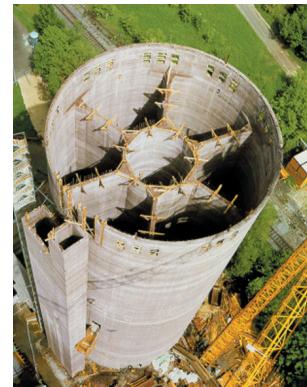
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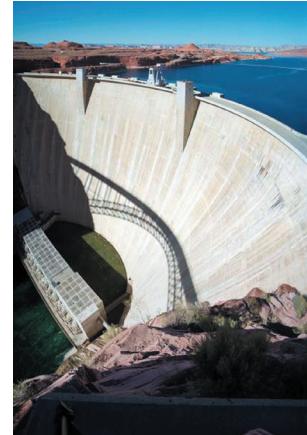
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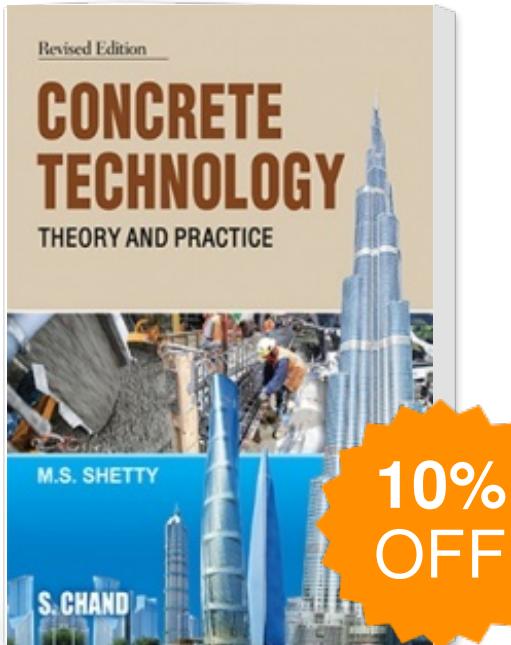


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