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
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Research Centre
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ACKNOWLEDGMENTS

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 Co., Ltd., for taking the responsibility of publishing this book.

Place: Pune, 1982

M.S. SHETTY
PREFACE TO THE SIXTH EDITION

It gives me immense pleasure that the book first published in 1982, has seen more than 25 reprints. The popularity of this book amongst students and practicing engineers has given me the encouragement to revise this book to make it more useful to them. The proposal and encouragement given by officers of S. Chand & Company to bring this Sixth Edition in multicolour should make the book more useful and attractive.

Concrete technology is becoming a major branch of civil engineering. It is becoming the backbone of infrastructural developments of every country. It has made tremendous advancement in the western and the eastern world. Though India is lagging behind, we are catching up fast with the rest of the world.

It can be recalled that in the preface to the first edition (1982) I had mentioned that the cement production in India was 22 million tons. This was about eight decades after we first started manufacturing Portland Cement (1904). It is heart warming to note that in the subsequent two decades after 1982 i.e. in 2004, the production of cement has crossed 120 million tons. Today we are the second largest producer of cement in the world, only behind China.

The quantity of concrete and other cement products made, utilising over 120 million tons of cement to cater for the tremendous infrastructural development that is taking place in the country, is making the concrete industry one of the biggest in monetary terms. Western and Eastern countries have been making concrete of strength M40, M80, M100 and over. In the recent past, we in India have started using concrete of strength M30, M50 and even M75. We have a long way to go to learn and practice the art and science of making High Performance Concrete (HPC) yet. The recent revision of IS 456, code of practice for plain and reinforced concrete is guiding concrete technologists to make strong and durable concrete.

I have grown older by twenty three years since I wrote the first edition. During these 23 years and especially in the last 15 years, I have had opportunities to deliver numerous lectures, training site engineers, conducting trials at large project sites, throughout the country which has made me once again a student of concrete technology and motivated me to revise this book.

Major revision has been carried out in Fifth and Sixth Edition. Topics, such as blended cements, use of admixtures and their use, field trials to find out their suitability, compatibility and dosage, RMe, pumping of concrete, latest methods mix design step by step, and extensive unconventional deliberation on durability, have been included.

Another special feature of this Sixth Edition is the inclusion of SELF COMPACTING CONCRETE, a revolutionary method of concrete construction. This innovative method which is found only in journals and seminar proceedings is rarely incorporated in textbooks. Similarly, other latest research information on Bacteria Concrete Geopolymer Concrete and Basalt fibre concrete are also included.

The book incorporates relevant information on numerous Indian standard specifications and code of practices relating to cement and concrete, including the latest revision of IS 456 of 2000 in respect of section 2 on materials, workmanship, inspection, testing and acceptance criteria. The book should serve as a vehicle to disseminate the information to all those who are interested in concrete construction.

I am sure that this multicolour revised edition will prove to be very useful to students of engineering, architects, practicing engineers and teachers in all engineering colleges. If this book helps to enthuse the readers and enable them to make better concrete at our construction sites, I would feel that my efforts are well rewarded.

I would like to express my sincere thanks to Shri Samir Surlaker, an authority on admixtures and construction chemicals in India, for helping me to enhance the technical content of this book. I am also thankful to the officers and staff of M/s S. Chand & Company Ltd. who were extremely amicable and helpful to bringing out this sixth edition in Multicolour.

Place: Pune
May 2005
M.S. SHETTY

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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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**Subject Index** 617-624
SARDAR SAROVAR DAM: Sardar Sarovar Project is an Inter-State Multi-Purpose project of National importance. It is one of the largest projects under implementation anywhere in the world.
THE IDUKKI HYDROELECTRIC PROJECT, KERALA: The reservoir covers nearly 60 square kilometres and has a catchment of 649 square km. Water from the reservoir is taken down to the underground power house at Moolamattom through an underground tunnel, yielding an average gross head of 2182 feet (665 metres). The project has an installed capacity of 780 MW with firm power potential of 230 MW at 100 per cent load factor.

THE BHAKRA DAM is a majestic monument across river Sutlej. The construction of this project was started in the year 1948 and was completed in 1963. It is 740 ft. high above the deepest foundation as straight concrete dam being more than three times the height of Qutab Minar. Bhakra Dam is the highest Concrete Gravity dam in Asia and Second Highest in the world.

SAI GANGA approach canal for water supply to Chennai Metro.
DELHI METRO Railway Station under construction.

THE BAHÁ'Í HOUSE OF WORSHIP known as the Lotus Temple, built near New Delhi.

Diamond shaped ‘MANI KANCHAN’ – Gem & Jewellery Park at Kolkata.

Unconventional building with pleasing architecture.
TARAPUR ATOMIC POWER PROJECT: Reactor Building no. 3 & 4.

Fully automatic construction of concrete pavement.

A view of large oval shaped dome under construction over Connaught Place Metro Railway Station. It is going to be a new landmark over Delhi Metro. It will be a modern version of Palika garden – A pride feature of Delhi Metro Project.

Sky Bus Metro, Goa

(XXX)
SOME LANDMARK HIGHRISE BUILDINGS IN THE WORLD

Figures on the top is the strength of concrete in MPa

*S Reinforced concrete frame
† Composite concrete/steel frame
** Also includes one experimental column of 117 MPa

SOME HIGHRISE BUILDINGS AROUND THE WORLD

Eiffel Tower
Chrysler Building
Empire State Building
John Hancock Building
World Trade Center
Sears Tower Center
Hong Kong Bank
First Interstate Bank
Bank of China
Petronas Towers

321 m 319 m 381 322 m 417 and 415 m 443 m 179 m 219 m 369 m 451 m

(xxxi)
CHANNEL TUNNEL RAIL LINK (UK).
Tunnel diameter: 6.84 m and 8.15 m. Number of segments 9+key. Segment thickness: 350 mm. Concrete grade: 60 MPa. Dramix steel fibre reinforcement is used for casting segments without conventional steel.

PETRONAS TWIN TOWERS in Kuala Lumpur Malaysia: One of the tallest (451 m.) buildings in the world.

...and many many more to expand and reshape the world we live in, — all in concrete.

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