

Multicolour Illustrative Edition

CONCRETE TECHNOLOGY THEORY AND PRACTICE

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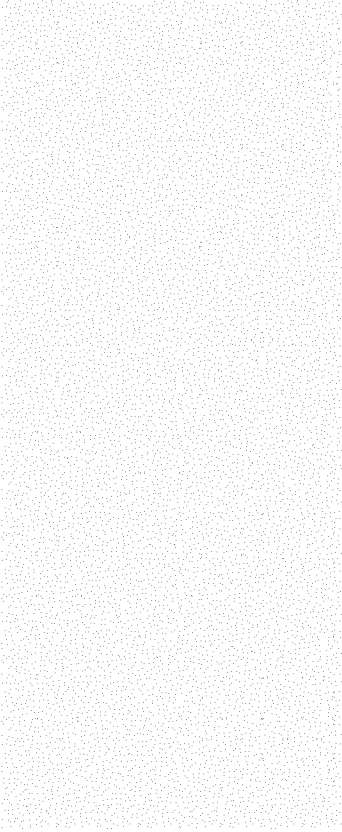
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**Dedicated
To
My Beloved Father
V. VENKAPPA SHETTY**

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
Madras

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 Koyana 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

I 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, RMC, 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 text books. 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

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

CONTENTS

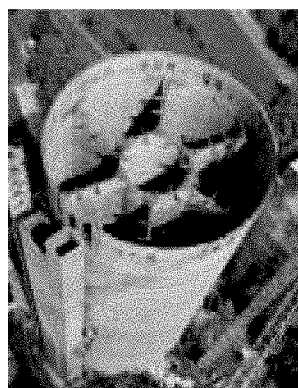
Chapter No.

Page No.

1. CEMENT

1-26

<i>General</i>	1
<i>Early History of Modern Cement</i>	2
<i>Manufacture of Portland Cement</i>	5
<i>Wet Process</i>	6
<i>Dry Process</i>	9
<i>Chemical Composition</i>	14
<i>Hydration of Cement</i>	17
<i>Heat of Hydration</i>	18
<i>Calcium Silicate Hydrates</i>	19
<i>Calcium Hydroxide</i>	20
<i>Calcium Aluminate Hydrates</i>	21
<i>Structure of Hydrated Cement</i>	22
<i>Transition Zone</i>	22
<i>Water Requirements for Hydration</i>	25



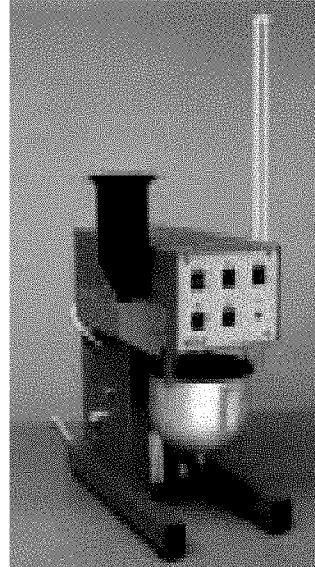
2. TYPES OF CEMENT AND TESTING OF CEMENT

27-65

<i>Types of Cement</i>	28
<i>ASTM Classification</i>	28
<i>Ordinary Portland Cement</i>	29
<i>Rapid Hardening Cement</i>	30
<i>Extra Rapid Hardening Cement</i>	30
<i>Sulphate Resisting Cement</i>	31
<i>Portland Slag Cement</i>	31
<i>Application of GGBS Concrete</i>	33
<i>Quick Setting Cement</i>	33
<i>Super Sulphated Cement</i>	34
<i>Low Heat Cement</i>	34
<i>Portland Pozzolana Cement</i>	35
<i>Advantages of PPC</i>	36
<i>Grading of PPC</i>	37
<i>Application</i>	37
<i>Air-Entraining Cement</i>	37
<i>Coloured Cement</i>	38
<i>Hydrophobic Cement</i>	39
<i>Masonry Cement</i>	39
<i>Expansive Cement</i>	40
<i>RS-T40 Special Grade Cement</i>	40
<i>Oil-Well Cement</i>	41
<i>Rediset Cement</i>	41

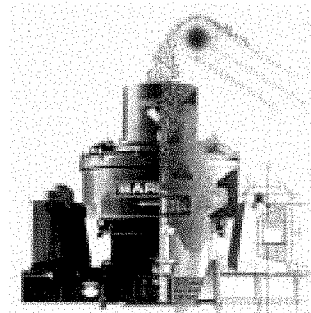


<i>Properties of Rediset</i>	41
<i>Applications</i>	42
<i>High Alumina Cement</i>	42
<i>Hydration of High Alumina Cement</i>	42
<i>High Alumina Cement Concrete</i>	43
<i>Refractory Concrete</i>	44
<i>Very High Strength Cement</i>	45
<i>Macro-defect free Cement</i>	45
<i>Densely Packed System</i>	45
<i>Pressure Densification and Warm Pressing</i>	45
<i>High Early Strength Cement</i>	46
<i>Pyrament Cement</i>	46
<i>Magnesium Phosphate Cement</i>	46
Testing of Cement	47
<i>Field Testing</i>	47
<i>Fineness Test</i>	48
<i>Sieve Test</i>	49
<i>Air Permeability Method</i>	49
<i>Standard Consistency Test</i>	50
<i>Setting Time Test</i>	50
<i>Initial Setting Time</i>	52
<i>Final Setting Time</i>	53
<i>Strength Test</i>	53
<i>Soundness Test</i>	54
<i>Heat of Hydration</i>	55
<i>Chemical Composition Test</i>	56
<i>Test Certificate</i>	56

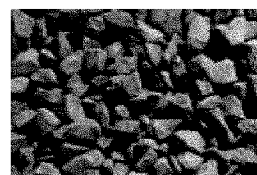
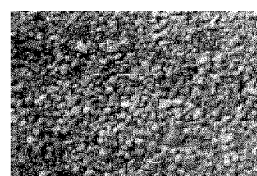
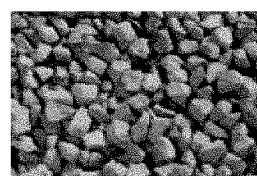
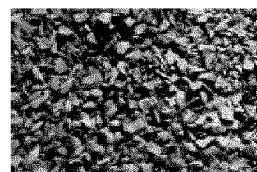


3. AGGREGATES AND TESTING OF AGGREGATES 66-118

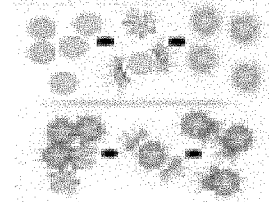
<i>General</i>	66
<i>Classification</i>	67
<i>Source</i>	67
<i>Aggregates from Igneous Rocks</i>	68
<i>Aggregates from Sedimentary Rocks</i>	68
<i>Aggregates from Metamorphic Rocks</i>	68
<i>Size</i>	69
<i>Shape</i>	70
<i>Texture</i>	73
<i>Measurement of Surface Texture</i>	74
<i>Strength</i>	74
<i>Aggregate Crushing Value</i>	75
<i>Aggregate Impact Value</i>	76
<i>Aggregate Abrasion Value</i>	76
<i>Deval Attrition Test</i>	76
<i>Dorry Abrasion Test</i>	76
<i>Los Angeles Test</i>	77
<i>Modulus of Elasticity</i>	77
<i>Bulk Density</i>	78



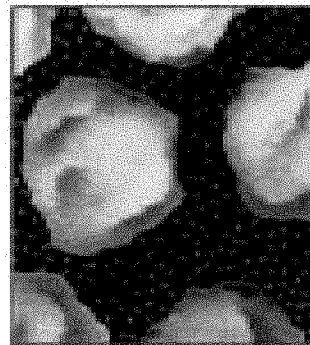
<i>Specific Gravity</i>	78
<i>Absorption and Moisture Content</i>	78
<i>Bulking of Aggregate</i>	80
<i>Measurement of Moisture Content of Aggregates</i>	81
<i>Drying Method</i>	82
<i>Displacement Method</i>	82
<i>Calcium Carbide Method</i>	82
<i>Electrical Meter Method</i>	82
<i>Automatic Measurement</i>	82
<i>Cleanliness</i>	83
<i>Soundness of Aggregate</i>	85
<i>Alkali-Aggregate Reaction</i>	85
<i>Factors Promoting Alkali-Aggregate Reaction</i>	86
<i>High Alkali Content in Cement</i>	88
<i>Availability of Moisture</i>	89
<i>Temperature Condition</i>	89
<i>Mechanism of Deterioration of Concrete</i>	89
<i>Control of Alkali Aggregate Reaction</i>	89
<i>Thermal Properties</i>	90
<i>Grading of Aggregates</i>	91
<i>Sieve Analysis</i>	93
<i>Combining Aggregates to obtain Specified Gradings</i>	94
<i>Specific Surface and Surface Index</i>	96
<i>Standard Grading Curve</i>	100
<i>Crushed Sand</i>	105
<i>Gap Grading</i>	107
<i>Testing of Aggregates</i>	107
<i>Test for Determination of Flakiness Index</i>	107
<i>Test for Determination of Elongation Index</i>	109
<i>Test for Determination of Clay and Fine Silt</i>	110
<i>Test for Determination of Organic Impurities</i>	111
<i>Test for Determination of Specific Gravity</i>	112
<i>Test for Bulk Density and Voids</i>	112
<i>Mechanical Properties of Aggregates</i>	113
<i>Test for Aggregate Crushing Value</i>	113
<i>Test for "Ten per cent Fines" Value</i>	114
<i>Test for Aggregate Impact Value</i>	114
<i>Test for Aggregate Abrasion Value</i>	115
4. WATER	119-123
<i>Qualities of Water</i>	119
<i>Use of Sea Water for Mixing Concrete</i>	122
5. ADMIXTURES AND CONSTRUCTION CHEMICALS	124-217
<i>General</i>	124
<i>Admixtures</i>	125
<i>Construction Chemicals</i>	126
<i>Plasticizers (Water Reducers)</i>	126



<i>Action of Plasticizers</i>	128
<i>Dispersion</i>	128
<i>Retarding Effect</i>	128
<i>Superplasticizers (High Range Water Reducers)</i>	129
<i>Classification of Superplasticizer</i>	130
<i>Effect of Superplasticizers on Fresh Concrete</i>	131
<i>Compatibility of Superplasticizers and Cement</i>	131
<i>Factors Effecting Workability</i>	136
<i>Type of Superplasticizers</i>	136
<i>Dosage</i>	136
<i>Mix Composition</i>	137
<i>Variability in Cement Composition</i>	137
<i>Mixing Procedure</i>	137
<i>Equipment</i>	138
<i>Site Problems in the use of Superplasticizers</i>	138
<i>Slump Loss</i>	140
<i>Steps for Reducing Slump Loss</i>	140
<i>Other Potential Problems</i>	142
<i>Effect of Superplasticizers on the Properties of Hardened Concrete</i>	143
<i>New Generation Superplasticizers</i>	144
<i>Carboxylated Acrylic Ester (CAE)</i>	144
<i>Multicarboxylate ther (MCE)</i>	147
<i>Retarders</i>	148
<i>Retarding Plasticizers</i>	149
<i>Accelerators</i>	149
<i>Accelerating Plasticizers</i>	158
<i>Airentraining Admixtures</i>	158
<i>Airentraining Agents</i>	159
<i>Factors Affecting Amount of Air-entrainment</i>	159
<i>The Effect of Air-entrainment on the Properties of Concrete</i>	160
<i>Resistance to Freezing and Thawing</i>	161
<i>Effect on Workability</i>	162
<i>Effect on Strength</i>	163
<i>Effect on Segregation and Bleeding</i>	166
<i>Effect on Permeability</i>	169
<i>Effect on Chemical Resistance</i>	169
<i>Effect on Sand, Water and Cement Content</i>	169
<i>Unit Weight</i>	170
<i>Alkali Aggregate Reaction</i>	170
<i>Modulus of Elasticity</i>	170
<i>Abrasion Resistance</i>	170
<i>Optimum Air Content in Concrete</i>	171
<i>Measurement of Air Content</i>	171
<i>Gravimetric Method</i>	171
<i>Volumetric Method</i>	173
<i>Pressure Method</i>	173
<i>The Water Type Meter</i>	173
<i>Pozzolanic or Mineral Admixtures</i>	174



<i>Po zzo lanic Mate rials</i>	175
<i>Natural Pozzo lans</i>	175
<i>Artificial Pozzo lans</i>	175
<i>Fly Ash</i>	176
<i>Effect of Fly Ash on Fresh Concrete</i>	179
<i>Effect of Fly Ash on Hardened Concrete</i>	180
<i>Durability of Concrete</i>	180
<i>High Volume Fly Ash Concrete (HVFA)</i>	180
<i>Properties of (HVFA) Fresh Concrete</i>	181
<i>Bleeding and Setting Time</i>	181
<i>Heat of Hydration</i>	182
<i>Curing of (HVFA) Concrete</i>	182
<i>Mechanical Properties of (HVFA) Concrete</i>	182
<i>Durability of (HVFA) Concrete</i>	182
<i>Use of High Volume Fly Ash</i>	183
<i>Silica Fume</i>	183
<i>Indian Scenario</i>	184
<i>Available Forms</i>	184
<i>Po zzo lanic Action</i>	185
<i>Influence on Fresh Concrete</i>	185
<i>Influence on Hardened Concrete</i>	186
<i>Mixing</i>	186
<i>Curing</i>	186
<i>Rice Husk Ash</i>	186
<i>Surkhi</i>	187
<i>Metakao lin</i>	188
<i>Ground Granulated Blast Furnace Slag (GGBS)</i>	189
<i>Performance of GGBS in Concrete</i>	191
<i>Fresh Concrete</i>	191
<i>Hardened Concrete</i>	191
<i>Damp-Proofing and Water-Proofing Admixtures</i>	192
<i>Gas Forming Agents</i>	193
<i>Air-De training Agents</i>	194
<i>Alkali Aggregate Expansion Inhibitors</i>	194
<i>Workability Agents</i>	195
<i>Grouting Agents</i>	195
<i>Corrosion Inhibiting Agents</i>	196
<i>Bonding Admixtures</i>	196
<i>Fungicidal, Germicidal and Inse cticidal Admixtures</i>	196
<i>Colouring Agents</i>	197
<i>Miscellaneous Admixtures</i>	197
<i>Damp-proo fers</i>	197
<i>Construction Chemicals</i>	198
<i>Membrane Forming Curing Compounds</i>	200
<i>Drying Behaviour</i>	201
<i>Types of Curing Compounds</i>	201
<i>Application Procedure</i>	201
<i>General Characteristics</i>	202

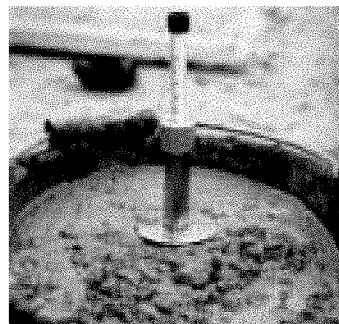


<i>Water Retention Test</i>	203
<i>Polymer Bonding Agents</i>	204
<i>Polymer Modified Mortar for Repair and Maintenance</i>	204
<i>Mould Releasing Agents</i>	205
<i>Installation Aids</i>	205
<i>Floor Hardners and Dust Proofer</i>	206
<i>Non-Shrink High Strength Grout</i>	207
<i>Surface Retarders</i>	207
<i>Bond Aid for Plastering</i>	208
<i>Ready to use Plaster</i>	208
<i>Guniting Aid</i>	208
<i>Construction Chemicals for Waterproofing</i>	209
<i>Integral Waterproofing Compound</i>	210
<i>Acrylic Based Polymer Coatings</i>	210
<i>Mineral Based Polymer Modified Coatings</i>	211
<i>Protective and Decorative Coatings</i>	212
<i>Chemical DPC</i>	212
<i>Waterproofing Adhesives for Tile, Marble and Granite</i>	213
<i>Silicone based Water Repellant Materials</i>	214
<i>Injection Grout for Cracks</i>	214
<i>Joint Sealants</i>	215
<i>Concrete Repair Systems</i>	215
<i>Stages for Repair Works</i>	215

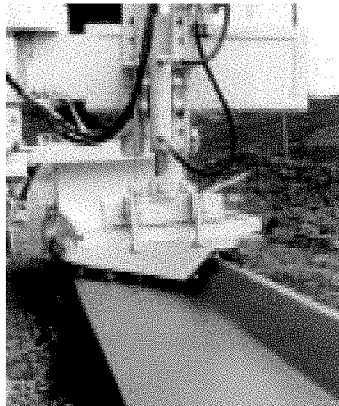
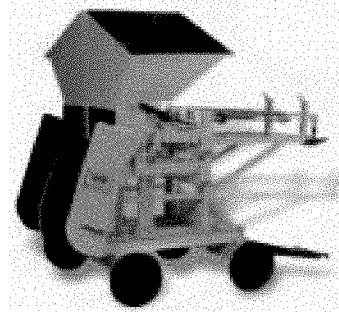
6. FRESH CONCRETE

218-297

<i>Workability</i>	219
<i>Factors Affecting Workability</i>	220
<i>Water Content</i>	220
<i>Mix Proportions</i>	220
<i>Size of Aggregate</i>	221
<i>Shape of Aggregate</i>	221
<i>Surface Texture</i>	221
<i>Grading of Aggregate</i>	221
<i>Use of Admixture</i>	221
<i>Measurement of Workability</i>	222
<i>Slump Test</i>	222
<i>K-Slump Tester</i>	224
<i>Remarks</i>	227
<i>Compacting Factor Test</i>	227
<i>Flow Test</i>	228
<i>Flow Table Apparatus</i>	229
<i>Accessory Procedure</i>	230
<i>Kelly Ball Test</i>	231
<i>Vee Bee Consistometer Test</i>	232
<i>Segregation</i>	233
<i>Bleeding</i>	234
<i>Method of Test for Bleeding</i>	236



<i>Setting Time of Concrete</i>	236
<i>Process of Manufacture of Concrete</i>	238
<i>Batching</i>	238
<i>Volume Batching</i>	238
<i>Weight Batching</i>	240
<i>Measurement of Water</i>	241
<i>Mixing</i>	241
<i>Hand Mixing</i>	242
<i>Machine Mixing</i>	242
<i>Mixing Time</i>	245
<i>Retempering</i>	246
<i>Maintenance of Mixer</i>	247
<i>Transporting</i>	247
<i>Mortar Pan</i>	247
<i>Wheel Barrow</i>	248
<i>Crane Bucket and Ropeway</i>	249
<i>Truck Mixer and Dumper</i>	249
<i>Belt Conveyors</i>	249
<i>Chute</i>	249
<i>Skip and Hoist</i>	249
<i>Transit Mixer</i>	250
<i>Pumps and Pipeline</i>	251
<i>Development of Concrete Pump</i>	251
<i>Concrete Pumps</i>	251
<i>Types of valve</i>	252
<i>Pipeline and Couplings</i>	252
<i>Laying the Pipeline</i>	253
<i>Capabilities of Concrete Pump</i>	253
<i>Pumpable Concrete</i>	254
<i>Design Consideration</i>	255
<i>Choosing Correct Pump</i>	256
<i>Common Problems</i>	258
<i>Clearing Blockages</i>	259
<i>Placing Concrete</i>	259
<i>Form Work</i>	261
<i>Stripping Time</i>	261
<i>Under Water Concreting</i>	262
<i>Compaction of Concrete</i>	265
<i>Hand Compaction</i>	266
<i>Compaction by Vibration</i>	267
<i>Internal Vibrator</i>	268
<i>Formwork Vibrator</i>	268
<i>Table Vibrator</i>	269
<i>Platform Vibrator</i>	269
<i>Surface Vibrator</i>	269
<i>Compaction by Pressure and Jolting</i>	269
<i>Compaction by Spinning</i>	269
<i>Vibratory Roller</i>	269

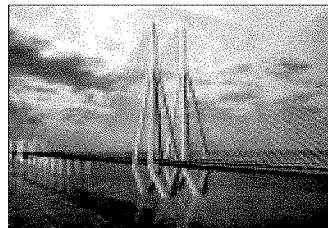


<i>General Points on Using Vibrators</i>	270
<i>Further Instructions on use of Vibrators</i>	270
<i>Height of Concrete Layer</i>	271
<i>Depth of Immersion of Vibrator</i>	271
<i>Spacing and Number of Insertion Positions</i>	272
<i>Speed of Insertion</i>	272
<i>Duration of Vibration</i>	273
<i>Vibrating Concrete at Junctions</i>	273
<i>Vibrating Reinforced Concrete</i>	273
<i>Vibrating Near the Form Work</i>	273
<i>Vibrating High Walls and Columns</i>	276
<i>Over Vibration</i>	276
<i>Output of Immersion Vibrations</i>	276
<i>Re vibration</i>	276
<i>Vibration of Light-weight Concrete</i>	277
<i>Curing of Concrete</i>	277
<i>Curing methods</i>	279
<i>Water curing</i>	279
<i>Membrane curing</i>	280
<i>Application of Heat</i>	281
<i>Steam curing</i>	282
<i>High Pressure Steam curing</i>	287
<i>Curing by Infra-red Radiation</i>	288
<i>Electrical curing</i>	289
<i>Miscellaneous Methods of Curing</i>	289
<i>When to Start Curing</i>	289
<i>Finishing</i>	291
<i>Formwork Finishes</i>	291
<i>Surface Treatment</i>	292
<i>Exposed Aggregate Finish</i>	293
<i>Bush Hammering</i>	293
<i>Applied Finish</i>	293
<i>Miscellaneous Finish</i>	294
<i>Wear Resistant Floor Finish</i>	294
<i>Requirement of a Good Finish</i>	295
<i>Grinding and Polishing</i>	295
<i>Craziness</i>	295
<i>Whisper Concrete Finish</i>	296



7. STRENGTH OF CONCRETE **298-324**

<i>General</i>	298
<i>Water / Cement Ratio</i>	299
<i>Gel / Space Ratio</i>	301
<i>Gain of Strength with Age</i>	303
<i>Accelerated Curing Test</i>	306
<i>Maturity Concept of Concrete</i>	306
<i>Effect of Maximum Size of Aggregate</i>	311

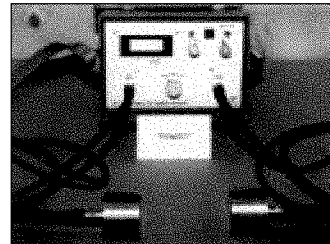


<i>Relation between Compressive and Tensile Strength</i>	311
<i>Centre Point and Third Point Loading</i>	314
<i>Bond Strength</i>	315
<i>Aggregate Cement Bond Strength</i>	316
<i>High Strength Concrete</i>	318
<i>Seeding</i>	319
<i>Revibration</i>	319
<i>High Speed Slurry Mixing</i>	319
<i>Use of Admixture</i>	319
<i>Inhibition of Cracks</i>	319
<i>Sulphur Impregnation</i>	319
<i>Use of Cementitious Aggregate</i>	319
<i>Ultra High Strength Concrete</i>	319
<i>Compaction by Pressure</i>	319
<i>Helical Binding</i>	320
<i>Polymer Concrete</i>	320
<i>Reactive Powder Concrete</i>	320
<i>High-Performance Concrete (HPC)</i>	321
<i>Aggregates for HPC</i>	322



8. ELASTICITY, CREEP AND SHRINKAGE **325-348**

<i>Elastic Properties of Aggregate</i>	325
<i>Relation between Modulus of Elasticity and Strength</i>	328
<i>Factors Affecting Modulus of Elasticity</i>	329
<i>Dynamic Modulus of Elasticity</i>	331
<i>Poisson's Ratio</i>	332
<i>Creep</i>	332
<i>Rheological Representation of Creep</i>	333
<i>Macroscopic Rheological Approach</i>	333
<i>Microscopic Rheological Approach</i>	334
<i>Hydration under Sustained Load</i>	335
<i>Measurement of Creep</i>	336
<i>Factors Affecting Creep</i>	339
<i>Influence of Aggregate</i>	339
<i>Influence of Mix Proportions</i>	339
<i>Influence of Age</i>	339
<i>Effect of Creep</i>	339
<i>Shrinkage</i>	340
<i>Plastic Shrinkage</i>	341
<i>Drying Shrinkage</i>	343
<i>Factors Affecting Shrinkage</i>	344
<i>Moisture Movement</i>	347
<i>Autogenous Shrinkage</i>	347
<i>Carbonation Shrinkage</i>	347



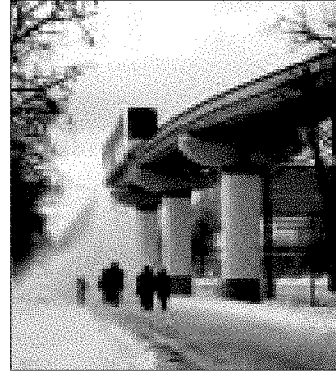
9. DURABILITY OF CONCRETE **349-419**

<i>General</i>	349
<i>Strength and Durability Relationship</i>	350

<i>Volume Change in Concrete</i>	352
<i>Definition of Durability</i>	352
<i>Significance of Durability</i>	352
<i>Impact of W /C Ratio on Durability</i>	353
<i>Permeability</i>	354
<i>Permeability of Cement Paste</i>	354
<i>Permeability of Concrete</i>	356
<i>Interaction between Permeability, Volume Change and Cracking</i>	357
<i>Factors Contributing to Cracks in Concrete</i>	361
<i>Plastic Shrinkage Cracks</i>	361
<i>Settlement Cracks</i>	362
<i>Bleeding</i>	362
<i>Delayed Curing</i>	362
<i>Constructional Effects</i>	363
<i>Early Frost Damage</i>	363
<i>Unsound Materials</i>	364
<i>Shrinkage</i>	364
<i>Drying Shrinkage</i>	365
<i>Thermal Shrinkage</i>	365
<i>Thermal Conductivity</i>	367
<i>Thermal Diffusivity</i>	368
<i>Specific Heat</i>	370
<i>Coefficient of Thermal Expansion</i>	370
<i>Mass Concrete</i>	372
<i>Thermal Expansion and Shrinkage</i>	373
<i>Extensibility</i>	375
<i>Joints in Concrete</i>	376
<i>Construction Joints</i>	376
<i>Expansion Joints</i>	376
<i>Contraction Joints</i>	379
<i>Isolation Joints</i>	381
<i>Concrete Subjected to High Temperature</i>	382
<i>Fire Resistance</i>	382
<i>Freezing and Thawing</i>	383
<i>Deicing Effects of Salts</i>	387
<i>Moisture Movements</i>	387
<i>Transition Zone</i>	387
<i>Biological Process</i>	388
<i>Structural Design Deficiencies</i>	388
<i>Chemical Action</i>	389
<i>Sulphate Attack</i>	389
<i>Methods of Controlling Sulphate Attack</i>	390
<i>Use of Sulphate Resisting Cement</i>	390
<i>Quality of Concrete</i>	390
<i>Use of Air-entrainment</i>	390
<i>Use of Pozzolana</i>	390
<i>High Pressure Steam Curing</i>	390
<i>Use of High Alumina Cement</i>	390



<i>Alkali-Aggregate Reaction</i>	394
<i>Acid Attack</i>	395
<i>Concrete in Sea Water</i>	396
<i>Carbonation</i>	398
<i>Rate of Carbonation</i>	398
<i>Measurement of Depth of Carbonation</i>	400
<i>Chloride Attack</i>	400
<i>Corrosion of Steel (Chloride Induced)</i>	402
<i>Corrosion Control</i>	404
<i>Metallurgical Methods</i>	405
<i>Corrosion Inhibitors</i>	405
<i>Coatings to Reinforcement</i>	406
<i>Fusion Bonded Epoxy Coating</i>	407
<i>Galvanised Reinforcement</i>	408
<i>Cathodic Protection</i>	408
<i>Coatings to Concrete</i>	408
<i>Design and Detailing</i>	409
<i>Nominal Cover to Reinforcement</i>	409
<i>Crack Width</i>	411
<i>Deterioration of Concrete by Abrasion, Erosion and Cavitation</i>	411
<i>Effects of Some Materials on Durability</i>	412
<i>Action of Mineral Oils</i>	412
<i>Action of Organic Acids</i>	412
<i>Vegetables and Animal Oils and Fats</i>	412
<i>Action of Sugar on Concrete</i>	413
<i>Action of Sewage</i>	413
<i>Surface Treatments of Concrete</i>	413
<i>Maximum Cement Content</i>	415
<i>Concluding Remarks on Durability</i>	418

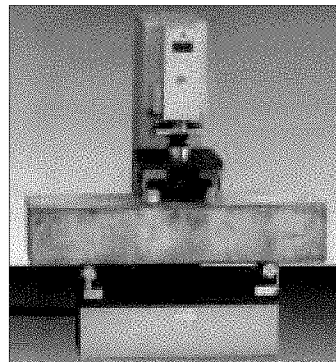


10. TESTING OF HARDENED CONCRETE **420-457**

<i>Compression Test</i>	421
<i>Moulds</i>	422
<i>Compacting</i>	422
<i>Compaction by Hand</i>	423
<i>Compaction by Vibration</i>	423
<i>Capping Specimens</i>	424
<i>Neat cement</i>	424
<i>Cement mortar</i>	424
<i>Sulphur</i>	424
<i>Hard plaster</i>	425
<i>Curing</i>	425
<i>Making and Curing Compression Test Specimen in the Field</i>	425
<i>Failure of Compression Specimen</i>	425
<i>Effect of Height / Diameter Ratio on Strength</i>	427
<i>Comparison between Cube and Cylinder Strength</i>	428
<i>Flexural Strength of Concrete</i>	428
<i>Determination of Tensile Strength</i>	429



<i>Procedure</i>	431
<i>Placing of Specimen in the Testing Machine</i>	431
<i>Indirect Tension Test Methods</i>	433
<i>Ring Tension Test</i>	434
<i>Advantage of ring tension test</i>	434
<i>Limitations of ring tension test</i>	434
<i>Double Punch Test</i>	434
<i>Factors Influencing the Strength Results</i>	435
<i>Test Cores</i>	436
<i>Strength of cores</i>	437
<i>Non-Destructive Testing Methods</i>	437
<i>Schmidt's Rebound Hammer</i>	439
<i>Limitation</i>	439
<i>Rebound number and strength of concrete</i>	440
<i>Penetration Techniques</i>	441
<i>Pullout test</i>	444
<i>Dynamic or Vibration Method</i>	444
<i>Resonant Frequency Method</i>	445
<i>Usefulness of resonant frequency method</i>	445
<i>Pulse Velocity Method</i>	446
<i>Techniques of measuring pulse velocity through concrete</i>	447
<i>Factors affecting the measurement of pulse velocity</i>	447
<i>Smoothness of contact surface under test</i>	447
<i>Influence of path length on pulse velocity</i>	448
<i>Temperature of concrete</i>	448
<i>Moisture condition of concrete</i>	448
<i>Presence of reinforcement</i>	448
<i>Accuracy of measurement</i>	449
<i>Applications</i>	449
<i>Establishing uniformity of Concrete</i>	449
<i>Establishing acceptance criteria</i>	449
<i>Determination of pulse modulus of elasticity</i>	450
<i>Estimation of strength of concrete</i>	450
<i>Determination of setting characteristics of concrete</i>	450
<i>Studies on durability of concrete</i>	450
<i>Measurement of deterioration of concrete due to fire exposure</i>	451
<i>Relationship between Pulse Velocity and Static Young's Modulus of Elasticity</i>	452
<i>Combined Methods</i>	452
<i>Radioactivity Methods</i>	452
<i>Nuclear Methods</i>	453
<i>Magnetic Methods</i>	454
<i>Electrical Methods</i>	454
<i>Tests on Composition of Hardened Concrete</i>	454
<i>Determination of Cement Content</i>	454
<i>Determination of Original w /c Ratio</i>	455
<i>Physical Method</i>	455
<i>Accelerated Curing Test</i>	456



11. CONCRETE MIX DESIGN 458-503

<i>General</i>	458
<i>Concept of Mix Design</i>	459
<i>Variables in Proportioning</i>	459
<i>Various Methods of Proportioning</i>	460
<i>Statistical Quality Control of Concrete</i>	460
<i>Common Terminologies</i>	461
<i>Calculation of Standard Deviation and Coefficient of Variation</i>	463
<i>Relation between Average Design Strength and Specified Minimum Strength</i>	463
<i>American Concrete Institute Method of Mix Design</i>	466
<i>Data to be Collected</i>	466
<i>Example: ACI Committee 211.1-91 Method</i>	471
<i>Road Note Number 4 Method</i>	473
<i>DOE Method of Concrete Mix Design</i>	474
<i>Example — DOE Method</i>	477
<i>Concrete Mix Design Procedure for Concrete with Fly-Ash</i>	482
<i>Example of Mix Design with Fly-Ash with DOE Method</i>	482
<i>Mix Design for Pumpable Concrete</i>	484
<i>Example: Basic Design Calculations for a Pumpable Concrete Mix</i>	488
<i>Indian Standard Recommended Method of Concrete Mix Design</i>	489
<i>Illustrative Example of Concrete Mix Design</i>	495
<i>Rapid Method</i>	498
<i>Steps of Mix Design based on rapid method</i>	499
<i>Sampling and Acceptance Criteria</i>	500
<i>Frequency of Sampling</i>	500
<i>Test Specimen</i>	501
<i>Test Results</i>	501
<i>Acceptance Criteria</i>	502
<i>Compressive Strength</i>	502
<i>Flexural Strength</i>	502
<i>Inspection and Testing of Structures</i>	502
<i>Core Test</i>	502
<i>Load Test for Flexural Member</i>	502
<i>Non-destructive Test</i>	503

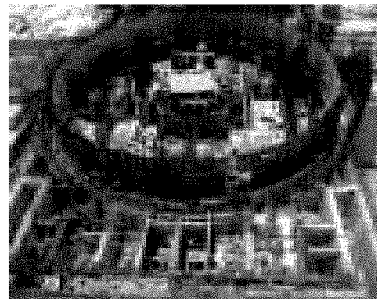


12. SPECIAL CONCRETE AND CONCRETING METHODS 504-607

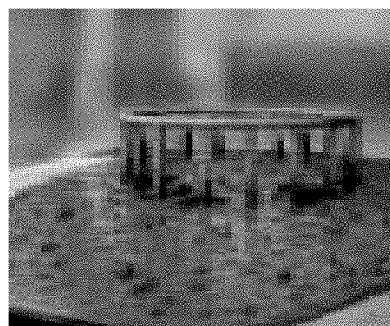
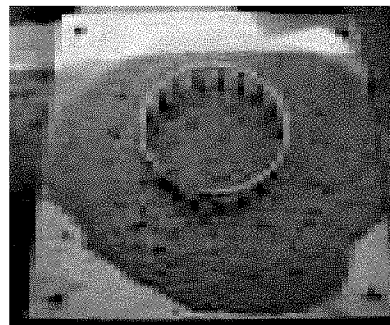
<i>Special concrete</i>	504
<i>Light-weight concrete</i>	506
<i>Pumice</i>	506
<i>Diatomite</i>	507
<i>Scoria</i>	507
<i>Volcanic Cinders</i>	507
<i>Saw Dust</i>	507
<i>Rice Husk</i>	507
<i>Brick Bats</i>	508
<i>Cinder, Clinker and Breeze</i>	508
<i>Foamed Slag</i>	508
<i>Bloated Clay</i>	509
<i>Sintered Fly Ash</i>	509



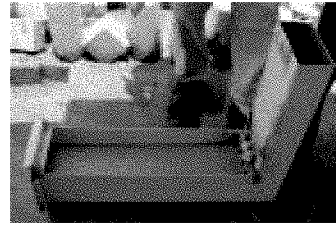
<i>Exfoliated Vermiculite</i>	509
<i>Expanded Perlite</i>	509
<i>Light-weight Aggregate Concrete</i>	510
<i>Structural Light-weight Concrete</i>	513
<i>Workability</i>	513
<i>Design of Light-weight Aggregate Concrete Mix</i>	514
<i>Mixing Procedure</i>	514
<i>Aerated Concrete</i>	514
<i>Properties</i>	516
<i>No-fines Concrete</i>	517
<i>Mix Proportion</i>	517
<i>Drying Shrinkage</i>	518
<i>Thermal Conductivity</i>	519
<i>Application</i>	519
<i>High Density Concrete</i>	520
<i>Types of Radiation Hazards</i>	521
<i>Shielding Ability of Concrete</i>	521
<i>Concrete for Radiation Shielding</i>	522
<i>Sulphur-Infiltrated Concrete</i>	525
<i>Application</i>	526
<i>Fibre Reinforced Concrete</i>	526
<i>Fibres used</i>	527
<i>Factors Effecting Properties</i>	528
<i>Relative Fibre Matrix Stiffness</i>	528
<i>Volume of Fibres</i>	528
<i>Aspect Ratio of Fibres</i>	529
<i>Orientation of Fibres</i>	529
<i>Workability</i>	530
<i>Size of coarse Aggregate</i>	530
<i>Mixing</i>	530
<i>Application</i>	531
<i>Glass Fibre Reinforced Cement</i>	531
<i>Current Development in (FRC)</i>	532
<i>High Fibre Volume Micro-Fibre System</i>	532
<i>Slurry Infiltrated Fibre Concrete</i>	532
<i>Compact Reinforced Composites</i>	532
<i>Polymer Concrete</i>	532
<i>Type of Polymer Concrete</i>	533
<i>Polymer Impregnated Concrete</i>	533
<i>Polymer Cement Concrete</i>	534
<i>Polymer concrete</i>	534
<i>Partially Impregnated Concrete</i>	535
<i>Properties of Polymer Impregnated Concrete</i>	536
<i>Stress-Strain Relationship</i>	536
<i>Compressive Strength</i>	536
<i>Tensile Strength</i>	537
<i>Creep</i>	539
<i>Shrinkage due to Polymerisation</i>	539
<i>Durability</i>	539
<i>Water Absorption</i>	540
<i>Coefficient of Thermal Expansion</i>	540



Resistance to Abrasion	540
Wear and Skid Resistance	540
Fracture of Polymer Impregnated Concrete	540
Application of Polymer Impregnated Concrete	541
Cold Weather Concreting	542
Effects of Cold Weather on Concrete	542
Low Temperature but above 0°C	453
Low Temperature but below 0°C after Concreting	543
Temperature Below 0°C at the Time of Concreting	544
Hardened Concrete Subjected to Freezing and Thawing	544
Concreting Methods at Sub-zero Temperature	544
Hot Weather Concreting	552
Precautions Taken	554
Aggregates	554
Water	555
Production and Delivery	556
Prepacked Concrete	556
Vacuum Concrete	558
Rate of Extraction of Water	558
Vacuum Dewatered Concrete	560
Gunite or Shotcrete	562
Dry-Mix Process	562
Wet-Mix Process	563
Advantages of Wet and Dry Process	563
General Use of Shotcrete	563
Concluding Remarks on Shotcrete	565
Recent Studies	566
Ferro cement	566
Casting Techniques	568
Hand Plastering	568
Semi-Mechanised Process	568
Centrifuging	569
Guniting	570
Application	570
Roller Compacted Concrete	570
Self compacting Concrete (SCC)	572
Material for SCC	573
Example of SCC Mixes	574
Requirements for self-compacting concrete	575
Workability Requirement for the fresh SCC	576
Production and Placing	577
Mix Design	577
Test Methods	578
Slump flow Test	579
J-ring test	580
V-Funnel Test	581
L-Box test method	582
U-Box Test	583
Full Box Test	584
Orimet test	587
Complexities involved in making SCC	588
New Generation Plasticizers	589
Indian Scenario of SCC	590



<i>Experience of Delhi Metro Project</i>	590
<i>Experience of Mock-up Trials at Tarapur Atomic Power Project</i>	591
<i>Use of SCC Kaiga</i>	592
<i>Trials at SERC Chennai</i>	594
<i>Study at Hong Kong</i>	595
<i>How economical is Self Compacting Concrete</i>	597
<i>Bacterial Concrete</i>	598
<i>Experimental Investigations</i>	598
<i>Zeopolymer Concrete</i>	599
<i>Basalt fibre concrete and concrete reinforced with basalt fibre reinforcements</i>	602
General Reference Books	608-611
List of Indian Standard Specifications and Code of Practices, Related to Cement and Concrete	612-616
Subject Index	617-624



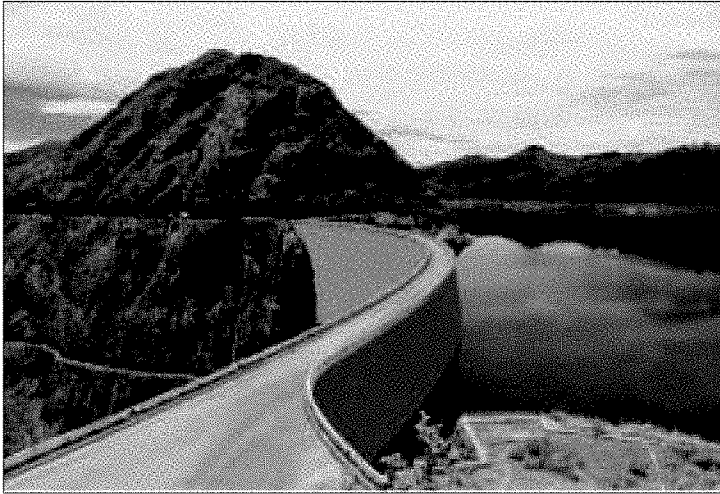
CONCRETE

IN THE UNENDING SERVICE OF NATION BUILDING

LET US LEARN THIS SUBJECT TO BE A
PART OF THE NATION BUILDING TEAM

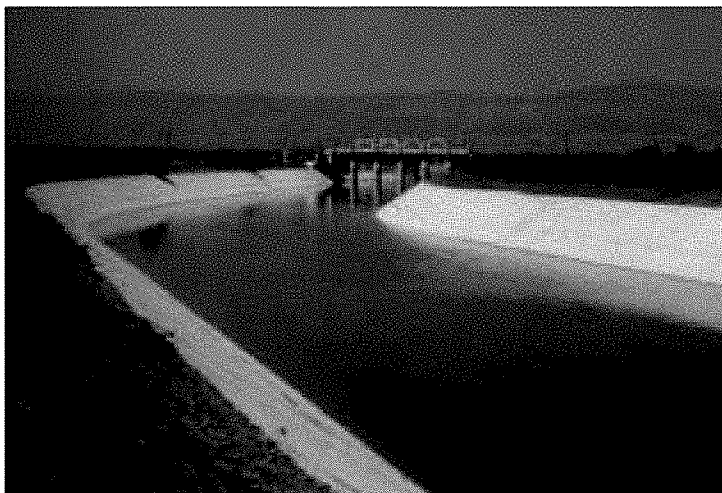
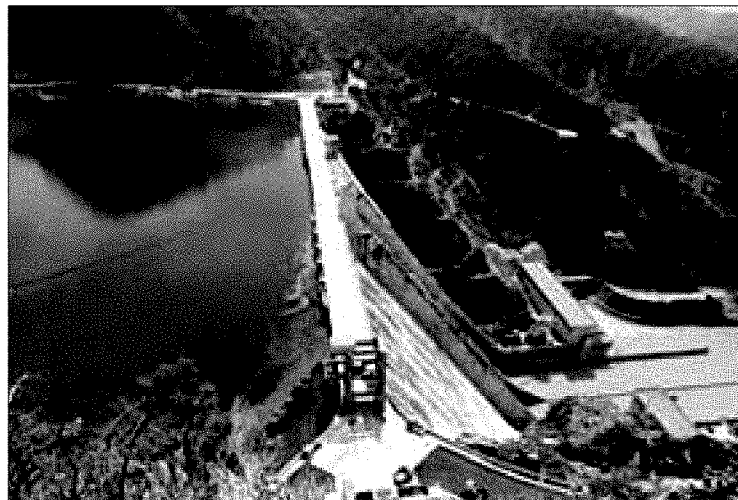


SARDAR SAROVAR DAM : Sardar Sarovar Project is an Inter-State Multi-Purpose project of National importance. It is one of the largest projects under implementation anywhere in the world.

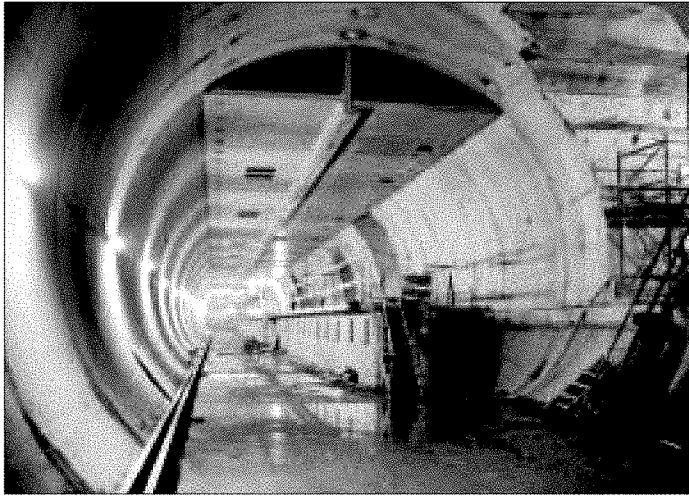


THE IDUKKI HYDROELECTRIC PROJECT, KERALA : The reservoir covers nearly 60 square kilometres and has a catchment of 649 square km. Water from the reservoir is taken down to the underground power house at Moolamattom through an underground tunnel, yielding an average gross head of 2182 feet (665 metres). The project has an installed capacity of 780 MW with firm power potential of 230 MW at 100 per cent load factor.

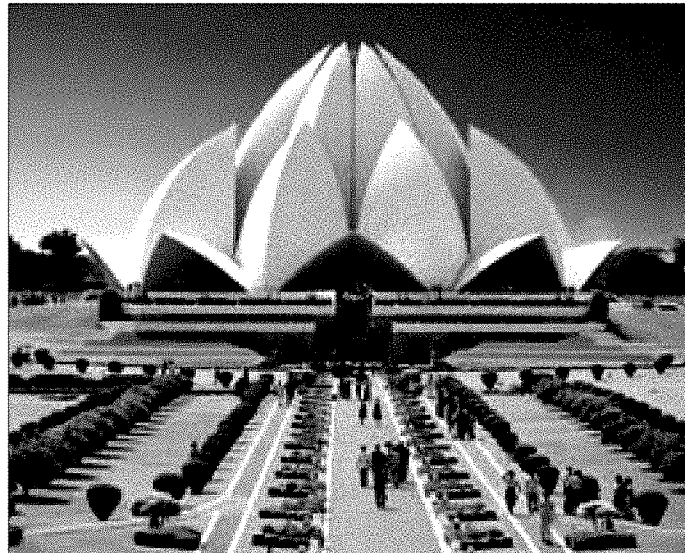
THE BHAKRA DAM is a majestic monument across river Sutlej. The construction of this project was started in the year 1948 and was completed in 1963 . It is 740 ft. high above the deepest foundation as straight concrete dam being more than three times the height of Qutab Minar. Bhakra Dam is the highest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



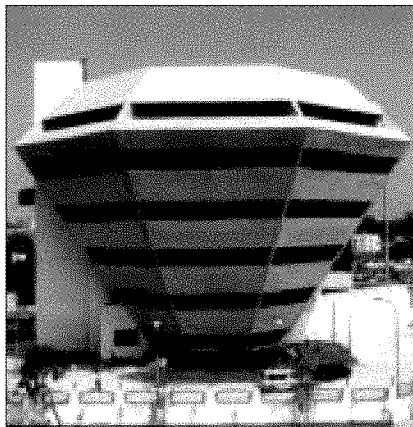
SAI GANGA approach canal for water supply to Chennai Metro.



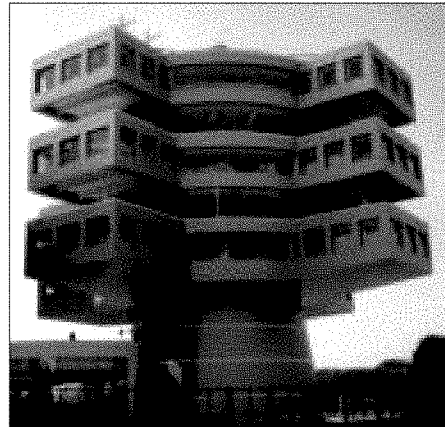
◀
DELHI METRO Railway Station
under construction.



▶
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.

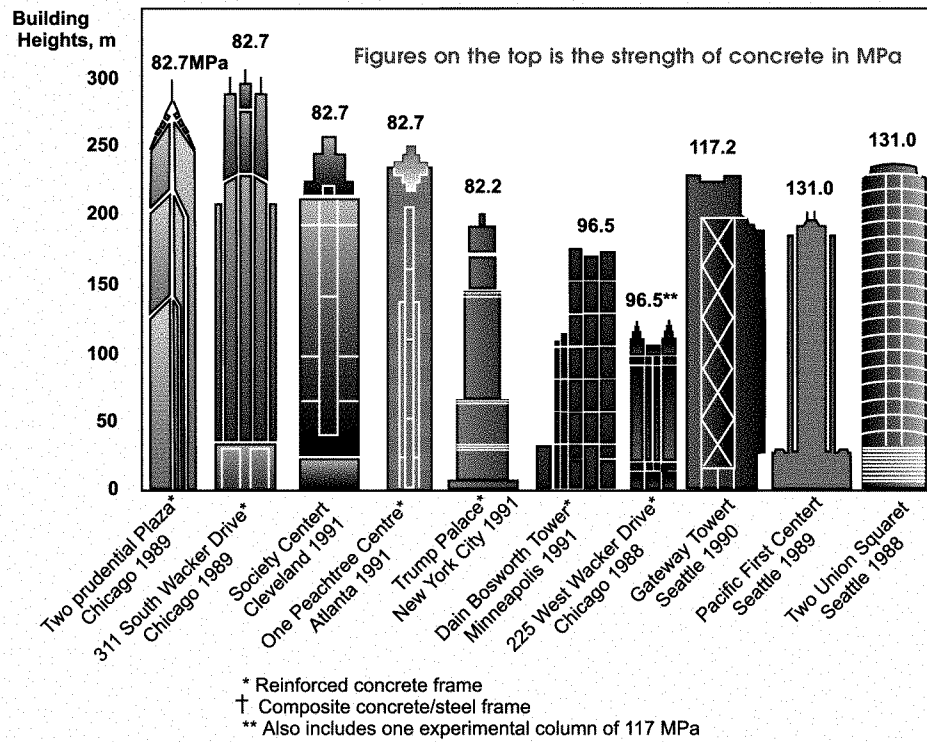


▲
A view of large oval shaped dome under construction over Connaught Place Metro Railway Station. It is going to be a new landmark over Delhi Metro. It will be a modern version of Palika garden – A pride feature of Delhi Metro Project.

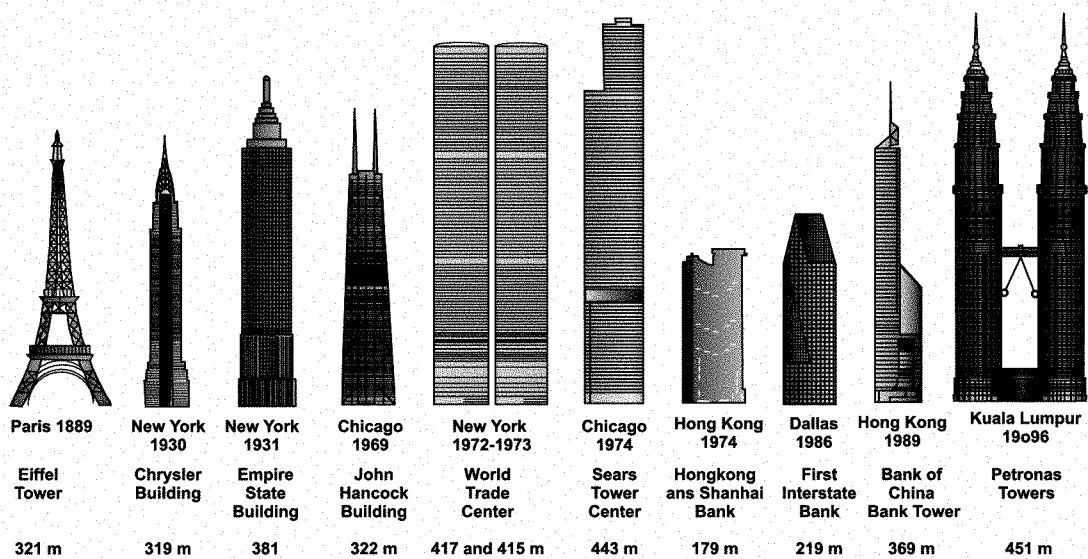
►
Sky Bus Metro, Goa



SOME LANDMARK HIGHRISE BUILDINGS IN THE WORLD

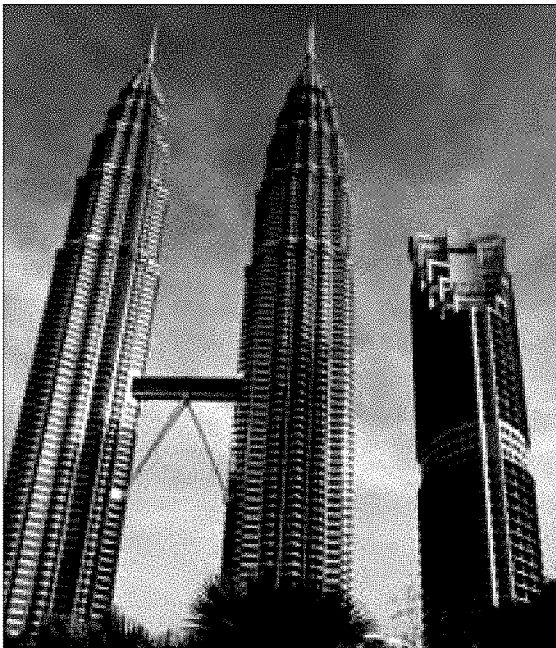


SOME HIGHRISE BUILDINGS AROUND THE WORLD





▲ 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 (451m.)
buildings in the world.

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