

CONTENTS

1. INTRODUCTION	1
2. PORTLAND CEMENT-TYPES, PROPERTIES AND SPECIFICATIONS	3
Summary	3
2.1 Introduction	4
2.2 History of Portland Cement	4
2.3 Manufacture	6
2.4 Composition of Portland Cement Clinker	14
2.5 Types of Portland Cement	24
2.6 Blended Portland Cements	29
2.7 Technically Important Properties of Portland Cement-Testing and Specifications	31
2.8 Uniformity of Cements	95
2.9 Sampling	98
2.10 Storage of Cements	100
3. HYDRATION OF PORTLAND CEMENT	103
Summary	103
3.1 Introduction	104
3.2 Reactions in Early Hydration and Setting	108
3.3 Reactions in the Hardening Process	112
3.4 Mechanism of Hydration	116
3.5 Structure of the Cement Paste	122
3.6 Effect of Cement Composition on the Strength Development-Mathematical Models	135
4. HYDRAULIC CEMENTS OTHER THAN STANDARD PORTLAND	158
Summary	158
4.1 Introduction	159
4.2 High-Alumina Cement	160
4.3 Expansive Cement	166
4.4 Special Portland Cements	171
4.5 Other Hydraulic Cementing Materials	177
4.6 Latent Hydraulic Materials	183
4.7 Fly Ash and Silica Fume	191
4.8 Selection of Cements	211
4.9 Future of Cements	212

5. WATER	214
Summary	214
5.1 Introduction	215
5.2 Mixing Water	215
5.3 Water for Curing and Washing	219
6. ADMIXTURES	221
Summary	221
6.1 Introduction	222
6.2 Classification	223
6.3 Air-Entraining Admixtures	224
6.4 Accelerating Admixtures	236
6.5 Water-Reducing Admixtures and Set-Controlling Admixtures	246
6.6 Polymers	258
6.7 Other Chemical Admixtures	266
6.8 Finely Divided Mineral Admixtures	269
6.9 Storage, Sampling, and Testing	270
6.10 Future of Admixtures	271
7. MINERAL AGGREGATES-GENERAL	274
Summary	274
7.1 Introduction	275
7.2 Classification of Aggregates	275
7.3 Sampling of Aggregates	280
8. MINERAL AGGREGATES-PHYSICAL PROPERTIES	287
Summary	287
8.1 Introduction	289
8.2 Specific Gravity and Solid Volume	289
8.3 Absorption, Moisture Content, and Permeability	297
8.4 Unit Weight, Voids Content, and Bulking	303
8.5 Strength, Toughness, Hardness, and Deformability	306
8.6 Thermal Properties	319
8.7 Durability and Soundness	321
8.8 Porosity in Aggregates	333
8.9 Wear and Skid Resistance	339

9. CHEMICAL PROPERTIES OF AGGREGATES	349
Summary	349
9.1 Introduction	350
9.2 Deleterious Materials	351
9.3 Reactivity of Concrete Aggregates	361
9.4 Deterioration of Aggregates by Chemical Attacks from Outside	372
10. GEOMETRIC PROPERTIES OF AGGREGATES	375
Summary	375
10.1 Shape and Surface Texture of Particles	377
10.2 Particle Size	383
10.3 Sieves and Screens	386
10.4 Grading	389
10.5 Sieve Test	390
10.6 Grading Curves	391
10.7 Grading Representation in Triangular Diagram	396
10.8 Numerical Characterization of Grading	399
10.9 Average Particle Size of the Complete Grading	404
11. FINENESS MODULUS AND SPECIFIC SURFACE	411
Summary	411
11.1 Fineness Modulus	412
11.2 Experimental Justification of the Fineness Modulus	420
11.3 Optimum Fineness Moduli	423
11.4 Specific Surface	430
11.5 Critique of the Specific Surface and Other Numerical Characteristics	436
11.6 Attempts to Improve Numerical Grading Characterization	438
12. GRADING EVALUATION AND SPECIFICATION	442
Summary	442
12.1 Grading Evaluation	443
12.2 Grading Specification in General	444
12.3 Specification of Maximum Particle Size	447
12.4 Specification of the Sand and Fine Sand Contents	447
12.5 Specification of the Grading Curve	449
12.6 Grading Specification with Limit Curves	458
12.7 Grading Specification on Percentage Passing-Retained Basis	462
12.8 Grading Specifications with Particular Conditions	464
12.9 Specifications with Fineness Modulus	469
12.10 Critical Comparison of Various Methods for Grading Evaluation	472

13. INTERNAL STRUCTURE OF CONCRETE AND ITS OPTIMIZATION	475
Summary	475
13.1 Aggregate Grading and the Internal Structure of Concrete	476
13.2 Need for Blending Aggregates	483
13.3 General Theory of Blending	485
13.4 Improvement of Grading	488
13.5 Blending of Two Aggregates	490
13.6 Graphical Methods for Blending Proportions	494
13.7 Graphical Method by Rothfuchs	494
13.8 British Method	497
13.9 The Triangular Method	504
13.10 Critical Comparison of the Methods for Blending Proportions	511
14. LIGHTWEIGHT AND HEAVYWEIGHT AGGREGATES	512
Summary	512
14.1 Introduction	513
14.2 Lightweight Aggregates	514
14.3 Types of Lightweight Aggregates	517
14.4 Possible Problems Related to Lightweight Aggregates	522
14.5 Requirements and Test Methods for Lightweight Aggregates	524
14.6 Heavyweight Aggregates	527
14.7 Possible Problems Related to Heavyweight Aggregates	530
14.8 Requirements and Test Methods for Heavyweight Aggregates	532
15. HANDLING AND SELECTION OF AGGREGATES	533
Summary	533
15.1 Aggregate Handling	534
15.2 Selection of Aggregates	538
15.3 Future of Aggregates	542
BIBLIOGRAPHY	543
INDEX	641