

- 1 Thermoanalytical Techniques p. 1
- 1.0 Introduction p. 1
- 2.0 Classical Techniques p. 2
- 2.1 Differential Thermal Analysis and Differential Scanning Calorimetry p. 2
- 2.2 DSC p. 5
- 2.3 Calibration of DTA and DSC p. 7
- 2.4 Thermogravimetry p. 12
- 2.5 High Resolution TG p. 14
- 3.0 Modern Techniques p. 20
- 3.1 Thermomechanical Analysis (TMA) p. 20
- 3.2 Dynamic Mechanical Analysis (DMA) p. 22
- 3.3 Dielectric Analysis (DEA) p. 23
- 3.4 Conduction Calorimetry p. 26
- References p. 30
- 2 Introduction to Portland Cement Concrete p. 35
- 1.0 Production of Portland Cement p. 36
- 2.0 Composition p. 37
- 3.0 Individual Cement Compounds p. 38
- 3.1 Tricalcium Silicate p. 38
- 3.2 Dicalcium Silicate p. 43
- 3.3 Tricalcium Aluminate p. 44
- 3.4 The Ferrite Phase p. 45
- 4.0 Relative Behaviors of Individual Cement Minerals p. 46
- 5.0 Hydration of Portland Cement p. 48
- 6.0 Properties of Cement Paste p. 51
- 6.1 Setting p. 51
- 6.2 Microstructure p. 52
- 6.3 Bond Formation p. 53
- 6.4 Density p. 54
- 6.5 Pore Structure p. 54
- 6.6 Surface Area and Hydraulic Radius p. 54
- 6.7 Mechanical Properties p. 55
- 7.0 Permeability of Cement Paste p. 56
- 8.0 Dimensional Changes p. 57
- 9.0 Models of Hydrated Cement p. 57
- 10.0 Mathematical Models p. 58
- 11.0 Concrete Properties p. 60
- 11.1 Workability p. 60
- 11.2 Setting p. 61
- 11.3 Bleeding and Segregation p. 61
- 11.4 Mechanical Properties p. 61
- 12.0 Durability of Concrete p. 62
- 13.0 Alkali-Aggregate Expansion p. 63
- 14.0 Frost Action p. 63
- 15.0 Sea Water Attack p. 64
- 16.0 Corrosion of Reinforcement p. 65

- 17.0 Carbonation of Concrete p. 65
- 18.0 Delayed/Secondary Ettringite Formation p. 66
- References p. 67
- 3 Formation and Hydration of Cement and Cement Compounds p. 71
- 1.0 Introduction p. 71
- 2.0 Raw Materials p. 73
- 3.0 Clinkerization p. 77
- 4.0 Synthesis of Cement Phases p. 82
- 5.0 Polymorphism in Silicates p. 87
- 6.0 Hydration p. 89
- 6.1 Calcium Silicates p. 89
- 6.2 Calcium Aluminates p. 99
- 6.3 Calcium Aluminates Plus Gypsum p. 104
- 7.0 Portland Cement p. 111
- 8.0 CaO-SiO₂-Al₂O₃-H₂O and Related Systems p. 118
- 9.0 Durability Aspects p. 122
- 9.1 Aggregates p. 122
- 9.2 Magnesium Oxide p. 124
- 9.3 High Temperature Effects p. 126
- 9.4 Freezing-Thawing Processes p. 127
- 9.5 Carbonation p. 131
- 9.6 Chemical Attack p. 134
- 9.7 Aged Concrete p. 135
- References p. 136
- 4 Introduction to Concrete Admixtures p. 143
- 1.0 Introduction p. 143
- 2.0 Accelerators p. 145
- 2.1 Effect of Calcium Chloride on Calcium Silicates p. 146
- 2.2 Effect of Calcium Chloride on Calcium Aluminate p. 149
- 2.3 Effect of Calcium Chloride on Cement p. 150
- 2.4 Effect of Calcium Chloride on Concrete p. 151
- 2.5 Triethanolamine (TEA) p. 153
- 2.6 Formates p. 156
- 2.7 Other Non-Chloride Accelerators p. 159
- 3.0 Water Reducers and Retarders p. 162
- 3.1 Introduction p. 162
- 3.2 Retarders p. 164
- 3.3 Water Reducers p. 167
- 4.0 Superplasticizers p. 169
- 5.0 Air-Entraining Agents p. 173
- 6.0 Mineral Admixtures p. 174
- 6.1 Fly Ash p. 175
- 6.2 Slag p. 176
- 6.3 Silica Fume p. 176
- 7.0 Miscellaneous Admixtures p. 177

- 7.1 Expansion Producers p. 178
- 7.2 Pigments p. 178
- 7.3 Dampproofing and Waterproofing Admixtures p. 178
- 7.4 Pumping Aids p. 178
- 7.5 Flocculating Admixtures p. 178
- 7.6 Bacterial, Fungicidal, and Insecticidal Admixtures p. 179
- 7.7 Shotcreting Admixtures p. 179
- 7.8 Antiwashout Admixtures p. 179
- 7.9 Corrosion Inhibiting Admixtures p. 179
- 7.10 Alkali-Aggregate Expansion Reducing Admixtures p. 180
- 7.11 Polymer-Modified Mortars/Concrete p. 180
- 7.12 Admixtures for Oil Well Cements p. 180
- 7.13 Antifreezing Admixtures p. 181
- References p. 182
- 5 Accelerating Admixtures p. 189
 - 1.0 Introduction p. 189
 - 2.0 Calcium Chloride p. 190
 - 3.0 Non-Chloride Accelerators p. 202
 - References p. 218
- 6 Retarding and Water Reducing Admixtures p. 221
 - 1.0 Introduction p. 221
 - 2.0 Lignosulfonates p. 222
 - 2.1 Tricalcium Aluminate p. 222
 - 2.2 Tricalcium Aluminate-Gypsum-Calcium Lignosulfonate-Water p. 224
 - 2.3 Tetracalcium Aluminoferrite-Calcium Lignosulfonate-Water p. 225
 - 2.4 Tricalcium Silicate-Lignosulfonate-Water p. 226
 - 2.5 Dicalcium Silicate-Lignosulfonate-Water System p. 229
 - 2.6 Tricalcium Silicate-Tricalcium Aluminate-Lignosulfonate-Water System p. 230
 - 2.7 Cement-Lignosulfonate-Water System p. 232
 - 3.0 Sugar-Free Lignosulfonate p. 235
 - 4.0 Hydroxycarboxylic Acids p. 238
 - 5.0 Sugars p. 239
 - 6.0 Phosphonates p. 240
 - 7.0 Conduction Calorimetric Assessment of Retarders p. 245
 - 8.0 Slump Loss p. 248
 - 9.0 Abnormal Setting p. 251
 - 10.0 Ready-Mix Concrete p. 252
 - 11.0 Other Admixtures p. 254
 - 12.0 Identification of Water Reducers/Retarders p. 254
 - References p. 257
- 7 Superplasticizing Admixtures p. 261
 - 1.0 Introduction p. 261
 - 2.0 Tricalcium Aluminate p. 262
 - 3.0 Tricalcium Aluminate-Gypsum System p. 265
 - 4.0 Tricalcium Silicate p. 269
 - 5.0 Cement p. 273

- 6.0 Thermal Analysis of Superplasticizers p. 287
- References p. 289
- 8 Supplementary Cementing Materials and Other Additions p. 293
- 1.0 Introduction p. 293
- 2.0 Fly Ash p. 294
- 3.0 Silica Fume p. 300
- 4.0 Slags p. 308
- 5.0 Rice Husk Ash p. 319
- 6.0 Metakaolinite p. 323
- 7.0 Natural Pozzolans p. 328
- 8.0 Relative Effects of Pozzolans and Their Mixtures p. 332
- 9.0 Miscellaneous Additives p. 338
- References p. 345
- 9 Introduction to Non-Portland Cement Binders and Concrete p. 355
- 1.0 Introduction p. 355
- 2.0 Magnesium Oxychloride Cement p. 356
- 2.1 Description p. 356
- 2.2 Hydration Reactions p. 356
- 2.3 Microstructure Development p. 357
- 2.4 Strength Development p. 357
- 2.5 Resistance To Water p. 360
- 3.0 Magnesium Oxysulfate Cement p. 360
- 3.1 Hydration p. 360
- 3.2 Strength Development p. 361
- 4.0 Calcium Aluminate Cements p. 362
- 4.1 Description p. 362
- 4.2 Hydration p. 363
- 4.3 Strength Development p. 365
- 4.4 Strength and the Conversion Reaction p. 365
- 4.5 Inhibition of C₃AH₆ Formation p. 366
- 4.6 Durability p. 367
- 4.7 Chemical Admixtures p. 367
- 4.8 Refractory Applications p. 369
- 5.0 Portland Cement-Calcium Aluminate Cement Blends p. 370
- 5.1 Introduction p. 370
- 5.2 Hydration p. 370
- 5.3 Setting Behavior and Ettringite Nucleation p. 372
- 5.4 Early Strength Development p. 373
- 5.5 CAC-Based Expansive Cement Reactions p. 375
- 5.6 Chemical Admixtures p. 378
- 6.0 Phosphate Cement Systems p. 379
- 6.1 Description p. 379
- 7.0 Magnesia Phosphate Cement Binders p. 381
- 7.1 Mechanical Properties p. 381
- 7.2 Additives p. 385
- 7.3 Calcium Phosphate-Based Materials p. 386

- 7.4 Lime Silico-Phosphate Cement p. 387
- 8.0 Regulated-Set Cement p. 388
- 8.1 Description p. 388
- 8.2 Paste and Mortar Hydration p. 388
- 9.0 Mechanical Properties and Durability of Jet Set-Based Cement Systems p. 392
- 9.1 Strength, Microhardness, and Modulus of Elasticity p. 392
- 9.2 Durability p. 395
- 9.3 Gypsum p. 395
- References p. 397
- 10 Non-Portland Rapid Setting Cements p. 403
- 1.0 Introduction p. 403
- 2.0 Calcium Aluminate Cements p. 404
- 2.1 Basic Reactions p. 404
- 2.2 Thermal Analysis of Hydrated Calcium Aluminate Cements p. 405
- 3.0 Jet Set (Regulated-Set) Cement p. 422
- 3.1 Hydration of $11 \text{ CaO} \cdot 7 \text{ Al}_2\text{O}_3 \cdot \text{CaF}_2$ p. 422
- 4.0 Magnesium Oxychloride and Magnesium Oxysulfate Cement Systems p. 430
- 5.0 Zinc Oxychloride Cement p. 437
- 6.0 Magnesia-Phosphate Cements p. 438
- 7.0 Hydroxyapatite p. 444
- References p. 446
- 11 Gypsum and Gypsum Products p. 449
- 1.0 Introduction p. 449
- 2.0 Differential Thermal Analysis (DTA) and Differential Scanning Calorimetry (DSC) p. 450
- 3.0 Thermogravimetric Analysis (TG) p. 454
- 4.0 Dehydration of Gypsum p. 455
- 5.0 Simultaneous TG-DTG-DTA p. 459
- 6.0 Conversion Reactions p. 462
- 6.1 Dihydrate to β -Anhydrite p. 462
- 6.2 Conversion of Soluble to Insoluble Anhydrite p. 467
- 7.0 Controlled Transformation Rate Thermal Analysis (CRTA) p. 467
- 7.1 CRTA and Kinetic Modeling p. 473
- 8.0 A Three Step Gypsum Dehydration Process p. 477
- 9.0 Industrial Applications p. 480
- 9.1 Portland Cement and Stucco p. 480
- 9.2 Gypsum-Based Cements p. 482
- 9.3 Sedimentary Rocks Containing Gypsum p. 484
- 9.4 Quality Control of Commercial Plasters p. 484
- 9.5 White Coat Plaster p. 487
- 9.6 Expanding Cement p. 488
- References p. 488
- 12 Clay-Based Construction Products p. 491
- 1.0 Introduction p. 491
- 2.0 Thermal Behavior and Identification of Clays and Accessory Minerals p. 492
- 2.1 DTA of Clay Minerals p. 492

- 2.2 Other Thermal Methods p. 500
- 2.3 Accessory Minerals p. 505
- 3.0 Applications p. 508
- 3.1 Analysis of Brick Clays p. 508
- 3.2 Thermal Efficiency of Kilns p. 508
- 3.3 Dark Color of Soils p. 508
- 3.4 Bloatability of Clays p. 510
- 3.5 Weathering of Roofing Slates p. 513
- 3.6 Soil Stabilization p. 514
- 3.7 Structural Ceramics p. 514
- 3.8 Solid Waste in Clay Bricks p. 517
- 3.9 Archaeological Investigations p. 518
- 4.0 Durability of Clay Bricks p. 519
- 4.1 Dimensional Changes p. 519
- 4.2 Saturation Coefficient p. 521
- 4.3 Firing Temperature of Clay Brick p. 521
- 4.4 Brick Particulate Additives for Concrete p. 526
- References p. 529
- 13 Introduction to Organic Construction Materials p. 531
- 1.0 Introduction p. 531
- 2.0 Adhesives and Sealants p. 538
- 2.1 Adhesives p. 538
- 2.2 Sealants p. 547
- 3.0 Paints and Coatings p. 553
- 4.0 Asphalt - Bituminous Materials p. 560
- 5.0 Roof Covering Materials p. 563
- 5.1 Polymers p. 565
- 5.2 Membrane Characteristics p. 568
- References p. 573
- 14 Sealants and Adhesives p. 579
- 1.0 Introduction p. 579
- 2.0 Test Methods p. 580
- 3.0 Applications p. 584
- 3.1 Sealants p. 584
- 3.2 Adhesives p. 599
- References p. 606
- 15 Roofing Materials p. 611
- 1.0 Introduction p. 611
- 2.0 Bituminous Roofing Material p. 612
- 3.0 Synthetic Roofing Membranes p. 613
- 4.0 Applications p. 615
- References p. 627
- 16 Paints and Coatings p. 633
- 1.0 Introduction p. 633
- 2.0 Paints p. 634
- 3.0 Coatings p. 640

- 3.1 Intumescent Coatings p. 640
- 3.2 Silicone Coatings p. 645
- 3.3 Organic Coatings Degradation (Service-Life) p. 647
- 3.4 Inorganic Coatings p. 649
- 3.5 Miscellaneous Coatings p. 650
- References p. 652
- Index p. 655