

Contents

Acknowledgements	<i>page</i>
Introduction	
1 Water-reducing agents	
1 Background and definitions	
2 The chemistry of water-reducing admixtures	
3 The effects of water-reducing admixtures on the water–cement system	14
1.3.1 Rheological considerations	14
1.3.2 Initial surface effects	18
1.3.3 Effects on the products and kinetics of hydration	26
1.3.4 Interpretation in terms of a mode of action	32
1.4 The effects of water-reducing admixtures on the properties of concrete	
The effects of water-reducing admixtures on the properties of plastic concrete	33
1.5.1 Air entrainment	33
1.5.2 Workability	34
1.5.3 Workability loss	40
1.5.4 Water reduction	44
1.5.5 Setting characteristics of fresh concrete containing water-reducing admixtures	48
1.5.6 The stability of fresh concrete containing water-reducing admixtures	48
1.5.7 Mix design considerations	
1.6 The effect of water-reducing admixtures on the properties of hardened concrete	

1.6.1	Structural design parameters	54
1.6.2	Durability aspects	61
1.6.3	Durability guidelines	84
2.	Air-entraining agents	90
2.1	Background and definitions	90
2.2	The chemistry of air-entraining agents	92
2.3	The effects on the water—cement system	95
2.3.1	Rheology	95
2.3.2	Air content and characteristics	98
2.3.3	Distribution between solid and aqueous phases	101
2.3.4	Effects on the hydration chemistry of cement	103
2.3.5	Interpretation as a mechanism of action	104
2.4	The effect of air-entraining agents on the properties of plastic concrete	105
2.4.1	Volume of air entrained	106
2.4.2	The stability of entrained air	114
2.4.3	Workability	117
2.4.4	Water reduction	117
2.4.5	Mix stability	117
2.4.6	Mix design requirements	118
2.5	The effect of air-entraining agents on the properties of hardened concrete	120
2.5.1	Structural design parameters	120
2.5.2	Durability aspects	122
3.	Concrete waterproofers	134
3.1	Background and definitions	134
3.2	The chemistry of concrete waterproofers	136
3.3	The effects of waterproofers on the water—cement system	138
3.3.1	Bleeding of cement pastes	138
3.3.2	Hydration of cement pastes	139
3.3.3	Effects on the capillary system of hardened pastes	139
3.4	The effects of waterproofers on the properties of plastic concrete	141
3.5	The effects of waterproofers on the properties of hardened concrete	141
3.5.1	Structural design parameters	141
3.5.2	Durability aspects	142
4.	Accelerators	145
4.1	Background and definitions	145
4.2	The chemistry of accelerators	146
4.3	The effects of accelerators on the water—cement system	147
4.3.1	Rheological effects	147

CONTENTS

vii

4.3.2 Chemical effects	147
4.3.3 Effects on cement hydration	149
4.3.4 Mechanism of action	156
4.4 The effects of accelerators on the properties of plastic concrete	158
4.4.1 Effect on heat evolution	159
4.4.2 Effect on the setting time	159
4.5 The effects of accelerators on the properties of hardened concrete	160
4.5.1 Structural design parameters	160
4.5.2 Durability aspects	162
5. Applications of admixtures	177
5.1 General guide to applications of admixtures	177
5.1.1 Containers and delivery	177
5.1.2 Storage	181
5.1.3 Admixture dispensers	182
5.1.4 Point of addition	185
5.2 Applications	186
5.2.1 Site-batched and placed concrete	186
5.2.2 Ready-mixed concrete	201
5.2.3 Pre-cast concrete industry	208
6. Analysis of hardened concrete for admixture type and quantity	216
Chemical types	216
Analysis scheme	217
Cautionary note	225
Index	227