

Contents

List of contributors	ix
Acknowledgment	xi
1 Introduction	1
<i>Ana Catarina Jorge Evangelista, Vivian W.Y. Tam and Mahfooz Soomro</i>	
1.1 Construction and demolition waste — overview	1
1.2 Sustainability and the benefits of LCA — recycled concrete	3
1.3 Outline of the book	5
References	8
2 Production of cement and its environmental impact	11
<i>Mahfooz Soomro, Vivian W.Y. Tam and Ana Catarina Jorge Evangelista</i>	
2.1 Introduction	11
2.2 Cement manufacture	11
2.3 Cement chemical composition	16
2.4 Clinker phase composition	17
2.5 Properties of clinker phases	20
2.6 Cement hydration products	24
2.7 Types of cements and blended cements	26
2.8 Environmental impact of cement production	35
2.9 Summary	43
References	43
3 Industrial and agro-waste materials for use in recycled concrete	47
<i>Mahfooz Soomro, Vivian W.Y. Tam and Ana Catarina Jorge Evangelista</i>	
3.1 Flyash	47
3.2 Waste glass as Pozzolan	59
3.3 Silica fume	67
3.4 Rice husk ash	73
3.5 Sugarcane bagasse ash (SCBA)	77
3.6 Palm oil fuel ash (POFA)	84
3.7 Life cycle assessment (LCA) of recycled concrete containing by-products and plant materials	90
3.8 Summary	96
References	97

4	Recycled aggregates and their properties	119
	<i>Fernando L. Gayarre, Carlos López-Colina, Lara Carral, Miguel A. Serrano, Jesús M. Suárez and Rebeca Martínez</i>	
4.1	Introduction	119
4.2	Aggregates from CDW	120
4.3	Composition of RMA and RCA	122
4.4	Relationship between physical properties	133
4.5	Blast furnace slag (BFS)	134
4.6	Electric arc furnace slag (EAF-slag)	136
4.7	Coal fly ash	137
4.8	Scrap tires	140
4.9	Municipal solid waste (MSW) combustor ash	143
4.10	Inert/incinerated sewage sludge	144
4.11	Urban plastic waste	146
4.12	Waste glass	149
4.13	Foundry sand	151
4.14	Summary	152
	References	154
5	Quality improvement of recycled aggregate	161
	<i>Mahfooz Soomro, Vivian W.Y. Tam, Mitsuhiro Shigeishi, Ni Nyoman Kencanawati, Takao Namihira and Katarzyna Kalinowska</i>	
5.1	Introduction	161
5.2	Quality improvement of recycled aggregate using thermal-mechanical-chemical process	167
5.3	Alternative uses of removed residual mortar	177
5.4	Recycling of concrete rubble using thermo-mechanical treatment	181
5.5	Summary	188
	References	189
6	Recycled concrete for structural applications	195
	<i>João Pacheco, Jorge de Brito, Carlos Chastre and Luís Evangelista</i>	
6.1	Coarse recycled aggregates for concrete	195
6.2	Coarse recycled aggregate produced from concrete waste	197
6.3	Mechanical behavior of recycled aggregate concrete	198
6.4	Overview of the structural behavior of recycled aggregate concrete	203
6.5	Model uncertainty of recycled aggregate concrete design	204
6.6	Concluding remarks	221
	Acronyms and Symbols	223
	References	223

7	Recycled concrete for nonstructural applications	233
	<i>Wei Chen and Ruoyu Jin</i>	
7.1	Introduction	233
7.2	Use of recycled concrete in nonstructural applications	234
7.3	Practices and issues of adopting recycled aggregates in new applications	246
7.4	Types of nonstructural members	248
7.5	Case studies	255
7.6	Summary	258
	References	259
8	Durability of recycled concrete	265
	<i>Nariman J. Khalil</i>	
8.1	Introduction	265
8.2	Permeability	266
8.3	Chemical attacks on concrete	268
8.4	Freeze and thaw cycles	271
8.5	Resistance to carbonation	273
8.6	Resistance to corrosion	274
8.7	Alkali-silica reaction	275
8.8	Gas penetration	276
8.9	Future advances	277
	References	278
9	Alternative binders—high volume bauxite red mud alkali activated cements and concretes	283
	<i>Pavel V. Krivenko, Oleksandr Kovalchuk and Victoria Zozulynets</i>	
9.1	Introduction	283
9.2	Role of red mud in the microstructure formation of hardened cement paste	287
9.3	Compositions and properties of red mud containing alkali activated materials	292
9.4	Conclusions	304
	References	304
10	Life cycle assessment for structural and non-structural concrete	309
	<i>Karoline Figueiredo and Assed Haddad</i>	
10.1	Introduction	309
10.2	LCA phases and related concepts	311
10.3	Databases available	317
10.4	LCA-based software tools	318
10.5	Life cycle impact assessment (LCIA)	319
10.6	Interpretation	322

10.7	Key aspects to consider during a concrete-LCA practice	323
10.8	Data reliability	323
10.9	Concrete constituents	324
10.10	Circular economy	325
10.11	Dynamic LCA framework	327
10.12	Life cycle thinking	327
10.13	Summary - environmental impacts and their management	329
	Acknowledgment	330
	References	331
11	Asset management of recycled concrete applications	337
	<i>Sheyla Serra, Carlos Soares and Luiz Sarti Junior</i>	
11.1	Introduction	337
11.2	Asset Management Systems and Standards	338
11.3	Decision-support tools for asset management	342
11.4	Contextual factors for the asset management system	344
11.5	Questions for designing a recycled concrete asset management system	356
11.6	Conclusions	359
	Acknowledgments	359
	References	360
	Index	365