Contents

1 Introduction **1**

1.1 General 1

1.2 Terms and definitions 4

2 Framework of environmental design **9**

2.1 Scope and objective 9

2.2 Environmental design 9

3 BAT systems in concrete technology **12**

3.1 Environmental aspects in concrete industries 12

3.2 Cement production 13

3.2.1 General 13

3.2.2 Environmental impacts 14

3.2.3 Environmental contribution 15

3.2.4 BAT system 17

3.3 Aggregate production 20

3.3.1 Environmental impacts 20

3.3.2 BAT system 24

3.3.3 Standards and recommendations 25

3.4 Production of reinforcement and prestressing steel 27

3.5 Concrete production and transportation 27

3.5.1 Environmental impact 28

3.5.2 BAT system 30

3.5.3 Standards 32

3.6 Execution 33

3.6.1 Environmental impact 33

3.6.2 BAT system 35

3.7 Recycling of concrete 36

3.7.1 Environmental impact 36

3.7.2 BAT system 40

3.7.3 Research, development and standard of concrete demolition and recycling 43

3.7.4 Standards and recommendations 46

4 Maintenance systems of concrete structures in environmental design **48**

4.1 General 48

4.2 BAT of maintenance method of concrete structures 48

4.3 Standards and recommendations 50

5 Methodologies for environmental impact evaluation and optimization of concrete structures 53
5.1 Context and principles 53
5.2 Evaluation criteria and data 55
5.2.1 General 55
5.2.2 Materials and energy flows 56
5.2.3 LCA databases 56
5.3 Principles of environmental impact evaluation 57
5.3.1 General 57
5.3.2 Life cycle concept 57
5.3.3 Probability of environmental impact 59
5.3.4 Weighing 60
5.3.5 Sensitivity analysis 61
5.3.6 Eco-value 61
5.4 Life cycle assessment 62
5.4.1 General 62
5.4.2 Life cycle assessment – implementation of ISO 14040 principles 62
5.4.3 LCA of concrete structure – An example of assessment model 63
5.5 Environmental impact evaluation 63
5.5.1 General 63
5.5.2 Environmental labels and declarations for construction products 65
5.5.3 Eco-indicator method 66
5.5.4 Complex LCA of products of processes using SimaPro software 67
5.5.5 Environmental/economic performance balance – BEES model 67
5.5.6 Global emission model for integrated systems – GEMIS 68
5.5.7 LCA software at the building level 69
5.5.8 Environmental audits of buildings 70
5.6 Environment-based optimization 72