



Sustainability in Engineering Design and Construction

J. K. Yates
Daniel Castro-Lacouture



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Sustainability in Engineering Design and Construction

This book is dedicated to the students who encouraged the authors to write it so they would be able to learn more about sustainable design and construction and to all of the youth who are interested in preserving the planet for future generations.

This book is also dedicated to Colten Guerra, the 4-year-old great nephew of Dr. Yates, who has a long battle ahead of him fighting cancer.

Dr. Castro-Lacouture dedicates this book to his wife Paula and his children Eva, Matias, and Camilo.

Preface

The purpose of this book is to introduce sustainability and sustainable practices to members of the engineering and construction (E&C) industry and to provide insight into how to design and construct sustainable structures. Information is presented on why sustainable practices are being used, how they are being implemented, and what the potential benefits of their use are for members of E&C firms.

This book is unique because it not only addresses the sustainable aspects of buildings but also covers sustainable practices during engineering design and construction operations for all types of E&C projects. Many books focus on the sustainability certification rating systems used for evaluating buildings after they are complete, and these rating systems are mentioned in this book, but the main focus of this book is on providing information on how to address sustainability in all of the E&C industry sectors during engineering design and construction operations.

The first part of the book, Chapters 1 through 3, provides background information on sustainability, sustainable development practices, corporate social responsibility, supply chain management, early adopters of government sustainability objectives, barriers and drivers for implementing sustainable development practices, sustainability in the construction sector, domestic and foreign environmental regulations, sustainability global reporting initiatives, the social and community impact of projects, the environmental impact of production operations for construction materials, and global environmental management standards.

The first part of the book also includes information on the global treaties influencing the incorporation of sustainable practices into engineering design and construction operations such as the Kyoto Protocol Treaty, Basel Convention, Rio Declaration, and Stockholm Convention. It also presents information on clean development mechanisms, joint implementation practices, carbon sinks, and emissions credits. The environmental laws affecting E&C professionals working in the United States are covered to illustrate their impact on engineering designs and construction operations.

The middle part of the book, Chapters 4 through 10, presents information on sustainable designs; selecting sustainable sites; designing for passive survivability; designing for disassembly; and information on the ISO 14000 standard. It also discusses life-cycle cost assessment models and how to quantify all of the sustainable impacts on construction including the overall costs of materials taking into consideration cradle-to-grave economic and environmental costs. The middle section of the book also provides a summary of the results obtained from a research investigation into how sustainable practices are already being integrated into E&C firms and projects. Information is provided on how sustainability techniques are being used in the E&C industry, and on corporate- and project-level sustainability practices. The last part of the middle section of the book discusses global sustainability trends and implications and provides samples of some of the environmental degradation mitigation strategies being used throughout the world.

The third part of the book, Chapters 11 through 15, covers specific sustainability concepts and processes by including detailed information on sustainable construction materials and processes, heavy construction equipment, and traditional and alternative energy sources. It also provides background information on the Leadership in Energy and Environmental Design (LEED) Green Building Rating System and many other sustainability organizations and certification programs such as the International Green Construction Code, the Building Resource Energy and Environmental Assessment Model (BREEAM), Green Globes, Comprehensive Assessment System for Building Environmental Efficiency (CASBEE) comprehensive assessment, Chartered Institute of Building's Sustainability and the Construction Industry in the United Kingdom Building for Environmental and Economic Sustainability (BEES) Stars, Green Advantage, Green Star, Green Guide to Specifications, British Standards Institute BES 6001, Responsible Sources Model, the Sustainable Sites Initiative, Design Quality Indicators, Civil Engineering Environmental Quality Assessment and Award Scheme, Los Alamos National Laboratory Sustainable Design Guide, the World Green Building Council, Green Guides to Specifications, United Nations Environment Programme, the Sustainable Building Alliance, GreenRoads, Green Building National Standard that incorporates NSI/ASHRAE/IES/USGBC Standard 189.1-2104, and others.

The last part of the book, Chapter 16, includes implementation resources developed during a research investigation funded by the Construction Industry Institute and conducted by Research Team 250, called Sustainable Industrial Engineering and Construction. The Research Team 250 members were from E&C firms and government agencies, and their names and affiliations are included in our "Acknowledgments" section. The implementation resources included in this book are a Sustainability Quick Start Guide, two Sustainability Maturity Models, a Sustainability Index Metric, and a Checklist for Evaluating the Sustainability of Construction Jobsite Operations. These implementation resources are used by members of E&C firms to help them implement sustainability programs and to evaluate the sustainability of engineering designs and construction operations. To illustrate how the checklist for evaluating the sustainability of construction jobsite operations is implemented on projects, Appendices D through F include three sample sustainability project execution plans developed using the checklist for actual construction projects located in Arizona, North Carolina, and Pennsylvania.

This book provides information on (1) definitions for sustainability terms, (2) sources for locating global sustainability requirements, (3) current sustainability issues and sustainable designs, (4) environmental laws related to sustainability and their implications, (5) sustainable design, (6) life-cycle cost assessment models, (7) sustainable practices currently being used in the E&C industry, (8) corporate-level sustainability practices, (9) project-level sustainability practices, (10) global sustainability trends and implications, (11) sustainable materials, (12) sustainable heavy construction equipment, (13) traditional and alternative energy sources, (14) the LEED Green Building Rating System, (15) sustainability organizations and certification programs, (16) sustainability implementation resources, and (17) a summary of sustainable engineering design and construction.

The end of each chapter contains a list of key terms, discussion questions, and references. Appendix A includes a list of commonly used acronyms and organizations related to sustainable practices along with their definitions. Other instructional materials and resources are available for educators, including PowerPoint lectures for each chapter, solutions to the discussion questions at the end of each chapter, and sample examination questions. These materials and resources are available at <https://www.crcpress.com/product/isbn/9781498733915>

The underlying theme of this book is to enhance the use of sustainability practices by providing information on how to incorporate sustainability practices into engineering designs and construction operations in all of the E&C industry sectors. Sustainability practices not only are evaluated after a structure is completed but they also need to be integrated into the designs, materials, processes, and operations used to build structures.

Acknowledgments

Environmental consciousness increased during the last half of the twentieth century, and a resurgence of environmental concern occurred during the beginning of the twenty-first century. One of the major drivers for implementing sustainable practices at the beginning of the twenty-first century was the youth who came of age during this period. They are concerned about the state of the environment, and the environmental consequences they have inherited affecting their world.

It was university engineering and construction students who asked the authors to develop a course on sustainability in engineering design and construction so they could be more informed about their role in improving the environment for future generations. The discussions about sustainability that the authors had with students led to a research investigation on sustainability in the industrial construction sector that contributed to the body of knowledge already available for the building sector. Many aspects of the research were incorporated into lecture materials that the authors used in engineering and construction courses and the final result is this book, which captures for engineering and construction students and industry professionals information that helps them provide sustainable services to clients and improve the environmental aspects of society.

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sustainable practices in the engineering and construction industry. Their contributions to this book are greatly appreciated by the authors.

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Authors

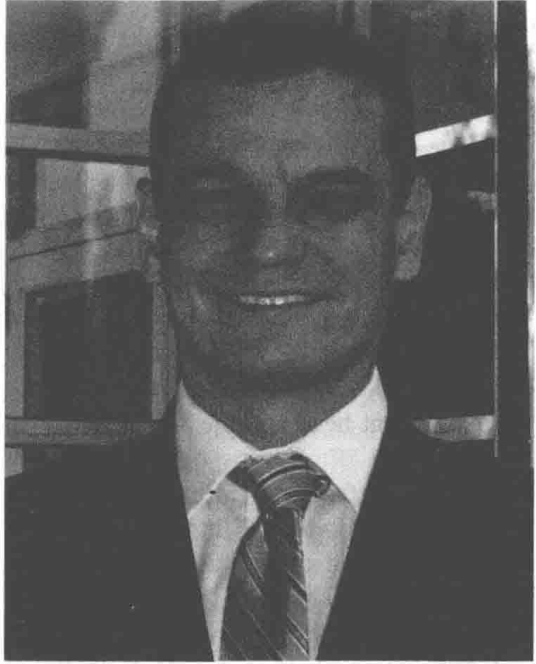
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Dr. Castro-Lacouture has been a member of governing boards and organizations at the local, national, and international levels, such as the Architecture/Construction/Engineering (ACE) Mentor Program of Atlanta, the American Society of Civil Engineers' Construction Institute North Georgia Chapter, the Green Advantage Certification Board, the International Council for Building (CIB) Working Commission W117 on Performance Measurement in Construction, and the International Association for Automation and Robotics in Construction (IAARC). He has taught 26 undergraduate and graduate courses and was corecipient of the best paper award at two international conferences. He earned his bachelor of science degree in civil engineering at the Universidad de Los Andes, Colombia; masters of science degree in construction management at the University of Reading, United Kingdom; and PhD in construction engineering and management at the School of Civil Engineering, Purdue University, West Lafayette, Indiana.

Contents

Preface.....	xix
Acknowledgments.....	xxiii
Authors.....	xxv
Chapter 1 Introduction	1
1.1 Importance of Understanding Sustainability in Engineering Design and Construction Operations.....	1
1.2 Sustainable Development	2
1.3 Corporate Social Responsibility	2
1.4 Triple Bottom Line	3
1.5 Sustainability in Engineering and Construction Operations.....	3
1.6 Implementing Sustainable Practices during Engineering and Construction Projects.....	5
1.7 Definitions	6
1.7.1 Sustainability and Industrial Sustainability	6
1.7.2 Sustainable Development	6
1.7.3 Corporate Sustainability and Corporate Social Responsibility	7
1.7.4 Sustainable Construction and Green Building	8
1.7.5 Supply Chain Management and Integrated Chain Management	9
1.7.6 Environmental Collaborations	9
1.7.7 Sustainability Stakeholders	10
1.7.8 Industrial Ecology	10
1.7.9 Pollution Prevention	10
1.7.10 Environmental Management	11
1.7.11 Energy Auditing	11
1.7.12 Embodied Energy	11
1.7.13 Eutrophication and Acidification	11
1.7.14 Other Terms Related to Sustainable Development.....	12
1.8 Sustainability Research in Engineering Design and Construction Operations.....	13
1.9 Organization of This Book.....	17
1.10 Summary	18
1.11 Key Terms.....	19
1.12 Discussion Questions.....	19
References	20

Chapter 2	Sources of Information on Sustainability Requirements	23
2.1	Sustainability Requirements.....	23
2.2	Early Adopters of Government Sustainability Objectives	24
2.3	Drivers for Implementing Sustainable Development Practices.....	25
2.4	Barriers to Implementing Sustainable Practices and Liability Issues.....	26
2.4.1	Liabilities Related to Designing and Constructing a LEED-Certified Building	27
2.5	Sustainability in the Building Sector	28
2.6	Sustainability in the Construction Sector.....	29
2.7	Pollution and Waste Management	31
2.8	Global Environmental Treaties.....	31
2.9	Foreign Government Environmental Regulations.....	32
2.10	Domestic Environmental Regulations.....	33
2.11	Summary	33
2.12	Key Terms.....	33
2.13	Discussion Questions.....	34
	References	34
Chapter 3	Sustainability Issues in the Engineering and Construction Industry ...	37
3.1	Obstacles to the Implementation of Sustainable Development Practices	37
3.2	Sustainability Global Reporting Initiatives.....	39
3.2.1	Global Reporting Profiles.....	42
3.2.2	Corporate Structure Governance	42
3.2.3	Contents of Global Sustainability Reports.....	42
3.2.4	Core Sustainability Indicators.....	43
3.2.5	Social Performance Indicators	44
3.3	Social and Community Impacts of Construction Projects	44
3.3.1	Calculating the Loss of Productivity Due to Adjacent Construction Projects	46
3.3.2	Calculating the Impact on Project Values	46
3.3.3	Calculating User Delay Costs.....	46
3.3.4	Calculating Average Traffic Delay Costs	47
3.4	Global Impacts Caused by Construction Projects	47
3.4.1	Noise and Particulate Pollution Impacts	49
3.4.2	Ecosystem Encroachment	49
3.4.3	Use of Unauthorized Landfills	49
3.4.4	Environmental Impacts of Construction Operations	50
3.4.5	Construction Waste Generation.....	50
3.4.6	Producing Lower Levels of Waste.....	52
3.5	Responsible Supply Chains and Procurement Practices	55
3.5.1	Supply Chain Management	55

3.6	Resource Efficiency: Reducing Energy Consumption During Construction.....	56
3.7	Renewable Energy	58
3.8	Mining, Metals, and Minerals Industry	59
3.9	Oil and Gas Industry	60
3.10	Summary	61
3.11	Key Terms.....	62
3.12	Discussion Questions.....	63
	References	64
Chapter 4	Sustainable Engineering Design	67
4.1	Introduction	67
4.2	Design Elements That Enhance Sustainability	67
4.2.1	Sustainable Design Elements	68
4.2.2	Passive Survivability	70
4.3	Selecting Sustainable Sites	71
4.4	Sustainable Landscapes.....	72
4.5	Storm Water Management.....	73
4.6	Evaluating Sustainable Process Alternatives	74
4.7	Designing for the Use of Sustainable Materials.....	74
4.8	Principles and Strategies of Designing for Disassembly.....	75
4.9	Environmental Impact of Production Operations for Construction Materials	76
4.10	International Organization for Standardization 14000 Environmental Management Standards	77
4.11	Summary	80
4.12	Key Terms.....	80
4.13	Discussion Questions.....	81
	References	81
Chapter 5	Environmental Laws and Their Implications.....	83
5.1	United Nations Framework Convention on Climate Change	84
5.2	Kyoto Protocol	86
5.3	Clean Development Mechanism, Joint Implementation Practices, Carbon Sinks, and Emission Credits	87
5.3.1	Emissions Trading	88
5.3.2	Carbon Sinks	88
5.4	Basel Convention	88
5.5	Rio Declaration.....	89
5.6	Stockholm Convention	89
5.7	Global Environmental Compliance.....	90
5.8	Global Environmental Management Standards	90

5.9	United States Environmental Protection Agency Laws	90
5.9.1	Council on Environmental Quality	92
5.9.2	Environmental Protection Agency	92
5.9.3	Environmental Impact Statements	93
5.10	Federal Laws of Concern to Engineers and Constructors.....	93
5.10.1	Air Pollution Control Act of 1955	93
5.10.2	Clean Air Acts of 1963, 1970, and 1990	94
5.10.3	Motor Vehicle Air Pollution Control Act of 1965	94
5.10.4	Air Quality Act of 1967.....	94
5.10.5	National Environmental Policy Act of 1969	95
5.10.6	National Environmental Policy Act of 1970	96
5.10.7	Noise Pollution Act of 1972	96
5.10.8	Federal Water Pollution Act of 1948, 1972, and 1977	96
5.10.9	Federal Insecticide, Fungicide, and Rodenticide Acts of 1972 and 1996	98
5.10.10	Toxic Substance Control Act of 1976	98
5.10.11	Solid Waste Disposal Act of 1965, Resource Conservation and Recovery Act of 1976, and Hazardous and Solid Waste Act of 1984.....	99
5.10.12	Comprehensive Environmental Response, Compensation, and Liability Act of 1980	99
5.10.13	Occupational Safety and Health Communication Standard of 1988	101
5.10.14	Energy Independence and Security Act of 2007.....	102
5.10.15	America's Proposed Climate Security Act of 2007 ..	103
5.10.16	Climate Change Legislation Design: U.S. Government White Paper of 2007	104
5.11	Foreign Government Environmental Laws	105
5.12	Summary	106
5.13	Key Terms.....	106
5.14	Discussion Questions.....	108
	References	109

Chapter 6 Life-Cycle Cost Assessment Models..... 113

6.1	Economic Considerations	113
6.2	Computer Software for Sustainability Assessment	115
6.3	Life-Cycle Assessment Processes	118
6.3.1	Emergy Accounting and Emdollars	121
6.3.2	Social Cost/Benefit Analysis.....	121
6.4	Emissions during the Transportation of Construction Materials.....	122
6.5	Summary	126
6.6	Key Terms.....	127
6.7	Discussion Questions.....	127
	References	128

Chapter 7	Sustainable Practices in the Engineering and Construction Industry	129
7.1	Procedures Implemented Related to Sustainable Development	129
7.2	Examples of Sustainability Considerations Included in Life-Cycle Analysis	130
7.3	When Sustainability Social Issues Are Evaluated and How They Are Evaluated	130
7.4	Government Regulations Related to Sustainability Being Implemented on Construction Projects	131
7.5	Economic Benefits of Implementing Sustainable Practices	131
7.6	Techniques for Measuring the Benefits of Using Sustainable Practices	131
7.7	Methods for Measuring Sustainability Metrics	132
7.8	Social, Reputation, or Economic Benefits of Using Sustainable Practices	132
7.9	Social Conditions Addressed during Construction Projects	132
7.10	Structured Approaches Used to Include Sustainability Considerations during Design	133
7.11	Designs, Construction Components, or Practices That Include Sustainable Components	134
7.12	Engineering Design Practices That Incorporate Sustainable Practices	135
7.13	Sustainable Materials Considered during the Design Stage	137
7.14	Technologies for Reducing Energy Consumption on Projects	137
7.15	Techniques for Reducing Pollution during Construction	138
7.16	Processes for Recycling Waste at the End of Construction	139
7.17	Processes for Reselling or Reusing Material By-Products	140
7.18	Levels of Recycling or Reusing Materials Compared to Projects before Sustainability	140
7.19	Techniques for Improving Resource Efficiency	140
7.20	Criteria for Prequalifying Vendors and Suppliers	141
7.21	Renewable Energy Sources for Construction Projects	141
7.22	Techniques for Reducing Waste during Construction	142
7.23	Mobilization and Demobilization Processes That Include Sustainable Practices	142
7.24	Top Five Sustainability Considerations	143
7.25	An Example of Six Sustainable Development Procedures	144
7.26	Summary	146
7.27	Key Terms	146
7.28	Discussion Questions	147
	Reference	148