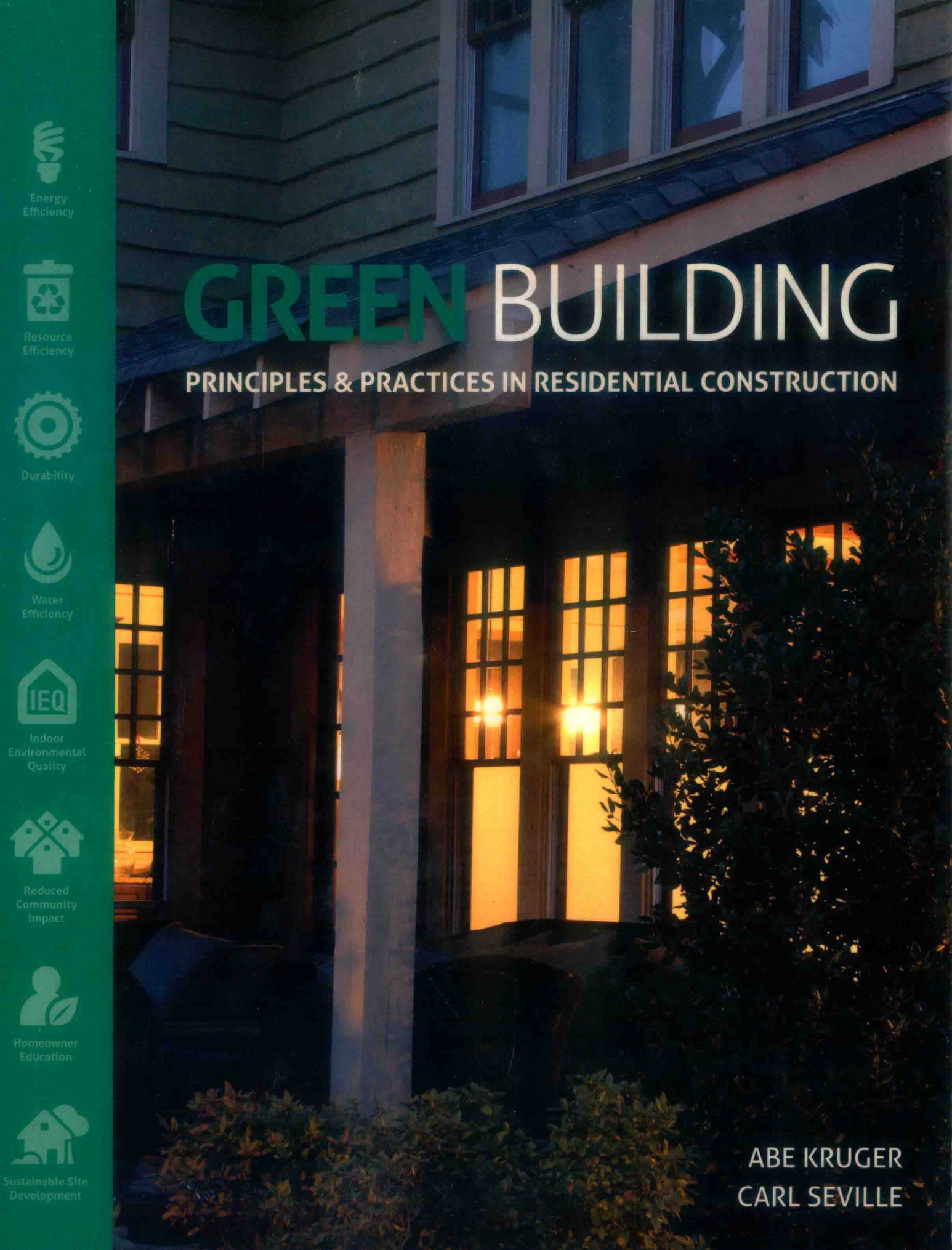
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Resource Efficiency
Durability
Water Efficiency
IEQ
Indoor Environmental Quality
Reduced Community Impact
Homeowner Education
Sustainable Site Development
GREEN BUILDING
PRINCIPLES & PRACTICES IN RESIDENTIAL CONSTRUCTION
ABE KRUGER
CARL SEVILLE

GREEN BUILDING

Principles and Practices in Residential Construction

ABE KRUGER
CEM, LEED AP Homes + ND
President, Kruger Sustainability Group

DARRYL SEVILLE
LEED AP Homes
President, Seville Consulting, LLC
Contributing Editor, Green Building Advisor
Green Building Curmudgeon

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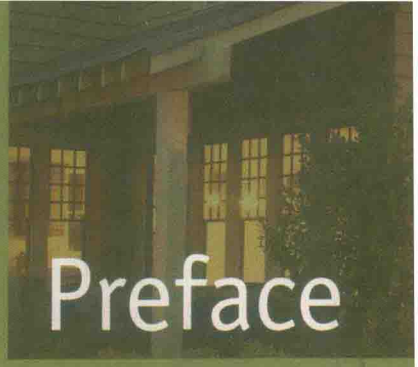
GREEN BUILDING

Principles and Practices in Residential Construction



Preface

Introduction

Residential green building has been evolving for several decades, reaching its first level of maturity with the development of building certification programs. As these programs move into their second and third generations of development, we believe the time has come for a comprehensive text that specifically addresses green building principles as they apply to single-family homes. In the marketplace, green building has experienced steady growth, with wider acceptance in some markets than others. In 2005, green building was a small, burgeoning market, comprising approximately 2% of commercial and residential construction.[1] This percentage represented a total value of $10 billion ($3 billion for residential and $7 billion for commercial). By 2013, McGraw-Hill Construction estimates the overall green building market may reach between $96 and $140 billion for residential and commercial buildings. The recent financial crisis has significantly reduced the pace of new construction, but green building continues to increase its share of the market.

The current state of residential green building as a distinct discipline is primarily limited to training and designation offered by professional organizations and to certification of individual buildings. Limited college and post-graduate level training is currently available in sustainable residential construction. We hope that *Green Building: Principles and Practices in Residential Construction* will provide a foundation for future programs on the subject.

[1] McGraw-Hill Construction (2009). 2009 Green Outlook: Trends Driving Change Report.

About the Cover

The cover photo is from the Glenwood Park community in Atlanta, Georgia. Glenwood Park is an entire community built with green building principles. Each residence adheres to the EarthCraft House construction standard developed by Southface Energy Institute and the Greater Atlanta Home Builders Association. Additional images of the community appear in Chapter 3 (Figures 3.8a and 3.8b). The photo was taken by Abby Smith (http://www.abbysmithphotography.com).

Approach

We have used our varied experience in building, remodeling, building science, and green home evaluation to create this comprehensive introductory text on green homes. Our approach in the book is to provide an overview of the concepts for green building, followed by detailed methods for incorporating materials and methods into specific projects as well as real-world examples of implementation. Residential green building as a discipline has developed in the field with little college-level training available. As students see career opportunities in residential green building, educational programs are needed to prepare them for the industry. Most existing books on the subject are either focused on commercial construction or target the consumer. *Green Building: Principles and Practices in Residential Construction* is designed to serve students seeking careers in the residential construction industry as well as industry professionals.

This book is structured to provide anyone with an interest in home construction and renovation with a guide to understanding both the principles and implementation of green building. It gives both beginning and advanced students, as well as experienced professionals, useful information that they can incorporate into their studies and practices.

ORGANIZATION

Green Building: Principles and Practices in Residential Construction is divided into five sections, beginning with an introduction to the concepts, followed by sections that roughly track the sequence of a construction project:

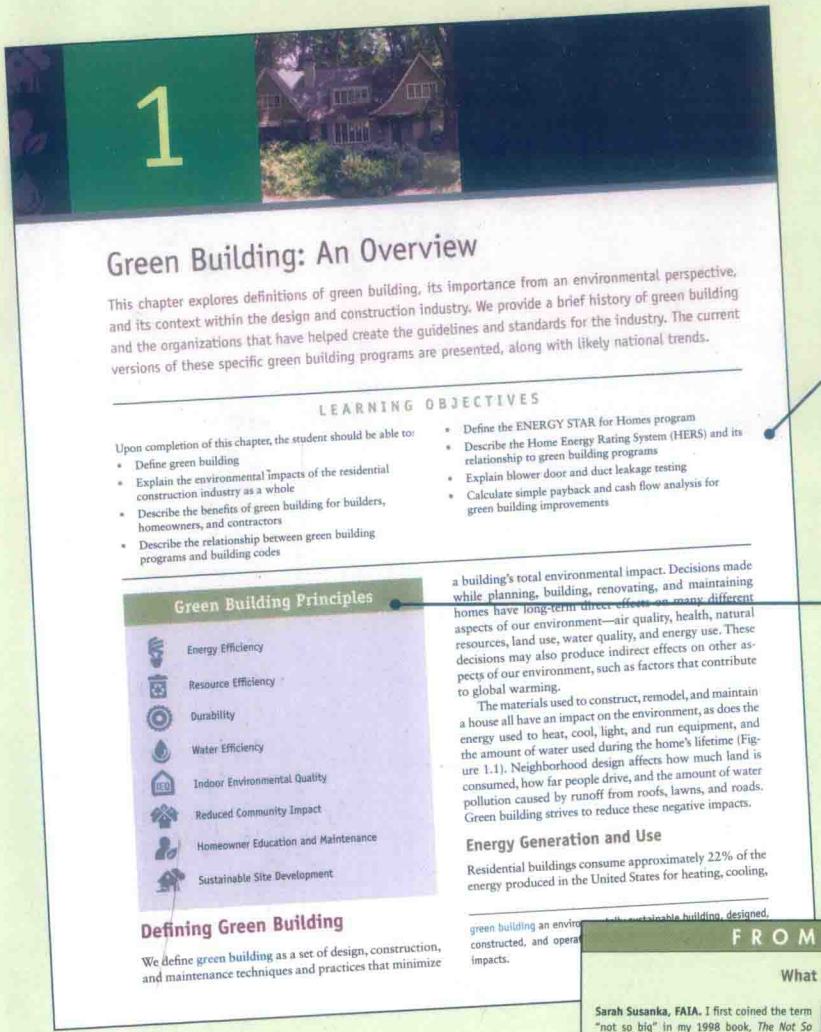
- Section One—What Is Green Building and Why Does It Make Sense?
- Section Two—Structural Systems
- Section Three—Exterior Finishes
- Section Four—Interior Systems
- Section Five—Mechanical Systems

Section One includes four chapters, beginning with a Green Building: An Overview, followed by The House as a System, then Planning Green From the Start, and closing with Insulation and Air Sealing. **Section Two** has chapters that cover Foundations, Floors and Exterior Walls, and Roofs and Attics. **Section Three** begins with Fenestration, followed by Exterior Wall Finishes, Outdoor Living Spaces, and finally Landscaping. **Section Four** is a single chapter, Interior Finishes. **Section Five** begins with a chapter on Heating, Ventilation, and Air Conditioning, followed by chapters on Electrical, Plumbing, and Renewable Energy. We close with a short Epilogue that provides both a recap of the text and a look into the future of the industry. The content may be used as presented, or the chapters can be rearranged to accommodate alternate formats for traditional or individualized instruction.

Each chapter begins with an outline of the green elements covered in the text, then moves on to the subject's effect on the whole-house system and an overview of materials and methods; the chapter ends with a section on remodeling considerations. Because a core tenant of green building is designing the structure for its particular climate, we emphasize throughout the chapters any regional issues that should be considered. Certain chapters vary from this structure, particularly those that cover mechanical systems in which materials and methods may be more intertwined than other areas.

KEY FEATURES

This book includes many features to assist students as they progress through the chapters:



1

Green Building: An Overview

This chapter explores definitions of green building, its importance from an environmental perspective, and its context within the design and construction industry. We provide a brief history of green building and the organizations that have helped create the guidelines and standards for the industry. The current versions of these specific green building programs are presented, along with likely national trends.

LEARNING OBJECTIVES

Upon completion of this chapter, the student should be able to:

- Define green building
- Explain the environmental impacts of the residential construction industry as a whole
- Describe the benefits of green building for builders, homeowners, and contractors
- Describe the relationship between green building programs and building codes
- Define the ENERGY STAR for Homes program
- Describe the Home Energy Rating System (HERS) and its relationship to green building programs
- Explain blower door and duct leakage testing
- Calculate simple payback and cash flow analysis for green building improvements

Green Building Principles

Energy Efficiency
Resource Efficiency
Durability
Water Efficiency
Indoor Environmental Quality
Reduced Community Impact
Homeowner Education and Maintenance
Sustainable Site Development

Defining Green Building

We define green building as a set of design, construction, and maintenance techniques and practices that minimize a building's total environmental impact. Decisions made while planning, building, renovating, and maintaining homes have long-term direct effects on many different aspects of our environment—air quality, health, natural resources, land use, water quality, and energy use. These decisions may also produce indirect effects on other aspects of our environment, such as factors that contribute to global warming.

The materials used to construct, remodel, and maintain a house all have an impact on the environment, as does the energy used to heat, cool, light, and run equipment, and the amount of water used during the home's lifetime (Figure 1.1). Neighborhood design affects how much land is consumed, how far people drive, and the amount of water pollution caused by runoff from roofs, lawns, and roads. Green building strives to reduce these negative impacts.

Energy Generation and Use

Residential buildings consume approximately 22% of the energy produced in the United States for heating, cooling,

green building an enviro... constructed, and operat... impacts.

Learning Objectives: A clear set of learning objectives provides an overview of the chapter material and can be used by students to check whether they have understood and retained important points.

"Green Building Principles" Icons: A unique feature of this book are the "8 Principles" icons that help describe our core principles of green building. Located at the beginning of each chapter, these icons serve as a reminder of what the principles are and present an efficient way to note the specific green practices covered in a particular chapter.

"From Experience" Features: These boxes highlight industry leaders discussing a variety of important issues, and also practicing professionals sharing their knowledge of the industry and their success in employing specific techniques in their projects.

FROM EXPERIENCE

What Is a Not So Big House?

Sarah Susanka, FAIA. I first coined the term "not so big" in my 1998 book, *The Not So Big House*, in an attempt to help describe an alternative to our ever-increasing house size. I wanted to make people aware that size has almost nothing to do with the qualities of home that most homeowners are seeking when they build or remodel.

Photo by Cheryl Kelly

Susanka is a member of the College of Fellows of the American Institute of Architects (FAIA) and a senior fellow of the Design Futures Council. Susanka is the author of nine best-selling books, including The Not So Big House *(Taunton, 1998),* The Not So Big Life *(Random House, 2007),* Not So Big Remodeling *(Taunton, 2009), and most recently,* More Not So Big Solutions for Your Home *(Taunton, 2010).*

What I knew as a residential architect was that many of my clients wanted a better house than their existing one and assumed that better must automatically mean bigger. It's just not so. In fact, in the vast majority of cases, bigger just means bigger, and the new homeowners end up being disappointed that their new house doesn't really feel like the dream home they'd thought they were building.

But Not So Big® doesn't mean small. In fact, it's not about mandating any specific size of house at all. Household needs differ, so the assessment about how much space is needed can only be made by the people who will eventually live there. Instead, it's about focusing on quality rather than quantity and about tailoring the house for the way we actually live, rather than designing for a more formal way of life that no longer reflects our current needs.

I tell people that a good rule of thumb in right-sizing a home to make it Not So Big is to aim for about a third less space than they think they need but to budget about the same amount of money as they would have for their larger vision of home, reapportioning dollars out of square footage and into the quality and character of the interior space and building envelope.

By eliminating rooms that get used only a few times a year, such as the formal living room and dining room, and by designing the house so that every space is in use every day, there's a natural reduction in the home's size without any sense of something being lost. If we're not using those spaces anyway, why build them?

In addition, the walls, windows, roof, and foundation of the house are designed to be highly energy-efficient and are built using sustainable materials and building practices. The house should also be designed to maintain an excellent indoor air quality that can provide a healthy and comfortable platform for everyday life.

I point out to my readers that a smaller but better designed house actually lives larger than one that's significantly bigger because the spaces work together as an integrated whole, perfectly supporting the lives of the inhabitants. It's a strategy that will appeal to not only the original homeowners but also to future generations, providing a delightful as well as comfortable environment for all their lives.

Lastly, a Not So Big house is a house that is beautiful and that inspires those who live within its walls. Beauty really does matter in terms of sustainability because people tend to take good care of places they find beautiful and delightful, so making a home Not So Big should really be one of the first steps in sustainable design and construction.

Some of the key features of a Not So Big house or remodel are as follows:

- Designed for comfort and livability—for the way we *really* live
- Designed to be as energy efficient and sustainable as possible
- Designed for our human scale (rather than for giants)
- Designed to last for centuries rather than for decades
- Designed in all three dimensions, with plenty of ceiling height variety to define and articulate activity areas
- Designed to be just the right size to accommodate the homeowners' needs—not too big, and not too small either
- Designed to be beautiful as well as functional and to inspire its occupants every day

Note: *Not So Big® is a registered trademark of Susanka Studios.*

Did You Know?

Radiant Barriers

Radiant barriers reduce the amount of heat entering or leaving the home by way of radiation. Attic radiant barriers are most effective in warm and hot climates with ductwork in the attic. During the summer, radiant barriers can significantly reduce attic temperatures and, in some cases, may reduce cooling loads in the house. Radiant barriers usually consist of a thin sheet or coating of a highly reflective material (usually aluminum) applied to one or both sides of a substrate material. Any of several types of substrates may be used, including kraft paper, plastic film, cardboard, plywood, or oriented strand board (OSB) sheathing, and rigid insulation materials. Although many radiant barrier products provide an "effective" or "equivalent" R-value, these products provide very little reduction in conductive heat flow and therefore often have R-values of less than R-1. The radiant barrier may be laminated directly to the roof decking (Figure 2.13a) or be fastened to the underside of the roof rafters (Figure 2.13b). See Chapter 7 for more information.

Figure 2.13a Radiant barriers may be applied in the factory to the roof decking for easy installation. LP's TechShield is OSB with a perforated radiant barrier that reduces radiant heat transfer and allows moisture drying.

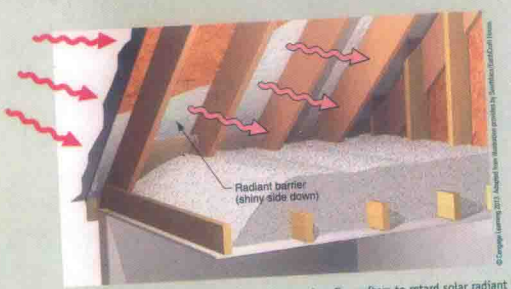


Figure 2.13b Radiant barriers may be applied to the underside of roofing rafters to retard solar radiant heat transfer.

"Did You Know?" Features: Located throughout the text, these boxed features highlight unique or critical issues that deserve special attention, as well as tables that provide comparisons between different materials and technologies for quick reference.

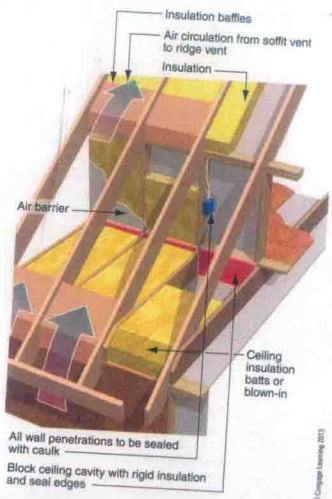


Figure 4.18 Attic knee walls must be fully air sealed with a backside air barrier. Blocking below knee walls prevents attic air from communicating with floor systems. Baffles in ventilated cathedral ceilings direct air around insulation.

Fiberglass Insulation

Fiberglass batt insulation is available in two forms: as *unfaced batts* or as *faced batts*, with foil or kraft paper facing. Faced batts are installed in walls by stapling the facing to the sides, or preferably, to the face of the studs. Faced batts are available in widths designed for friction fit between standard wall stud dimensions. Unfaced batts fit in wall cavities by friction (Figure 4.19a). Floor installations use metal clips, or tiger teeth, to hold the batts in place (Figure 4.19b). On ceilings, batts are stapled in place before the drywall is installed, or loose-laid between joists afterwards.

faced batts batt insulation that contain a foil or kraft paper vapor retarder covering.

unfaced batts cotton or fiberglass batt insulation that does not contain a vapor retarder covering.

While readily available outside the United States, rigid fiberglass board insulation is not a common product; however, interest and availability is increasing. Unlike rigid foam boards, it does not require the use of added fire retardants.

Blown-in fiberglass can be installed in walls and above ceilings. Ceiling insulation is sprayed on loosely to a specified depth to obtain the correct R-value. Wall insulation can be applied with or without an acrylic binder and in varying densities, which provide different R-values. Insulation sprayed with a binder adheres to stud cavities and is scraped even with studs after installation. When no binder is used, fabric mesh is installed on the walls, and then the insulation is sprayed into the cavity through the holes of the mesh (see Figure 4.20).

Historically, fiberglass batt insulation was manufactured with phenol formaldehyde (PF) binders to hold the fibers together, but some products now use acrylic or bio-based binders without any PF. Although most of the PF dissipates during manufacture, some continues to release into the wall cavity, which could be a problem for extremely chemically sensitive people. Off-gassing is the process by which many chemicals volatilize, or let off molecules in a gas form into the air. Many manufacturers now offer product lines that use non-PF binders or no binders at all.

Loose-fill fiberglass insulation uses no binders in manufacture, but this feature is not without its drawbacks. Fiberglass fibers can become airborne during installation, and inhalation of these particles poses the risk for potential lung problems. Fiberglass insulation is frequently manufactured with a minimum of 20%, and often more, recycled content, although removed insulation and installation scraps are not normally recycled.

Mineral Wool Insulation

Mineral wool insulation refers to either *slag wool* or *rock wool*. Slag wool is made from an iron ore blast furnace waste product. Rock wool is produced from natural basalt rock. One leading manufacturer uses a 50/50 mix of these two sources. The majority of the

phenol formaldehyde a potentially harmful chemical binder commonly used in fiberglass insulation and engineered wood products.

off-gassing the process by which many chemicals volatilize, or let off molecules in a gas form into the air; see also *volatile organic compounds*.

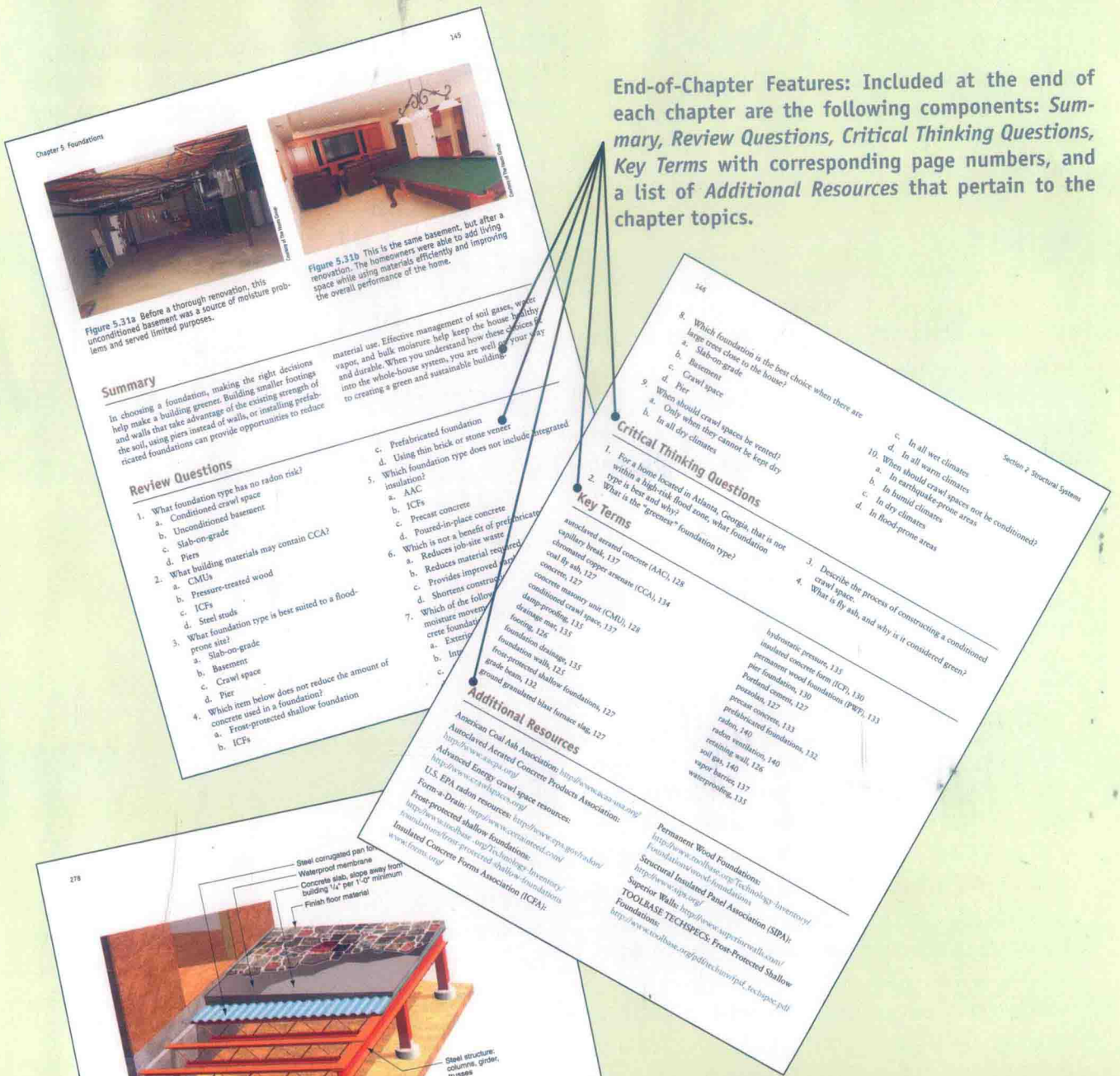
mineral wool insulation a manufactured wool-like material consisting of fine inorganic fibers made from slag and used as loose fill or formed into blanket, batt, block, board, or slab shapes for thermal and acoustical insulation; also known as *rock wool* or *slag wool*.

slag wool another name for *mineral wool*.

rock wool another name for *mineral wool*.

In-Text Glossary: Definitions of key concepts are provided on the page where the concept is first mentioned and defined. A paginated list of the key concepts also appears at the end of each chapter. The glossary at the end of the book contains a complete list of the key concepts together with their definitions.

End-of-Chapter Features: Included at the end of each chapter are the following components: *Summary, Review Questions, Critical Thinking Questions, Key Terms* with corresponding page numbers, and a list of *Additional Resources* that pertain to the chapter topics.



Chapter 5 Foundations 145

Figure 5.31a Before a thorough renovation, this unconditioned basement was a source of moisture problems and served limited purposes.

Figure 5.31b This is the same basement, but after a renovation. The homeowners were able to add living space while using materials efficiently and improving the overall performance of the home.

Summary

In choosing a foundation, making the right decisions help make a building greener. Building smaller footings and walls that take advantage of the existing strength of the soil, using piers instead of walls, or installing prefabricated foundations can provide opportunities to reduce material use. Effective management of soil gases, water vapor, and bulk moisture help keep the house healthy and durable. When you understand how these choices fit into the whole-house system, you are well on your way to creating a green and sustainable building.

Review Questions

1. What foundation type has no radon risk?
   a. Conditioned crawl space
   b. Unconditioned basement
   c. Slab-on-grade
   d. Piers
2. What building materials may contain CCA?
   a. CMUs
   b. Pressure-treated wood
   c. ICFs
   d. Steel studs
3. What foundation type is best suited to a flood-prone site?
   a. Slab-on-grade
   b. Basement
   c. Crawl space
   d. Pier
4. Which item below does not reduce the amount of concrete used in a foundation?
   a. Frost-protected shallow foundation
   b. ICFs
   c. Prefabricated foundation
   d. Using thin brick or stone veneer
5. Which foundation type does not include integrated insulation?
   a. AAC
   b. ICFs
   c. Precast concrete
   d. Poured-in-place concrete
6. Which is not a benefit of prefabricated foundations?
   a. Reduces job-site waste
   b. Reduces material required
   c. Provides improved
   d. Shortens construction
7. Which of the following
   moisture movement
   a. Exterior
   b. Ins
   c.

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8. Which foundation is the best choice when there are large trees close to the house?
   a. Slab-on-grade
   b. Basement
   c. Crawl space
   d. Pier
9. When should crawl spaces be vented?
   a. Only when they cannot be kept dry
   b. In all dry climates
   c. In all wet climates
   d. In all warm climates
10. When should crawl spaces not be conditioned?
    a. In earthquake-prone areas
    b. In humid climates
    c. In dry climates
    d. In flood-prone areas

Critical Thinking Questions

1. For a home located in Atlanta, Georgia, that is not within a high-risk flood zone, what foundation type is best and why?
2. What is the "greenest" foundation type?
3. Describe the process of constructing a conditioned crawl space.
4. What is fly ash, and why is it considered green?

Key Terms

autoclaved aerated concrete (AAC), 128
capillary break, 137
chromated copper arsenate (CCA), 134
coal fly ash, 127
concrete, 127
concrete masonry unit (CMU), 128
conditioned crawl space, 137
damp-proofing, 135
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flooring, 126
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Additional Resources

American Coal Ash Association: http://www.acaa-usa.org/
Autoclaved Aerated Concrete Products Association: http://www.aacpa.org/
Advanced Energy crawl space resources: http://www.crawlspaces.org/
U.S. EPA radon resources: http://www.cerainstitute.com/
Form-a-Drain: http://www.epa.gov/radon/
Frost-protected shallow foundations: http://www.toolbase.org/Technology-Inventory/foundations/frost-protected-shallow-foundations
Insulated Concrete Forms Association (ICFA): www.forms.org/
Permanent Wood Foundations: http://www.toolbase.org/Technology-Inventory/foundations/wood-foundations
Structural Insulated Panel Association (SIPA): http://www.sipa.org/
Superior Walls: http://www.superiorwalls.com/
TOOLBASE TECHSPECS: Frost-Protected Shallow Foundations: http://www.toolbase.org/pdf/techinfosheets/techspec.pdf

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Figure 10.14 Elevated concrete porch floors can be constructed on steel posts and beams, providing a long-lasting, low-maintenance structure. The membrane surface should slope at least 1/4" per foot.

Figure 10.15 Thermally treated wood begins as standard lumber and then undergoes a heat-based, chemical-free process that changes compounds in the wood. The result is a wood product that is resilient to rot, decay, and the elements.

over time. Composites may require closer joist spacing than is needed for wood decking because of their lower tensile strength. Composite waste cannot be recycled, so careful planning is needed to reduce the amount of waste generated.

Naturally Decay-Resistant Lumber

Naturally decay-resistant woods, such as redwood, western cedar, cypress, black locust, Pacific yew, and Ipe, are not prone to moisture damage. Naturally decay-resistant wood is less common than in years past. Only the old-growth heartwood of cedar and redwood is resistant to rot; new-growth sagwood does not have the same properties. Use of these woods, particularly the

naturally decay-resistant wood wood species, such as redwood, western cedar, cypress, black locust, Pacific yew, and Ipe, that are not prone to moisture damage.

An Extensive Art Program: A comprehensive collection of vivid illustrations and photos helps bring key concepts to life, enabling the reader to understand complex concepts more easily.

Supplements

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- A Testbank in ExamView format includes hundreds of questions and enables you to edit, delete, or add your own questions as well as create your own tests using the questions provided. This flexible format makes this feature a handy tool for evaluating your students on the concepts presented in each chapter.
- An Image Library containing illustrations from the book enables you to supplement and enhance your classroom presentations.
- Link to delmarlearning.com and click on building trades to review other Delmar Learning titles available in the construction fields.

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About the Authors

Abe Kruger

Abe Kruger is a certified Building Performance Institute (BPI) Building Analyst, Certified Energy Manager (CEM), and Home Energy Rating System (HERS) trainer and Rater as well as an active member of the Residential Energy Services Network (RESNET) National Technical Committee. Mr. Kruger is a designated Leadership in Energy and Environmental Design (LEED) Accredited Professional (AP) Homes and LEED AP Neighborhood Development (ND). He has conducted energy efficiency and conservation training for builders, renovators, home inspectors, contractors, and homeowners around the country. Mr. Kruger provides green building training and presentations at regional and national conferences, including RESNET, Affordable Comfort, Inc. (ACI), Green Prints, and Greenbuild, and he is accredited to perform EarthCraft House, LEED for Homes, and ENERGY STAR certifications. Mr. Kruger also assists with designing, implementing, and evaluating utility-run energy efficiency programs. In 2009, Mr. Kruger founded Kruger Sustainability Group to provide green building training, consulting, and curriculum development for colleges, companies, utilities, and nonprofit organizations.

http://www.KrugerSustainabilityGroup.com
abe@KrugerSustainabilityGroup.com

Carl Seville

Carl Seville has honed his expertise in sustainable construction through over 30 years as a contractor, educator, and consultant in the residential construction industry. He trains construction industry and allied professionals throughout the country on sustainable construction practices and certifies single and multifamily buildings under the LEED for Homes, EarthCraft House, and National Green Building Programs. His groundbreaking work has been recognized with numerous awards, including the Energy Value Housing Award (2009), two Green Advocate of the Year Awards (2005, 2007), two National Green Building Awards (2004, 2006), and the EarthCraft House Leadership award (2006). Mr. Seville is a Building Performance Institute (BPI) building analyst and a Home Energy Rating System (HERS) rater, and he holds the Leadership in Energy and Environmental Design (LEED) AP Homes and Green Rater designations.

http://www.greencurmudgeon.com
http://www.sevilleconsulting.com

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Joe Dusek—Triton College
George Ford—West Carolina University
Tim Gibson—John A. Logan College
Eric A. Holt—Perdue University
Gary Klein—Affiliated International Management
Carlos Martin
Stephen McCormick—Santa Fe Community College
Luke Morton
Ed Moore—York Technical College
Amy Musser—Vandemusser Design, PLLC
Norma Nusz Chandler—South Dakota State University
Cindy Ojczyk—Verified Green, Inc.
Ashley B. Richards, Jr.—Richards & Company, Inc.
Lingguang Song, Ph.D—University of Houston
Alex Wilson—Building Green, Inc.
Robert A. Wozniak—Pennsylvania College of Technology
Peter Yost—Building Green, Inc.

Special Contributors

Green Building Advisors: Martin Holliday, Dan Morrison
Building Green: Alex Wilson, Peter Yost
Southface Energy Institute
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Introduction to Green Building: Principles and Practices in Residential Construction

Green Building Overview

Green building is a set of design, construction, and building operation practices that minimize a building's total environmental impact. Decisions made while planning, building, renovating, and maintaining homes have long-term direct impacts on many different aspects of our environment—air quality, health, natural resources, land use, water quality, and energy use. At the same time, our building decisions have major economic implications, from the cost of land and materials to the labor and financing required to build.

Buildings are a primary point of consumption of energy, water, and raw materials. Residential buildings account for approximately 21% of all primary energy use in the United States, while commercial buildings represent another 19%.[1] Internationally, residential buildings use approximately 15% of primary energy.[2] Buildings are also responsible for a significant portion of air and water pollution.

The Eight Principles of Green Building

Although there is no universal definition of green building, we have identified eight green building principles that should always be considered when designing, building, or maintaining a home. These principles are similar to the approach defined by the United States Green Building Council's Leadership in Energy and Environmental Design (LEED) rating system and other green home rating programs.

- **Energy Efficiency:** Reducing the energy required to live in a house by designing it from the beginning with reduced consumption and increased efficiency in mind through appropriate equipment selection and high-quality construction methods
- **Resource Efficiency:** Reducing the total quantity of materials required to build or remodel a house, including selecting materials that are extracted, processed, and delivered to the job site with the least environmental impact and energy use; reusing previously used materials; and recycling of construction waste
- **Durability:** Using materials and methods that require less maintenance and increase the life of the structure; by reducing the frequency of repair and replacement, less waste is generated, and fewer materials are needed through the life of a house
- **Water Efficiency:** Reducing the amount of water used inside and outside the house through increased efficiency and minimizing opportunities for more consumption
- **Indoor Environmental Quality:** Improving occupant health by controlling moisture, toxic materials, and pollutants inside the house
- **Reduced Community Impact:** Limiting negative economic effects on the local community through responsible development and construction practices; considering how the selection of materials has an impact on the health and economic conditions of the global community—workers and local residents where products are extracted and manufactured for use in homes
- **Homeowner Education and Maintenance:** Educating homeowners and occupants to operate and maintain their homes to remain efficient, healthy, and durable throughout their lifetime
- **Sustainable Site Development:** Avoiding development of environmentally sensitive areas, orienting lots and homes to take advantage of the sun, promoting building near public transit and amenities to reduce driving, carefully managing the site

[1] U.S. Department of Energy, 2008 Buildings Energy Data Book, Section 1.1.1, 2008, http://buildingsdatabook.eren.doe.gov/

[2] http://www.eia.doe.gov/oiaf/ieo/world.html

during construction to reduce silt runoff and maintain native vegetation, and providing for permanent storm water management to reduce contaminant runoff from site to public waterways

Because all of the concepts will not be emphasized in every chapter, we have developed a series of icons to represent the different principles. The beginning of each chapter will list the icons that correspond to the principles covered in that chapter. These icons serve as a reminder of what the principles are and present an efficient way to note the green practices covered in a particular chapter.

Approach to Green Building in This Book

In this book, we cover green building in a "best practices" approach to low-rise residential construction. We examine the considerations that must be taken into account during the design, site development, and construction phases of the project, and we present the options available in material use—all with an eye toward building a truly green house.

Many green building techniques are simply those that consciously include and enforce good quality. Throughout the text, we describe how to simply build better homes that provide comfortable, safe, durable, and efficient living environments. Readers may be surprised to see that the term *green* is used sparingly throughout the text.

The book is broken into five sections that roughly follow the construction schedule. Section One defines green building, establishing why green building is desirable, and explaining the science behind green. At the foundation of green building is applied building science. For a home to operate efficiently and effectively, moisture, heat and air flow must be controlled (see Chapter 2). Section Two covers the structural systems of a home. Here we explore foundations, floors, walls, ceilings, and roofs. Section Three delves into exterior finishes, including windows and doors, cladding, outdoor spaces, and landscaping. Section Four examines interior finishes, and Section Five explores mechanical systems, including heating, ventilation, and air conditioning as well as electrical, plumbing, and renewable energy.

A Final Note

Regardless of your professional path, we hope you take away from this book an appreciation for the complexity of the issues and a firmer understanding of what it means to be truly green—recognizing that it is not just a buzzword. Now is an exciting time to be in the construction industry because of the rapidly changing products and techniques that are being developed to build better, greener homes.

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