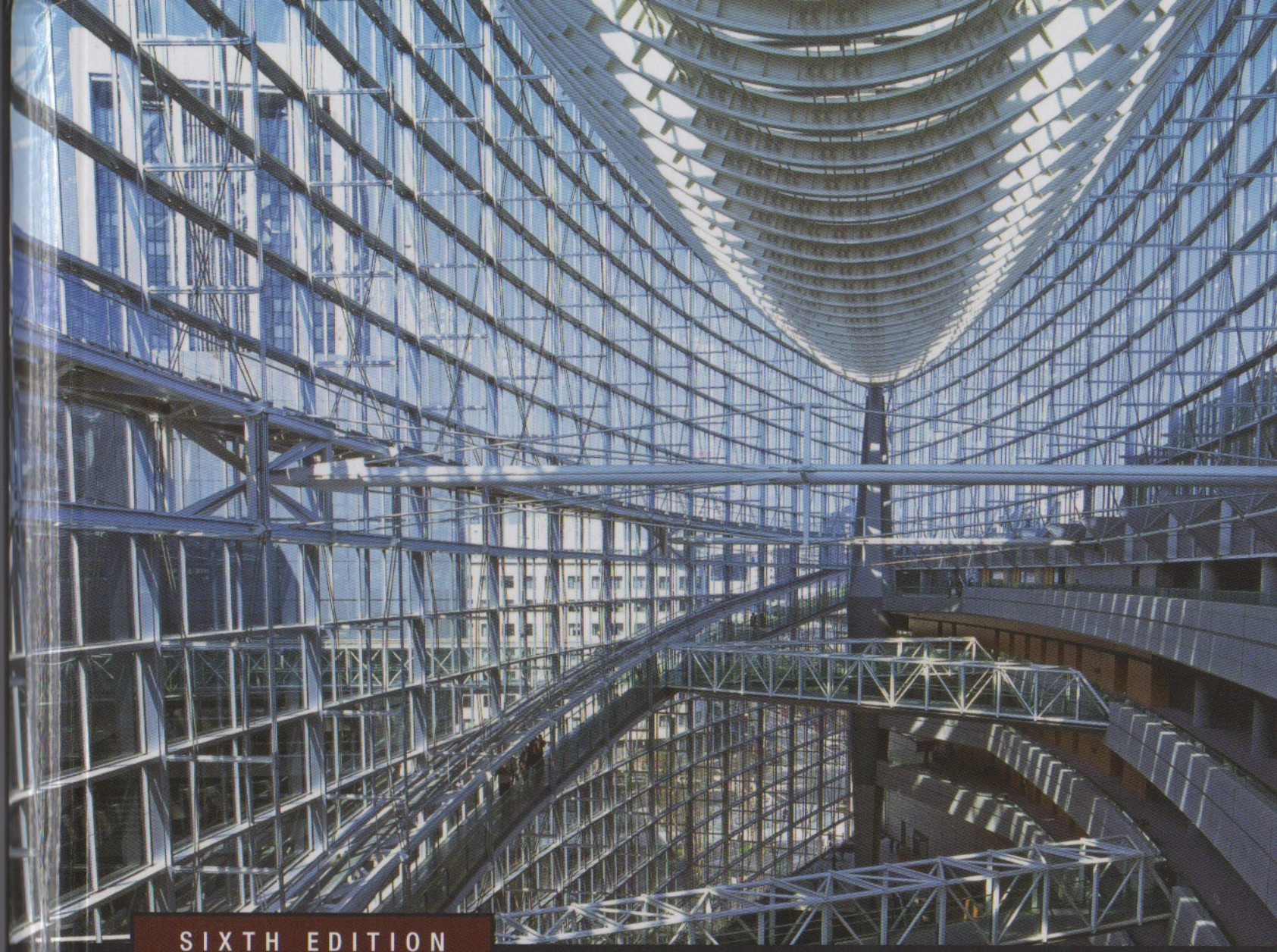
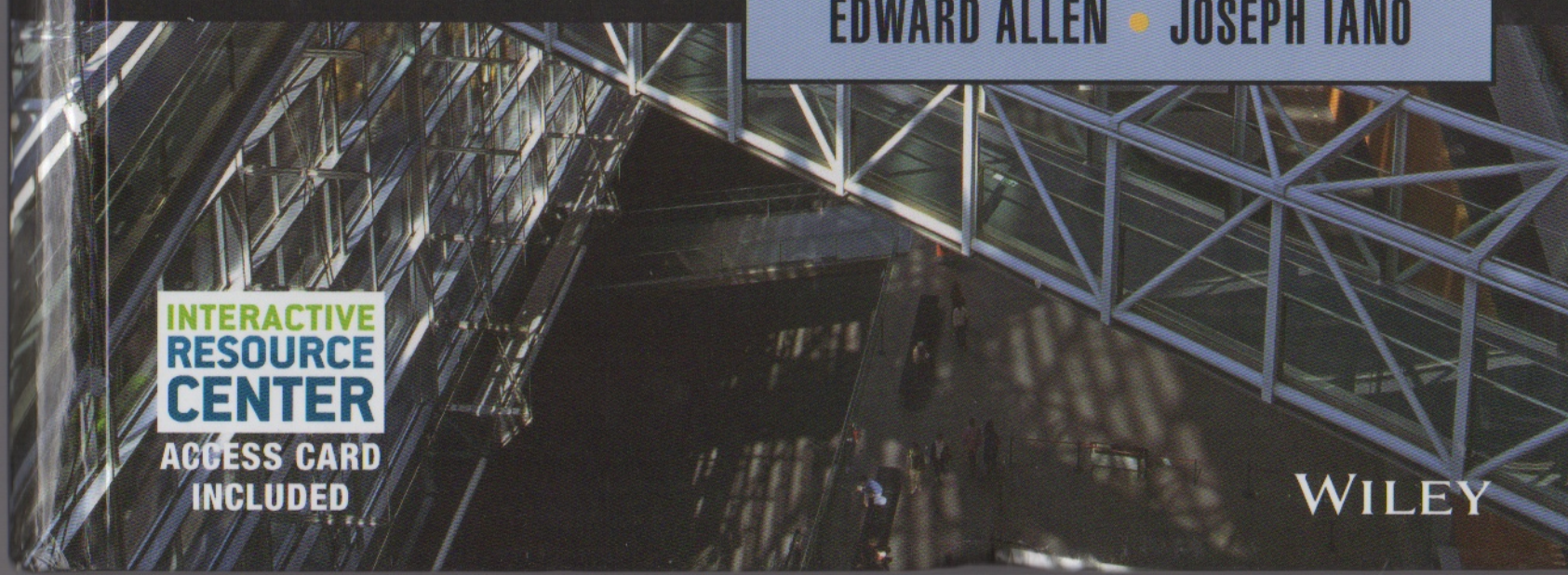


SIXTH EDITION

Fundamentals of Building Construction

Materials and Methods

EDWARD ALLEN • JOSEPH IANO



INTERACTIVE RESOURCE CENTER
ACCESS CARD INCLUDED

WILEY

1

MAKING BUILDINGS

- **Learning to Build**
- **Buildings and the Environment**
  - Sustainable Building Materials
  - Assessing Sustainable Buildings
- **The Work of the Design Professional**
  - Zoning Ordinances
  - Building Codes
  - Other Constraints
  - Construction Standards and Information Resources
- **The Work of the Construction Professional**
  - Providing Construction Services
  - Construction Scheduling
  - Managing Construction
- **Trends in the Delivery of Design and Construction Services**
  - Increasing Collaboration Among Team Members
  - Improving Efficiency in Production
  - Improving Information Management

An ironworker connects a steel wide-flange beam to a column.
(Courtesy of Bethlehem Steel Company)

We build because not all human activity can take place outdoors. We need shelter from sun, wind, rain, and snow. We need dry, level surfaces for our activities. Often we need to stack these surfaces to multiply available space. On these surfaces, and within our shelter, we need air that is warmer or cooler, more or less humid, than outdoors. We need less light by day, and more by night, than is offered by the natural world. We need services that provide energy, communications, and water and dispose of wastes. So, we gather materials and assemble them into the constructions we call buildings in an attempt to satisfy these needs.

Learning to Build

This book is about the materials and methods of building construction. Throughout it, alternative ways of building are described: different structural systems, different methods of building enclosure, and different interior finishes. Each has characteristics that distinguish it from the alternatives. Sometimes a material is selected chiefly for its visual qualities, as in choosing one type of granite over another, selecting a particular color of paint, or specifying a special pattern of tile. Visual distinctions can extend beyond surface qualities. A designer may prefer the massive appearance of a masonry bearing wall building to that of a more slender exposed steel frame on one project, yet would choose the steel for another. Choices may be made for functional reasons, as in selecting a highly durable and water-resistant polished concrete instead of carpet or wood for a restaurant kitchen floor. Or, choices can be made on purely technical grounds, as, for example, in selecting a construction system that is noncombustible, so as to achieve a suitable level of building fire safety.

A building designer's choices are frequently constrained by regulations intended to protect public safety and welfare. Choices may be influenced by considerations of environmental sustainability. And frequently, selections are made on economic grounds. Sometimes one system is chosen over another because its first cost is less. Other times the full life-cycle costs—including first cost, maintenance, energy consumption, useful lifetime, and replacement—of competing systems are compared.

In describing the major systems of building construction, this textbook presents concerns that fall into two broad categories: building performance and building construction. Performance concerns relate to the inescapable problems that must be confronted in every building: fire; the flow of heat, air, and water vapor through the building enclosure; the small, but nonetheless important, movements of the building and its parts; water leakage; acoustical performance; aging and deterioration of materials; cleanliness; building maintenance; and so on.

Construction concerns relate to the practical problems of getting a building built safely, on time, within budget, and to the required standards of quality: sequencing of construction operations for maximum productivity; optimum use of building trades; division of work between the shop and the building site; convenient and safe worker access to construction operations; effects of weather; making building components fit together; quality testing of materials and components during construction; and much more. To the novice, these matters may seem of minor consequence when compared to the larger and often more interesting themes of building form and function. To the experienced building professional, who has seen buildings fail both aesthetically and functionally for want of attention to one or more of these concerns, these are issues that must be resolved as a matter of course to ensure a successful project outcome.

To gain a thorough knowledge of building construction, it is incumbent upon the student to go beyond what can be presented here—to other books, product literature, trade publications, professional periodicals, and especially the design office, workshop, and building site. One must learn how materials feel in the hand; how they look in a building; how they are manufactured, worked, and put in place; how they perform in service; how they deteriorate with time. One must become familiar with the people and organizations that produce buildings—the architects, engineers, materials suppliers, contractors, subcontractors, workers, inspectors, managers, and building owners—and learn to understand their respective methods, problems, and points of view. There is no other way to gain the breadth of information and experience necessary than to get involved in the art and practice of building.

In the meantime, this long and hopefully enjoyable process of education in the materials and methods of building construction can begin with the information presented in this textbook.

Go into the field where you can see the machines and methods at work that make the modern buildings, or stay in construction direct and simple until you can work naturally into building-design from the nature of construction.

—Frank Lloyd Wright, "To the Young Man in Architecture," 1931

Buildings and the Environment

In constructing and occupying buildings, we expend vast quantities of the earth's resources and generate a significant portion of its environmental pollution. Buildings account for 30 to 40 percent of the world's energy consumption and carbon dioxide gas (CO_2) emissions. In the United States, buildings consume approximately 35 percent of this country's energy, 65 percent of its electricity, 12 percent of its potable water, and 30 percent of its raw materials. Building construction and operation together are responsible for roughly 40 percent of U.S. total greenhouse gas emissions and a third of its solid waste stream. Buildings are also significant emitters of particulates and other air pollutants. In short, building construction and operation cause many forms of environmental degradation and place a heavy burden on the earth's resources.

One simple definition of *sustainability* is building to meet the needs of the present generation without compromising the ability of future generations to meet their needs. By consuming irreplaceable fossil fuels and other nonrenewable resources, by building in sprawling urban patterns that cover extensive areas of prime agricultural land, by using destructive forestry practices that degrade natural ecosystems, by allowing topsoil to be eroded by wind and water, by generating substances that pollute water, soil, and air, and by generating copious amounts of waste materials that are eventually incinerated or buried in the earth, we have been building in a manner that will make it increasingly difficult for our children and grandchildren to meet their needs for communities, buildings, and healthy lives.

Sustainable building construction demands a more symbiotic relationship between people, buildings, communities, and the natural environment. Sustainable buildings—in both their operation and construction—must use less energy, consume fewer resources, cause less pollution of the air, water, and soil, reduce waste, discourage wasteful land development practices, contribute to the protection of natural environments and ecosystems, provide healthier interiors for building occupants, and minimize adverse social impacts.

The practice of sustainable design and construction, also called *green building*, continues to mature. The understanding of the interplay between buildings and the environment has deepened and standards for sustainability continue to evolve. Interest in and adoption of green building has broadened among public agencies, private owners, and building occupants. The design and construction industry has become more skillful at applying green practices, and sustainable building is becoming more integrated with mainstream practice. As a result, sustainable building performance is improving while the premium in cost and effort to design and construct such buildings in comparison to conventional buildings is declining or disappearing completely.

Sustainable Building Materials

Building sustainably requires access to information about the environmental impacts of the materials used in construction. For example, when selecting a material, the designer must ask: Does its manufacture depend on the extraction of nonrenewable resources, or is it made from recycled or rapidly renewable materials? Is additional energy required to ship the material from a distant location, or is it produced locally? Does the material contain toxic ingredients or generate unhealthful emissions, or is it free of such concerns? To enable meaningful decision making, reliable product information must be readily available to all the parties involved in the selection of materials for sustainable building design.

A series of international standards, designated as ISO 14020, distinguish three types of *environmental labels* that define expectations for comprehensiveness and reliability of sustainable materials and product information:

- *Type I Ecolabels* are independent, third-party certifications of environmental performance. Their accuracy and comprehensiveness are intended to ensure that the information provided is unbiased, relevant, and reliable.
- *Type II Self-Declared Environmental Claims* are provided directly by product manufacturers, without independent verification. They may also be more limited in scope than Type I labels. Type II labels may provide useful information, but users must employ their own judgment in evaluating the appropriateness of these products for a particular application.
- *Type III Environmental Impact Labels* provide the most comprehensive assessments of products and their environmental impacts on a comprehensive life-cycle basis. However, they do not in themselves provide environmental ratings or judgments—it is up to the user to interpret the data for this purpose. The information in Type III labels is independently verified, but the label itself may be prepared by the product manufacturer.

An example of a Type I Ecolabel is Green Seal Standard GS-11 for Paints and Coatings. Green Seal is a not-for-profit, independent organization that develops sustainability standards and certifications. For a paint or coating product to be certified to the GS-11 standard, it must:

- Meet minimum performance requirements, such as adhesion, ease of application, hiding power, washability, and fade resistance
- Be free of highly hazardous ingredients (for example, carcinogens)
- Not exceed permitted amounts for other less hazardous ingredients such as volatile organic compounds (a class of chemicals that contribute to air pollution and can act as irritants to building occupants)

Cover image: © Amana Images/Alamy
Cover design: Michael Rutkowski

This book is printed on acid-free paper. ♾

Published by John Wiley & Sons, Inc., Hoboken, New Jersey.

Published simultaneously in Canada.

Library of Congress Cataloging-in-Publication Data:
Allen, Edward, 1938-
Fundamentals of building construction : materials and methods /
Edward Allen and Joseph Iano. – Sixth Edition.
pages cm
Includes index.
ISBN 978-1-118-13891-5 (hardback); ISBN 978-1-118-41919-9 (ebk); ISBN 978-1-118-42086-7 (ebk)
1. Building. 2. Building materials. I. Iano, Joseph. II. Title.
TH145.A417 2013
690–dc23

2013002846

Printed in the United States of America

V10004851_101718