

The Sustainable Concrete Guide



Applications

Andrea J. Schokker, Editor

 **U.S. GREEN
CONCRETE COUNCIL**

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The transformation toward sustainable development provides the concrete industry with a tremendous opportunity and responsibility to inform stakeholders about our material's ability to not only enhance the built environment for people and communities but also to protect our planet as well. The longevity of service of concrete structures continues to be a critical environmental asset, with beneficial impact on natural resource conservation, landfill use, and CO₂ reduction. In addition, such long-serving structures contribute positive social and economic benefits. And, when safeguarding against the devastation caused by natural or man-made disasters, the resilience of concrete structures becomes essential for protecting people, protecting communities, and protecting our planet's resources.

I extend my gratitude to the Editorial Review Panel of Michael Deane, Kevin MacDonald, Aris Papadopoulos, Michael Paul, Richard Stehly, and Wayne Trusty for the countless hours they spent providing direction, content, and editorial support for this guide, after the completion of the first "Strategies and Examples" guide just months before. My dear friend and colleague, Richard Stehly, who passed away just prior to the publishing of this book, was a visionary and inspired each of us to embrace the opportunity for using concrete in sustainable development. He will be missed, and his contribution to this guide is one of the many legacies he leaves for us all.

In compiling this book, the Editorial Review Panel worked with associations, institutes, and organizations that represent concrete materials, products, and construction to qualify and quantify concrete applications in regards to sustainable development. It is to these associations, institutes, and organizations that have invested so much time, effort, and knowledge to this industry-wide resource that I dedicate this book; their knowledge and experience will provide designers and constructors with the information and understanding necessary to transform the built environment. For that, I am grateful. Our industry is grateful.



Florian G. Barth
President, U.S. Green Concrete Council

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INTRODUCTION




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Concrete is the most used construction material in the world with over 25 billion tons (22.7 billion metric tons) placed each year (World Business Council for Sustainable Development 2009). This book is the second in a series of guides on sustainable concrete. The first book, *The Sustainable Concrete Guide—Strategies and Examples* (Schokker 2010), provides an overview of the aspects for potential contributions to sustainability of concrete used in buildings. While the two books can serve as stand-alone references, the *Strategies and Examples* book provides a base of knowledge about using concrete to achieve more sustainable buildings. This book, *Applications*, focuses on integrating sustainable strategies into the selection of concrete materials, constructing with concrete, and identifying uses for a multitude of concrete applications.

The book is divided into five parts: 1) materials, 2) construction, 3) applications, 4) concrete in sustainable structures, and 5) codes. Part 1 addresses the material components and their sustainable benefits when used in the production of concrete. Part 2 covers the construction team's role from production, waste stream management, scheduling through quality control, and commissioning. Part 3 describes the sustainable attributes of various concrete systems and products highlighted by a list of sustainable attributes for each

application. Part 4 provides a summary of how concrete structural elements can be integrated into overall building design, as well as solutions to meet typical building needs. Part 4 also covers detailed information on maintenance, repair, preservation, and adaptive reuse. Part 5 provides an overview of how sustainable recommendations are migrated from voluntary acceptance to mandatory considerations in codes and standards. Case studies and examples are used throughout to demonstrate how sustainable benefits have been achieved in practice. The information presented in this book is based on referenced material from the individual organizational members of the Concrete Joint Sustainability Initiative (discussed below) with expertise in the various materials, production, construction, and applications.

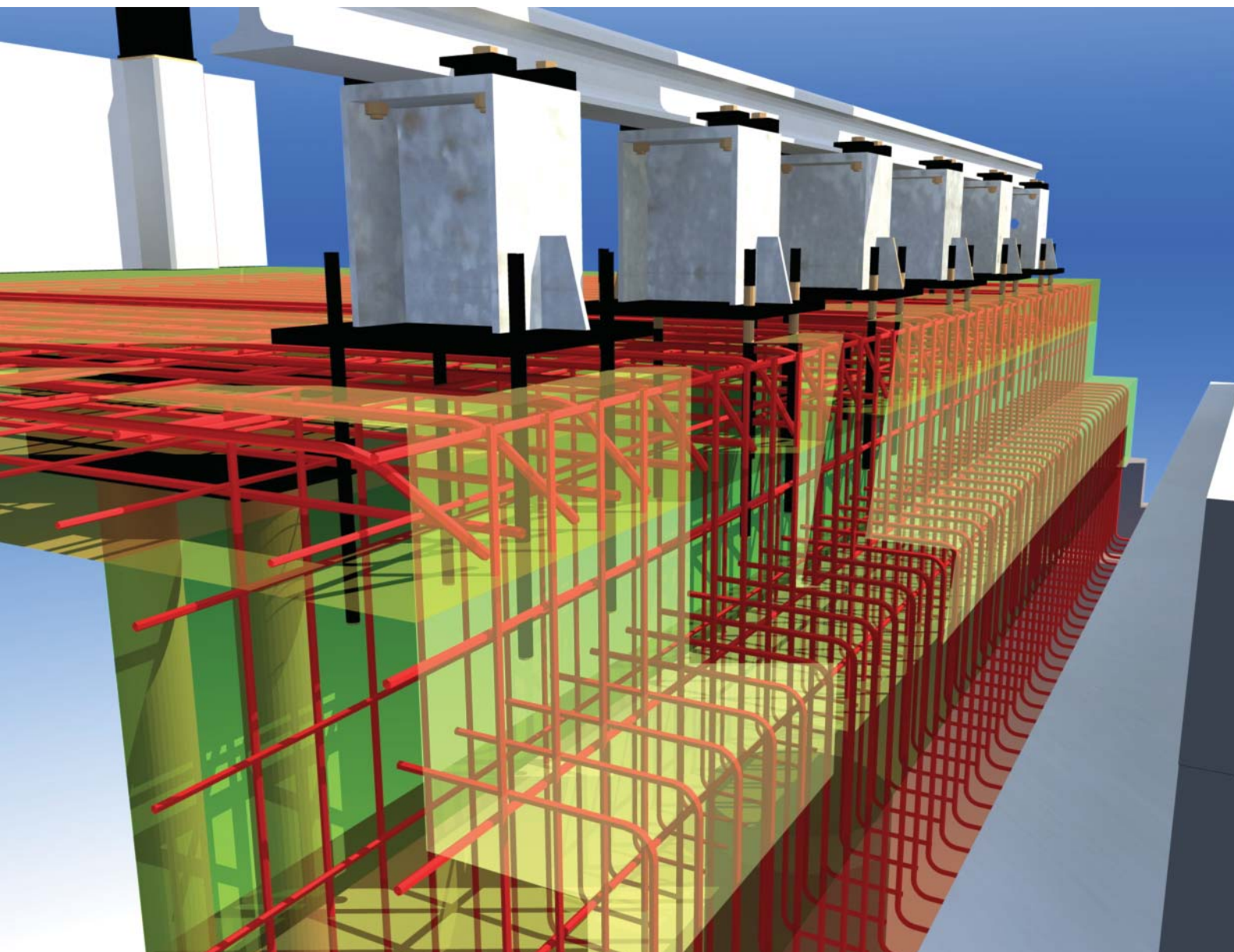
After a number of years of addressing sustainability individually, numerous stakeholders in the concrete industry agreed to advance the sustainable benefits of concrete by forming the Concrete Joint Sustainability Initiative (Concrete JSI) in 2009. Concrete JSI member organizations agree to contribute to a unified vision focused around the social values provided by concrete structures. Concrete structures as defined by the Concrete JSI include “all vertical and horizontal applications and all concrete products.” This focus on concrete structures moves the Concrete



Photo courtesy of Post-Tensioning Institute

JSI members toward an integrated systems approach to sustainability and is centered on the key values of concrete structures:

- **Stewardship of Nature's Resources** – Concrete can play a vital role in the way we conserve and protect natural resources in the structures we create with it and the processes by which we produce it. Concrete offers long-lasting service with minimal maintenance, along with recycled content and end-of-service recyclability. In its many forms, uses, and styles, concrete can reduce the need for additional building materials, operating energy in buildings and transportation, conversion of undeveloped land, retention ponds, and other traditional storm-water management systems.
- **Stewardship of Financial Resources** – In the case of concrete, the length of service that results



Rendering courtesy of Virtual Design & Construction Dept., KLORMAN Construction

from its durability, the versatility of its design and applications, the speed of construction, and the in-place performance all contribute to a return on the investment. Concrete structures provide long-term savings in operating cost and service life. In addition, their durability, their resistance to damage from harsh weather, pests and natural disasters, and their low maintenance requirements are beneficial to future owners and users.

- **Durability, Safety, and Stability** – Concrete is a lasting material that provides shelter to get through disasters with less damage, less loss, and less waste. It connects people to each other through transportation corridors, gathering places, and monuments. It also helps ensure that critical services like roads, hospitals, communications, data transmission, and emergency services can remain in operation.
- **Aesthetics** – Aside from the basic functionality, the look and feel of a place influences how successfully it serves its purpose. Concrete is strong and functional, yet its fluidity lets the designer adapt it to whatever form, scale, shape, surface, and texture he can imagine. Beyond a visual aesthetic, designers can use concrete to affect sound—either through amplification or dampening between spaces.

Nearly 30 organizations are members of the Concrete JSI, showing a commitment to a unified systems approach to improving sustainability of concrete structures and in educating engineers, architects, owners, contractors, and the general public. This book includes educational information from members of the Concrete JSI to help these decision-makers in understanding the various sustainable attributes of the many concrete systems that are available.

This book, *The Sustainable Concrete Guide—Applications*, its companion book *The Sustainable Concrete Guide—Strategies and Examples*, and the Concrete JSI Web site, www.sustainableconcrete.org, provide hundreds of strategies, resources, and case studies on the use on concrete in sustainable development.

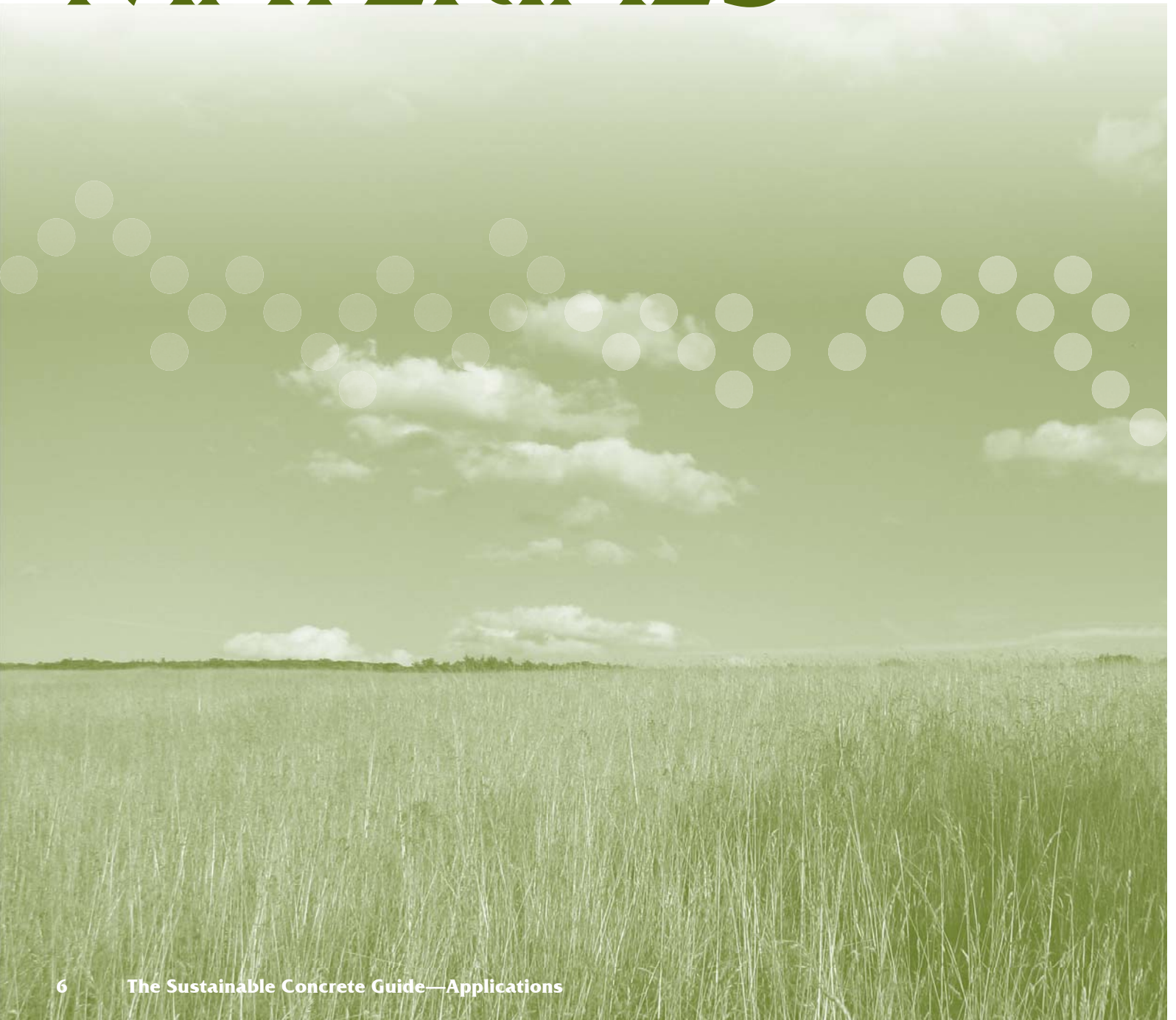


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PART 1— MATERIALS



Introduction

Part 1 addresses the materials (water, cement, supplementary cementitious materials [SCMs], aggregates, reinforcement, admixtures, and other materials) that are used in the applications presented later in the book. Each of the seven materials chapters provides (as applicable): definitions, primary sustainable attributes, contributions to longevity and life cycle, opportunities to reduce/reuse/recycle, industry initiatives, and sources for additional information.