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Resilience-Based Performance

Next Generation Guidelines for Buildings and Lifeline Standards

Risk and Resilience Measurement Committee

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Resilience-Based Performance

Next Generation Guidelines for Buildings and Lifeline Standards

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Preface

Since the turn of the century, there has been a marked increase in research, education, and advocacy toward developing strategies for increasing the resilience of communities to natural and man-made hazards. While resilience is defined in many ways, it generally refers to the ability of different social units (individuals, households, organizations, communities, regions and nations) to minimize the effect of, adapt to, and recover from disruptive events. Achieving resilience is a complex problem that must consider and integrate what communities need from their social, economic, natural, and built environments. This work specifically focuses on what enhancements are needed in the design and construction of buildings and lifeline systems to support a community's social stability, economic vitality, and environmental sustainability.

A major challenge in enhancing a community's built environment stems from the current approach used to establish the performance goals of buildings and infrastructure systems. Current code-based standards are primarily focused on individual facilities and are out of sync with the resilience needs of the broader community. The emphasis on life safety and a lack of consideration of the consequences of loss of functionality will result in extensive socioeconomic disruptions and slow recovery after a major hazard event. A new generation of standards is needed, which redefines the current design approach such that it integrates community-level resilience goals with functional recovery-based design standards for individual facilities. It requires a convergent approach that brings together engineers, social scientists, economists, environmentalists, and more.

Building on the framework that was advanced by the National Institute of Standards and Technology's *Resilience Planning Guide for Buildings and Infrastructure*, the Risk and Resilience Measurements Committee (RRMC) of ASCE has embarked on a long-term project to develop the needed, next-generation, resilience-based design standards for buildings and lifeline systems. This book represents a foundation and first step in what promises to be a long and complex transition.

The RRMC is one of four committees within the newly formed ASCE Infrastructure Resilience Division. The division was organized and chartered to advance resilient practices and improve the performance of civil infrastructure and lifeline systems recognizing their interdependent relationships and using risk and uncertainty principles.

Chris Poland and Henry Burton, Co-chairs, RRMC

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Executive Summary

Built infrastructure, which includes buildings, building clusters, lifeline systems, and other engineered systems, is critical to the functionality of communities. Through a complex network of interactions and interdependencies, the built environment supports economic, social, cultural, and other types of community development. However, the physical, functional, geo-spatial, and informational interdependencies within the components and systems of the built environment are such that physical damage caused by natural hazard events can have enduring adverse effects on a range of community activities. A community that is resilient to natural hazards can minimize the initial impacts of, adapt to, and quickly recover from a natural hazard event. The performance of built infrastructure under normal operating and extreme loading, and its specific role in supporting normal functioning, are key considerations in assessing and enhancing community resilience. However, current codes and standards generally do not explicitly consider the function of an infrastructure system or component in establishing its desired performance in hazard events. In most cases, the safety of users is the primary (and often, only) criterion.

The primary objective of this book is to create a roadmap for the next generation of resilience-based performance standards and guidelines for the built environment. Central to the notion of resilience-based standards is an explicit link between the performance targets for buildings and lifelines and the high-level resilience goals of the community. A conceptual framework is proposed, which takes on a hierarchical structure, connecting community resilience goals with the performance objectives defined at the infrastructure system scale (e.g., building clusters and lifelines) and the component level (e.g., individual buildings and lifeline components and subsystems). A focused review of the ongoing research and practice toward the development of resilience-based standards is also presented. The specific goals of this review are: to summarize and synthesize the state of research and practice on infrastructure performance and community resilience, to identify the existing tools and methods that are relevant to advancing the proposed conceptual framework, and to highlight future research needs. The review is divided into four thematic areas: characterizing communities and their supporting infrastructure, characterizing hazards, measuring and assessing community resilience, and measuring and assessing infrastructure performance. The main findings from these four areas are summarized in the paragraphs that follow.

The proposed conceptual framework begins with the implementation of a stakeholder-driven process to establish community resilience goals. Performance objectives for "vital functions"—those goods, services, activities, and exchanges that support normal community functioning (e.g., energy, transportation,