Masonry Structural Design

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Masonry Structural Design

Jennifer Eisenhauer Tanner, Ph.D., P.E.
Richard E. Klingner, Ph.D.

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About the Authors

Jennifer Eisenhauer Tanner is an Associate Professor of Civil and Architectural Engineering at the University of Wyoming, Laramie, Wyoming. She is chair of ACI Committee 526, Autoclaved Aerated Concrete and was previously a member of TMS 402 (masonry code) for 12 years. In 2010 she received the ACI Young Member Award for Professional Achievement and was made an ACI Fellow in 2016. Her research interests include laboratory and field testing; nondestructive testing; concrete and masonry durability, building performance, and material performance. Her teaching interests include Masonry Design, Concrete Design, Construction Materials, Structural Analysis, and Earthquake Engineering.

Richard E. Klingner is Emeritus Professor of Civil, Architectural, and Environmental Engineering at The University of Texas in Austin, where he taught graduate and undergraduate courses, including a course in masonry engineering. His research interests include the behavior and design of masonry structures for earthquake loads. He was active in numerous technical committees including The Masonry Society, the American Concrete Institute, the American Society of Civil Engineers, and the American Society for Testing and Materials. From 2002 to 2008, he was Chair of the Masonry Standards Joint Committee, charged with developing and maintaining U.S. masonry design provisions during that period.

This book is dedicated to
Timothy Eisenhauer and to Ann Klingner.

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Preface

This book came from the merging of material from two masonry courses, each developed by one of the two authors. It covers the design of masonry structures using the 2015 *International Building Code*, the *ASCE 7-10* loading standard, and the *TMS 402-13* and *TMS 602-13* design and construction standards. Although the book was conceived primarily as a textbook for masonry design courses in civil or architectural engineering programs at the undergraduate or graduate level, it is also intended for use in self-study and continuing education by practicing engineers. It emphasizes the strength design of masonry and also includes allowable-stress design.

Chapter 1 of this book begins, not with design calculations, but rather with a basic discussion of how wall-type buildings behave and how those buildings can be detailed and specified using masonry. The reason for this is that until the reader understands how the elements of a masonry building work together structurally, the design of those individual elements will not have a clear purpose. Many categories of masonry buildings require only the most rudimentary structural design, and the first part of this book is intended to show how to detail and specify detail for such buildings correctly.

Chapter 2 then covers the terminology of masonry and masonry materials, followed by an explanation of their basic behavior, and ending with a summary of how to use ASTM specifications for masonry materials.

Chapters 3 and 4 address structural design provisions for masonry elements and structures. In the context of *TMS 402-13,* masonry elements are classified by structural function, and as unreinforced or reinforced. Strength design and allowable-stress design are discussed, along with the loads and loading combinations used for each design approach. To reinforce concepts not always explicitly covered in civil or architectural engineering programs, these chapters include detailed examples of the calculation of design for wind and seismic loads according to the 2015 *IBC* and *ASCE 7-10*, the load standard referenced by that model code.

Chapters 5 and 6 address the strength design of unreinforced and reinforced masonry elements, respectively. Chapters 7 and 8 repeat that presentation for allowable-stress design. In Chapter 9, the strength and allowable-stress provisions of *TMS 402-13* are compared.

In Chapter 10, the lateral load analysis of low-rise wall structures is discussed, and specific recommendations are presented for hand analysis and computer-aided analysis. In Chapter 11, design and detailing of floor and roof diaphragms are discussed.

Chapters 12 and 13 present the preliminary design, using strength procedures, of two representative prototype masonry buildings. The first building is a low-rise

commercial building, designed for gravity and wind loads; the second is a four-story hotel, designed for gravity and earthquake loads.

Chapter 14 addresses autoclaved aerated concrete (AAC) masonry, an innovative construction material addressed by the 2015 *IBC*, *ASCE 7-10*, *TMS 402-13*, *TMS 602-13*, and ASTM specifications. Background material on AAC masonry is reviewed, and design examples are presented. Chapter 14 ends with a preliminary design example of a three-story hotel, subjected to gravity and earthquake loads.

Jennifer Eisenhauer Tanner, Ph.D., P.E.
Richard E. Klingner, Ph.D.

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