Building Code Requirements and Specification for Masonry Structures

Containing

Building Code Requirements for Masonry Structures
(TMS 402-13/ACI 530-13/ASCE 5-13)

Specification for Masonry Structures
(TMS 602-13/ACI 530.1-13/ASCE 6-13)

and Companion Commentaries

Developed by the Masonry Standards Joint Committee (MSJC)

THE MASONRY SOCIETY
Advancing the knowledge of masonry

The Masonry Society
105 South Sunset Street, Suite Q
Longmont, CO 80501
www.masonrysociety.org

aci
American Concrete Institute®
Advancing concrete knowledge

American Concrete Institute
P.O. Box 9094
Farmington Hills, MI 48333
www.concrete.org

SEI ASCE
STRUCTURAL ENGINEERING INSTITUTE

Structural Engineering Institute of the American Society of Civil Engineers
1801 Alexander Bell Drive
Reston, VA 20191
www.seinstitute.org

ABSTRACT

Building Code Requirements and Specification for Masonry Structures contains two standards and their commentaries: Building Code Requirements for Masonry Structures (TMS 402-13/ACI 530-13/ASCE 5-13) and Specification for Masonry Structures (TMS 602-13/ACI 530.1-13/ASCE 6-13). These standards are produced through the joint efforts of The Masonry Society (TMS), the American Concrete Institute (ACI), and the Structural Engineering Institute of the American Society of Civil Engineers (SEI/ASCE) through the Masonry Standards Joint Committee (MSJC). The Code covers the design and construction of masonry structures while the Specification is concerned with minimum construction requirements for masonry in structures. Some of the topics covered in the Code are: definitions, contract documents; quality assurance; materials; placement of embedded items; analysis and design; strength and serviceability; flexural and axial loads; shear; details and development of reinforcement; walls; columns; pilasters; beams and lintels; seismic design requirements; glass unit masonry; veneers; and autoclaved aerated concrete masonry. An empirical design method and prescriptive method applicable to buildings meeting specific location and construction criteria are also included. The Specification covers subjects such as quality assurance requirements for materials; the placing, bonding and anchoring of masonry; and the placement of grout and of reinforcement. This Specification is meant to be modified and referenced in the Project Manual. The Code is written as a legal document and the Specification as a master specification required by the Code. The commentaries present background details, committee considerations, and research data used to develop the Code and Specification. The Commentaries are not mandatory and are for information of the user only.

Adopted as standards of the American Concrete Institute (September 13, 2013), the Structural Engineering Institute of the American Society of Civil Engineers (September 4, 2013), and The Masonry Society (August 27, 2013) to supersede the 2011 edition in accordance with each organization's standardization procedures. These standards were originally adopted by the American Concrete Institute in November, 1988, the American Society of Civil Engineers in August, 1989, and The Masonry Society in July, 1992.

ISBN 978-1-929081-43-1
ISBN 1-929081-43-X
Produced in the United States of America

About the MSJC and its Sponsors

Masonry Standards Joint Committee

The Masonry Standards Joint Committee (MSJC) is, as its name suggests, a joint committee sponsored by The Masonry Society (TMS), the American Concrete Institute (ACI), and the Structural Engineering Institute of the American Society of Civil Engineers (SEI/ASCE). Its mission is to develop and maintain design and construction standards for masonry for reference by or incorporation into model building codes regulating masonry construction. In practice, the MSJC is responsible for the maintenance of the *Building Code Requirements for Masonry Structures* (TMS 402/ACI 530/ASCE 5), *Specification for Masonry Structures* (TMS 602/ACI 530.1/ASCE 6) and their companion *Commentaries*. Committee membership is open to all qualified individuals, within the constraints of balance requirements, balloting schedules and particular needs for technical expertise. Committee meetings are open to the public.

Committee Activities include:

1. Evaluate and ballot proposed changes to existing standards of the committee.
2. Develop and ballot new standards for masonry.
3. Resolve Negative votes from ballot items.
4. Provide interpretation of existing standards of the Committee.
5. Identify areas of needed research.
6. Sponsor educational seminars and symposia.
7. Monitor international standards.

Additional details of the Committee, its work, and its meeting schedule are posted at www.masonrysociety.org and can be obtained from The Masonry Society. A roster of the Committee Members during the 2013 Revision Cycle is shown on the following page.

THE MASONRY SOCIETY

Advancing the knowledge of masonry

The Masonry Society (TMS) was founded in 1977 as a not-for-profit professional, technical, and educational association dedicated to the advancement of knowledge on masonry. Today TMS is an international gathering of people interested in the art and science of masonry, and its members include design engineers, architects, builders, researchers, educators, building officials, material suppliers, manufacturers, and others who want to contribute to and benefit from the global pool of knowledge on masonry.

TMS gathers and disseminates technical information through its committees, publications, codes and standards, newsletter, refereed journal, educational programs, workshops, scholarships, disaster investigation team, and conferences. The work of TMS is conducted by individual TMS members and through the volunteer committees composed of both members and non-members. The Masonry Society serves as the lead Society for the support of the MSJC, and as such, meetings of the committee are held at TMS meetings and activities of the Committee are managed by TMS.

For more information about TMS, contact The Masonry Society, 105 South Sunset Street, Suite Q, Longmont, Colorado, 80501-6172 U.S.A; Phone: 303-939-9700; Fax:303-541-9215; E-mail: info@masonrysociety.org; Website: www.masonrysociety.org

American Concrete Institute®
Advancing concrete knowledge

The AMERICAN CONCRETE INSTITUTE

ACI was founded in 1904 as a nonprofit membership organization dedicated to public service and representing the user interest in the field of concrete. ACI gathers and distributes information on the improvement of design, construction, and maintenance of concrete products and structures. The work of ACI is conducted by individual ACI members and through volunteer committees composed of both members and non-members.

The committees, as well as ACI as a whole, operate under a consensus format, which assures all participants the right to have their views considered. Committee activities include the development of building codes requirements and specifications, analysis of research and development results, presentation of construction and repair techniques, and education.

Individuals interested in the activities of ACI are encouraged to become members. There are no educational or employment requirements. ACI's membership is composed of engineers, architects, scientists, contractors, educators, and representatives from a variety of companies and organizations. Members are encouraged to participate in committee activities that relate to their specific areas of interest.

For more information about ACI, contact the American Concrete Institute, 38800 Country Club Drive, Farmington Hills, MI 48331 U.S.A; Phone: 248-848-3700; Fax: 248-848-3701; Website: www.concrete.org

SEI STRUCTURAL ENGINEERING INSTITUTE
ASCE

The Structural Engineering Institute (SEI) is a 22,000 plus member organization within the American Society of Civil Engineers (ASCE). SEI is organized into four Divisions. The Business and Professional Activities Division (BPAD), promotes needed change in business and professional development issues unique to the structural engineering profession. The Codes and Standards Activities Division (CSAD) develops and maintains leading design standards that are used worldwide. The Local Activities Division (LAD) provides technical, educational, and professional program support to the local structural technical groups within ASCE's sections and branches. The Technical Activities Division (TAD) advances the profession with the dedicated work of its 70 plus technical committees that produce technical papers and publications and produce the *Journal of Structural Engineering*, the *Journal of Bridge Engineering*, and the *Practice Periodical on Structural Design and Construction*.

Through its four divisions, SEI advances the profession in many ways including developing standards such as ASCE 7, encouraging discussion about licensure issues, enriching local Structural Technical Group programs, leading coordination efforts with other standards organizations, conducting an annual Structures Congress, offering cutting edge presentations, offering specialty conferences on topics of interest to the Structural Engineering community, coordinating efforts with other structural engineering organizations, responding to the community's need for help in crisis, and providing low-cost seminars and webinars to the Structural Engineering community

For more information about SEI, contact the Structural Engineering Institute, 1801 Alexander Bell Drive, Reston, VA 20191; Phone: 703-295-6196; E-mail: jrossberg@asce.org; Website: www.seinstitute.org

Masonry Standards Joint Committee

Diane B. Throop - Chair
Richard M. Bennett - Vice Chair
Gerald A. Dalrymple - Secretary

Voting Members on Main Committee[1]

Daniel P. Abrams	Thomas A. Gangel	Richard E. Klingner*	Arturo Ernest Schultz
Jennifer R. Bean Popehn*	David C. Gastgeb	W. Mark McGinley*	Kurtis K. Siggard
Richard M. Bennett*	S. K. Ghosh	David I. McLean	Jennifer E. Tanner
David T. Biggs*	Benchmark H. Harris	Darrell W. McMillian	John G. Tawresey
Robert N. Chittenden	Ronald J. Hunsicker	John M. Melander	Jason J. Thompson
John Chrysler*	Edwin T. Huston	Raymond T. Miller	Margaret I. Thomson
Chukwuma G. Ekwueme	Keith Itzler*	Vilas Mujumdar	Diane B. Throop*
Fernando Fonseca	Rochelle C. Jaffe*	Jerry M. Painter	Charles J. Tucker*
Susan M. Frey+	Eric N. Johnson*	David L. Pierson	Scott W. Walkowicz*
Edward L. Freyermuth	Rashod R. Johnson	Max L. Porter	A. Rhett Whitlock

Voting Members of Subcommittees Only[2]

Bruce Barnes	Mohamed ElGawady	Matthew D. Jackson	Thomas M. Petreshock
Russell H. Brown	James A. Farny	John J. Jacob +	Alan Robinson
Charles B. Clark	James Feagin	Yasser Korany	Paul G. Scott
Thomas M. Corcoran	Sonny J. Fite	James M. LaTave	John J. Smith
George E. Crow III	David Gillick	Walter Laska	Bruce Weems
Terry M. Curtis	Edgar F. Glock Jr.	Nicholas T. Loomis	David B. Woodham
Mark A. Daigle	Dennis W. Graber	Peter J. Loughney	Rick Yelton
Gerald A, Dalrymple	Brian J. Grant	Sunup S. Mathew	Tianyi Yi
Manuel A. Diaz	Charles A. Haynes	James P. Mwangi	
Steve M. Dill	David Chris Hines	Khaled Nahlawi	

Subcommittee Corresponding (C) and Consulting (CN) Members[3]

Sergio M. Alcocer (C)	Richard Fillmann (C)	Shelley Lissel (C)	Donato Pompo (C)
James E. Amrhein (C)+	Hans Rudolf Gnaz (C)	John Maloney (C)	Matthew Reiter (C)
Ronald E. Barnett (C)	Clarence Heider (C)	John H. Matthys (C)	Drew Rouland (C)
J. Gregg Borchelt (C)	R. Craig Henderson (C)	Scott E. Maxwell (C)	Nigel G. Shrive (CN)
Jim Bryja (C)	Timothy S. Hess (C)	Donald G. McMican (C)	Christopher Sieto (C)
J. Leroy Caldwell (C)	Augusto F. Holmberg (C)	John R. Merk (C)	Dana Smith (C)
Mario J. Catani (CN)	Jason M. Ingham (C)	Ali M. Memari (C)	Gary R. Sturgeon (C)
Angelo Coduto (C)	Mervyn J. Kowalsky (C)	Ehsan Minaie (C)	Christine A. Subasic (C)
Paul Curtis (C)	David G. Kurtanich (C)+	David Mulick (C)	Brian Trimble (C)
Majed A. Dabdoub (C)	James Lai (C)	Mel Oller (C)	Miroslav Vejvoda (C)
Jamie L. Davis (C)	Mark Larsen (C)	Adrian W. Page (CN)	Tyler W. Witthuhn (C)
James Daniel Dolan (C)	Hojin Lee (C)	William D. Palmer Jr. (C)	Thomas C. Young (C)
Dan Eschelbacher (C)	Andres Lepage (C)	Guilherme A. Parsekian (C)	Daniel Zechmeister (C)

1 Main Committee Members during the 2013 Revision Cycle. They participated in Committee activities, voted on Main Committee ballots and participated in Subcommittee activities including voting and correspondence.
2 Subcommittee Members during the 2013 Revision Cycle. They participated in Committee activities, voted on Subcommittee ballots and were able to comment on Main Committee ballots.
3 Corresponding and Consulting Members during the 2013 Revision Cycle. They could participate in Subcommittee activities but did not have voting privileges.
* Subcommittee Chair during the 2013 Revision Cycle
\+ Deceased

Additional Recognitions and Credits

In addition to the Masonry Standards Joint Committee, a number of individuals assisted in the development, review, and layout of the provisions. Their contributions are greatly appreciated.

TMS Technical Activities Committee

David I. McLean, Chair

Peter Babaian	Darrell W. McMillian	James P. Mwangi	Sarah L. Rogers
Sunup Mathew	Raymond T. Miller	John J. Myers	Jason J. Thompson

ACI Technical Activities Committee Review Group

H.R. Hamilton III Kevin MacDonald

ASCE Codes and Standards Committee

Neil M. Hawkins, Chair

James H. Anspach	Paul A. Harren	Thomas G. Krzewinski	Michael W. Salmon
David J. Eaton	David Hein	Bonnie E. Manley	Warren K. Wray
John A. Frauenhoffer	Conrad G. Keyes Jr.	Matt L. Porter	

Staff Liaisons

Khaled Nahlawi, ACI Paul Sgambati, SEI of ASCE Phillip J. Samblanet, TMS

Publishing Assistance

Kathy Keller, Administrative Assistant, WDP Manassas VA office	Susan Scheurer, Committee Liaison, The Masonry Society	Leyla Scott, Office Manager WDP Manassas, VA office

Cover Design

Thomas Escobar, Design Director, Masonry Institute of America

Final Editing & Proofing

Luis Dominguez, Production Manager, Masonry Institute of Americas

Susan Scheurer, Committee Liaison, The Masonry Society

Indexing

Christen Snydal

Layout of this Publication

This publication is broken into several major parts.

- The first major section contains the standard *Building Code Requirements for Masonry Structures*, designated as TMS 402-13/ACE 530-13/ASCE 5-13 and the commentary on the Code provisions. These pages are designated by a "C" in the page number. Following this portion are references for the Code Commentary. These references are also designated with "C" page numbers, although these pages have their own "bleed tabs" on the page edges to make them easier to locate when trying to identify the references cited in the Code Commentary.

- The second major section of this publication contains the standard *Specification for Masonry Structures* designated as TMS 602-13/ACE 530.1-13/ASCE 6-13 and commentary on the Specification provisions. These pages are designated by an "S" in the page number. Following this portion are references for the Specification Commentary. These references are also designated with "S" page numbers, although these pages have their own "bleed tabs" on the page edges to make them easier to locate when trying to identify the references cited in the Specification Commentary.

- At the end of this publication is an Index with major terms used in these standards. These pages are designated by an "I" in the page number

Additional information on the "Code" and the "Specification" is provided in the Synopsis for each.

Revision Formatting for the 2013 Building Code Requirements and Specification for Masonry Structures

As with the 2011 Edition of these standards, Commentary has been shown adjacent to Code and Specification requirements so that users can quickly and easily obtain background on the required provisions. Commentary is shown throughout these standards with light gray shading. Additional background on the purpose of the Commentary, and what is generally included in the Commentary is shown at the beginning of the Commentary Sections on pages C-1 and S-1. However, recognize that the Commentaries are for information only and are not mandatory.

While the 2011 Edition of these standards included revision bars and deletion arrows to designate places where major changes occurred since the 2008 edition of these standards, they have not been included in the 2013 Edition because of the major reformatting of the provisions. Had they been included, users would likely have been confused since so many provisions moved from the earlier edition, while some sections also were substantively revised. To assist users, a summary of major changes is included at http://www.masonrysociety.org/2013MSJC/index.htm. In addition, a cross reference index is also posted on that website to show where things moved from the 2011 edition. The use of revision bars and deletion arrows will be considered for future editions of the standards.

Other Formatting Conventions

To aide users of these standards, "bleed tabs" are provided on the outside edges of most pages so that the user can quickly to determine which portion (Code, Specification, References, or Index) they are reviewing.

Also be advised that a number of pages are intentionally left blank so that the beginning of each Chapter starts on a right hand page.

Building Code Requirements for Masonry Structures (TMS 402-13/ACI 530-13/ASCE 5-13)

TABLE OF CONTENTS

PART 5 — APPENDICES, pg. C-209

Building Code Requirements for Masonry Structures (TMS 402-13/ACI 530-13/ASCE 5-13)

SYNOPSIS

This Code covers the design and construction of masonry structures. It is written in such form that it may be adopted by reference in a legally adopted building code.

Among the subjects covered are: definitions; contract documents; quality assurance; materials; placement of embedded items; analysis and design; strength and serviceability; flexural and axial loads; shear; details and development of reinforcement; walls; columns; pilasters; beams and lintels; seismic design requirements; glass unit masonry; and veneers. An empirical design method applicable to buildings meeting specific location and construction criteria are also included.

The quality, inspection, testing, and placement of materials used in construction are covered by reference to TMS 602-13/ACI 530.1-13/ASCE 6-13 Specification for Masonry Structures and other standards.

Keywords: AAC, masonry, allowable stress design, anchors (fasteners); anchorage (structural); autoclaved aerated concrete masonry, beams; building codes; cements; clay brick; clay tile; columns; compressive strength; concrete block; concrete brick; construction; detailing; empirical design; flexural strength; glass units; grout; grouting; infills; joints; loads (forces); limit design; masonry; masonry cements; masonry load bearing walls; masonry mortars; masonry walls; modulus of elasticity; mortars; pilasters; prestressed masonry, quality assurance; reinforced masonry; reinforcing steel; seismic requirements; shear strength; specifications; splicing; stresses; strength design, structural analysis; structural design; ties; unreinforced masonry; veneers; walls.