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) of...
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)
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 a 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.

The Masonry Standards Joint Committee, which is sponsored by The Masonry Society, the American Concrete Institute, and the Structural Engineering Institute of the American Society of Civil Engineers, is responsible for these standards and strives to avoid ambiguities, omissions, and errors in these documents. In spite of these efforts, the users of these documents occasionally find information or requirements that may be subject to more than one interpretation or may be incomplete or incorrect. Users who have suggestions for the improvement of these documents are requested to contact TMS.

These documents are intended for the use of individuals who are competent to evaluate the significance and limitations of its content and recommendations and who will accept responsibility for the application of the material it contains. Individuals who use this publication in any way assume all risk and accept total responsibility for the application and use of this information.

All information in this publication is provided “as is” without warranty of any kind, either express or implied, including but not limited to, the implied warranties of merchantability, fitness for a particular purpose or non-infringement.

The sponsoring organizations, TMS, ACI, and SEI/ASCE, and their members disclaim liability for damages of any kind, including any special, indirect, incidental, or consequential damages, including without limitation, lost revenues or lost profits, which may result from the use of this publication.

It is the responsibility of the user of this document to establish health and safety practices appropriate to the specific circumstances involved with its use. The sponsoring organizations do not make any representations with regard to health and safety issues and the use of this document. The user must determine the applicability of all regulatory limitations before applying the document and must comply with all applicable laws and regulations, including but not limited to, United States Occupational Safety and Health Administration (OSHA) health and safety standards.


ALL RIGHTS RESERVED. This material may not be reproduced or copied, in whole or part, in any printed, mechanical, electronic, film, or other distribution and storage media, without the written consent of TMS.

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 (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
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

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 Engineers, the Journal of Bridge Engineers, 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 Committee1

Daniel P. Abrams
Jennifer R. Bean Popehn*
Richard M. Bennett*
David T. Biggs*
Robert N. Chittenden
John Chrysler*
Chukwuma G. Ekwueme
Fernando Fonseca
Susan M. Frey+
Edward L. Freyermuth

Thomas A. Gangel
David C. Gastgeb
S. K. Ghosh
Benchmark H. Harris
Ronald J. Hunskicker
Edwin T. Huston
Keith Itzler*
Rochelle C. Jaffe*
Eric N. Johnson*
Rashod R. Johnson

Richard E. Klingner*
W. Mark McGinley*
David I. McLean
Darrell W. McMillian
John M. Melander
Raymond T. Miller
Vilas Mujumdar
Jerry M. Painter
David L. Pierson
Max L. Porter

Arturo Ernest Schultz
Kurtis K. Siggard
Jennifer E. Tanner
John G. Tawresey
Jason J. Thompson
Margaret L. Thomson
Diane B. Throop*
Charles J. Tucker*
Scott W. Walkowicz*
A. Rhett Whitlock

Voting Members of Subcommittees Only2

Bruce Barnes
Russell H. Brown
Charles B. Clark
Thomas M. Corcoran
George E. Crow III
Terry M. Curtis
Mark A. Daigle
Gerald A. Dalrymple
Manuel A. Diaz
Steve M. Dill

Mohamed ElGawady
James A. Farny
Sonny J. Fite
David Gillick
Edgar F. Glock Jr.
Dennis W. Graber
Brian J. Grant
Charles A. Haynes
David Chris Hines

Matthew D. Jackson
John J. Jacob +
James M. LaFave
Sonny J. Fite
Peter J. Loughney
James P. Mwangi

Ali M. Memari (C)
Gary R. Sturgeon (CN)

Thomas M. Petreshock
Alan Robinson
Paul G. Scott
John J. Smith
Bruce Weems
David B. Woodham
Rick Yelton
Tianyi Yi

Subcommittee Corresponding (C) and Consulting (CN) Members3

Sergio M. Alcocer (C)
James E. Amrhein (C)+
Ronald E. Barnett (C)
J. Gregg Borchelt (C)
Jim Bryja (C)
J. Leroy Caldwell (C)
Mario J. Catani (CN)
Angelo Coduto (C)
Paul Curtis (C)
Majed A. Dabdoub (C)
Jamie L. Davis (C)
James Daniel Dolan (C)
Dan Eschenasy (C)

Richard Filloramo (C)
Hans Rudolf Ganz (C)
Clarett Heider (C)
R. Craig Henderson (C)
Timothy S. Hess (C)
Augusto F. Holmberg (C)
Jason M. Ingham (C)
Mervyn J. Kowalsky (C)
David G. Kurtanich (C)+
James Lai (C)
Mark Larsen (C)
Hojin Lee (C)
Andres Lepage (C)

Shelley Lissel (C)
John Maloney (C)
John H. Matthys (C)
Scott E. Maxwell (C)
Donald G. McMichan (C)
Ali M. Memari (C)
Ehsan Miniaie (C)
David Mulick (C)
Mel Oller (C)
Adrian W. Page (CN)
William D. Palmer Jr. (C)
Guilherme A. Parsekian (C)

Donato Pompo (C)
Matthew Reiter (C)
Drew Rouland (C)
Christopher Sieto (C)
Dana Smith (C)
Christine A. Subasic (C)
Brian Trimble (C)
Miroslav Veyvoda (C)
Tyler W. Wuthun (C)
Thomas C. Young (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.   Max L. Porter

Staff Liaisons

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

Balloting 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

### SYNOPSIS AND KEYWORDS, pg. C-ix

### PART 1 — GENERAL, pg. C-1

#### CHAPTER 1 — GENERAL REQUIREMENTS, pg. C-1

1.1 — Scope................................................................................................................................. C-1
   1.1.1 Minimum requirements .................................................................................................... C-1
   1.1.2 Governing building code ............................................................................................... C-1
   1.1.3 SI information ............................................................................................................ C-1

1.2 — Contract documents and calculations............................................................................. C-2

1.3 — Approval of special systems of design or construction.................................................. C-4

1.4 — Standards cited in this Code.......................................................................................... C-4

#### CHAPTER 2 — NOTATION AND DEFINITIONS, pg. C-7

2.1 — Notation ........................................................................................................................... C-7

2.2 — Definitions ....................................................................................................................... C-14

#### CHAPTER 3 — QUALITY AND CONSTRUCTION, pg. C-25

3.1 — Quality Assurance program .......................................................................................... C-25
   3.1.1 Level A Quality Assurance ......................................................................................... C-25
   3.1.2 Level B Quality Assurance ......................................................................................... C-26
   3.1.3 Level C Quality Assurance ......................................................................................... C-26
   3.1.4 Procedures ................................................................................................................... C-26
   3.1.5 Qualifications ............................................................................................................. C-27
   3.1.6 Acceptance relative to strength requirements ............................................................. C-31

3.2 — Construction considerations .......................................................................................... C-31
   3.2.1 Grouting, minimum spaces ........................................................................................ C-31
   3.2.2 Embedded conduits, pipes, and sleeves...................................................................... C-32

### PART 2 — DESIGN REQUIREMENTS, pg. C-35

#### CHAPTER 4 — GENERAL ANALYSIS AND DESIGN CONSIDERATIONS, pg. C-35

4.1 — Loading ............................................................................................................................ C-35
   4.1.1 General ......................................................................................................................... C-35
   4.1.2 Load provisions .......................................................................................................... C-35
   4.1.3 Lateral load resistance ............................................................................................... C-35
   4.1.4 Load transfer at horizontal connections ...................................................................... C-35
   4.1.5 Other effects .............................................................................................................. C-36
   4.1.6 Lateral load distribution ............................................................................................ C-36

4.2 — Material properties ........................................................................................................ C-37
   4.2.1 General ......................................................................................................................... C-37
   4.2.2 Elastic moduli ............................................................................................................ C-38
   4.2.3 Coefficients of thermal expansion ............................................................................ C-40
   4.2.4 Coefficients of moisture expansion for clay masonry ............................................. C-40
CHAPTER 5 — STRUCTURAL ELEMENTS, pg. C-47
5.1 — Masonry assemblies ................................................................. C-47
  5.1.1 Intersecting walls ................................................................. C-47
  5.1.2 Effective compressive width per bar ................................. C-50
  5.1.3 Concentrated loads ............................................................ C-51
  5.1.4 Multiwythe masonry elements ........................................ C-53

5.2 — Beams .................................................................................. C-57
  5.2.1 General beam design ........................................................ C-57
  5.2.2 Deep beams ................................................................. C-59

5.3 — Columns ............................................................................ C-61
  5.3.1 General column design .................................................... C-61
  5.3.2 Lightly loaded columns .................................................. C-62

5.4 — Pilasters ............................................................................. C-63

5.5 — Corbels ................................................................................ C-63
  5.5.1 Loadbearing corbels ......................................................... C-63
  5.5.2 Non-loadbearing corbels ................................................ C-63

CHAPTER 6 — REINFORCEMENT, METAL ACCESSORIES, AND ANCHOR BOLTS, pg. C-67
6.1 — Details of reinforcement and metal accessories .................... C-67
  6.1.1 Embedment ................................................................. C-67
  6.1.2 Size of reinforcement ...................................................... C-67
  6.1.3 Placement of reinforcement ........................................... C-67
  6.1.4 Protection of reinforcement and metal accessories ....... C-68
  6.1.5 Standard hooks ............................................................. C-69
  6.1.6 Minimum bend diameter for reinforcing bars ............... C-69

6.2 — Anchor Bolts ....................................................................... C-71
  6.2.1 Placement ................................................................. C-71
  6.2.2 Projected area for axial tension ..................................... C-73
  6.2.3 Projected area for shear ................................................ C-74
  6.2.4 Effective embedment length for headed anchor bolts ... C-76
  6.2.5 Effective embedment length of bent-bar anchor bolts ... C-76
  6.2.6 Minimum permissible effective embedment length ....... C-77
  6.2.7 Anchor bolt edge distance ............................................. C-77

CHAPTER 7 — SEISMIC DESIGN REQUIREMENTS, pg. C-79
7.1 Scope ................................................................................... C-79
7.2 General analysis ................................................................... C-80
  7.2.1 Element interaction ......................................................... C-80
  7.2.2 Load path ....................................................................... C-60
### CHAPTER 10 — PRESTRESSED MASONRY, pg. C-153

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.1</td>
<td>General</td>
<td>C-153</td>
</tr>
<tr>
<td>10.1.1</td>
<td>Scope</td>
<td>C-153</td>
</tr>
<tr>
<td>10.2</td>
<td>Design methods</td>
<td>C-154</td>
</tr>
<tr>
<td>10.2.1</td>
<td>General</td>
<td>C-154</td>
</tr>
<tr>
<td>10.2.2</td>
<td>After transfer</td>
<td>C-154</td>
</tr>
<tr>
<td>10.3</td>
<td>Permissible stresses in prestressing tendons</td>
<td>C-154</td>
</tr>
<tr>
<td>10.3.1</td>
<td>Jacking force</td>
<td>C-154</td>
</tr>
<tr>
<td>10.3.2</td>
<td>Immediately after transfer</td>
<td>C-154</td>
</tr>
<tr>
<td>10.3.3</td>
<td>Post-tensioned masonry members</td>
<td>C-154</td>
</tr>
<tr>
<td>10.3.4</td>
<td>Effective prestress</td>
<td>C-155</td>
</tr>
<tr>
<td>10.4</td>
<td>Axial compression and flexure</td>
<td>C-156</td>
</tr>
<tr>
<td>10.4.1</td>
<td>General</td>
<td>C-156</td>
</tr>
<tr>
<td>10.4.2</td>
<td>Service load requirements</td>
<td>C-157</td>
</tr>
<tr>
<td>10.4.3</td>
<td>Strength requirements</td>
<td>C-158</td>
</tr>
<tr>
<td>10.5</td>
<td>Axial tension</td>
<td>C-159</td>
</tr>
<tr>
<td>10.6</td>
<td>Shear</td>
<td>C-159</td>
</tr>
<tr>
<td>10.7</td>
<td>Deflection</td>
<td>C-160</td>
</tr>
<tr>
<td>10.8</td>
<td>Prestressing tendon anchorages, couplers, and end blocks</td>
<td>C-160</td>
</tr>
<tr>
<td>10.8.1</td>
<td></td>
<td>C-160</td>
</tr>
<tr>
<td>10.8.2</td>
<td></td>
<td>C-160</td>
</tr>
<tr>
<td>10.8.3</td>
<td></td>
<td>C-160</td>
</tr>
<tr>
<td>10.8.4</td>
<td>Bearing stresses</td>
<td>C-160</td>
</tr>
<tr>
<td>10.9</td>
<td>Protection of prestressing tendons and accessories</td>
<td>C-161</td>
</tr>
<tr>
<td>10.10</td>
<td>Development of bonded tendons</td>
<td>C-161</td>
</tr>
</tbody>
</table>

### CHAPTER 11 — STRENGTH DESIGN OF AUTOCLAVED AERATED CONCRETE (AAC) MASONRY, pg. C-163

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.1</td>
<td>General</td>
<td>C-163</td>
</tr>
<tr>
<td>11.1.1</td>
<td>Scope</td>
<td>C-163</td>
</tr>
<tr>
<td>11.1.2</td>
<td>Required strength</td>
<td>C-163</td>
</tr>
<tr>
<td>11.1.3</td>
<td>Design strength</td>
<td>C-163</td>
</tr>
<tr>
<td>11.1.4</td>
<td>Strength of joints</td>
<td>C-163</td>
</tr>
<tr>
<td>11.1.5</td>
<td>Strength-reduction factors</td>
<td>C-164</td>
</tr>
<tr>
<td>11.1.6</td>
<td>Deformation requirements</td>
<td>C-164</td>
</tr>
<tr>
<td>11.1.7</td>
<td>Anchor bolts</td>
<td>C-165</td>
</tr>
<tr>
<td>11.1.8</td>
<td>Material properties</td>
<td>C-165</td>
</tr>
<tr>
<td>11.1.9</td>
<td>Nominal bearing strength</td>
<td>C-166</td>
</tr>
</tbody>
</table>
PART 4 — PRESCRIPTIVE DESIGN METHODS, pg. C-183

CHAPTER 12 — VENEER, pg. C-183
12.1 — General ................................................................................................................................. C-183
  12.1.1 Scope ..................................................................................................................................... C-183
  12.1.2 Design of anchored veneer .................................................................................................. C-185
  12.1.3 Design of adhered veneer .................................................................................................. C-187
  12.1.4 Dimension stone .................................................................................................................. C-187
  12.1.5 Autoclaved aerated concrete masonry veneer ................................................................ C-187
  12.1.6 General design requirements ............................................................................................ C-187

12.2 — Anchored Veneer .................................................................................................................... C-188
  12.2.1 Alternative design of anchored masonry veneer ................................................................. C-188
  12.2.2 Prescriptive requirements for anchored masonry veneer .................................................. C-188

12.3 — Adhered Veneer ....................................................................................................................... C-194
  12.3.1 Alternative design of adhered masonry veneer ................................................................. C-194
  12.3.2 Prescriptive requirements for adhered masonry veneer .................................................... C-194

CHAPTER 13 — GLASS UNIT MASONRY, pg. C-197
13.1 — General .................................................................................................................................. C-197
  13.1.1 Scope ..................................................................................................................................... C-197
  13.1.2 General design requirements ............................................................................................ C-197
  13.1.3 Units ....................................................................................................................................... C-197

13.2 — Panel Size ............................................................................................................................... C-197
  13.2.1 Exterior standard-unit panels ............................................................................................. C-198
  13.2.2 Exterior thin-unit panels ..................................................................................................... C-199
  13.2.3 Interior panels ...................................................................................................................... C-199
  13.2.4 Curved panels ..................................................................................................................... C-200

13.3 — Support .................................................................................................................................... C-200
  13.3.1 General requirements .......................................................................................................... C-200
  13.3.2 Vertical ................................................................................................................................. C-200
  13.3.3 Lateral .................................................................................................................................. C-200

13.4 — Expansion joints ..................................................................................................................... C-202
13.5 — Base surface treatment .............................................................................................................................. C-202
13.6 — Mortar ....................................................................................................................................................... C-202
13.7 — Reinforcement ......................................................................................................................................... C-202

CHAPTER 14 — MASONRY PARTITION WALLS, pg. C-203

14.1 — General ....................................................................................................................................................... C-203
  14.1.1 Scope....................................................................................................................................................... C-203
  14.1.2 Design of partition walls ....................................................................................................................... C-203

14.2 — Prescriptive design of partition walls ........................................................................................................ C-203
  14.2.1 General..................................................................................................................................................... C-203
  14.2.2 Thickness limitations ............................................................................................................................ C-203
  14.2.3 Limitations .............................................................................................................................................. C-204

14.3 — Lateral support .......................................................................................................................................... C-206
  14.3.1 Maximum l/t and h/t .............................................................................................................................. C-206
  14.3.2 Openings ............................................................................................................................................... C-206
  14.3.3 Cantilever walls ..................................................................................................................................... C-208
  14.3.4 Support elements ................................................................................................................................... C-208

14.4 — Anchorage ................................................................................................................................................. C-208
  14.4.1 General..................................................................................................................................................... C-208
  14.4.2 Intersecting walls ................................................................................................................................ C-208

14.5 — Miscellaneous requirements ...................................................................................................................... C-208
  14.5.1 Chases and recesses .............................................................................................................................. C-208
  14.5.2 Lintels ....................................................................................................................................................... C-208
  14.5.3 Lap splices ............................................................................................................................................... C-208
PART 5 — APPENDICES, pg. C-209

CHAPTER A — EMPIRICAL DESIGN OF MASONRY, pg. C-209
A.1 — General ........................................................................................................... C-209
A.1.1 Scope .............................................................................................................. C-209
A.1.2 Limitations ..................................................................................................... C-209
A.2 — Height ............................................................................................................ C-213
A.3 — Lateral stability ............................................................................................. C-213
A.3.1 Shear walls ................................................................................................... C-214
A.3.2 Roofs ............................................................................................................ C-213
A.4 — Compressive stress requirements ................................................................. C-215
A.4.1 Calculations .................................................................................................. C-215
A.4.2 Allowable compressive stresses .................................................................... C-215
A.5 — Lateral support ............................................................................................. C-218
A.5.1 Maximum l/t and h/t ........................................................................................ C-218
A.5.2 Cantilever walls ............................................................................................. C-219
A.5.3 Support elements .......................................................................................... C-219
A.6 — Thickness of masonry .................................................................................. C-219
A.6.1 General .......................................................................................................... C-219
A.6.2 Minimum thickness ........................................................................................ C-219
A.6.3 Foundation walls .......................................................................................... C-220
A.6.4 Foundation piers .......................................................................................... C-220
A.7 — Bond ............................................................................................................. C-221
A.7.1 General .......................................................................................................... C-221
A.7.2 Bonding with masonry headers ..................................................................... C-221
A.7.3 Bonding with wall ties or joint reinforcement .............................................. C-221
A.7.4 Natural or cast stone ..................................................................................... C-222
A.8 — Anchorage .................................................................................................. C-222
A.8.1 General .......................................................................................................... C-222
A.8.2 Intersecting walls .......................................................................................... C-222
A.8.3 Floor and roof anchorage .............................................................................. C-224
A.8.4 Walls adjoining structural framing ................................................................. C-224
A.9 — Miscellaneous requirements ....................................................................... C-225
A.9.1 Chases and recesses ..................................................................................... C-225
A.9.2 Lintels .......................................................................................................... C-225

APPENDIX B — DESIGN OF MASONRY INFILL, pg. C-227
B.1 — General ........................................................................................................ C-227
B.1.1 Scope ............................................................................................................ C-227
B.1.2 Required strength ........................................................................................ C-228
B.1.3 Design strength ............................................................................................ C-228
B.1.4 Strength-reduction factors .......................................................................... C-228
B.1.5 Limitations .................................................................................................. C-228
B.2 — Non-Participating Infills ............................................................................. C-229
B.2.1 In-plane isolation joints for non-participating infills .................................. C-229
B.2.2 Design of for non-participating infills for out-of-plane loads ..................... C-229
B.3 — Participating Infills...................................................................................................................................... C-230
B.3.1 General................................................................................................................................................ C-230
B.3.2 In-plane connection requirements for participating infills ................................................................ C-230
B.3.3 Out-of-plane connection requirements for participating infills............................................................. C-231
B.3.4 Design of for participating infills for in-plane loads .............................................................................. C-231
B.3.5 Design of frame elements with participating infills for in-plane loads .................................................. C-232
B.3.6 Design of participating infills for out-of-plane forces .......................................................................... C-233

APPENDIX C — LIMIT DESIGN METHOD, pg. C-235
C — General C-235
C.1 — Yield mechanism................................................................................................................................... C-235
C.2 — Mechanism strength ............................................................................................................................. C-236
C.3 — Mechanism deformation......................................................................................................................... C-236

EQUATION CONVERSIONS, pg. C-237

CONVERSION OF INCH-POUND UNITS TO SI UNITS, pg. C-249

PREFIXES, pg. C-249

REFERENCE FOR THE CODE COMMENTARY, pg. C-251
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.
1.1 — Scope

1.1.1 Minimum requirements
This Code provides minimum requirements for the structural design and construction of masonry elements consisting of masonry units bedded in mortar.

1.1.2 Governing building code
This Code supplements the legally adopted building code and shall govern in matters pertaining to structural design and construction of masonry elements. In areas without a legally adopted building code, this Code defines the minimum acceptable standards of design and construction practice.

1.1.3 SI information
SI values shown in parentheses are not part of this Code. The equations in this document are for use with the specified inch-pound units only.

1.1.1 Minimum requirements
This code governs structural design of both structural and non-structural masonry elements. Examples of non-structural elements are masonry veneer, glass unit masonry, and masonry partitions. Structural design aspects of non-structural masonry elements include, but are not limited to, gravity and lateral support, and load transfer to supporting elements.

Masonry structures may be required to have enhanced structural integrity as part of a comprehensive design against progressive collapse due to accident, misuse, sabotage or other causes. General design guidance addressing this issue is available in Commentary Section 1.4 of ASCE 7. Suggestions from that Commentary, of specific application to many masonry structures, include but are not limited to: consideration of plan layout to incorporate returns on walls, both interior and exterior; use of load-bearing interior walls; adequate continuity of walls, ties, and joint rigidity; providing walls capable of beam action; ductile detailing and the use of compartmentalized construction.

1.1.3 SI information
The equivalent equations for use with SI units are provided in the Equation Conversions table in Part 5.