Masonry 101
Introduction to Masonry

TMS20201021

October 21, 2020 - 7 – 8 pm

W. Mark McGinley, Ph. D. , PE , FASTM, FTMS

The Masonry Society

AIA Provider: 50119857

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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

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Course Description

TMS will start a new Masonry Night School with a six session Masonry 101 course which will provide a comprehensive introduction to masonry materials and concepts for those who need a fast-track course, especially new designers and specifiers.

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Course Description

Night School gives a thorough review of masonry topics, with a progressive building of knowledge by the attendees. Future integration will allow for on-demand learning and a selection of specific topics of interest by those wishing to learn about various aspects and attributes of masonry. Masonry 101 is a full course intended to introduce those new to masonry to essential topics in a developing sequence, although attendees may participate in sessions individually if desired.

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Course Description

A total of 6 Sessions will be offered: These sessions will be offered live at 7 pm ET on the dates noted for 1 AIA LU credit each. Attend all six, or only those of interest to you.

- **Introduction to Masonry** by W. Mark McGinley, Ph.D., P.E., FASTM, FTMS, Professor of Civil Engineering at the University of Louisville on Wednesday, October 21
- **Introduction to Masonry Units** by Christine A. (Tina) Subasic, P.E., LEED AP, consulting architectural engineer in Raleigh, NC on Wednesday, October 28
- **Mortar** by Jamie Farny, Director, Building Marketing at the Portland Cement Association on Wednesday, November 4

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Course Description

A total of 6 Sessions will be offered: These sessions will be offered live at 7 pm ET on the dates noted for 1 AIA LU credit each. Attend all six, or only those of interest to you.

- **Reinforcement and Anchors** by Richard M. Bennett, Ph.D., P.E., FTMS, Professor at the University of Tennessee on Wednesday, November 11
- **Grout** by Jamie Farny, Director, Building Marketing at the Portland Cement Association on Wednesday, November 18
- **Masonry Assemblies** by W. Mark McGinley, Ph.D., P.E., FASTM, FTMS, Professor of Civil Engineering at the University of Louisville on Tuesday, November 24

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Learning Objectives

Introduction to Masonry

Learning Objectives include:

- Identify the terminology associated with masonry systems.
- Identify the common acronyms associated with masonry.
- Describe the performance attributes of masonry.
- List the key masonry codes, standards and resources.

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Basic Masonry Terminology

- Masonry is a system comprised of relatively small masonry units that are typically hand laid and bonded together with mortar. They are often grouted and reinforced.
- Can you identify:
  - Unit types, cmu, brick?
  - Bond type(s)?
  - Control Joint location?
  - Spacing of veneer ties?
  - Lintel Bearing?
  - Any other items shown?

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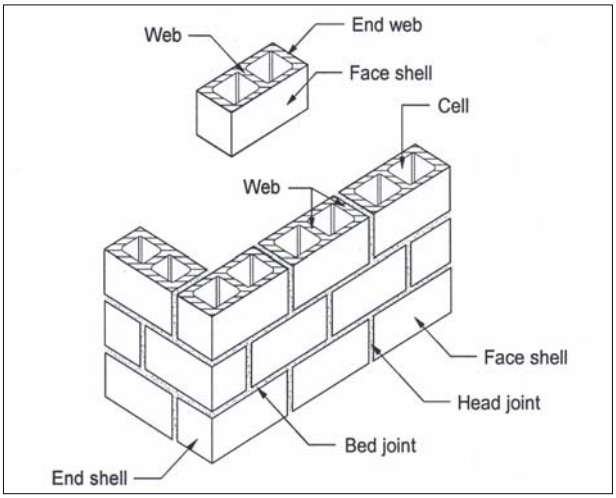
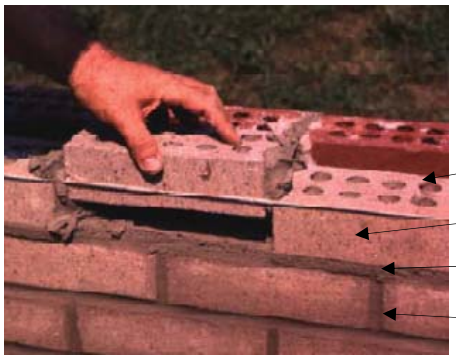
Basic Terms



- Concrete Masonry Unit Assemblies
- Typically hollow units

9

Basic Terms



- Clay Masonry Unit (brick) Assemblies
- Typically solid units

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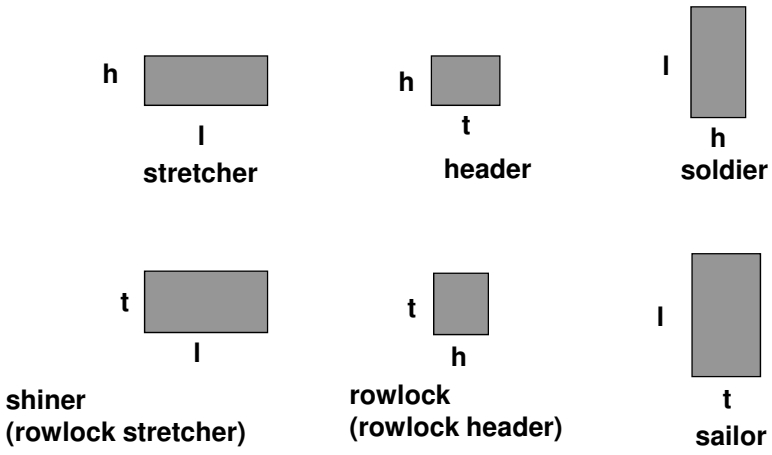
Basic Terms

- unit orientation (looking at wall)



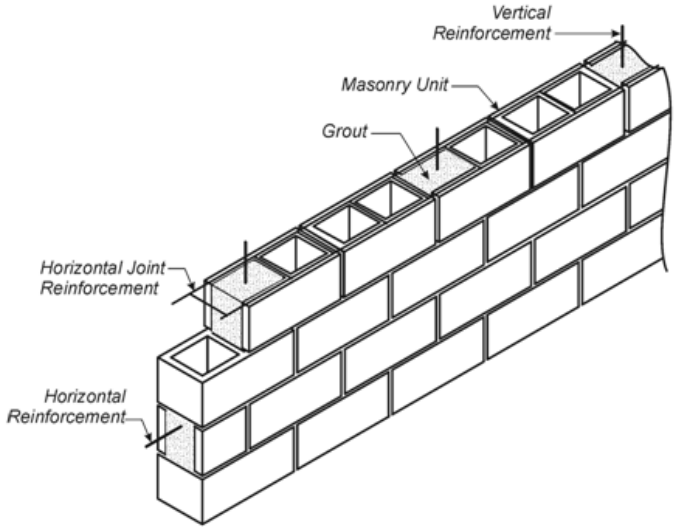
11

Basic Terms

- unit orientation (looking at wall)

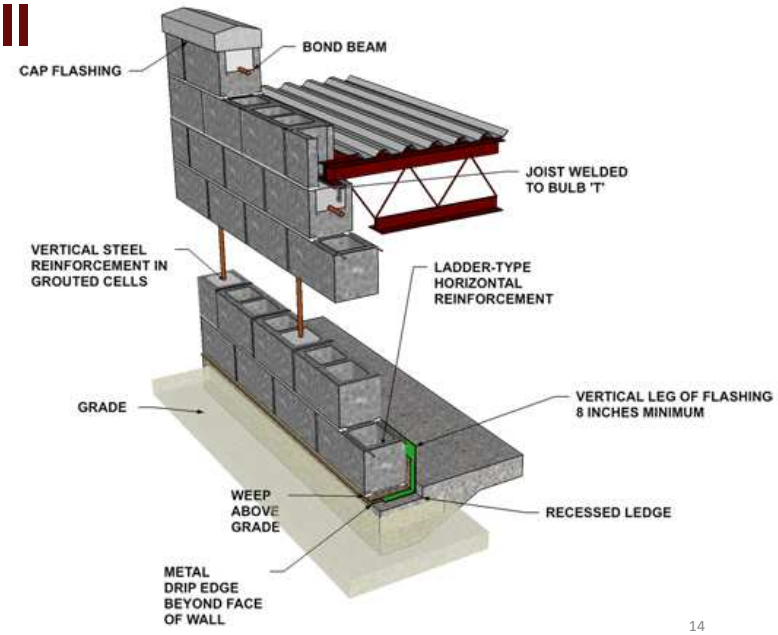
12

Single Wythe Wall



13

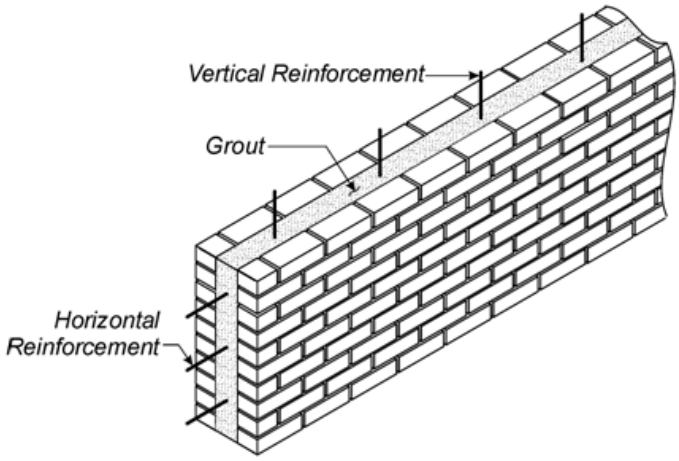
Single Wythe Wall



http://www.masonrysystems.org/wall-systems/cavity-wall-concrete-block-veneer-reinforced-concrete-block/

14

Two Wythe Wall – Composite Wall



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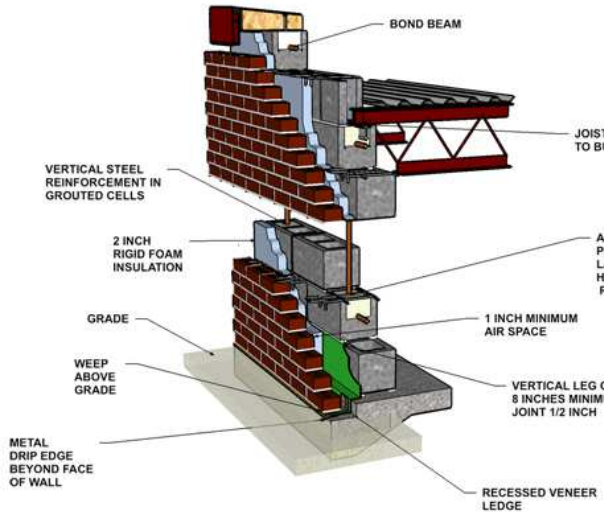
Two Wythe Wall – Veneer Wall



Recommend 2" air space

http://www.masonrysystems.org/wall-systems/cavity-wall-brick-veneer-reinforced-concrete-block/

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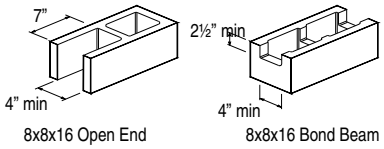
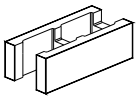
More Common for CMU to be Reinforced Masonry

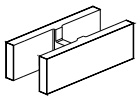


8x8x16 Open End

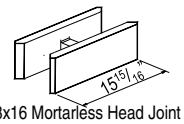
8x8x16 Bond Beam



8x8x16 Open End Bond Beam



8x8x16 Double Open End Bond Beam

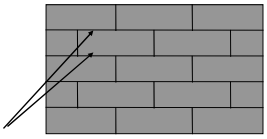


8x8x16 Mortarless Head Joint

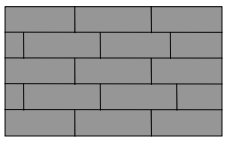
. . . basic terms

- bond patterns (looking at wall)

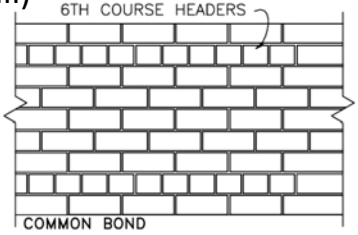
bed joints

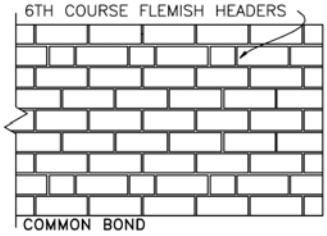


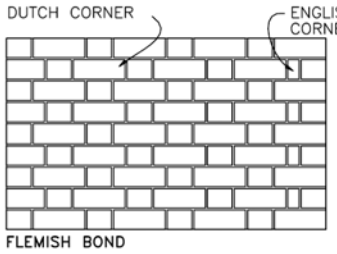
Running Bond

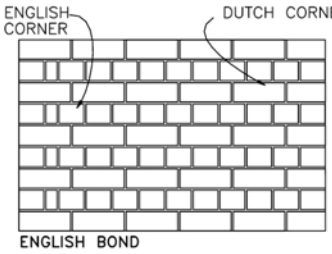


1/3 Running Bond



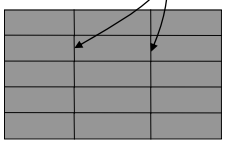




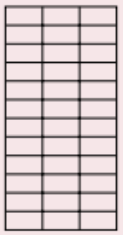


. . . basic terms

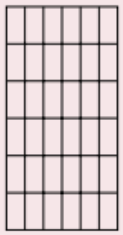
- bond patterns (looking at wall)



Stack Bond

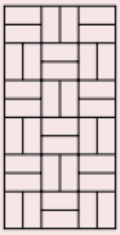


Horizontal stack



Vertical stack

From www.ncma.org



Basket weave B

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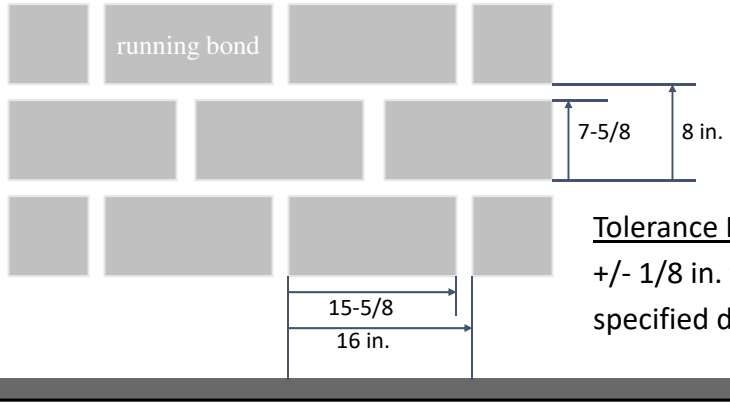
Dimensions – Masonry Module

Nominal dimensions are equal to the specified dimensions plus the thickness of one mortar joint (typically 3/8 in.) – Masonry Module is most commonly 8 inches - that is - unit coursing and lengths multiples - Also 12" for some clay units



Tolerance Permitted:

+/- 1/8 in. from the specified dimensions

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Select Masonry Acronyms

CJ	Control Joint
ACMV	Adhered Concrete Masonry Veneer
BAC	Bricklayers and Allied Craftworkers
BIA	Brick Industry Association - used to be called Brick Institute of America
CCMPA	Canadian Concrete Masonry Producers Association

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Select Masonry Acronyms

CMAA	Concrete Masonry Association of Australia
CMU	Concrete Masonry Units
CMACN	Concrete Masonry Association of California and Nevada
ESCSI	Expanded Shale, Clay & Slate Institute
IMI	International Masonry Institute
IMS	International Masonry Society
MAC	Masonry Advisory Council

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Select Masonry Acronyms

MAC	Masonry Advisory Council
MAF	Masonry Association of Florida
MCAA	Mason Contractors Association of America
MCAC	Mason Contractors Association of California
MCRG	Masonry Conservation Research Group
MIA	Masonry Institute of America

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Select Masonry Acronyms

MSJC	Masonry Standards Joint Committee
MVMA	Masonry Veneer Manufacturers Association
MW	Moderate Weather
NAMC	North American Masonry Conference
NCMA	National Concrete Masonry Association
RBM	Reinforced Brick Masonry
PCA	Portland Cement Association

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Select Masonry Acronyms

SCG	Self Consolidating Grouts
SCIPI	Structural Clay Products Institute
SRWs	Segmental Retaining Walls
SW	Severe Weather
TMS	The Masonry Society
URM	Un-Reinforced Masonry
WSCPA	Western

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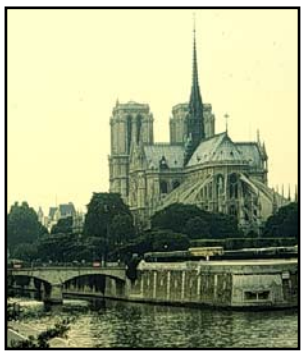
Performance Attributes of Masonry

- Durability – Properly maintained masonry will last for centuries.

Ann Boleyn Gate
Hampton Court Palace
1515 - 1530

Beijing
~ 1420
Temple of Heaven



Notre Dame 1235

Hadrians Tomb 139

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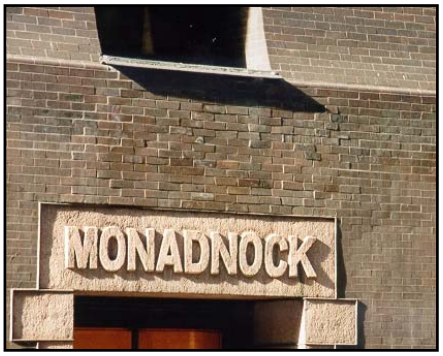
Performance Attributes of Masonry

- Strength – Masonry can be designed to resist significant loads.



Manadnock Building, Chicago , 1889
URM 16 stores LB
Uneinforced – 6 ft thick a base

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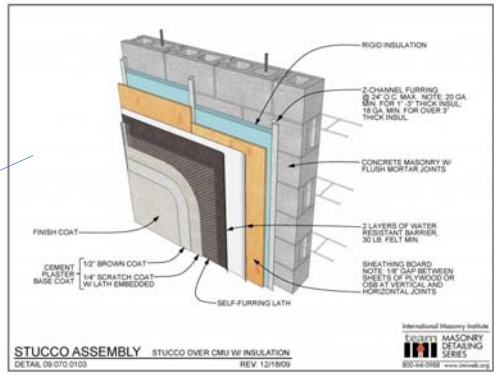
Performance Attributes of Masonry

- Strength – Masonry can be designed to resist significant loads, especially if reinforced.

The four towers of the 28 story Excalibur Hotel Las Vegas – Load bearing masonry – ncma.org



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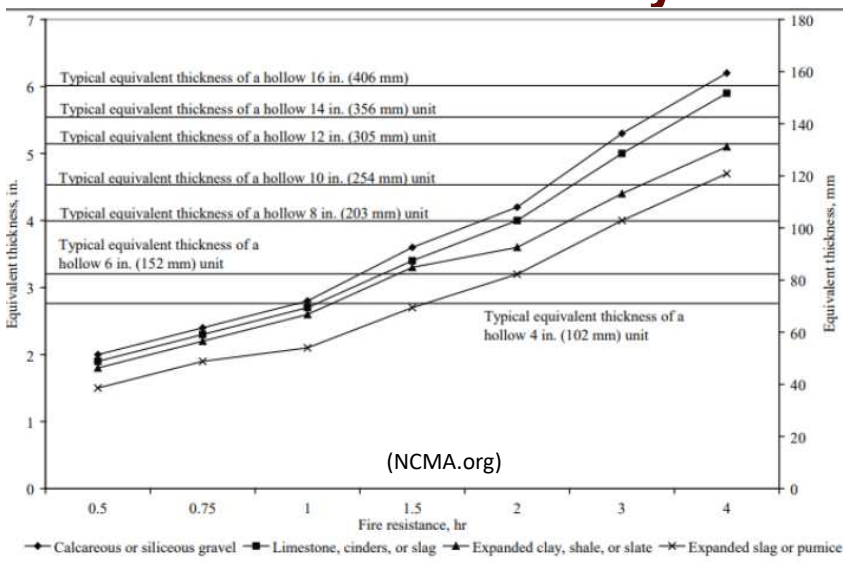
Performance Attributes of Masonry

- Fire Resistance – Inherent resistance to fire - noncombustible – can be incorporated in passive fire protection



(NCMA.org)

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Performance Attributes of Masonry

- Sound Resistance – High sound resistance as a result of the high density of the masonry assembly. Specialty units can increase this resistance.
- Security – Effective, durable barrier

Nominal unit thickness, in. (mm)	Density, pcf (kg/m³)	STC[a]			
		Hollow unit	Grout-filled unit	Sand-filled unit	Solid unit
8 (203)	85 (1,362)	44	55	52	52
	95 (1,522)	45	55	52	53
	105 (1,682)	46	56	53	54
	115 (1,842)	47	56	54	55
	125 (2,002)	48	57	54	56

(NCMA.org)

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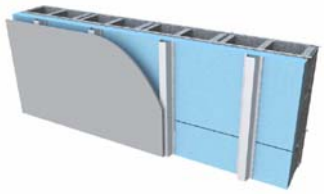
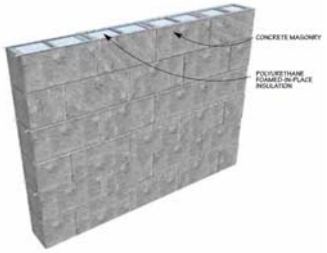
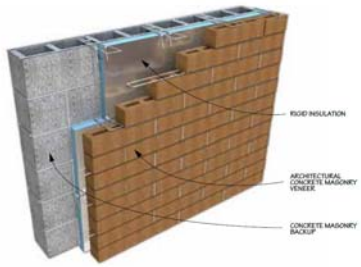
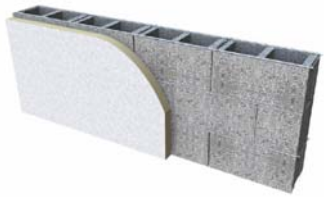
Performance Attributes of Masonry

- Thermal Resistance; low thermal resistance can be increased with insulation and thermal mass improves resistance to diurnal temperature fluctuations









(NCMA.org)

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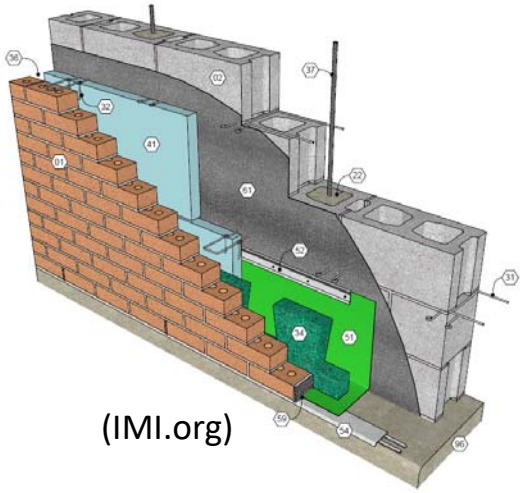
Performance Attributes of Masonry

- Barrier to moisture and air movements
  - Detailing of wall assemblies critical in limiting air and moisture movement



(IMI.org)

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References . Codes, Standards, an Alphabet Soup

- IBC
- MSJC
- TMS 402
- ACI 530
- ASCE 5
- TMS 602
- ASTM

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Masonry Requirements in the IBC – most states require some version

Chapter 14 – Exterior Walls (Veneer)

Chapter 17 – Special Inspections & Tests

Chapter 21 – Masonry

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Masonry Requirements in the IBC – most states

- In the past, some "MSJC" provisions were duplicated in the IBC, making differences between MSJC and IBC hard to spot (same for ASTM Standards).
- Most duplicate provisions were removed from the 2009 & 2012 IBC's, making differences easier to spot.
- More redundancy was removed from the 2015 IBC and the "MSJC" was changed to TMS 402/602 in the 2018 IBC

MSJC = Masonry Standards Joint Committee – aka ACI 530, ASCE 5, TMS 402. Now JUST TMS 402/602!

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Masonry Codes & Standards

- The IBC extensively references "Consensus" Design and Material Standards:
  - ASTM Standards for Materials
  - ASCE 7 for Loads (2016 or 2010)
  - ACI 318 for Concrete (2014)
  - "MSJC" (TMS 402/602) for Masonry

Most Recent Versions

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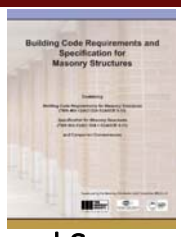
The TMS 402/602 (MSJC)



ACI
(ACI 530-13)
(ACI 530.1-13)

2013 MSJC
Code and Specification

Lead Sponsor
TMS
(TMS 402-13)
(TMS 602-13)

ASCE
(ASCE 5-13)
(ASCE 6-13)

MSJC
"Masonry Standards Joint Committee"

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MSJC. . . Now just TMS 402/602

- MSJC began in 1978
- MSJC developed Code and Specification under ANSI consensus procedures, for reference by model codes such IBC, NFPA
- Had been supported by TMS, ACI and ASCE
- ACI and ASCE graciously relinquished their rights in 2013, so that the 2016 edition and future editions are solely sponsored by TMS. As such, they are now:

TMS 402/602

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Relationship between IBC & TMS 402/602 through the years…

- With each new edition of IBC, more and more provisions have been removed from IBC Chapter 21, as the issues are addressed in the MSJC/TMS 402/602.

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. . . the ~~MSJC~~ (TMS 402/602) Code and Specification

- 2013 edition is referenced by 2015 IBC
- 2016 edition is referenced by 2018 IBC as SOLELY TMS 402/602
- Next edition: 2022 (6-year cycle)

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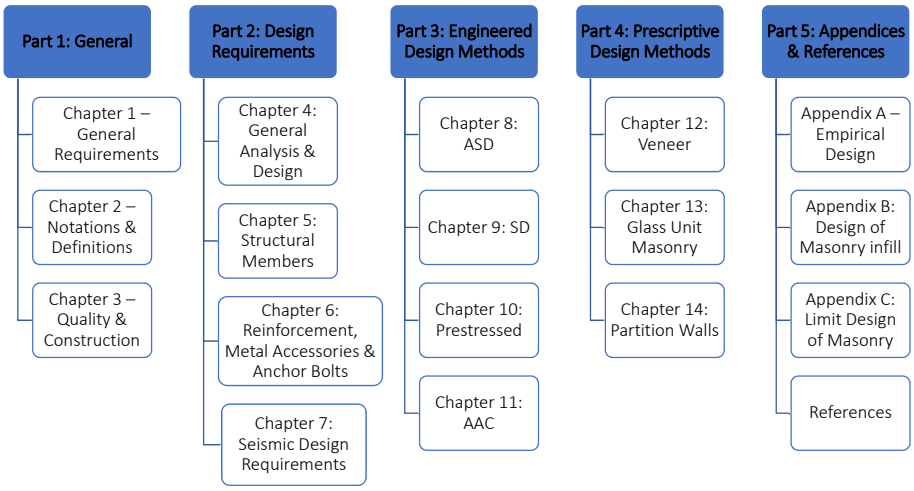
TMS 402-13 & 16 *Code* Organization



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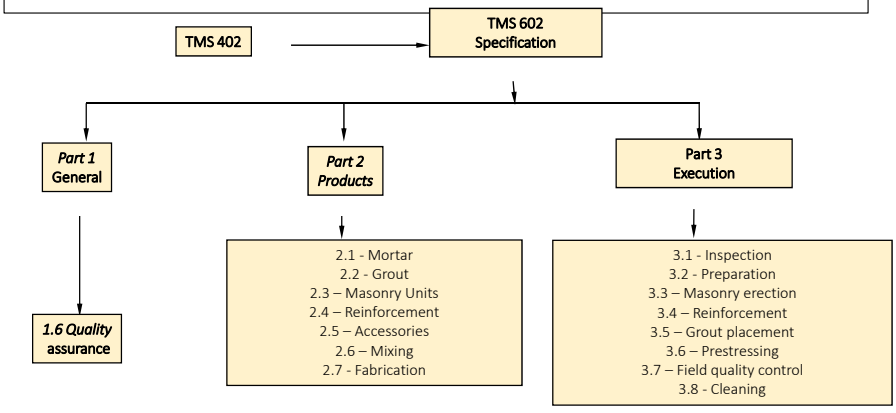
. . . TMS 602 Specification



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ASTM Standards

- Standards Define Materials and Methods (units, mortar, grout, etc.)

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C216 – Specification for Exterior Clay Brick

Designation: C216 – 19

Standard Specification for Facing Brick (Solid Masonry Units Made from Clay or Shale)[1]

This standard is issued under the fixed designation C216; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope*

1.1 This specification covers brick intended for use in masonry and supplying structural or facing components, or both, to the structure.

1.2 The requirements of this specification apply at the time of purchase. The use of results from testing of brick extracted from masonry structures for determining conformance or nonconformance to the requirements of this specification is beyond the intent of this specification.

1.3 The brick are prismatic units available in a variety of sizes, textures, colors, and shapes. This specification is not intended to provide specifications for paving brick (see Specification C902).

1.4 Brick are ceramic products manufactured primarily from clay, shale, or similar naturally occurring earthy substances and subjected to a heat treatment at elevated temperatures (firing). Additives or recycled materials are permitted to be included at the option of the manufacturer. The heat treatment must develop a fired bond between the particulate constituents to provide the strength and durability requirements of this specification (see Terminology C1232).

1.5 Brick are shaped during manufacture by molding, pressing, or extrusion, and the shaping method is a way to describe the brick.

1.5.1 This standard and its individual requirements shall not be used to qualify or corroborate the performance of a masonry unit made from other materials, or made with other forming methods, or other means of binding the materials.

1.6 Three types of brick in each of two grades are covered.

1.7 The text of this specification references notes and footnotes that provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of the standard.

1.8 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.9 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C67/C67M Test Methods for Sampling and Testing Brick and Structural Clay Tile

C902 Specification for Pedestrian and Light Traffic Paving Brick

C1232 Terminology for Masonry

C1272 Specification for Heavy Vehicular Paving Brick

3. Terminology

3.1 *Definitions*—For definitions relating to masonry and facing brick, refer to Terminology C1232.

4. Classification

4.1 *Grades*—Grades classify brick according to their resistance to damage by freezing and thawing when saturated at a moisture content not exceeding the 24-h cold water absorption. Two grades of facing brick are covered and the requirements are given in Section 7.

4.1.1 *Grade SW (Severe Weathering)*—Brick intended for use where high resistance to damage caused by cyclic freezing and thawing is desired.

4.1.2 *Grade MW (Moderate Weathering)*—Brick intended for use where moderate resistance to cyclic freezing and thawing damage is permissible.

[1] This specification is under the jurisdiction of ASTM Committee C15 on Manufactured Masonry Units and is the direct responsibility of Subcommittee C15.07 on Brick and Structural Clay Tile.

Current edition approved Dec. 1, 2019. Published December 2019. Originally approved in 1947. Last previous edition approved in 2017 as C216 – 17a. DOI: 10.1520/C0216-19.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

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C90 – Specification for Concrete Masonry Units (CMU)

Designation: C90 – 16a

Standard Specification for
Loadbearing Concrete Masonry Units[1]

This standard is issued under the fixed designation C90; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope*

1.1 This specification covers hollow and solid (see 5.3 and 5.4) concrete masonry units made from hydraulic cement, water, and mineral aggregates with or without the inclusion of other materials. There are three classes of concrete masonry units: Normal Weight, Medium Weight, and Lightweight. These units are suitable for both loadbearing and nonloadbearing applications.

1.2 Concrete masonry units covered by this specification are made from lightweight or normal-weight aggregates, or both.

Note 1—The requirements of this specification have been researched, evaluated, and established for over a century, resulting in the physical properties and attributes defined here. These requirements are uniquely and solely applicable to concrete masonry units manufactured on equipment using low or zero slump concrete and the constituent materials defined herein. Many performance attributes of concrete masonry units are indirectly accounted for, or inherently reflected within, the requirements of this specification without direct measurement, assessment, or evaluation. Applying the requirements of this specification to products that may be similar in appearance, use, or nature to those covered by this specification may not address all pertinent physical properties necessary to ensure performance or serviceability of the resulting construction in real-world applications under typical exposure environments. Products manufactured using alternative materials, manufacturing methods, or curing processes not covered by this specification should not be evaluated solely using the requirements in this specification; however, developers of new products can consider the property requirements of this specification as a beginning benchmark for unit performance. It is reasonable to test new products for system performance as well as unit performance.

1.3 The text of this specification references notes and footnotes which provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of the standard.

1.4 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

Note 2—When particular features are desired such as surface textures for appearance or bond, finish, color, or particular properties such as density classification, higher compressive strength, fire resistance, thermal performance or acoustical performance, these features should be specified separately by the purchaser. Suppliers should be consulted as to the availability of units having the desired features.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C33/C33M Specification for Concrete Aggregates
C140/C140M Test Methods for Sampling and Testing Concrete Masonry Units and Related Units
C150/C150M Specification for Portland Cement
C331/C331M Specification for Lightweight Aggregates for Concrete Masonry Units
C426 Test Method for Linear Drying Shrinkage of Concrete Masonry Units
C595/C595M Specification for Blended Hydraulic Cements
C618 Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
C979/C979M Specification for Pigments for Integrally Colored Concrete
C989/C989M Specification for Slag Cement for Use in Concrete and Mortars
C1157/C1157M Performance Specification for Hydraulic Cement
C1232 Terminology of Masonry
C1240 Specification for Silica Fume Used in Cementitious Mixtures
C1314 Test Method for Compressive Strength of Masonry Prisms
E519/E519M Test Method for Diagonal Tension (Shear) in Masonry Assemblages
E72 Test Methods of Conducting Strength Tests of Panels for Building Construction

3. Terminology

3.1 Terminology defined in Terminology C1232 shall apply for this specification.

[1] This specification is under the jurisdiction of ASTM Committee C15 on Manufactured Masonry Units and is the direct responsibility of Subcommittee C15.03 on Concrete Masonry Units and Related Units.

Current edition approved Dec. 15, 2016. Published January 2017. Originally approved in 1931. Last previous edition approved in 2016 as C90 – 15. DOI: 10.1520/C0090-16A.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

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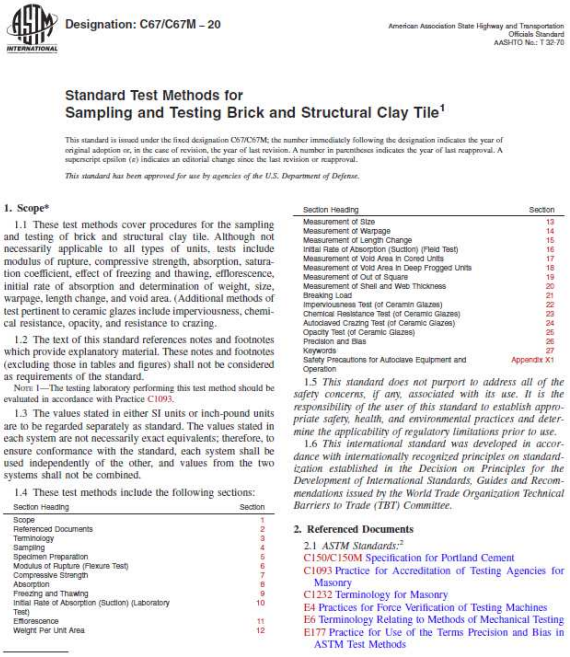
C67 – Test Methods for Clay Units



Designation: C67/C67M – 20

American Association State Highway and Transportation Officials Standard AASHTO No.: T 32-70

Standard Test Methods for
Sampling and Testing Brick and Structural Clay Tile[1]

This standard is issued under the fixed designation C67/C67M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope*

1.1 These test methods cover procedures for the sampling and testing of brick and structural clay tile. Although not necessarily applicable to all types of units, tests include modulus of rupture, compressive strength, absorption, saturation coefficient, effect of freezing and thawing, efflorescence, initial rate of absorption and determination of weight, size, warpage, length change, and void area. (Additional methods of test pertinent to ceramic glazes include imperviousness, chemical resistance, opacity, and resistance to crazing.

1.2 The text of this standard references notes and footnotes which provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of the standard.

Note 1—The testing laboratory performing this test method should be evaluated in accordance with Practice C1093.

1.3 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system are not necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other, and values from the two systems shall not be combined.

1.4 These test methods include the following sections:

Section Heading	Section
Scope	1
Referenced Documents	2
Terminology	3
Sampling	4
Specimen Preparation	5
Modulus of Rupture (Flexure Test)	6
Compressive Strength	7
Absorption	8
Freezing and Thawing	9
Initial Rate of Absorption (Suction) (Laboratory Test)	10
Efflorescence	11
Weight Per Unit Area	12
Measurement of Size	13
Measurement of Warpage	14
Measurement of Length Change	15
Initial Rate of Absorption (Suction) (Field Test)	16
Measurement of Void Area In Cored Units	17
Measurement of Void Area In Deep Frogged Units	18
Measurement of Out of Square	19
Measurement of Shell and Web Thickness	20
Breaking Load	21
Imperviousness Test (of Ceramin Glazes)	22
Chemical Resistance Test (of Ceramic Glazes)	23
Autoclaved Crazing Test (of Ceramic Glazes)	24
Opacity Test (of Ceramic Glazes)	25
Precision and Bias	26
Keywords	27
Safety Precautions for Autoclave Equipment and Operation	Appendix X1

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C150/C150M Specification for Portland Cement
C1093 Practice for Accreditation of Testing Agencies for Masonry
C1232 Terminology for Masonry
E4 Practices for Force Verification of Testing Machines
E6 Terminology Relating to Methods of Mechanical Testing
E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods

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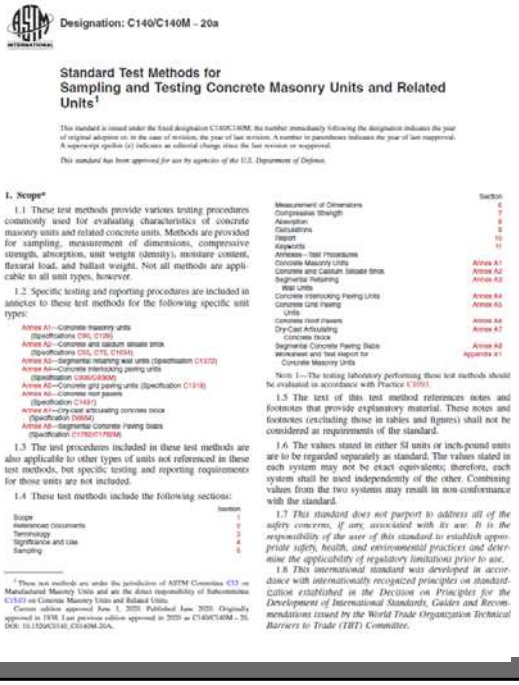
C140 – Test Methods for Concrete Units



Designation: C140/C140M – 20a

Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units[1]

This standard is issued under the fixed designation C140/C140M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope*

1.1 These test methods provide various testing procedures commonly used for evaluating characteristics of concrete masonry units and related concrete units. Methods are provided for sampling, measurement of dimensions, compressive strength, absorption, unit weight (density), moisture content, flexural load, and ballast weight. Not all methods are applicable to all unit types, however.

1.2 Specific testing and reporting procedures are included in annexes to these test methods for the following specific unit types:

Annex A1—Concrete masonry units (Specifications C90, C129)
Annex A2—Concrete and calcium silicate brick (Specifications C55, C73, C1634)
Annex A3—Segmental retaining wall units (Specification C1372)
Annex A4—Concrete interlocking paving units (Specification C936/C936M)
Annex A5—Concrete grid paving units (Specification C1319)
Annex A6—Concrete roof pavers (Specification C1491)
Annex A7—Dry-cast articulating concrete block (Specification D6684)
Annex A8—Segmental Concrete Paving Slabs (Specification C1782/C1782M)

1.3 The test procedures included in these test methods are also applicable to other types of units not referenced in these test methods, but specific testing and reporting requirements for those units are not included.

1.4 These test methods include the following sections:

	Section
Scope	1
Referenced Documents	2
Terminology	3
Significance and Use	4
Sampling	5
Measurement of Dimensions	6
Compressive Strength	7
Absorption	8
Calculations	9
Report	10
Keywords	11
Annexes—Test Procedures	
Concrete Masonry Units	Annex A1
Concrete and Calcium Silicate Brick	Annex A2
Segmental Retaining Wall Units	Annex A3
Concrete Interlocking Paving Units	Annex A4
Concrete Grid Paving Units	Annex A5
Concrete Roof Pavers	Annex A6
Dry-Cast Articulating Concrete Block	Annex A7
Segmental Concrete Paving Slabs	Annex A8
Worksheet and Test Report for Concrete Masonry Units	Appendix X1

Note 1—The testing laboratory performing these test methods should be evaluated in accordance with Practice C1093.

1.5 The text of this test method references notes and footnotes that provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of the standard.

1.6 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

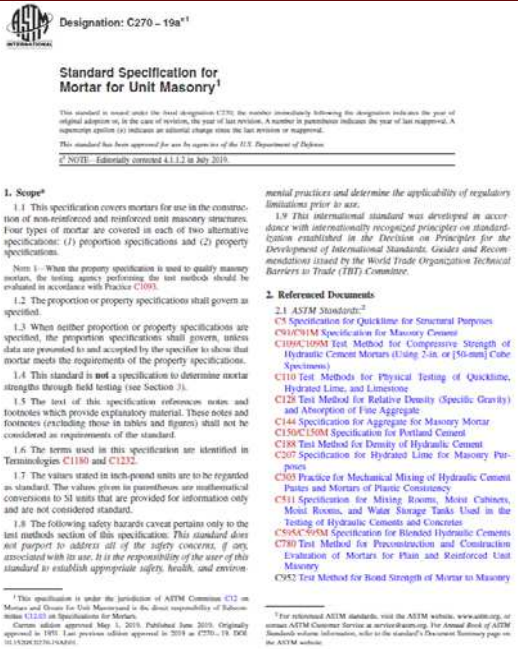
1.7 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.8 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

[1] These test methods are under the jurisdiction of ASTM Committee C15 on Manufactured Masonry Units and are the direct responsibility of Subcommittee C15.03 on Concrete Masonry Units and Related Units.

Current edition approved June 1, 2020. Published June 2020. Originally approved in 1938. Last previous edition approved in 2020 as C140/C140M – 20. DOI: 10.1520/C0140_C0140M-20A.

C270 – Specification for Mortar



Designation: C270 – 19a[ε1]

Standard Specification for Mortar for Unit Masonry[1]

This standard is issued under the fixed designation C270; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the U.S. Department of Defense.

ε[1] NOTE—Editorially corrected 4.1.1.2 in July 2019.

1. Scope*

1.1 This specification covers mortars for use in the construction of non-reinforced and reinforced unit masonry structures. Four types of mortar are covered in each of two alternative specifications: (*1*) proportion specifications and (*2*) property specifications.

Note 1—When the property specification is used to qualify masonry mortars, the testing agency performing the test methods should be evaluated in accordance with Practice C1093.

1.2 The proportion or property specifications shall govern as specified.

1.3 When neither proportion or property specifications are specified, the proportion specifications shall govern, unless data are presented to and accepted by the specifier to show that mortar meets the requirements of the property specifications.

1.4 This standard is **not** a specification to determine mortar strengths through field testing (see Section 3).

1.5 The text of this specification references notes and footnotes which provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of the standard.

1.6 The terms used in this specification are identified in Terminologies C1180 and C1232.

1.7 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.8 The following safety hazards caveat pertains only to the test methods section of this specification: *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.9 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]
C5 Specification for Quicklime for Structural Purposes
C91/C91M Specification for Masonry Cement
C109/C109M Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens)
C110 Test Methods for Physical Testing of Quicklime, Hydrated Lime, and Limestone
C128 Test Method for Relative Density (Specific Gravity) and Absorption of Fine Aggregate
C144 Specification for Aggregate for Masonry Mortar
C150/C150M Specification for Portland Cement
C188 Test Method for Density of Hydraulic Cement
C207 Specification for Hydrated Lime for Masonry Purposes
C305 Practice for Mechanical Mixing of Hydraulic Cement Pastes and Mortars of Plastic Consistency
C511 Specification for Mixing Rooms, Moist Cabinets, Moist Rooms, and Water Storage Tanks Used in the Testing of Hydraulic Cements and Concretes
C595/C595M Specification for Blended Hydraulic Cements
C780 Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry
C952 Test Method for Bond Strength of Mortar to Masonry

[1] This specification is under the jurisdiction of ASTM Committee C12 on Mortars and Grouts for Unit Masonry and is the direct responsibility of Subcommittee C12.03 on Specifications for Mortars.

Current edition approved May 1, 2019. Published June 2019. Originally approved in 1951. Last previous edition approved in 2019 as C270–19. DOI: 10.1520/C0270-19AE01.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

C476 – Specification for Grout

Designation: C476 – 20

Standard Specification for Grout for Masonry[1]

This standard is issued under the fixed designation C476; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope*

1.1 This specification covers two types of grout, fine and coarse grout, for use in the construction of masonry structures. Each type (fine and coarse) is further classified as conventional grout (requiring mechanical consolidation by puddling or vibration when placed) and self consolidating grout (not requiring mechanical consolidation when placed). Conventional grout is specified by (*1*) proportions or (*2*) strength requirements. Self-consolidating grout is specified by strength requirements.

1.2 The text of this specification references notes and footnotes that provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of this specification.

1.3 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C5 Specification for Quicklime for Structural Purposes

C29/C29M Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate

C143/C143M Test Method for Slump of Hydraulic-Cement Concrete

C150/C150M Specification for Portland Cement

C207 Specification for Hydrated Lime for Masonry Purposes

C260/C260M Specification for Air-Entraining Admixtures for Concrete

C404 Specification for Aggregates for Masonry Grout

C494/C494M Specification for Chemical Admixtures for Concrete

C595/C595M Specification for Blended Hydraulic Cements

C618 Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete

C989/C989M Specification for Slag Cement for Use in Concrete and Mortars

C1019 Test Method for Sampling and Testing Grout for Masonry

C1157/C1157M Performance Specification for Hydraulic Cement

C1602/C1602M Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete

C1611/C1611M Test Method for Slump Flow of Self-Consolidating Concrete

3. Materials

3.1 Materials used as ingredients in grout shall conform to the requirements specified in 3.1.1 – 3.1.5.

3.1.1 *Cementitious Materials*—Cementitious materials shall conform to one of the following specifications:

3.1.1.1 *Portland Cement*—Type I, IA, II, IIA, III, and IIIA of Specification C150/C150M.

3.1.1.2 *Blended Cements*—Type IL, IS(<70), IP, IT(S<70), or blended cements with special properties designated by (A), (MS), or (HS), or a combination of (A) and (MS) or (HS), as appropriate, of Specification C595/C595M.

3.1.1.3 *Hydraulic Cements*—Types GU, HE, MS, or HS of Specification C1157/C1157M.

3.1.1.4 *Quicklime*—Specification C5.

3.1.1.5 *Hydrated Lime*—Type S of Specification C207.

3.1.1.6 *Coal Fly Ash or Raw Calcined Natural Pozzolan*—Specification C618. Addition rates shall be in an amount governed by the portland-pozzolan cement category of Specification C595/C595M. The grout produced with blends of

[1] This specification is under the jurisdiction of ASTM Committee C12 on Mortars and Grouts for Unit Masonry and is the direct responsibility of Subcommittee C12.05 on Grout & Grout Admixtures for Masonry.

Current edition approved June 1, 2020. Published June 2020. Originally approved in 1962. Last previous edition approved in 2019 as C476 – 19. DOI: 10.1520/C0476-20.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

C1019 – Tests for Grout

Designation: C1019 – 19

Standard Test Method for Sampling and Testing Grout for Masonry[1]

This standard is issued under the fixed designation C1019; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope

1.1 This test method covers procedures for both field and laboratory sampling and compression testing of grout used in masonry construction. Grout for masonry is specified under Specification C476.

NOTE 1—The testing agency performing this test method should be evaluated in accordance with Practice C1093.

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C39/C39M Test Method for Compressive Strength of Cylindrical Concrete Specimens

C143/C143M Test Method for Slump of Hydraulic-Cement Concrete

C476 Specification for Grout for Masonry

C511 Specification for Mixing Rooms, Moist Cabinets, Moist Rooms, and Water Storage Tanks Used in the Testing of Hydraulic Cements and Concretes

C617 Practice for Capping Cylindrical Concrete Specimens

C1064/C1064M Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete

C1093 Practice for Accreditation of Testing Agencies for Masonry

C1611/C1611M Test Method for Slump Flow of Self-Consolidating Concrete

3. Significance and Use

3.1 Grout used in masonry is a fluid mixture of cementitious materials and aggregate with a high water content for ease of placement.

3.1.1 During construction, grout is placed within or between absorptive masonry units. Excess water must be removed from grout specimens in order to provide compressive strength test results more nearly indicative of the grout strength in the wall. In this test method, molds are made from masonry units having the same absorption and moisture content characteristics as those being used in the construction.

3.2 This test method is used to either help select grout proportions by comparing test values or as a quality control test for uniformity of grout preparation during construction.

3.3 The physical exposure condition and curing of the grout are not exactly reproduced, but this test method does subject the grout specimens to absorption conditions similar to those experienced by grout in the wall.

NOTE 2—Test results of grout specimens taken from a wall should not be compared to test results obtained with this test method.

4. Apparatus

4.1 *Maximum-Minimum Thermometer.*

4.2 *Straightedge*, a steel straightedge not less than 6 in. (152.4 mm) long and not less than 1/16 in. (1.6 mm) in thickness.

4.3 *Tamping Rod*, a round, straight, steel rod with a diameter of 3/8 ± 1/16 in. (10 ± 2 mm) and a length of 12 ± 4 inches (300 ± 100 millimetres). The rod shall have the tamping end or both ends rounded to a hemispherical tip of the same diameter as the rod.

[1] This test method is under the jurisdiction of ASTM Committee C12 on Mortars and Grouts for Unit Masonry and is the direct responsibility of Subcommittee C12.02 on Research and Methods of Tests.

Current edition approved Dec. 1, 2019. Published January 2020. Originally approved in 1984. Last previous edition approved in 2018 as C1019 – 18a. DOI: 10.1520/C1019-19.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

Helpful Resources, Websites

- ICC – International Code Council, www.iccsafe.org
- TMS – The Masonry Society, www.masonrysociety.org
- MIA – Masonry Institute of America www.masonryinsitute.org
- BIA – Brick Industry Association, www.gobrick.com
- IMI - International Masonry Institute, www.imiweb.org
- NCMA – National Concrete Masonry Association, www.ncma.org
- PCA – Portland Cement Association, www.cement.org

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This concludes The American Institute of Architects Continuing Education Systems Course

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