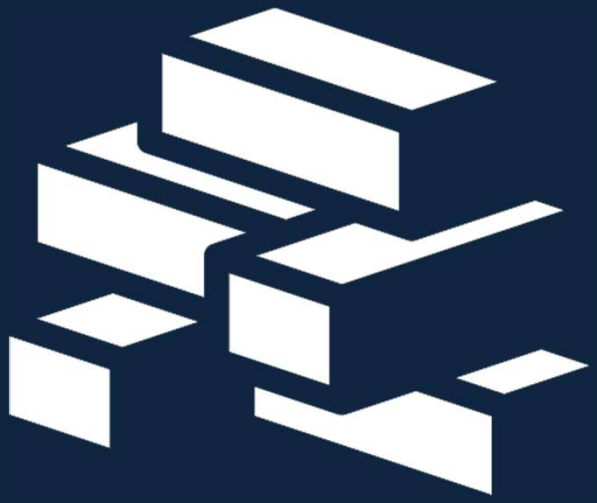


MASONRY Association of Florida

CONCRETE MASONRY

COMPONENT 1

GREG MOODY
FASTM, LEED AP BD + C

Greg Moody, AP BD+C, FASTM, is the Senior Technical Manager for Masonry Products for CEMEX. He is an ASTM Fellow and is active on numerous ASTM committees, include C01 - Cement, C09 - Concrete, C12 - Mortars and Grouts for Unit Masonry, C15 - Masonry Units, E54 - Homeland Security Applications, and E60 - Sustainability. Greg is very interested in seeking alternatives to current construction practices.

Senior Quality Assurance Manager, Masonry Products
CEMEX
greg.moody@cemex.com
407.402.4878

SPECIFIERS

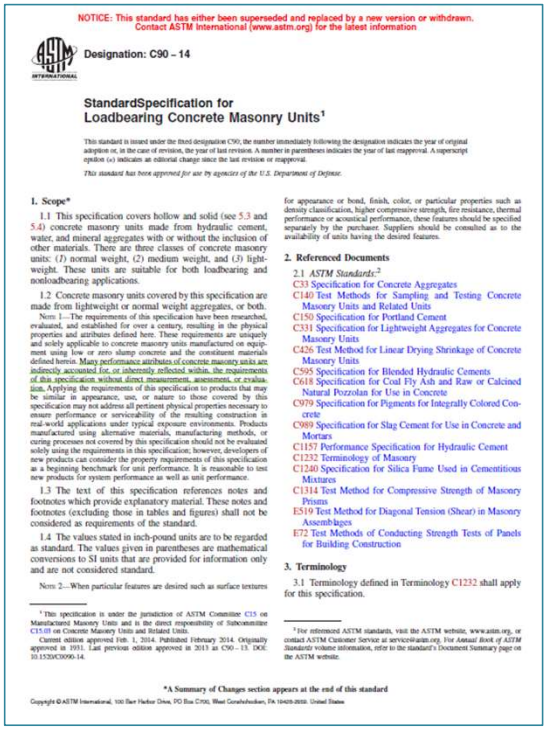
SPECIFIERS are usually interested in the following properties of block:

Compressive strength	Fire rating	Density (Class)	Dimensions
Shrinkage	Texture	Moisture content (Type)	Exposure durability (Grade)

ASTM Designation

C90 – since 1931
C140 – since 1938

- Letter – general classification
- Sequential Number
- “M” = metric
- Year Date
- “a” – first revision for the year
- “b” – second revision for the year
- superscript epsilon (ε) – editorial revision



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Designation: C90 – 14

StandardSpecification for
Loadbearing Concrete Masonry Units[1]

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E72 Test Methods of Conducting Strength Tests of Panels for Building Construction

3. Terminology

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[1] This specification is under the jurisdiction of ASTM Committee C15 on Manufactured Masonry Units and is the direct responsibility of Subcommittee C15.05 on Concrete Masonry Units and Related Units.

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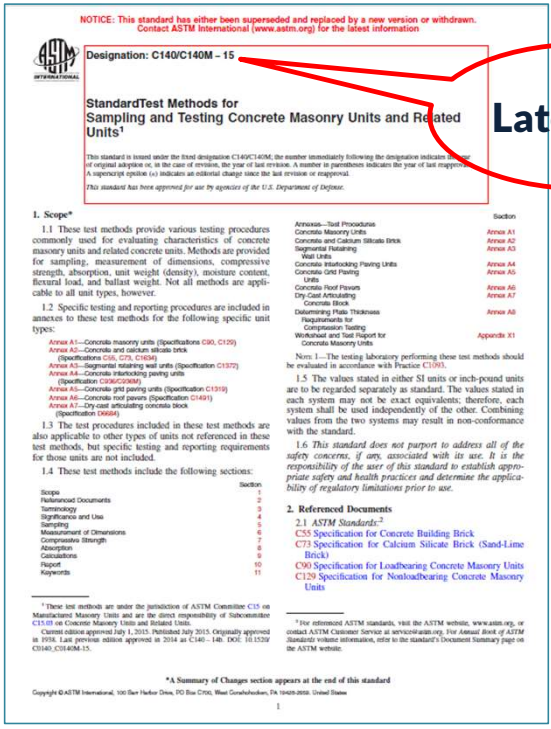

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Designation: C140/C140M – 15

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

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Latest is “- 20”

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)

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
Determining Plate Thickness Requirements for Compression Testing	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 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.

1.6 *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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C55 Specification for Concrete Building Brick
C73 Specification for Calcium Silicate Brick (Sand-Lime Brick)
C90 Specification for Loadbearing Concrete Masonry Units
C129 Specification for Nonloadbearing Concrete Masonry Units

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Current edition approved July 1, 2015. Published July 2015. Originally approved in 1938. Last previous edition approved in 2014 as C140 – 14b. DOI: 10.1520/C0140_C0140M-15.

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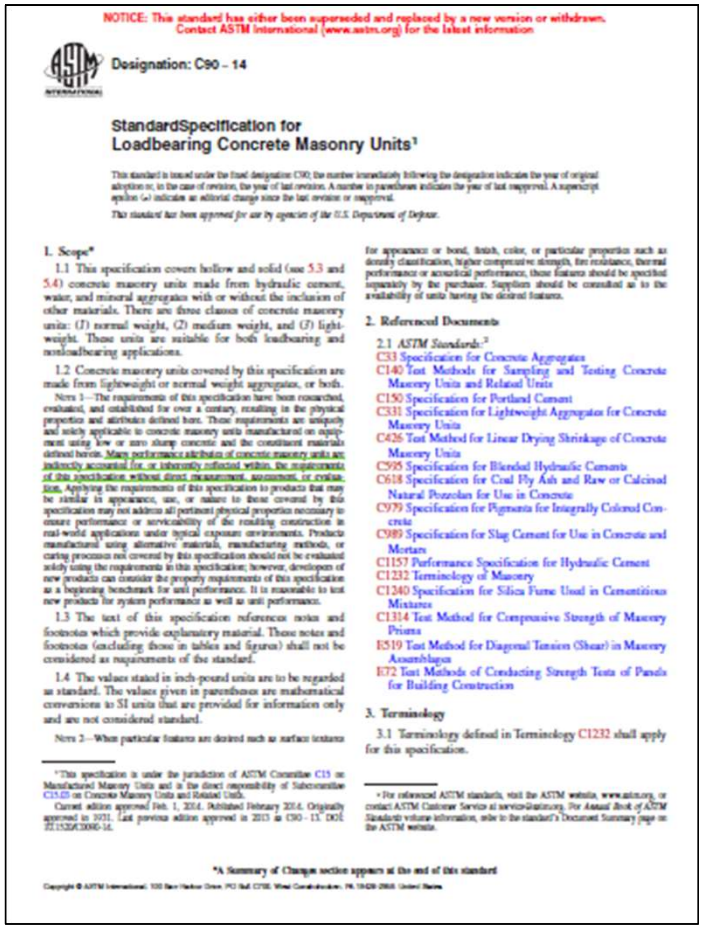
ASTM C90

- **In your ASTM Workbook, please turn to the "CONCRETE MASONRY" Section - page 3.**



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NOTE 1 - SPECIFIC COMPONENTS

“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.”

Note 1 – added in -12

It may look like a CMU, but it may not perform like a CMU

ASTM C90 Table 2 Classification

Density Classification	Oven-Dry Density of Concrete, lb/ft^3 (kg/m^3)
	Average of 3 Units
Lightweight	Less than 105 (1680)
Medium Weight	105 to less than 125 (1680–2000)
Normal Weight	125 (2000) or more

For concrete, the density is determined differently than block. For normal weight concrete, the density is usually the "plastic" or "fresh" density. For lightweight concrete, the "equilibrium" density is the pivotal density. For block, density is based upon dry weight.

TYPE (OUTDATED INFORMATION)

- ***Before 2000***, two type designations for concrete masonry units:
- Type I, moisture controlled
- Type II non-moisture-controlled

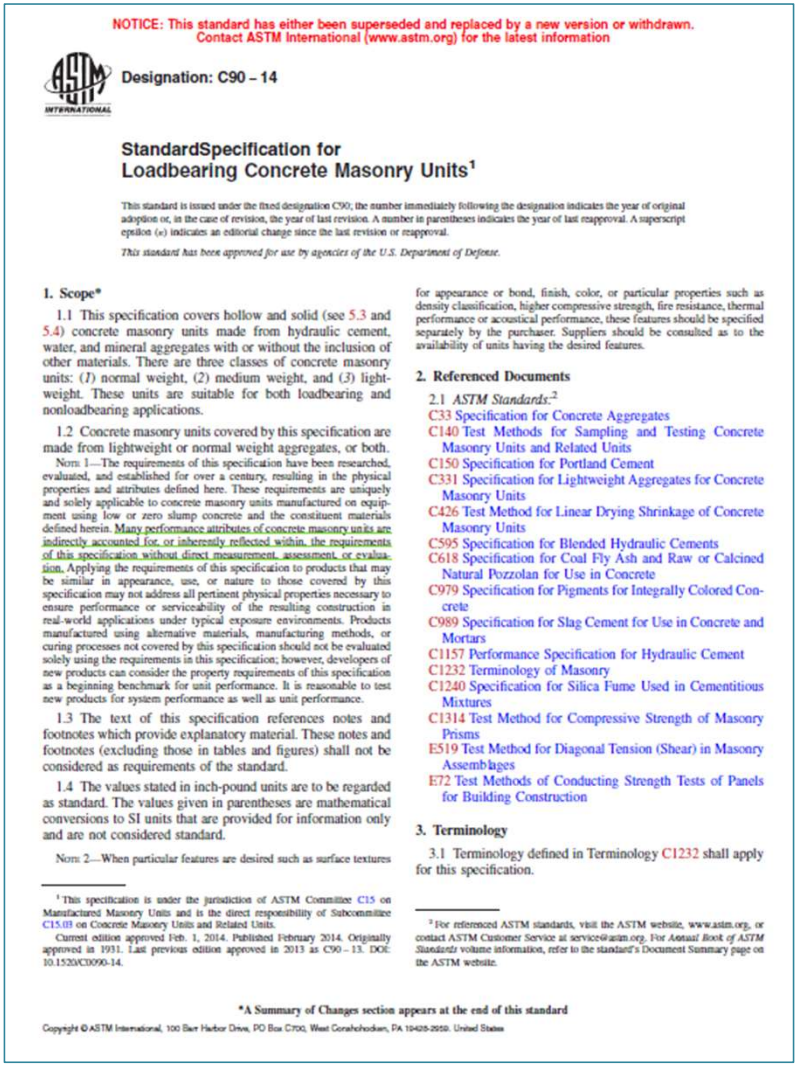
TABLE 1 Moisture-Content Requirements for Type I Units

Linear Shrinkage, %	Moisture Content, max, % of Total Absorption (Average of 3 Units)		
	Humidity Conditions at Job Site or Point of Use		
	Humid[A]	Intermediate[B]	Arid[C]
0.03 or less	45	40	35
From 0.03 to 0.045	40	35	30
0.045 to 0.065, max	35	30	25

[A] Average annual relative humidity above 75 %.
[B] Average annual relative humidity 50 to 75 %.
[C] Average annual relative humidity less than 50 %.
[D] See appendix for map of mean annual relative humidity.

ASTM C90 Type

"In 2000, the Type I (moisture-controlled) and Type II (non moisture-controlled) unit designations were removed from C90. The designations were withdrawn because they were difficult to effectively use and enforce, and because of newly developed concrete masonry crack control provisions." - NCMA TEK 1-1F - ASTM Specifications for Concrete Masonry Units



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StandardSpecification for Loadbearing Concrete Masonry Units[1]

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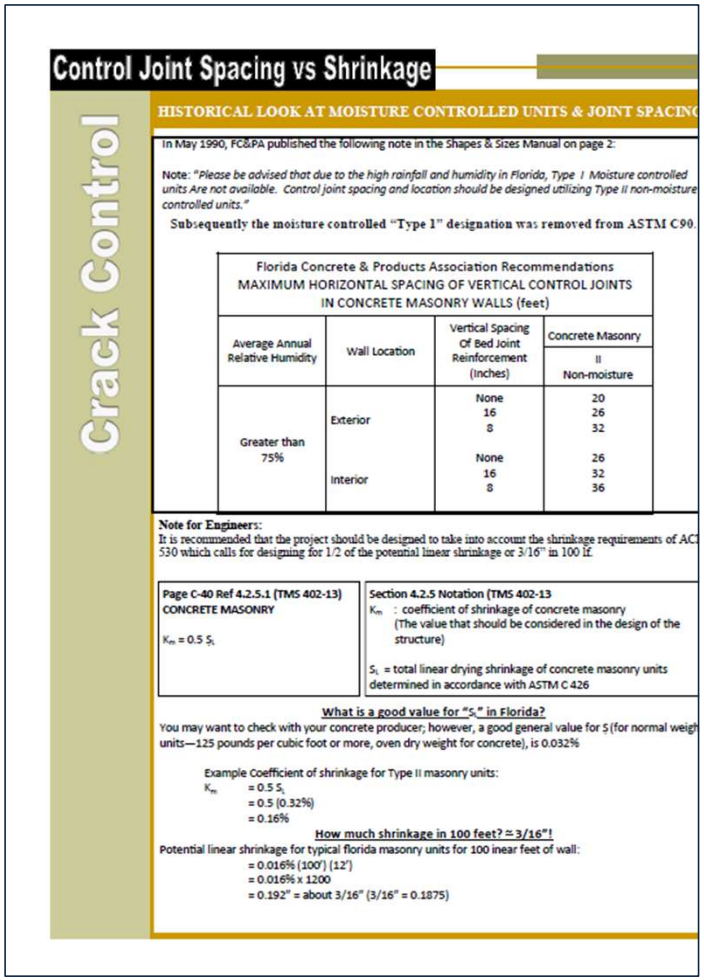


Control Joint Spacing vs Shrinkage

Crack Control

HISTORICAL LOOK AT MOISTURE CONTROLLED UNITS & JOINT SPACING

In May 1990, FC&PA published the following note in the Shapes & Sizes Manual on page 2:

Note: *"Please be advised that due to the high rainfall and humidity in Florida, Type I Moisture controlled units Are not available. Control joint spacing and location should be designed utilizing Type II non-moisture controlled units."*

Subsequently the moisture controlled "Type 1" designation was removed from ASTM C90.

Florida Concrete & Products Association Recommendations
MAXIMUM HORIZONTAL SPACING OF VERTICAL CONTROL JOINTS
IN CONCRETE MASONRY WALLS (feet)

Average Annual Relative Humidity	Wall Location	Vertical Spacing Of Bed Joint Reinforcement (Inches)	Concrete Masonry II Non-moisture
Greater than 75%	Exterior	None	20
		16	26
		8	32
	Interior	None	26
		16	32
		8	36

Note for Engineers:
It is recommended that the project should be designed to take into account the shrinkage requirements of AC 530 which calls for designing for 1/2 of the potential linear shrinkage or 3/16" in 100 lf.

Page C-40 Ref 4.2.5.1 (TMS 402-13) CONCRETE MASONRY

$K_m = 0.5\ S_t$

Section 4.2.5 Notation (TMS 402-13

K_m : coefficient of shrinkage of concrete masonry (The value that should be considered in the design of the structure)

S_t = total linear drying shrinkage of concrete masonry units determined in accordance with ASTM C 426

What is a good value for "S_t" in Florida?

You may want to check with your concrete producer; however, a good general value for S (for normal weigh units—125 pounds per cubic foot or more, oven dry weight for concrete), is 0.032%

Example Coefficient of shrinkage for Type II masonry units:

$K_m = 0.5\ S_t$
$= 0.5\ (0.32\%)$
$= 0.16\%$

How much shrinkage in 100 feet? ≈ 3/16"!

Potential linear shrinkage for typical florida masonry units for 100 linear feet of wall:

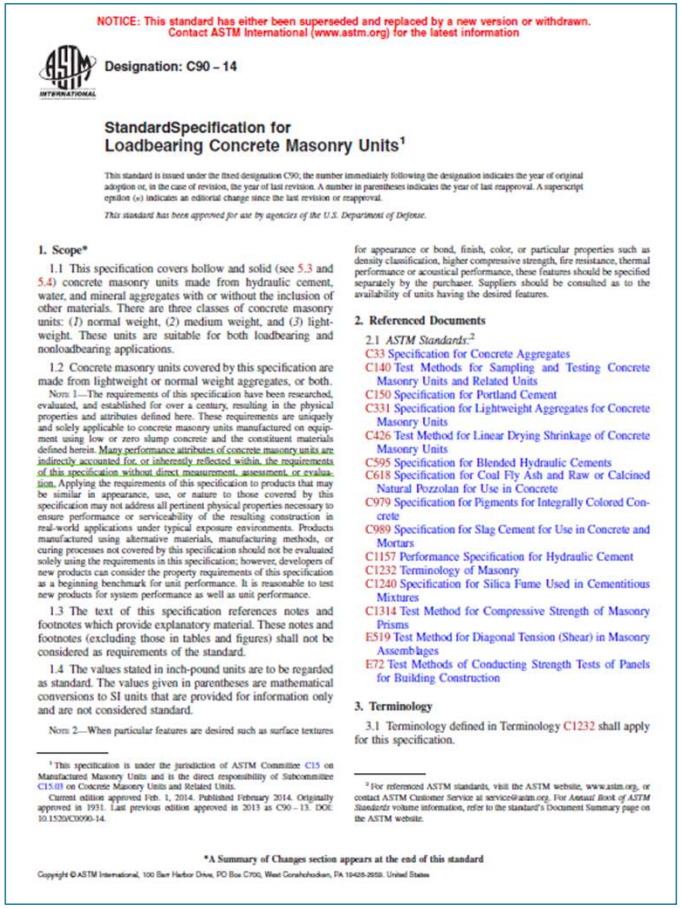
$= 0.016\%\ (100')\ (12')$
$= 0.016\% \times 1200$
$= 0.192"$ = about 3/16" (3/16" = 0.1875)

"BURY THE MYTH"

There are NO Type-I Block in Florida *(or Georgia for that matter)*

ASTM C90 GRADE (OUTDATED)

- In 1990, removing the unit grade classifications from the standard.
  - Grade N – For general use
  - Grade S – Limited to use above grade in exterior walls with weather protective coatings and in walls not exposed to weather.
    - Lower compressive strength and higher water absorption compared to Grade N units.



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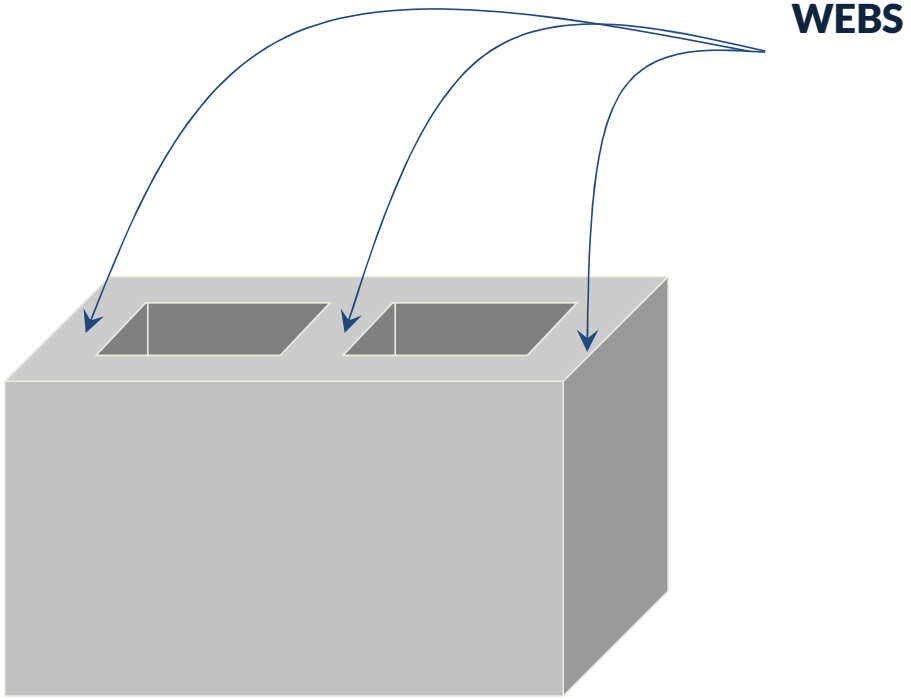
C90 WEB REVISIONS

This change only impacts the webs of units.

All other unit properties (face shells, compressive strength, etc.) remain unchanged.



ASTM C90-14

C90-14: Page 2 Table 1

Was 1” in C90-11a

TABLE 1 Minimum Face Shells and Web Requirements[A]

Nominal Width (W) of Units, in. (mm)	Face Shell Thickness (t_{fs}), min, in. (mm)[B,C]	Webs	
		Web Thickness[C] (t_w), min, in. (mm)	Normalized Web Area (A_{nw}), min, in.^{2}/ft^2 (mm^2/m^2)[D]
3 (76.2) and 4 (102)	¾ (19)	¾ (19)	6.5 (45,140)
6 (152)	1 (25)	¾ (19)	6.5 (45,140)
8 (203) and greater	1¼ (32)	¾ (19)	6.5 (45,140)

[A] Average of measurements on a minimum of 3 units when measured as described in Test Methods C140.

[B] When this standard is used for units having split surfaces, a maximum of 10 % of the split surface is permitted to have thickness less than those shown, but not less than ¾ in. (19.1 mm). When the units are to be solid grouted, the 10 % limit does not apply and Footnote C establishes a thickness requirement for the entire faceshell.

[C] When the units are to be solid grouted, minimum face shell and web thickness shall be not less than ⅝ in. (16 mm).

[D] Minimum normalized web area does not apply to the portion of the unit to be filled with grout. The length of that portion shall be deducted from the overall length of the unit for the calculation of the minimum web cross-sectional area.

Was 1” for 8-inch
1⅛” for 10-inch and greater
in C90-11a

ASTM C90-14

[D] Minimum normalized web area does not apply to the portion of the unit to be filled with grout. The length of that portion shall Be deducted from the overall Length of the unit for the cal-culation of the minimum web Cross-sectional area.

From Table 1

Nominal Width (W) of Units, in. (mm)
3 (76.2) and 4 (102)
6 (152)
8 (203) and greater

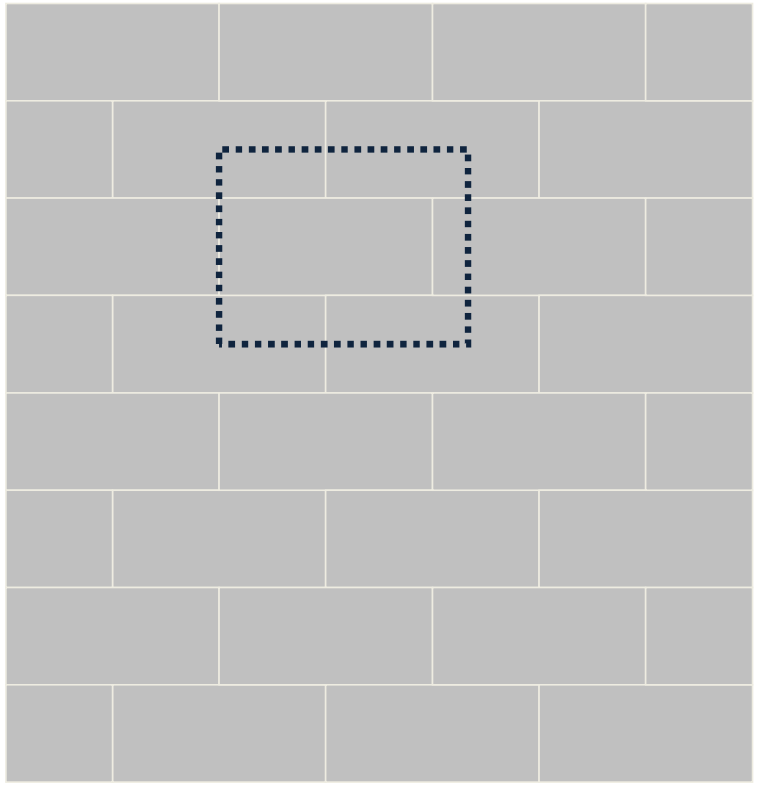
Normalized Web Area

C90-14: Page 2 Table 1

C90 Web Revisions

- **What does this mean?**

  For every square foot of wall surface, no less than 6.5 $in.^2$ of web must connect the front and back face shells, with no web measuring less than 0.75 in. in thickness.




15-5/8"
7-5/8"
7-5/8"

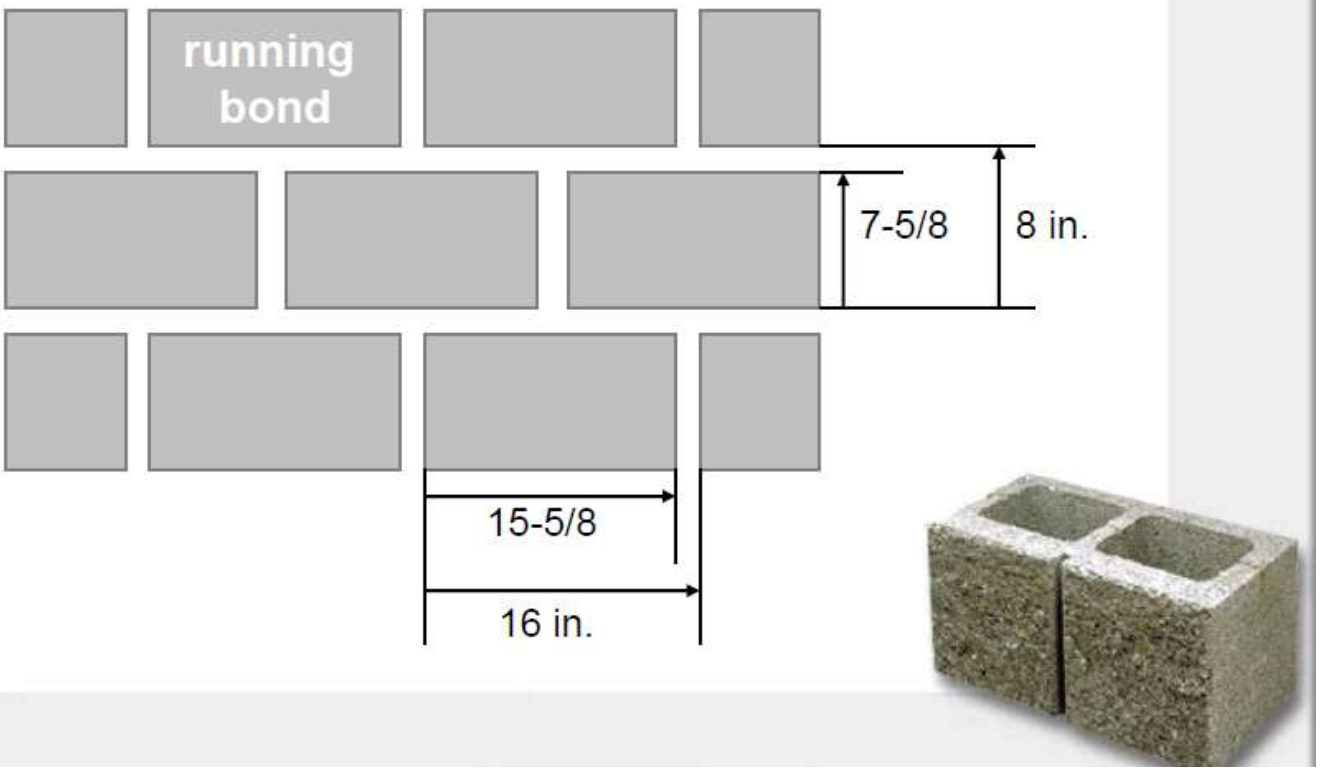
BLOCK DIMENSIONS

Width x Height X Length

Wookies
Hate
Lice

Nominal Dimensions

Nominal dimensions are equal to the standard dimensions plus the thickness of one mortar joint (typically 3/8 in.)



Permissible Variations in Dimensions

ASTM C90-14

6.1 *Standard Units*—For standard units, no overall dimension (width, height, and length) shall differ by more than ±⅛ in. (3.2 mm) from the specified dimensions.

6.2 *Particular Feature Units*—For particular feature units, dimensions shall be in accordance with the following:

6.2.1 For molded face units, no overall dimension (width, height, and length) shall differ by more than ±⅛ in. (3.2 mm) from the specified standard dimension. Dimensions of molded features shall be within ±1/16 in. (1.6 mm) of the specified standard dimensions and shall be within ±1/16 in. (1.6 mm) of the specified placement of the molded feature.

NOTE 7—Molded features include, but are not limited to: ribs, scores, hex-shapes, and patterns.

6.2.2 For split-faced units, all non-split overall dimensions shall differ by not more than ±⅛ in. (3.2 mm) from the specified standard dimensions.

ASTM C-90-14

C90-14: Page 3 @ 6.2 - 6.2.1 w/note 7

6.2 *Particular Feature Units*—For particular feature units, dimensions shall be in accordance with the following:

6.2.1 For molded face units, no overall dimension (width, height, and length) shall differ by more than ±⅛ in. (3.2 mm) from the specified standard dimension. Dimensions of molded features shall be within ±1/16 in. (1.6 mm) of the specified standard dimensions and shall be within ±1/16 in. (1.6 mm) of the specified placement of the molded feature.

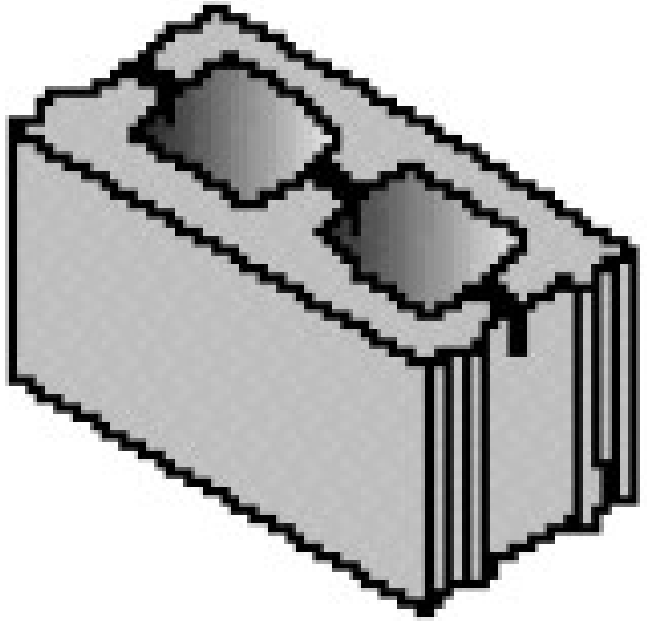
ASTM C-90-14

C90-14: Page 3 7.2

7.2 Where units are to be used in exposed wall construction, the face or faces that are to be exposed shall not show chips or cracks, not otherwise permitted in 7.1.2 and 7.1.3, or other imperfections when viewed from a distance of not less than 20 ft (6.1 m) under diffused lighting.

Core-Bar Cracks

5.1 At the time of delivery to the purchaser, units shall conform to the physical requirements prescribed in Table 1 and Table 2. All units shall be sound and free of cracks or other defects that interfere with the proper placement of the unit or significantly impair the strength or permanence of the construction. Minor cracks, incidental to the usual method of manufacture or minor chipping resulting from customary methods of handling in shipment and delivery, are not grounds for rejection.



ASTM C90-14

C90-14: Page 3@ 7.1.1

7.1 No more than 5 % of the units in the shipment shall exhibit one or more of the characteristics described in 7.1.1 through 7.1.4 and 7.2.

7.1.1 Units with dimensions not meeting the requirements of 6.1.

7.1.2 Units with finished face(s) containing chips larger than 1 in. (25.4 mm) in any direction.

7.1.3 Units with finished face(s) containing cracks wider than 0.02 in. (0.5 mm) and longer than 25 % of the nominal height of the unit.

7.1.4 Units that are broken.

ASTM C90-14

C 90 – 06

C 90

TABLE 2 Strength, Absorption, and Weight Classification Requirements

Weight Classification	Oven-Dry Density of Concrete, lb/ft³(kg/m³)	Maximum Water Absorption, lb/ft³(kg/m³)		Minimum Net Area Compressive Strength, lb/in²(MPa)	
	Average of 3 Units	Average of 3 Units	Individual Units	Average of 3 Units	Individual Units
Lightweight	Less than 105 (1680)	18 (288)	20 (320)	1900 (13.1)	1700 (11.7)
Medium Weight	105 to less than 125 (1680–2000)	15 (240)	17 (272)	1900 (13.1)	1700 (11.7)
Normal Weight	125 (2000) or more	13 (208)	15 (240)	1900 (13.1)	1700 (11.7)

C90 – 11b

Net Area Strength = 1900

TABLE 2 Strength, Absorption, and Density Classification Requirements

Density Classification	Oven-Dry Density of Concrete, lb/ft³ (kg/m³)	Maximum Water Absorption, lb/ft³ (kg/m³)		Minimum Net Area Compressive Strength, lb/in² (MPa)	
	Average of 3 Units	Average of 3 Units	Individual Units	Average of 3 Units	Individual Units
Lightweight	Less than 105 (1680)	18 (288)	20 (320)	1900 (13.1)	1700 (11.7)
Medium Weight	105 to less than 125 (1680–2000)	15 (240)	17 (272)	1900 (13.1)	1700 (11.7)
Normal Weight	125 (2000) or more	13 (208)	15 (240)	1900 (13.1)	1700 (11.7)

C90-14: Page 3 **Table 2**

C90 – 14

Net Area Strength = 2000

TABLE 2 Strength, Absorption, and Density Classification Requirements

Density Classification	Oven-Dry Density of Concrete, lb/ft³ (kg/m³)	Maximum Water Absorption, lb/ft³ (kg/m³)		Minimum Net Area Compressive Strength, lb/in² (MPa)	
	Average of 3 Units	Average of 3 Units	Individual Units	Average of 3 Units	Individual Units
Lightweight	Less than 105 (1680)	18 (288)	20 (320)	2000 (13.8)	1800 (12.4)
Medium Weight	105 to less than 125 (1680–2000)	15 (240)	17 (272)	2000 (13.8)	1800 (12.4)
Normal Weight	125 (2000) or more	13 (208)	15 (240)	2000 (13.8)	1800 (12.4)

Note: Most all block producers produce a block that meets **2000 psi** net area
Request a certification to that effect, if desired.

AGE OF COMPRESSIVE-STRENGTH

- Concrete
  - 28 days
- Mortar
  - 28 days
- Masonry Grout
  - 28 days
- Concrete Masonry Units
  - “At the time of delivery to the purchaser”

5.1 At the time of delivery to the purchaser, units shall conform to the physical requirements prescribed in Table 1 and Table 2. All units shall be sound and free of cracks or other

FIRE RATING

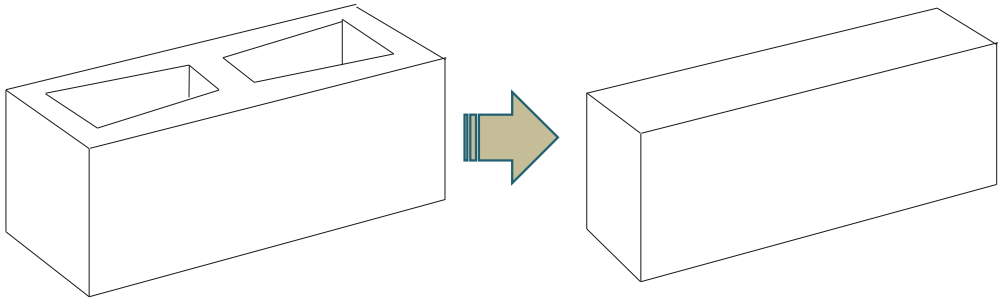
ASTM E119

“Equivalent Thickness”

Type of Aggregate	Minimum equivalent thickness for fire-resistance rating, in.														
	½ hr	¾ hr	1 hr	1¼ hr	1½ hr	1¾ hr	2 hr	2¼ hr	2½ hr	2¾ hr	3 hr	3¼ hr	3½ hr	3¾ hr	4 hr
Pumice or expanded slag	1.5	1.9	2.1	2.5	2.7	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.5	4.7
Expanded shale, clay or slate	1.8	2.2	2.6	2.9	3.3	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.8	4.9	5.1
Limestone, cinders or unexpanded slag	1.9	2.3	2.7	3.1	3.4	3.7	4.0	4.3	4.5	4.8	5.0	5.2	5.5	5.7	5.9
Calcareous or siliceous gravel	2.0	2.4	2.8	3.2	3.6	3.9	4.2	4.5	4.8	5.0	5.3	5.5	5.8	6.0	6.2

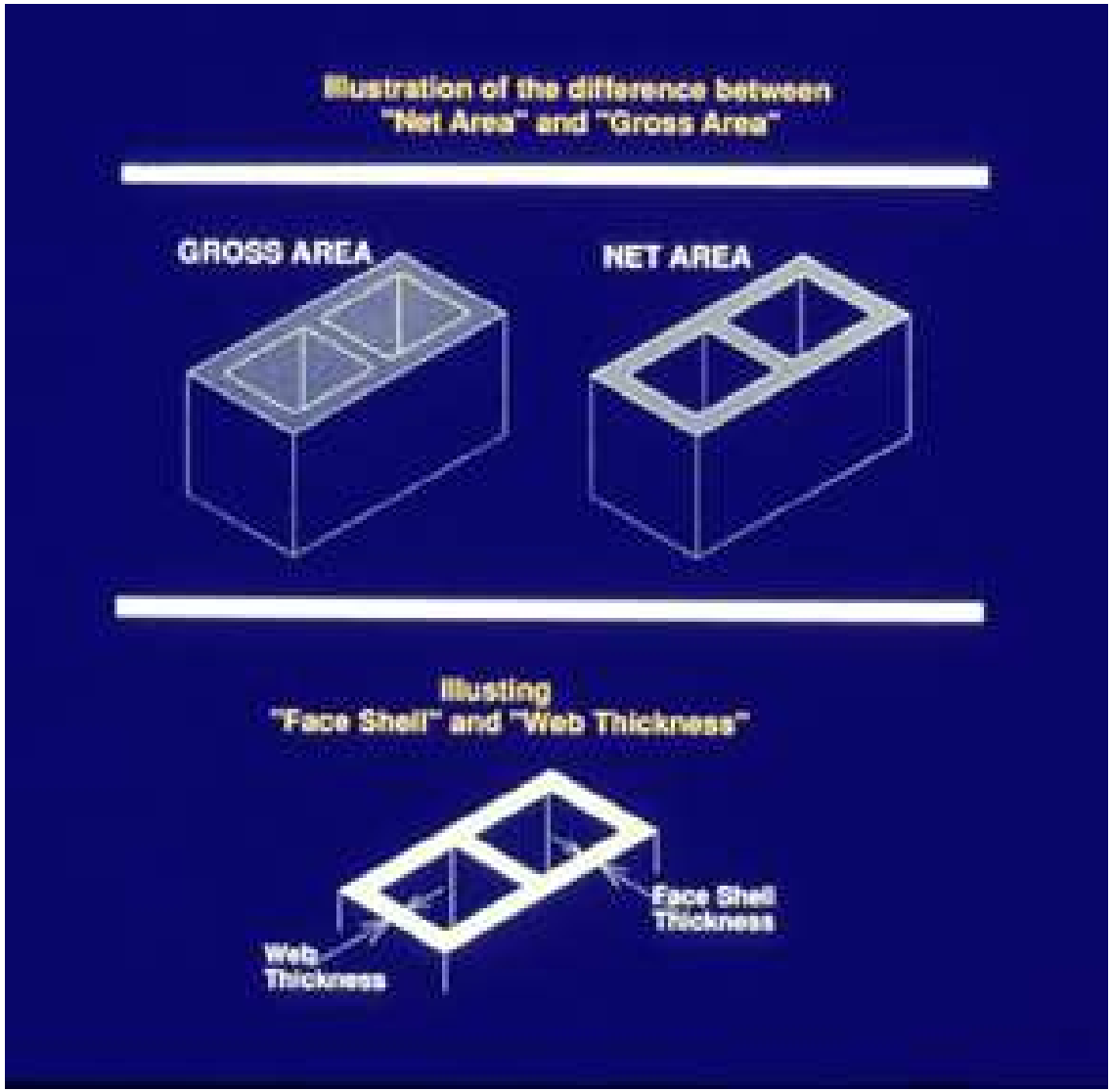
TERMINOLOGY: EQUIVALENT THICKNESS

Equivalent thickness is the theoretical thickness of the solid portion of a hollow CMU if the same amount of material was recast as a solid unit of the same height and length.



TERMINOLOGY
Gross Area / Net Area

Face Shell/ Cross Webs



ASTM C90-14

C90-14: Page 2@5.4

5.4 *Solid Units:*

5.4.1 The net cross-sectional area of solid units in every plane parallel to the bearing surface shall be not less than 75 % of the gross cross-sectional area measured in the same plane.

Solid Units ≥ 75 %

ASTM C90 Specification

ASTM C140 TEST METHOD

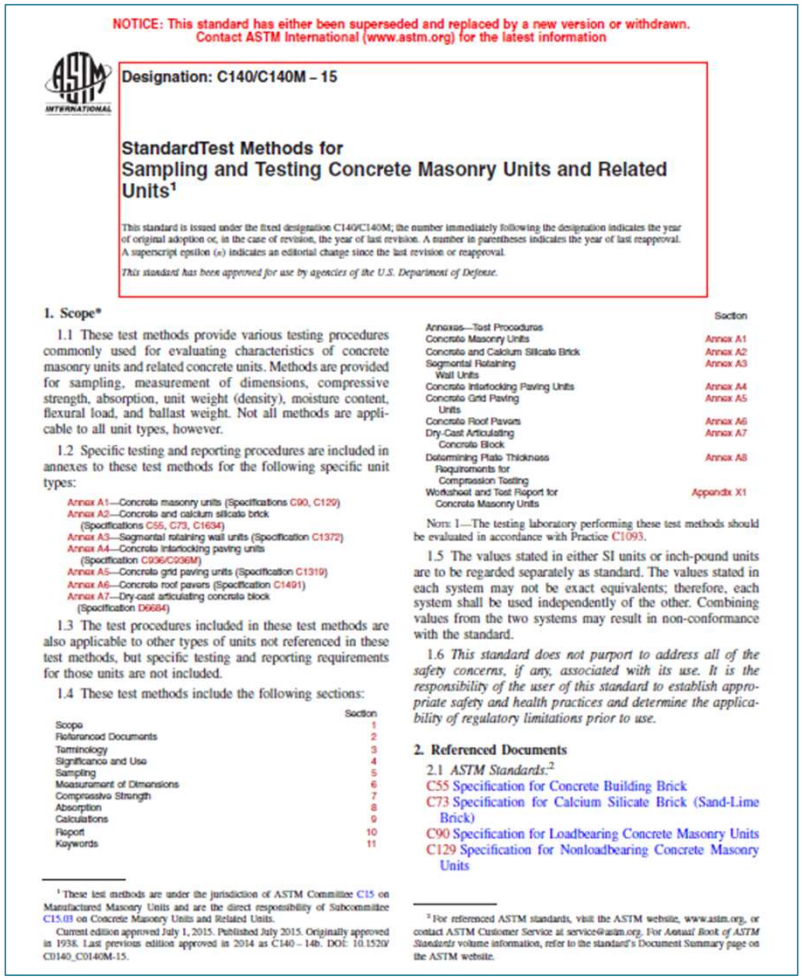
SAMPLING

- **The sampling rate in ASTM changed in 2014**
  - **from one set for every 50,000 units produced**
  - **to one set per year**
- **Moved for C140 to C90**

8.2 Compressive strength, absorption, density, and dimensional tolerances shall be based on tests of concrete masonry units of any configuration or dimension made with the same materials, concrete mix design, manufacturing process, and curing method, conducted in accordance with Test Methods C140 and within 12 months of production of the units.

ASTM C-140

Turn to “CONCRETE MASONRY” tab



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Contact ASTM International (www.astm.org) for the latest information

Designation: C140/C140M – 15

StandardTest 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)

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:

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

1.5 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.

1.6 *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 and health practices and determine the applicability of regulatory limitations prior to use.*

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ASTM C140-15 - Page 1 1.2

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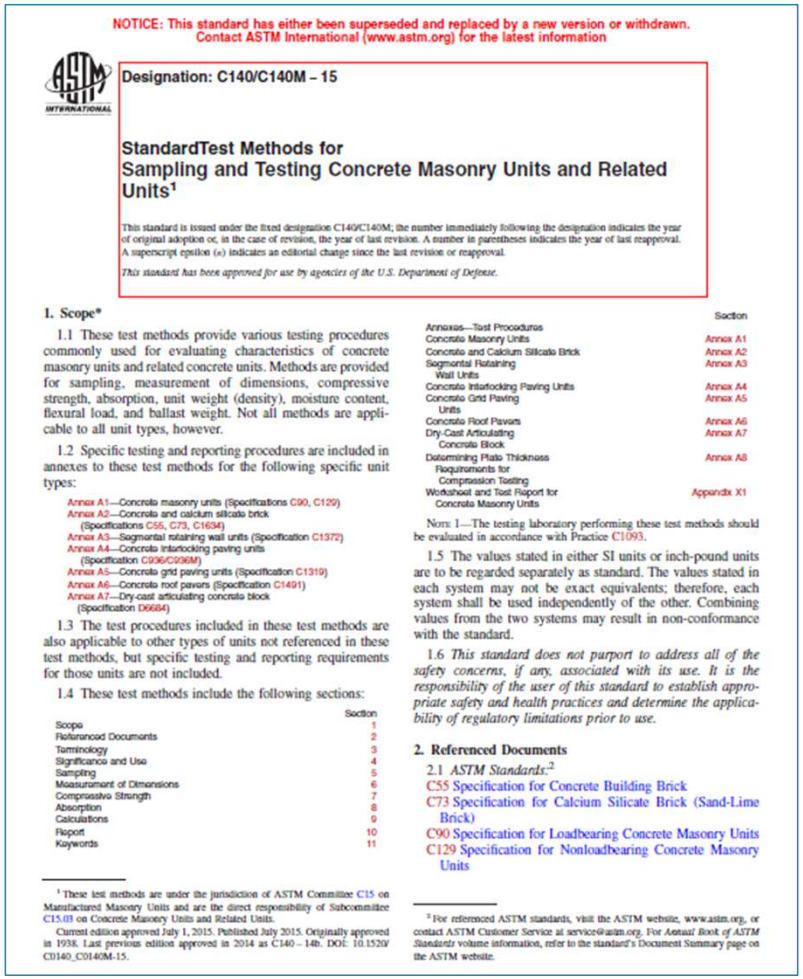

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	Section
Scope	1
Referenced Documents	2
Terminology	3
Significance and Use	4
Sampling	5
Measurement of Dimensions	6
Compressive Strength	7
Absorption	8
Calculations	9
Report	10
Keywords	11
Annexes—Test Procedures	
Concrete Masonry Units	Annex A1
Concrete 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
Determining Plate Thickness Requirements for Compression Testing	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.

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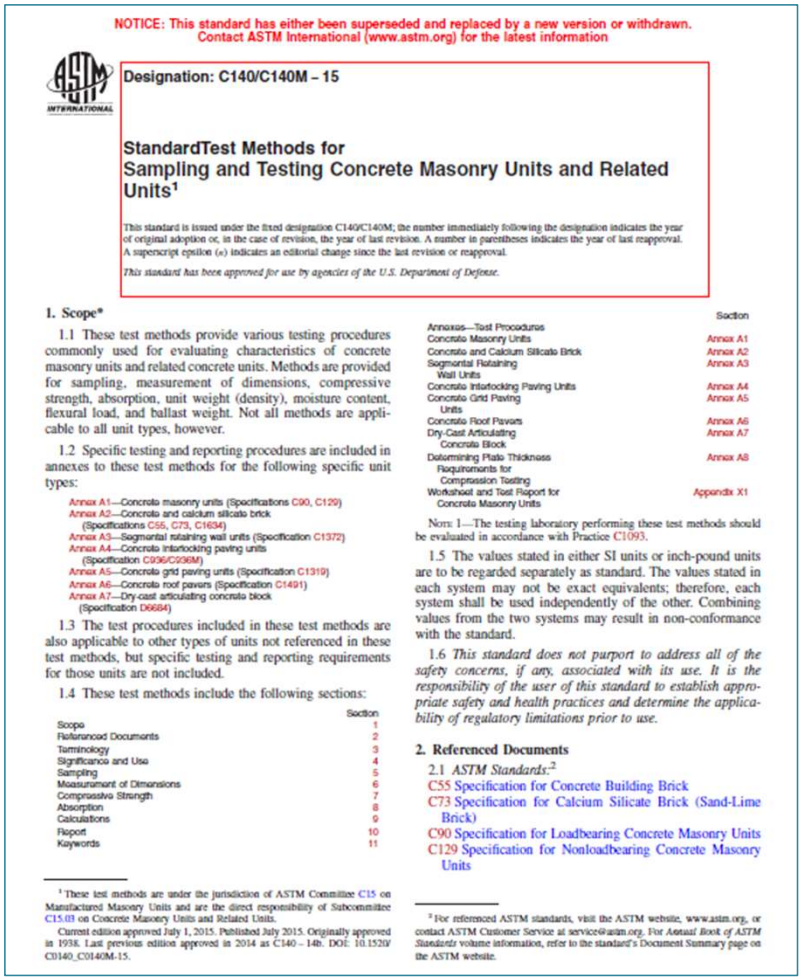
C140-15: Page 2 @ 5-5.1.1 5.1.2

"LOT"

5.1.2 The term "lot" refers to any number of concrete masonry units of any configuration or dimension manufactured by the producer using the same materials, concrete mix design, manufacturing process, and curing method.



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C140-15 Test Specimens

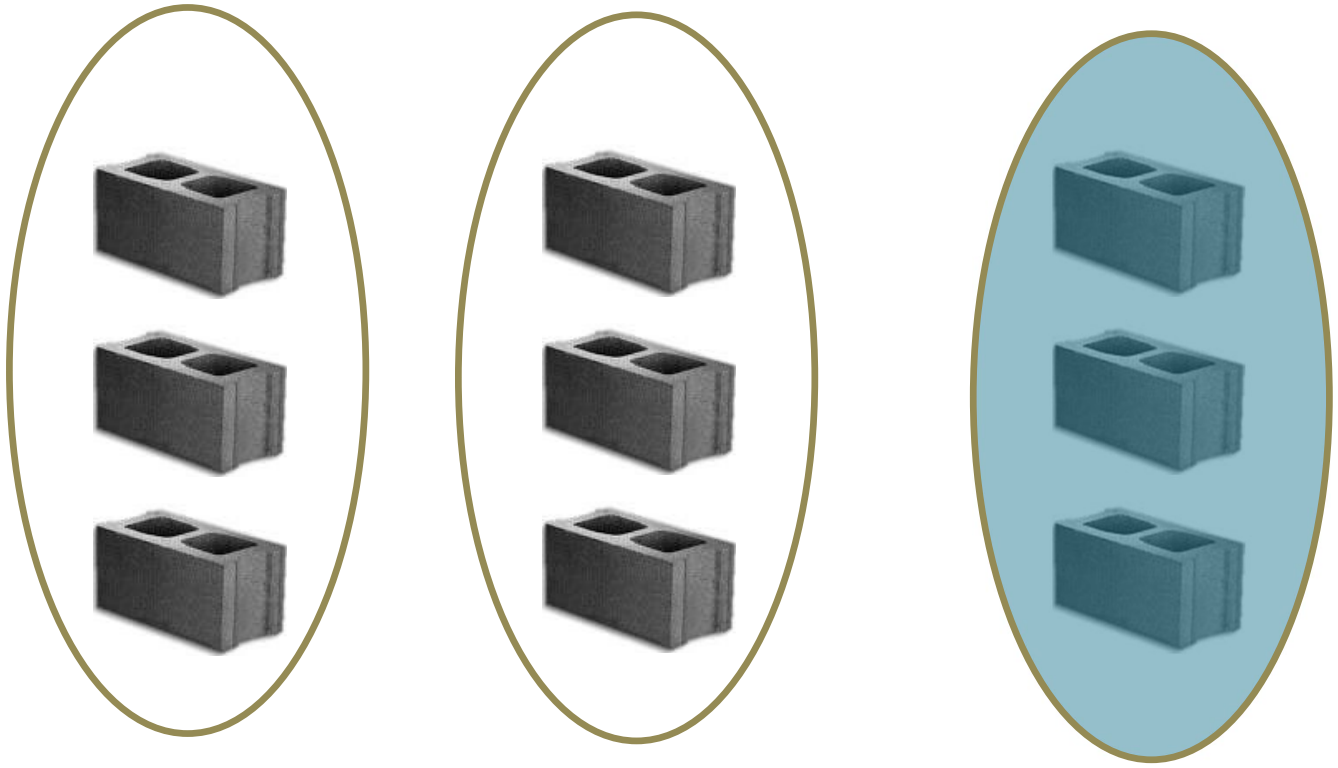
C140-15: Page 2 @ 5.2

5.2 *Number of Specimens:*

5.2.1 Unless specified otherwise in the applicable annex, a set of units shall consist of six full-size units.

6 units: 3 for compression &
3 for absorption

C140 TEST SPECIMENS



3 for Compressive Strength

3 for Absorption

Maybe 3 More for Shrinkage

ASTM C140-15

C140-15: Page 2 @ 5-5.1.1

5. Sampling

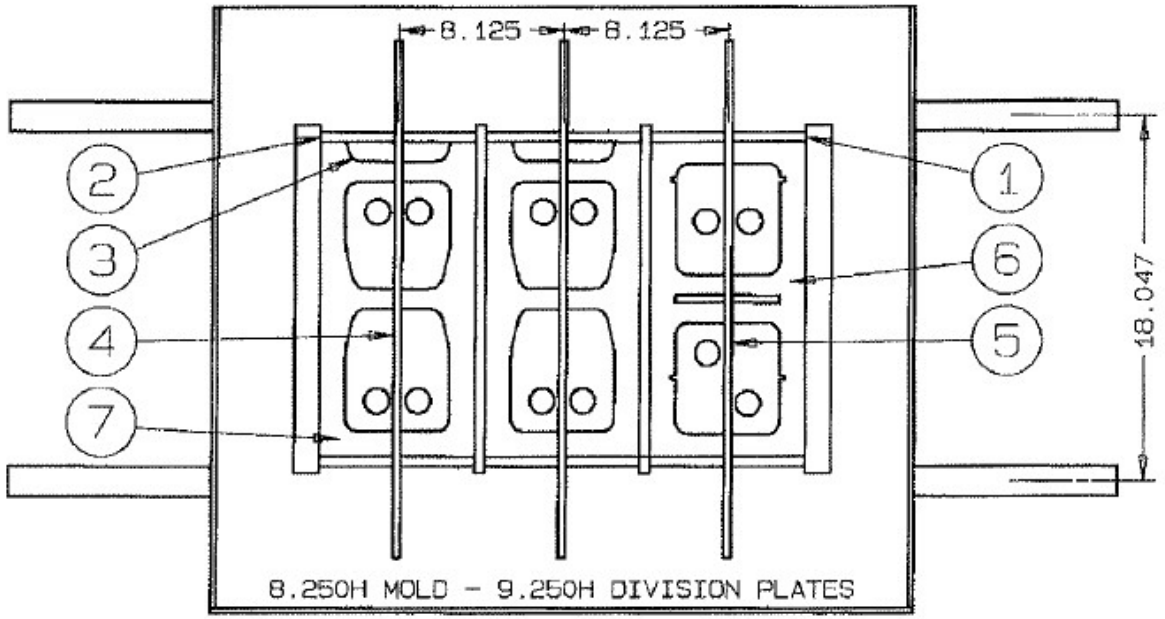
5.1 *Selection of Test Specimens:*

5.1.1 For purposes of testing, full-sized units shall be selected by the purchaser or authorized representative. The selected specimens shall be of similar configuration and dimensions. Specimens shall be representative of the whole lot of units from which they are selected.

Normally – Full Size Units

ALL SAME SHAPE

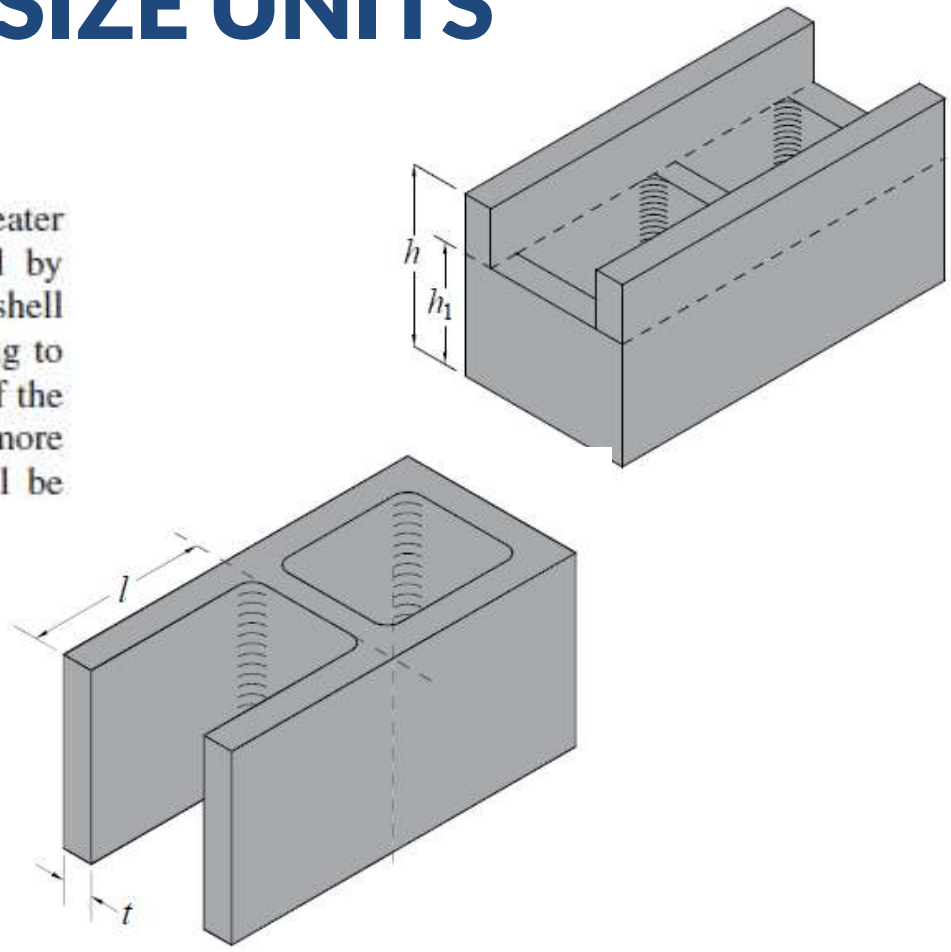
C140 5.1.1



NORMALLY – FULL SIZE UNITS

C140-15: Page 5 @ A1.3.1.1

A1.3.1.1 Unsupported projections having a length greater than the thickness of the projection shall be removed by saw-cutting. For units with recessed webs, the face shell projecting above the web shall be removed by saw-cutting to provide a full bearing surface over the net cross section of the unit. Where the resulting unit height would be reduced by more than one-third of the original unit height, the unit shall be coupon tested in accordance with A1.3.1.3.



NORMALLY – FULL SIZE UNITS

C140-15: Page 5 @ A1.3.1.1

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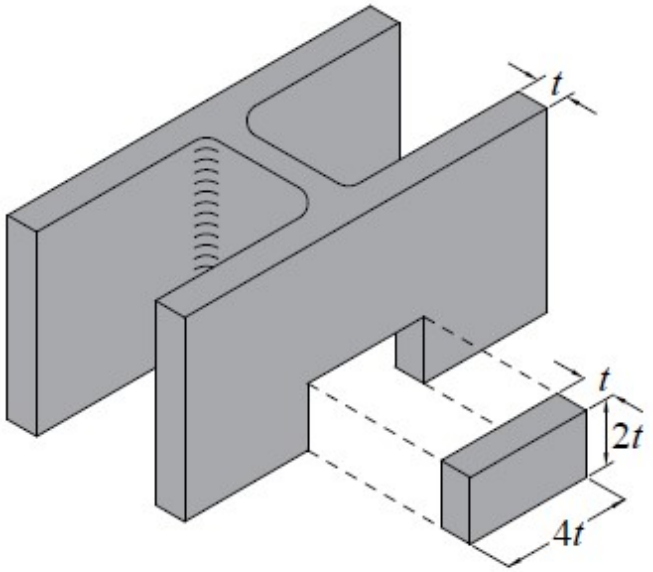


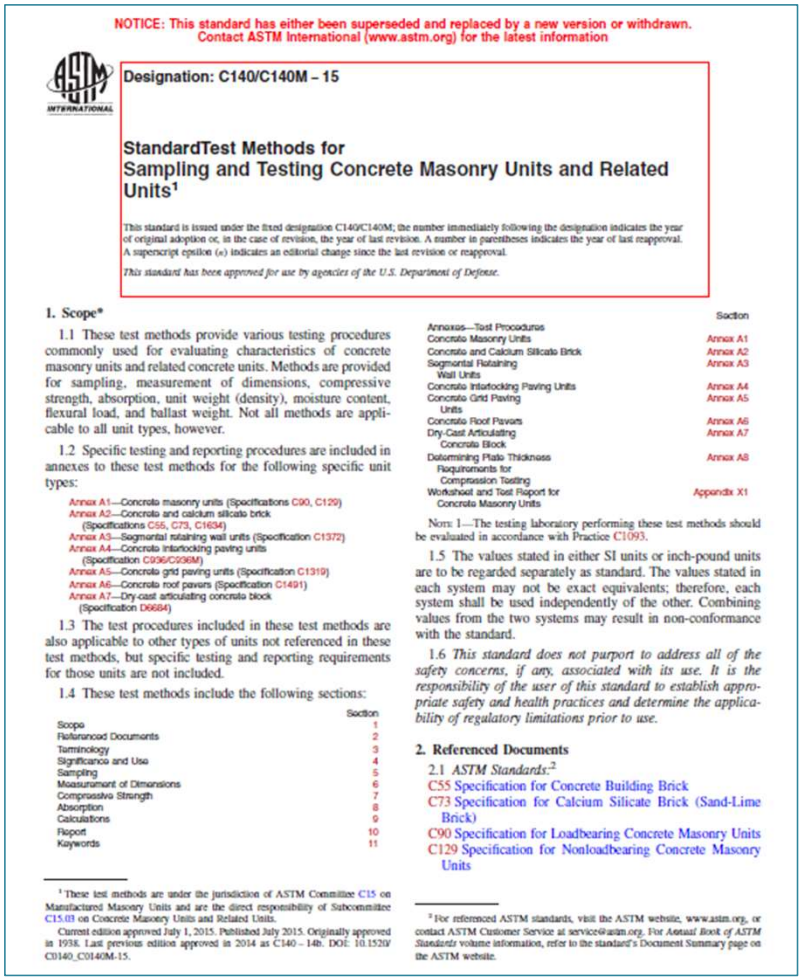
ASTM C140-15

W … AS RECEIVED

MEASUREMENT
ASTM C140
Section 6 and A1.2

A1.2 Measurement

A1.2.1 For each unit, measure and record the width (*W*) across the top and bottom bearing surfaces at mid-length, height (*H*) at mid-length of each face, and length (*L*) at mid-height of each face to the nearest division required to be reported.



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Designation: C140/C140M – 15

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

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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
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Worksheet and Test Report for Concrete Masonry Units	Appendix X1

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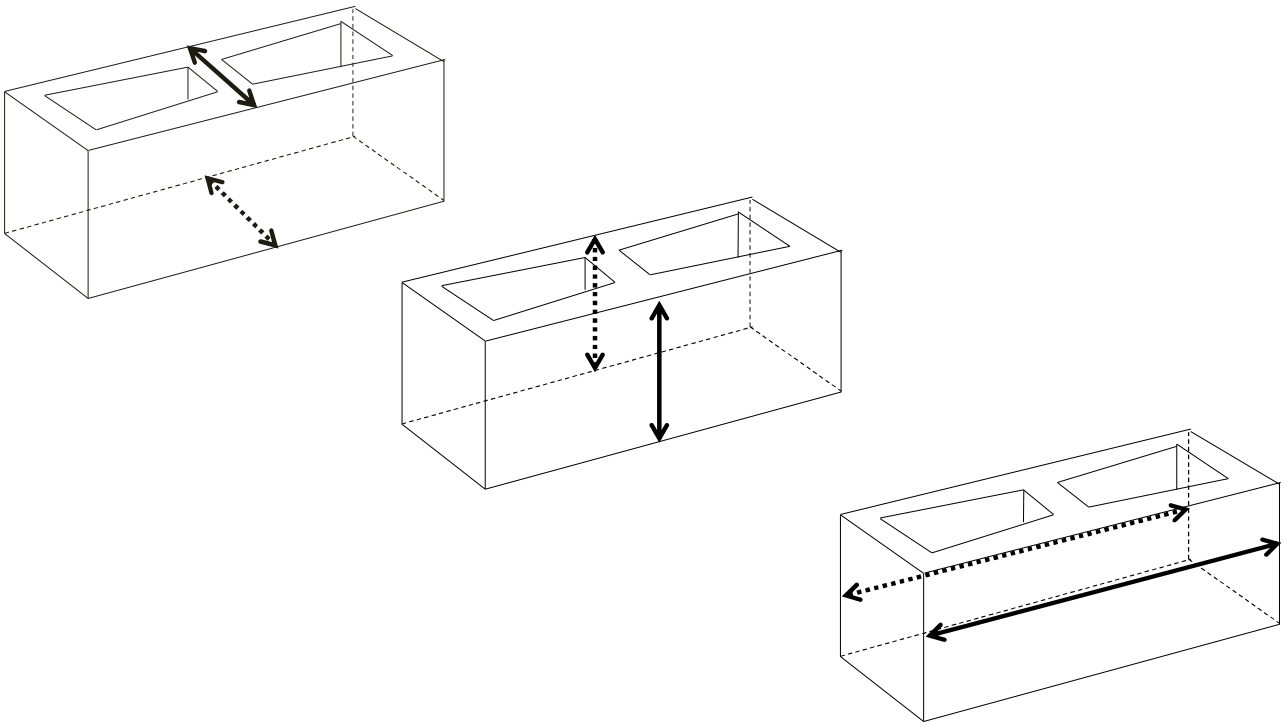
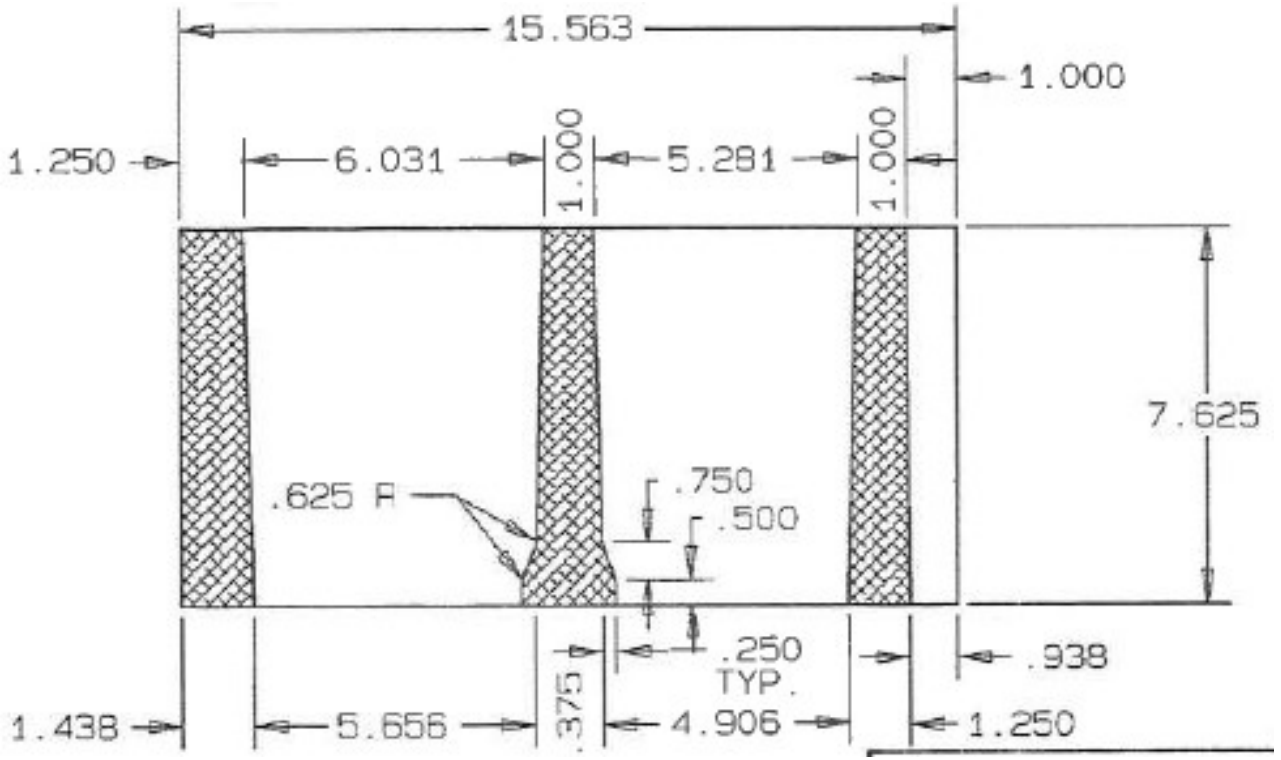
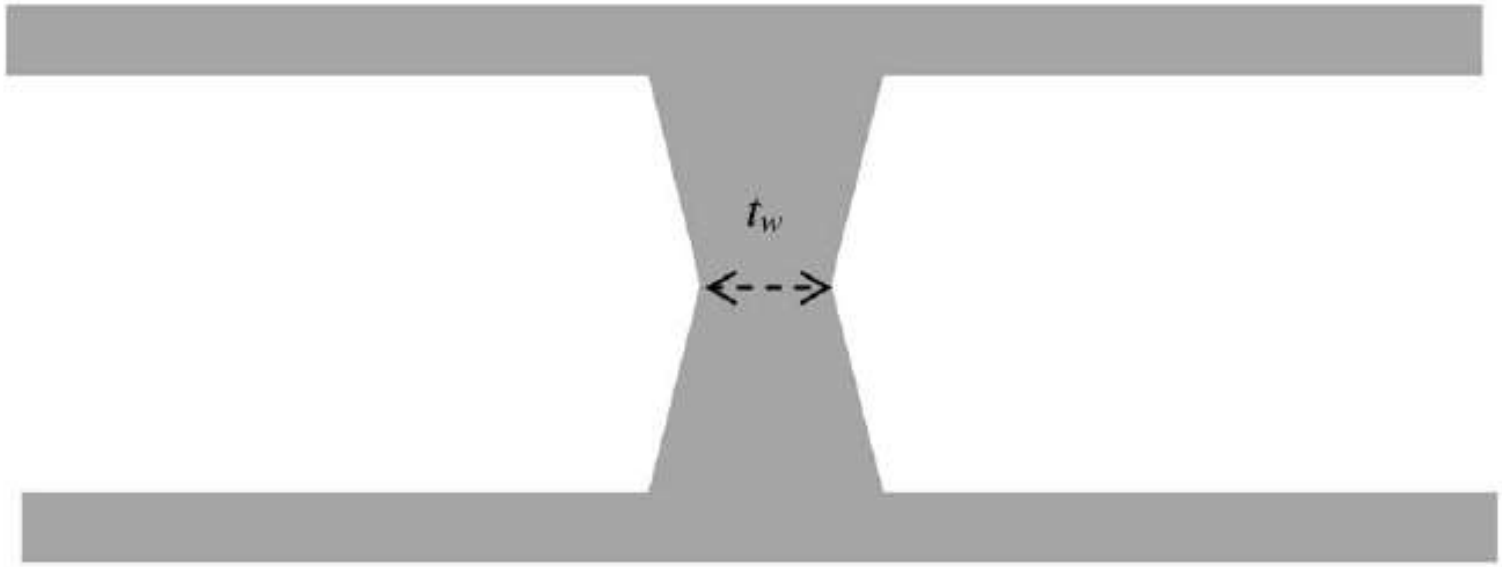


TAPERED WALLS



ONLY MEASURE WEBS ¾" OR THICKER



NOTE 1—If t_w is less than 0.75 in. [19 mm] over the entire height of the web, disregard entire area of that web when determining minimum web area.

FIG. A1.1 Example of Web with Irregular Cross-section—Plan View

ABSORPTION
(AND VOLUME)
ASTM C140
Section 8 and A1.4

BLOCK WEIGHTS

W_r – Received Weight

W_i – Immersed Weight

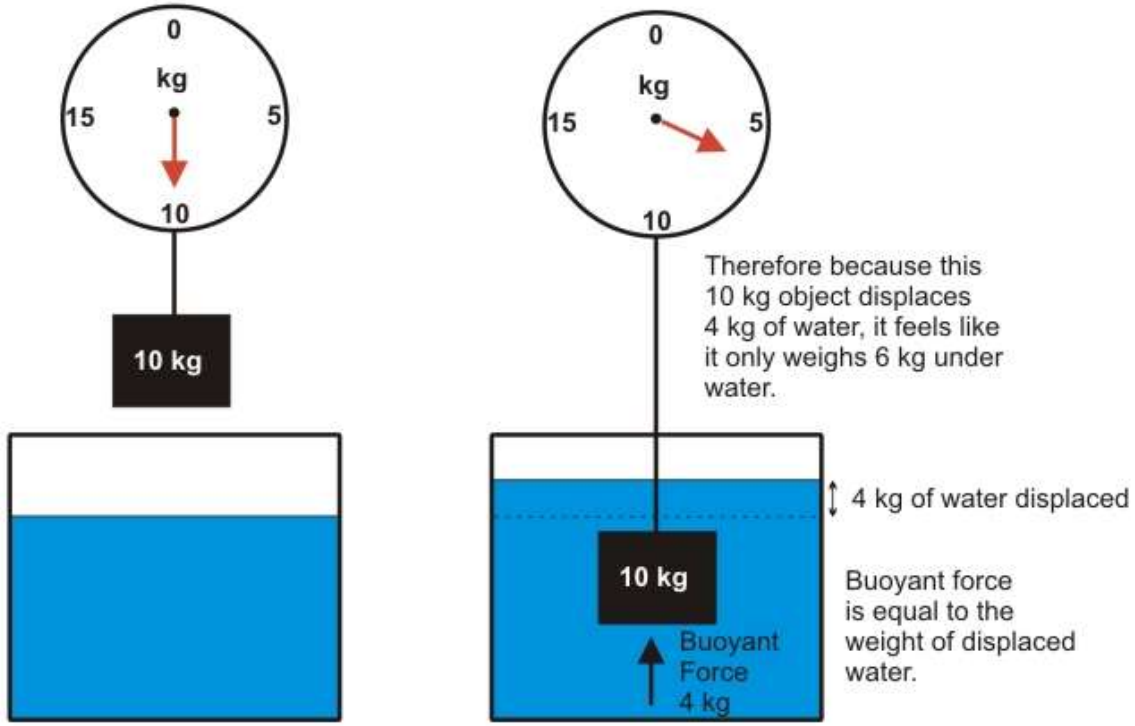
W_s – Saturated Weight

W_d – [Oven] Dry Weight

ARCHIMEDES' PRINCIPLE

UPWARD BUOYANT FORCE

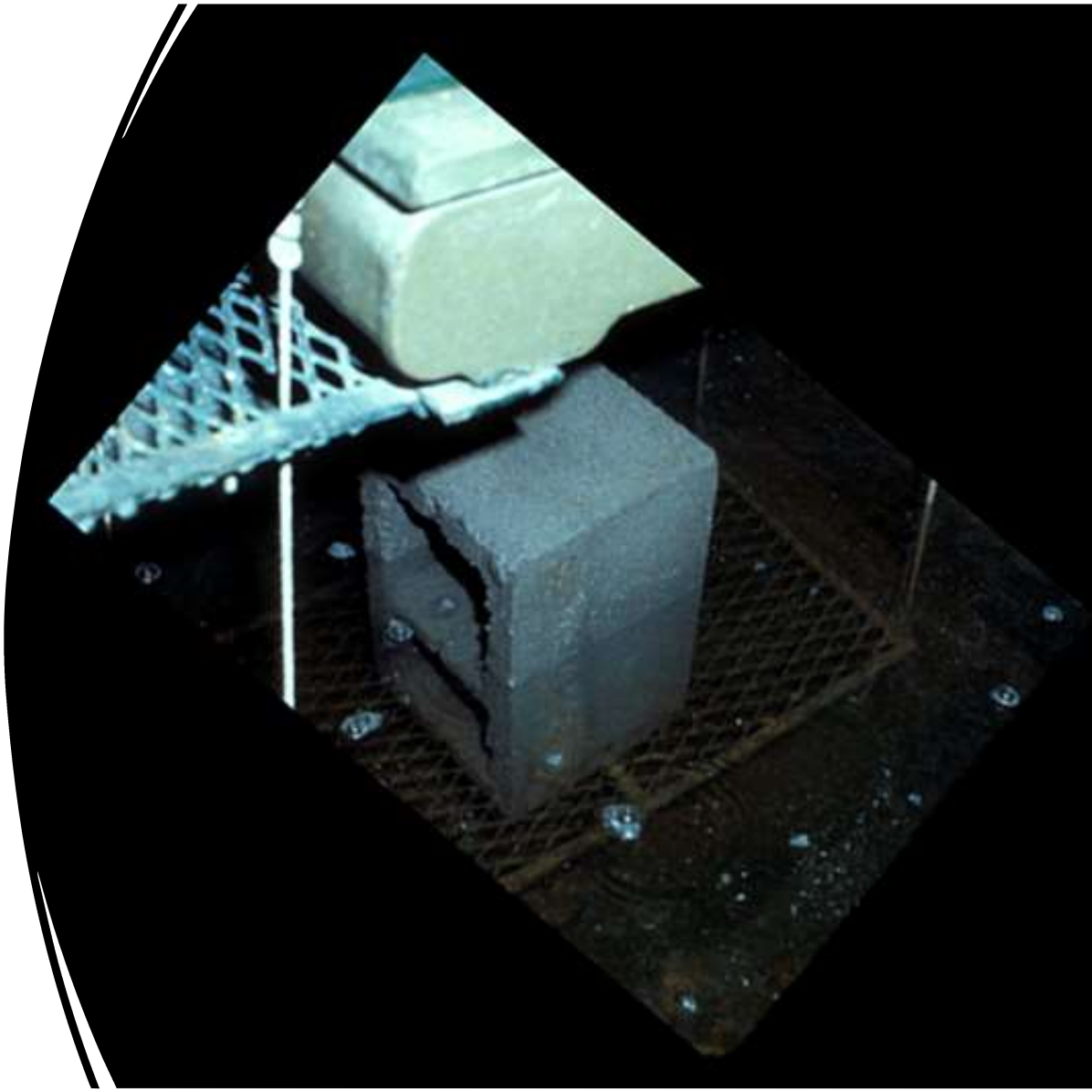
ARCHIMEDES' PRINCIPLE



W …
SATURATED, SURFACE DRY

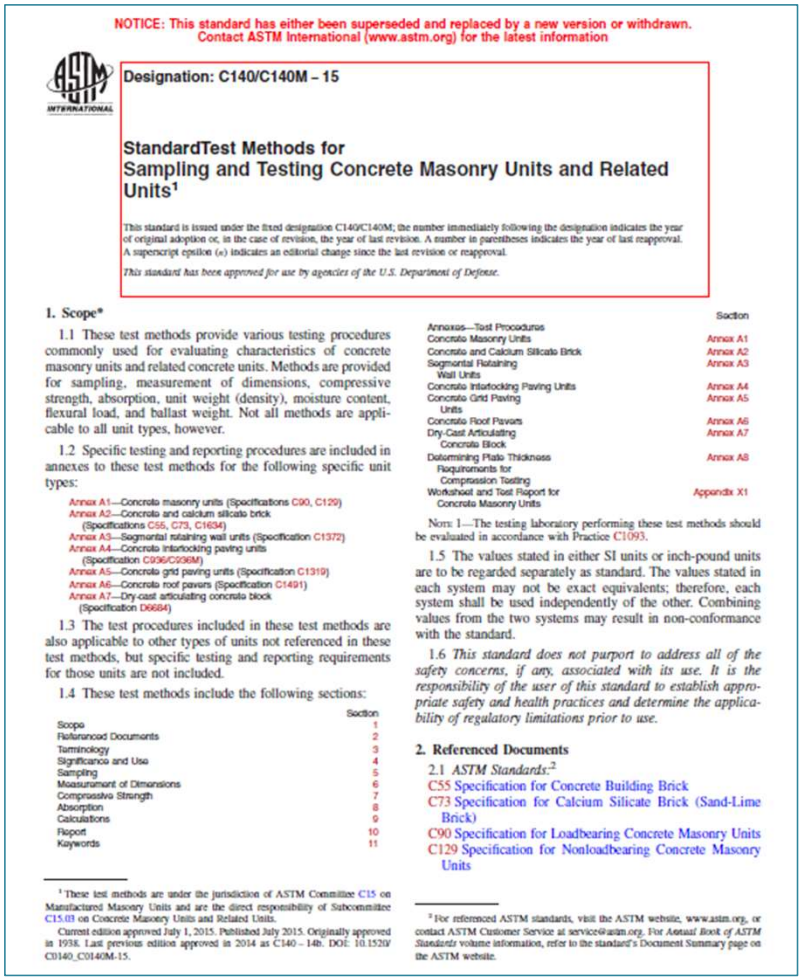
W …
SUBMERGED - SATURATED

Completely submerged in water



W … OVEN DRY

Calculations
ASTM C140
Section 9 and A1.5



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VOLUME BY ARCHIMEDES' PRINCIPLE

9. Calculations

9.1 *Absorption*—Calculate absorption as follows:

$$\text{Absorption, lb/ft}^3 = [(W_s - W_d)/(W_s - W_i)] \times 62.4 \quad (1)$$

9.3 *Density*—Calculate oven-dry density as follows:

$$\text{Density (D), lb/ft}^3 = [W_d/(W_s - W_i)] \times 62.4 \quad (3)$$

$$\text{Density (D), kg/m}^3 = [W_d/(W_s - W_i)] \times 1000$$

9.4 *Average Net Area*—Calculate average net area as follows:

$$\text{Net Volume } (V_n), \text{ ft}^3 = W_d/D = (W_s - W_i)/62.4 \quad (4)$$

$$\text{Net Volume } (V_n), \text{ mm}^3 = W_d/D = (W_s - W_i) \times 10^6$$

$$\text{Average Net Area } (A_n), \text{ in.}^2 = (V_n \times 1728)/H$$

$$\text{Average Net Area } (A_n), \text{ mm}^2 = V_n/H$$

ASTM C140-15 CALCULATIONS

C140-15: Page 4 @ 9- 9.1

9. Calculations

9.1 *Absorption*—Calculate absorption as follows:

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$$\text{Absorption, kg/m}^3 = [(W_s - W_d)/(W_s - W_i)] \times 1000$$

$$\text{Absorption, \%} = [(W_s - W_d)/W_d] \times 100$$

where:

W_s = saturated weight of specimen, lb (kg),
W_i = immersed weight of specimen, lb (kg), and
W_d = oven-dry weight of specimen, lb (kg).

ASTM C140-15 … THE W's

C140-15: Page 4 @ 9.2

9.2 *Moisture Content*—Calculate the moisture content of the unit at the time it is sampled (when W_r is measured) as follows:

$$\text{Moisture Content, \% of total absorption} = [(W_r - W_d)/(W_s - W_d)] \times 100 \quad (2)$$

where:

W_r = received weight of unit, lb (kg),
W_d = oven-dry weight of unit, lb (kg), and
W_s = saturated weight of unit, lb (kg).

NOTE 10—When determining the moisture content of a unit or set of units, the value determined is a measure of the water content of a unit based upon the received weight of the unit W_r. Thus, the moisture content calculation above is only applicable to the unit moisture content at the time the received weight, W_r, is obtained.

ASTM C140-15

C140-15: Page 4 @ 9.3

9.3 *Density*—Calculate oven-dry density as follows:

$$\text{Density (D), lb/ft}^3 = [W_d/(W_s - W_i)] \times 62.4 \quad (3)$$

$$\text{Density (D), kg/m}^3 = [W_d/(W_s - W_i)] \times 1000$$

where:

W_d = oven-dry weight of specimen, lb (kg),
W_s = saturated weight of specimen, lb (kg), and
W_i = immersed weight of specimen, lb (kg).

Density is mass divided by volume

Density Classification	Oven-Dry Density of Concrete, lb/ft^3 (kg/m^3)
	Average of 3 Units
Lightweight	Less than 105 (1680)
Medium Weight	105 to less than 125 (1680–2000)
Normal Weight	125 (2000) or more

ASTM C90 TABLE 2 CLASSIFICATION

ASTM C140-15

Properties affected by density of concrete include:

- **Wall Weight**
- **Building Weight**
- **Thermal Conductivity**
- **Heat Capacity**
- **Acoustic Properties**

ASTM C140-15 … NET AREA

C140-15: Page 4 @ 9.4

9.4 *Average Net Area*—Calculate average net area as follows:

$$\text{Net Volume } (V_n), \text{ ft}^3 = W_d/D = (W_s - W_i)/62.4 \quad (4)$$

$$\text{Net Volume } (V_n), \text{ mm}^3 = W_d/D = (W_s - W_i) \times 10^6$$

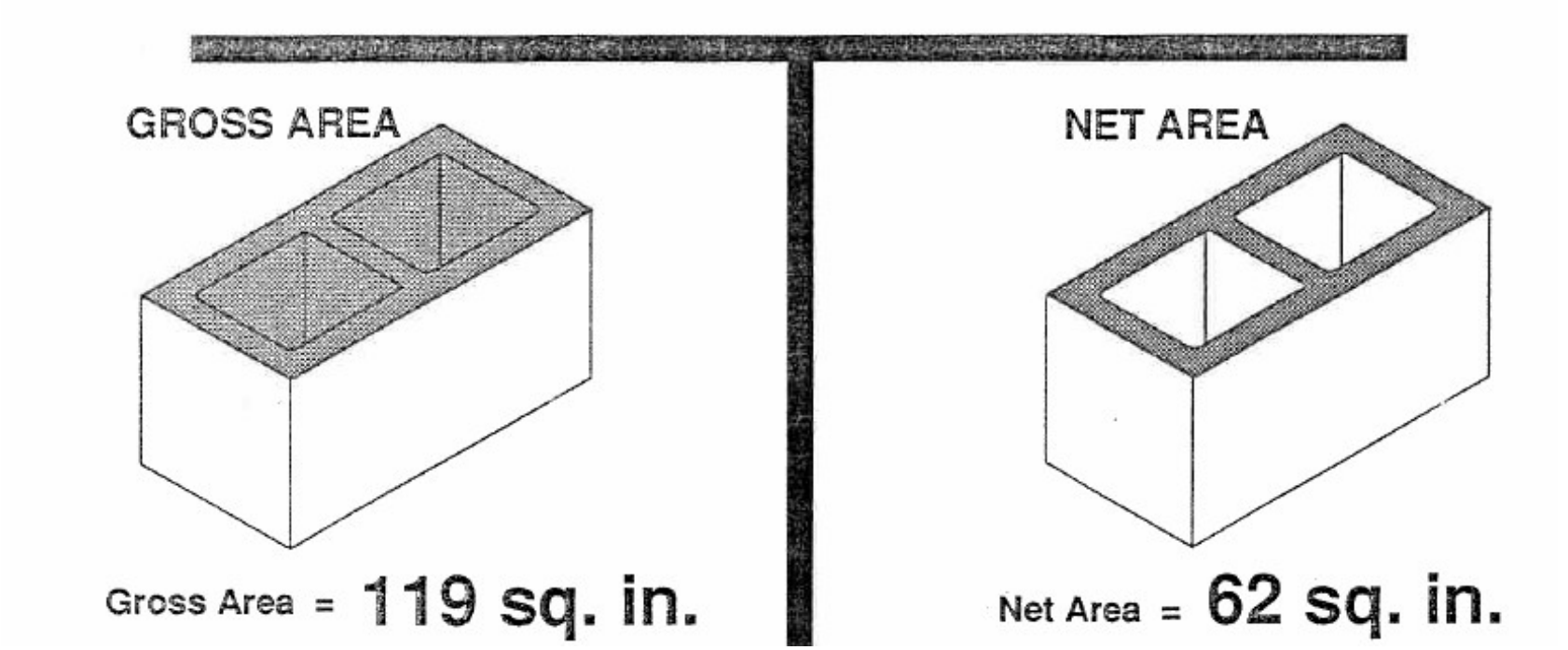
$$\text{Average Net Area } (A_n), \text{ in.}^2 = (V_n \times 1728)/H$$

$$\text{Average Net Area } (A_n), \text{ mm}^2 = V_n/H$$

where:

V_n = net volume of specimen, ft^3 (mm^3),
W_d = oven-dry weight of specimen, lb (kg),
D = oven-dry density of specimen, lb/ft^3 (kg/m^3),
W_s = saturated weight of specimen, lb (kg),
W_i = immersed weight of specimen, lb (kg),
A_n = average net area of specimen, in.^{2} (mm^2), and
H = average height of specimen, in. (mm).

NET AREA



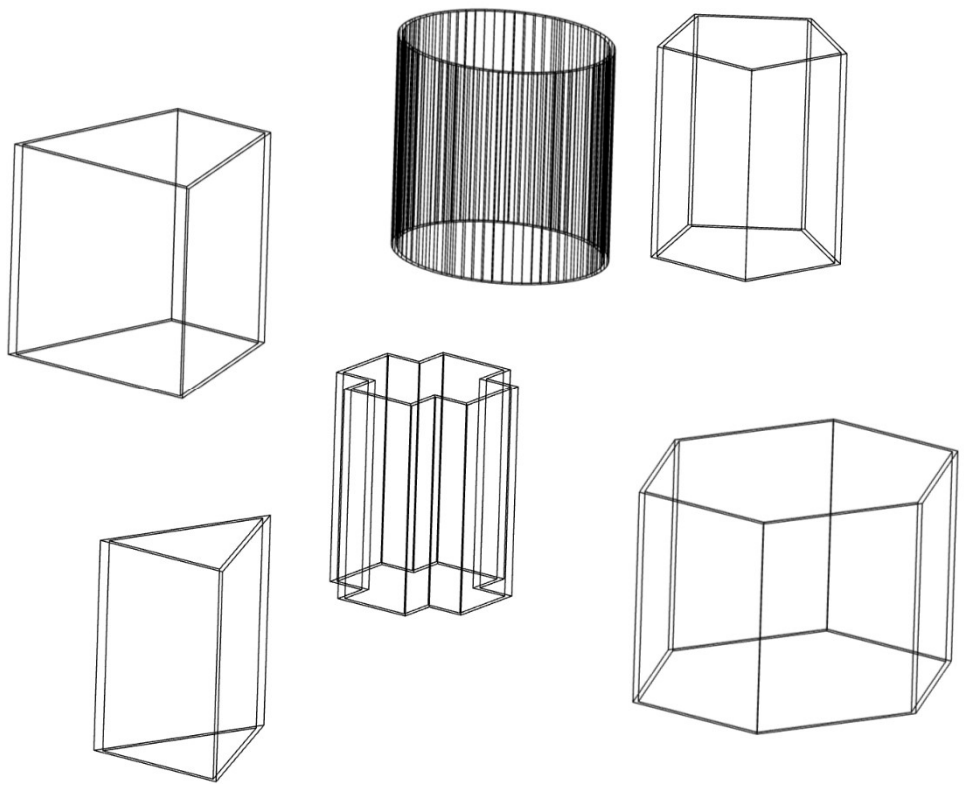
CALCULATING NET AREA

$$V = h \times A$$

$$A = V / h$$

Average Net Area (A_n), in.^{2} = ($V_n \times 1728$)/H

Average Net Area (A_n), mm^2 = V_n/H



C140 GROSS AREA

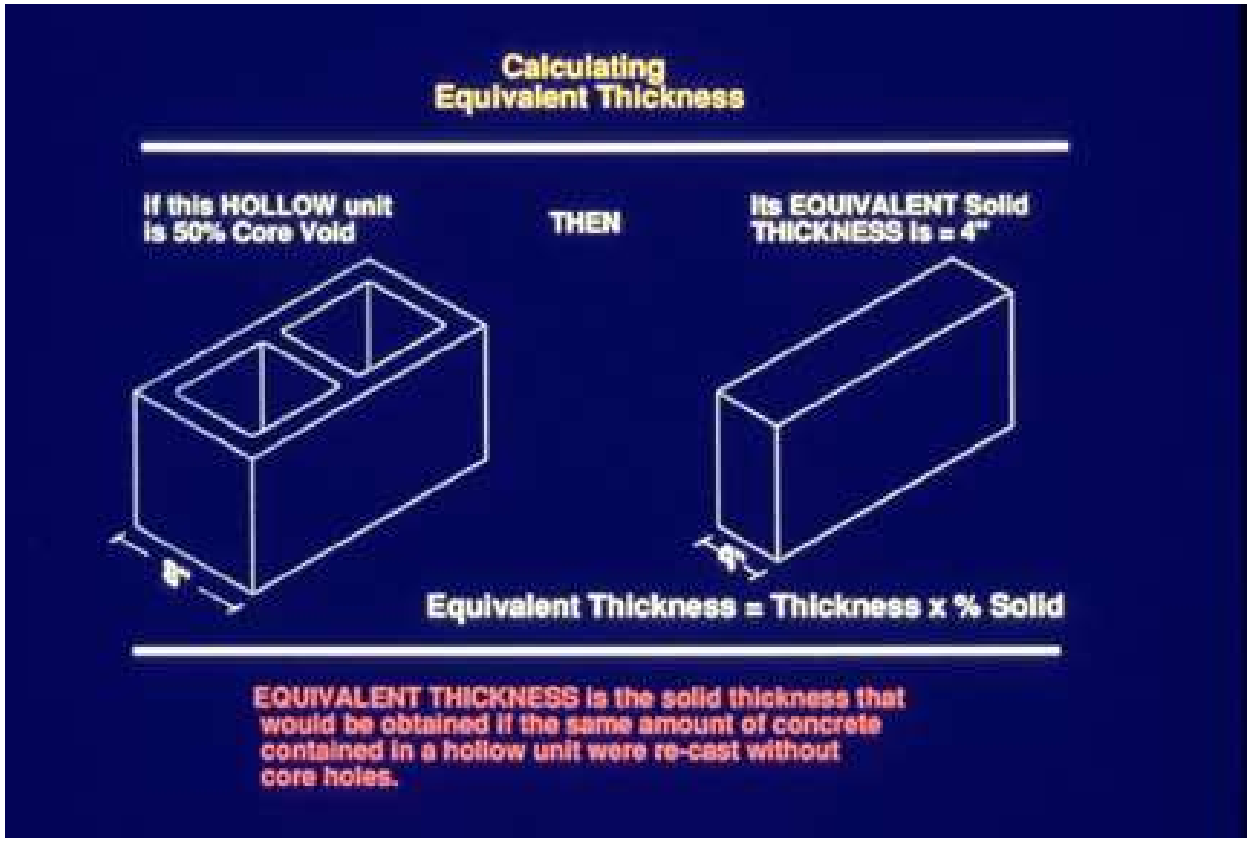
C140-15: Page 4 @ 9.5

9.5 *Gross Area*—Calculate gross area as follows:

$$\text{Gross Area } (A_g), \text{ in.}^2 \text{ (mm}^2\text{)} = L \times W \quad (6)$$

where:

A_g = gross area of the specimen, in.^{2} (mm^2),
L = average length of the specimen, in. (mm), and
W = average width of the specimen, in. (mm).



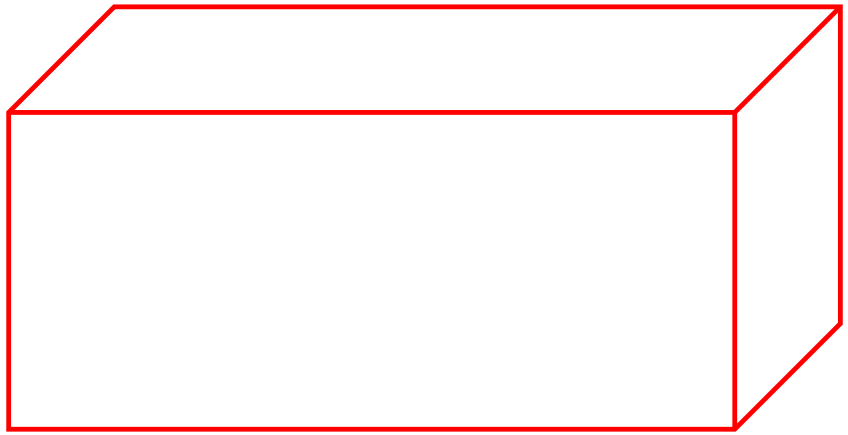
EQUIVALENT THICKNESS

ASTM C140-15 EQUIVALENT THICKNESS

C140-15: Page 6-A1.5.3 & 1.5.3.1

$$V = h \times L \times w$$

$$W = V / (h \times L)$$



ASTM C140-15 EQUIVALENT THICKNESS

C140-15: Page 8-A1.5.3 & 1.5.3.1

A1.5.3 *Equivalent Thickness*—Equivalent thickness for concrete masonry is defined as the average thickness of solid material in the unit and is calculated as follows:

$$T_e, \text{ in.} = [V_n/(L \times H)] \times 1728 \qquad \text{(A1.1)}$$

$$T_e, \text{ mm} = [V_n/(L \times H)]$$

where:

T_e = equivalent thickness, in. (mm),

V_n = average net volume of full-size units, ft^3 (mm^3) (see 9.4),

L = average length of full-size units, in. (mm) (see A1.2.1), and

H = average height of full-size units, in. (mm) (see A1.2.1).

A1.5.3.1 Equivalent thickness shall only be calculated and reported for full-size concrete masonry units.

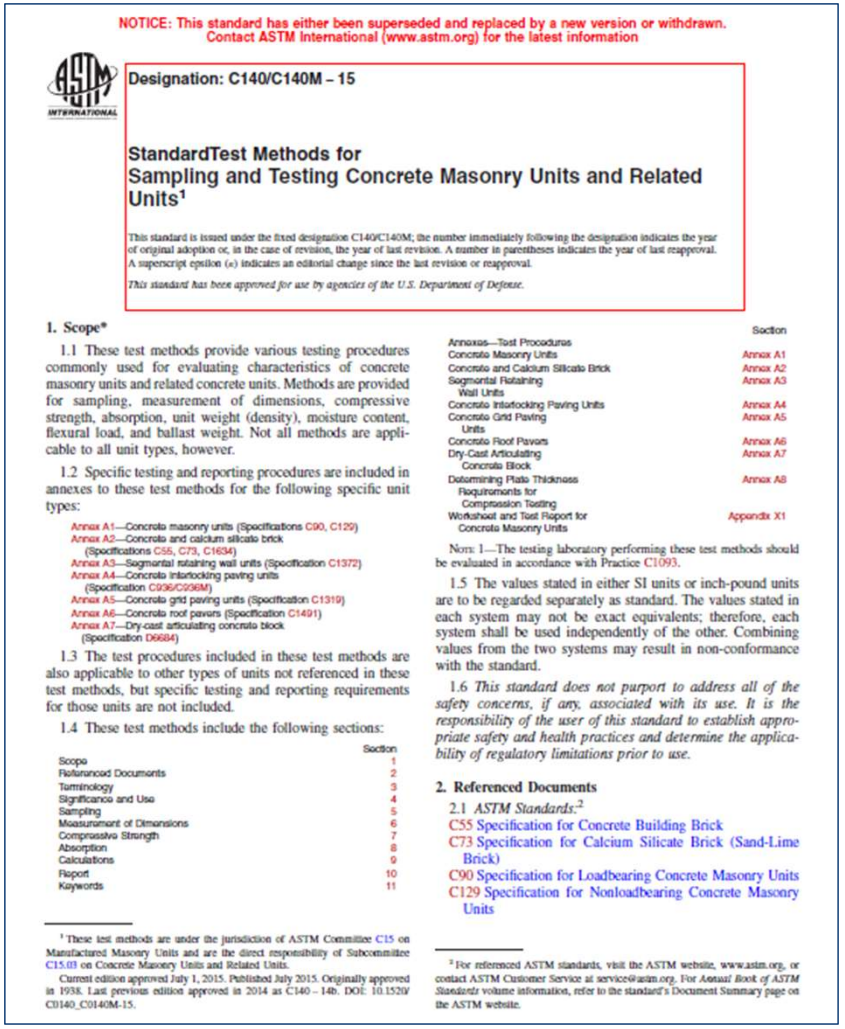
CALCULATIONS

A1.5.4 *Percent Solid*—Calculate the percent solid as follows:

$$\text{Percent solid, ft}^3\ (\%) = \left(\frac{(V_n \times 1728)}{(L \times W \times H)}\right) \times 100 \qquad \text{(A1.3)}$$

$$\left[\text{Percent solid , mm}^3\ (\%) = \left(\frac{V_n}{(L \times W \times H)}\right) \times 100\right]$$

COMPRESSIVE STRENGTH ASTM C140 SECTION 7 AND A1.3



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COMPRESSIVE STRENGTH

There are three common compressive strengths in testing concrete masonry units:

- **Gross Area Compressive Strength of Concrete Masonry Units** – no longer used under the building code, but often requested.

- **Net Area Compressive Strength of Concrete Masonry Units** – this strength is the result from the lab testing a single block.

- **Net Area Compressive Strength of Masonry (f'_m)** – this is the strength engineers use to design a building.

C140 Test Specimens-13

C140-15: Page 2 @ 5.2

Note that the specimens to determine the compressive load are different than the specimens that determine the net area.

3 for Compressive Strength

3 for Absorption

C140 PLATE THICKNESS

C140-15: Page 12- Fig. A7.2

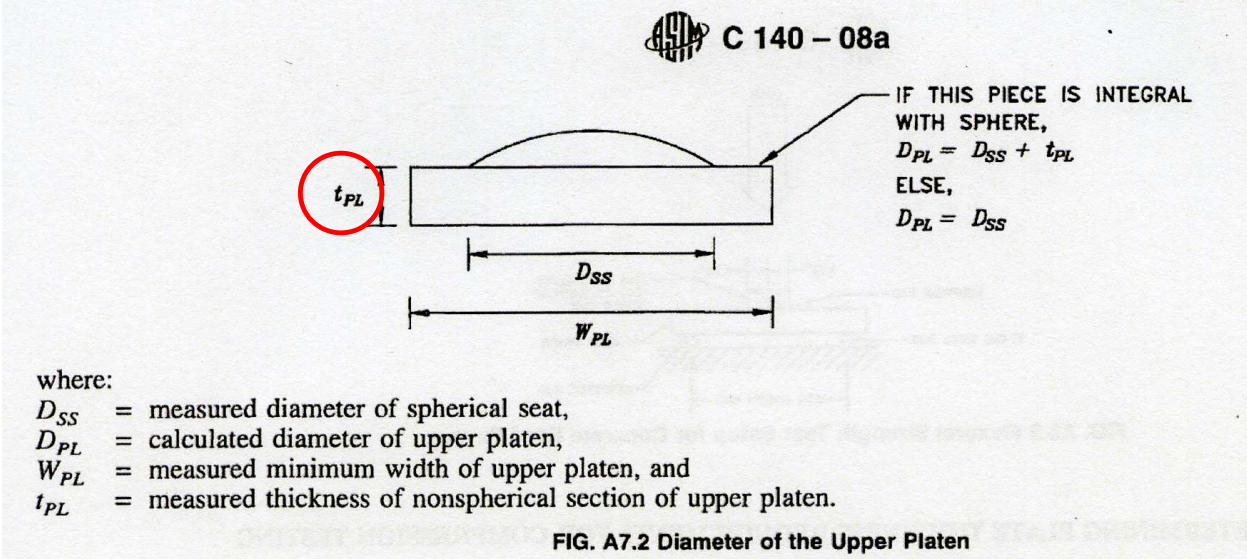
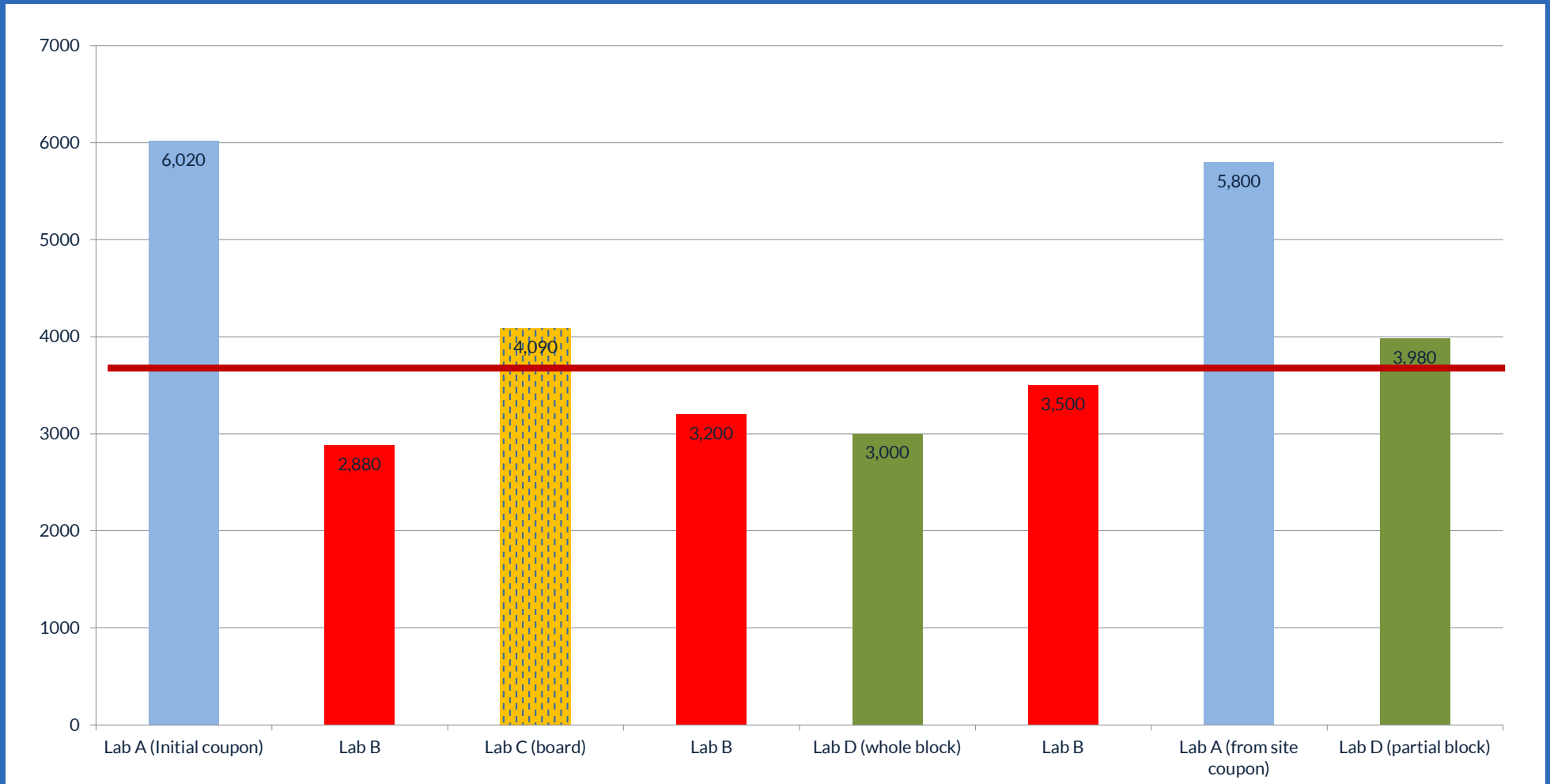


FIG. A7.2 Diameter of the Upper Platen

THIS NOTE FROM THE 2000 EDITION OF C140

(1) The plate thickness requirements for the compression machine was increased (doubled) with a change to paragraph 6.1.1. A new note 3 was added to discuss the influence of plate thickness.


7000
6000
5000
4000
3000
2000
1000
0
6,020
2,880
4,090
3,200
3,000
3,500
5,800
3,980
Lab A (Initial coupon)
Lab B
Lab C (board)
Lab B
Lab D (whole block)
Lab B
Lab A (from site coupon)
Lab D (partial block)

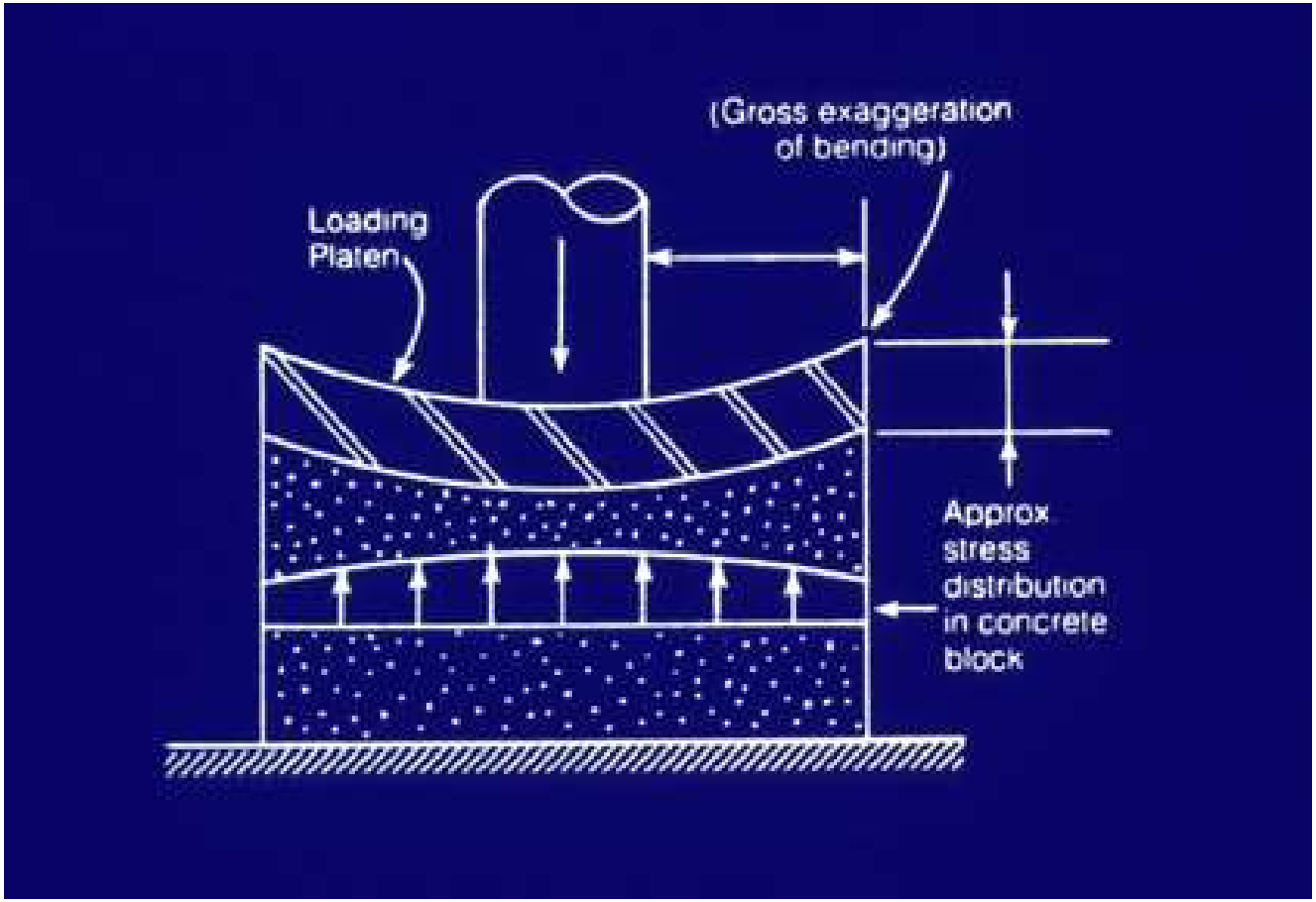
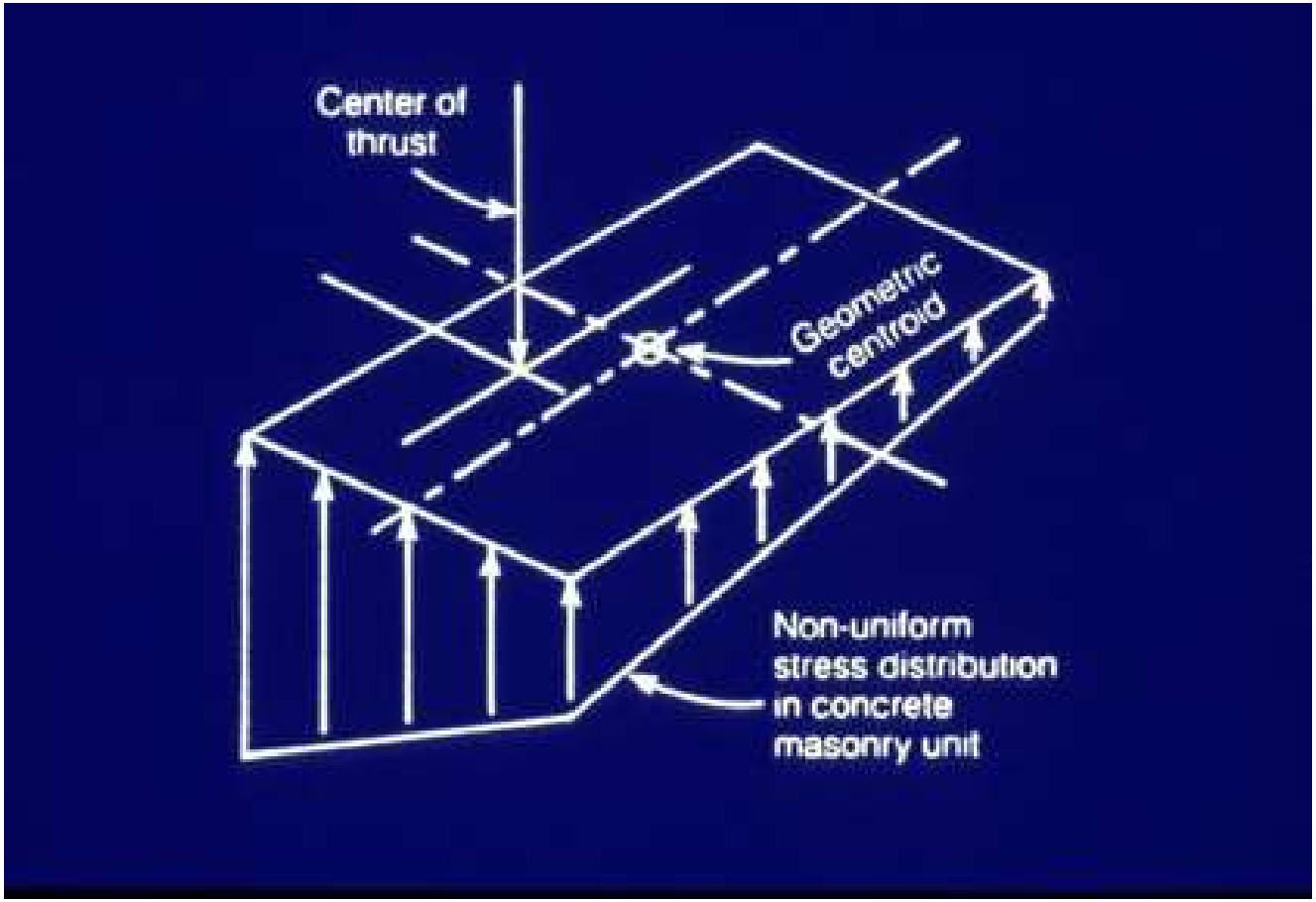


PLATE TOO THIN



CENTER OF MASS UNDER CENTER OF THRUST

ASTM C140-15 CAPS

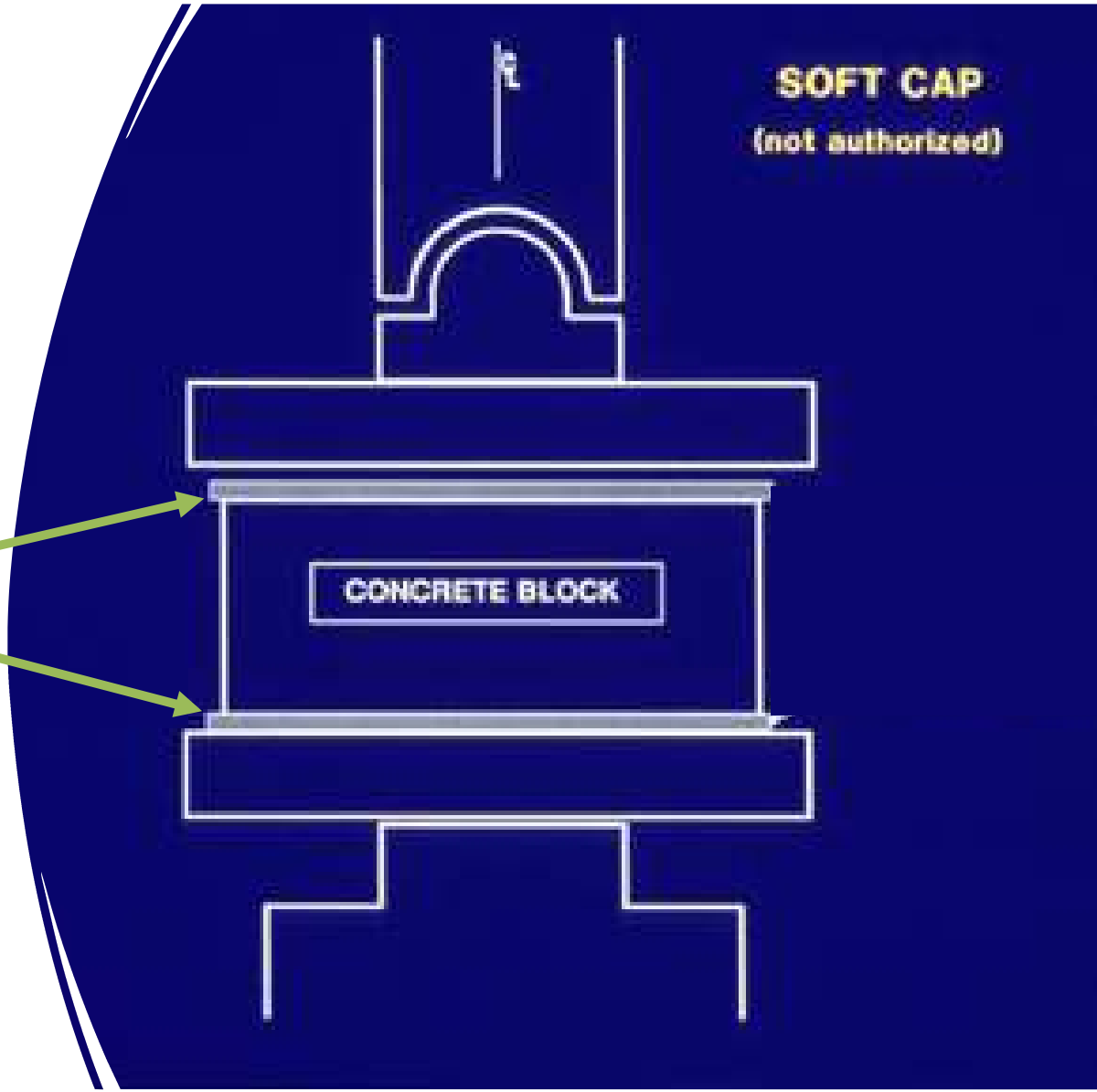
C140-15: PAGE 3 @ 7.3

SULFUR OR GYPSUM CAPS

7.3 *Capping*—Cap test specimens in accordance with Practice C 1552.

NO “SOFT” CAPS ALLOWED

In plant use of fiber board
In place of lab prepared
Gypsum or Sulfur Cap.
Soft fiber boards spread
Causing internal tension



9.6.1 *Net Area Compressive Strength*—Calculate the net area compressive strength of the specimen as follows:

$$\text{Net Area Compressive Strength, psi [MPa]} = P_{max}/A_n \qquad (8)$$

where:

P_{max} = maximum compressive load, lb [N], and
A_n = average net area of specimen, in.^{2} [mm^2].

9.6.2 *Gross Area Compressive Strength*—Calculate the gross area compressive strength of the specimen as follows:

$$\text{Gross Area Compressive Strength, psi [MPa]} = P_{max}/A_g \qquad (9)$$

where:

P_{max} = maximum compressive load, lb [N], and
A_g = gross area of specimen, in.^{2} [mm^2].

ASTM 140 – CALCULATING COMPRESSIVE STRENGTH

CONCEPTUAL ERRORS
(THIS PAGE FOLLOWS C140 IN THE BINDER)

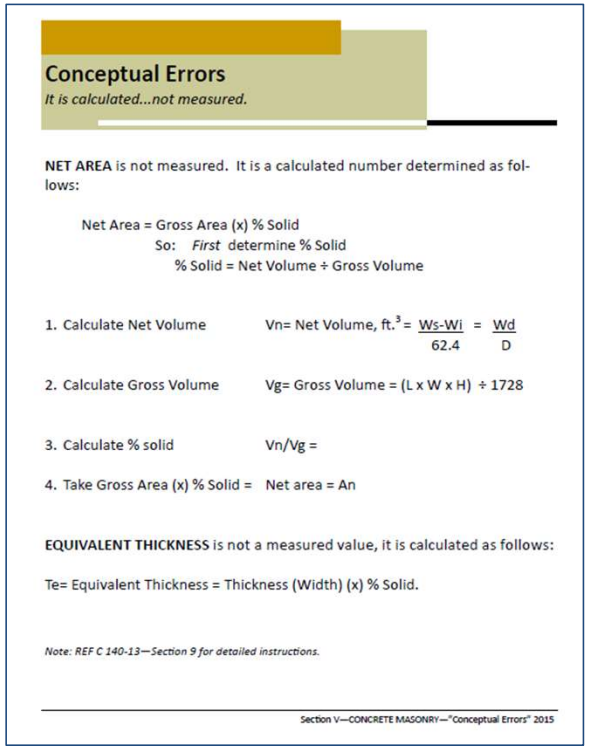
NET AREA is not measured. It is a calculated number determined as follows:

Net Area = Gross Area (x) % Solid
So: *First* determine % Solid
% Solid = Net Volume ÷ Gross Volume

1. Calculate Net Volume — $Vn = \text{Net Volume, ft.}^3 = \frac{Ws-Wi}{62.4} = \frac{Wd}{D}$
2. Calculate Gross Volume — Vg= Gross Volume = (L x W x H) ÷ 1728
3. Calculate % solid — Vn/Vg =
4. Take Gross Area (x) % Solid = — Net area = An

EQUIVALENT THICKNESS is not a measured value, it is calculated as follows:

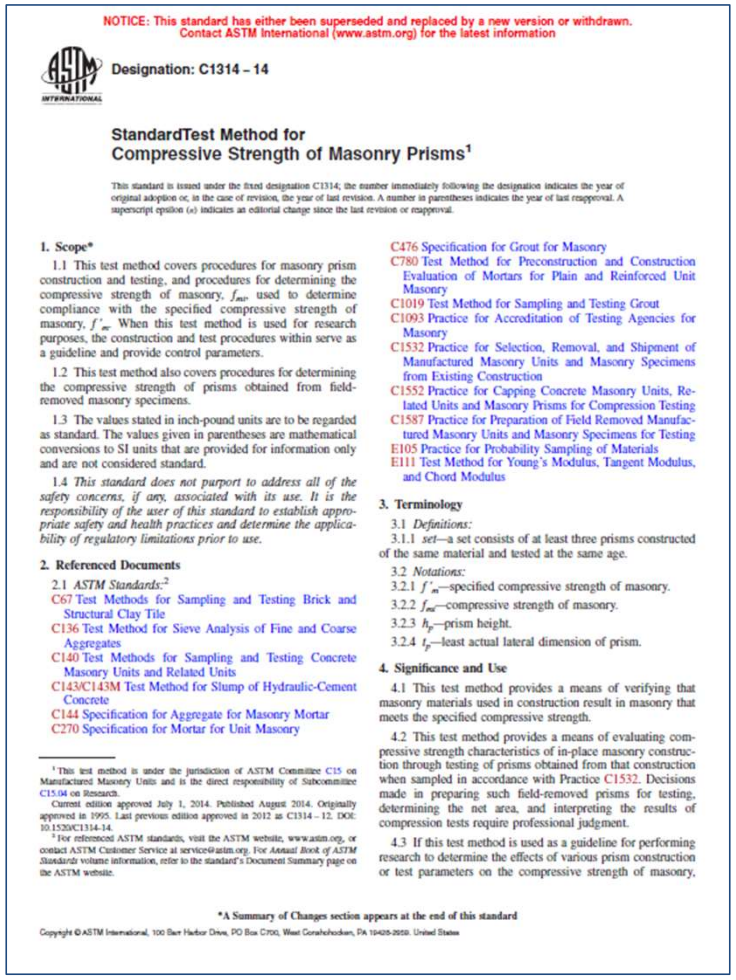
Te= Equivalent Thickness = Thickness (Width) (x) % Solid.



EQUIVALENT THICKNESS IS REQUIRED FOR FIRE RATING CALCULATION

C 1314 – STANDARD TEST METHOD FOR COMPRESSIVE STRENGTH OF MASONRY PRISMS

C1314-14 PAGE 1 TITLE



NOTICE: This standard has either been superseded and replaced by a new version or withdrawn.
Contact ASTM International (www.astm.org) for the latest information

Designation: C1314 – 14

StandardTest Method for Compressive Strength of Masonry Prisms[1]

This standard is issued under the fixed designation C1314; 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.

1. Scope*

1.1 This test method covers procedures for masonry prism construction and testing, and procedures for determining the compressive strength of masonry, f_m, used to determine compliance with the specified compressive strength of masonry, f'_m. When this test method is used for research purposes, the construction and test procedures within serve as a guideline and provide control parameters.

1.2 This test method also covers procedures for determining the compressive strength of prisms obtained from field-removed masonry specimens.

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 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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]
C67 Test Methods for Sampling and Testing Brick and Structural Clay Tile
C136 Test Method for Sieve Analysis of Fine and Coarse Aggregates
C140 Test Methods for Sampling and Testing Concrete Masonry Units and Related Units
C143/C143M Test Method for Slump of Hydraulic-Cement Concrete
C144 Specification for Aggregate for Masonry Mortar
C270 Specification for Mortar for Unit Masonry
C476 Specification for Grout for Masonry
C780 Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry
C1019 Test Method for Sampling and Testing Grout
C1093 Practice for Accreditation of Testing Agencies for Masonry
C1532 Practice for Selection, Removal, and Shipment of Manufactured Masonry Units and Masonry Specimens from Existing Construction
C1552 Practice for Capping Concrete Masonry Units, Related Units and Masonry Prisms for Compression Testing
C1587 Practice for Preparation of Field Removed Manufactured Masonry Units and Masonry Specimens for Testing
E105 Practice for Probability Sampling of Materials
E111 Test Method for Young's Modulus, Tangent Modulus, and Chord Modulus

3. Terminology

3.1 *Definitions:*
3.1.1 *set*—a set consists of at least three prisms constructed of the same material and tested at the same age.

3.2 *Notations:*
3.2.1 f'_m—specified compressive strength of masonry.
3.2.2 f_m—compressive strength of masonry.
3.2.3 h_p—prism height.
3.2.4 t_p—least actual lateral dimension of prism.

4. Significance and Use

4.1 This test method provides a means of verifying that masonry materials used in construction result in masonry that meets the specified compressive strength.

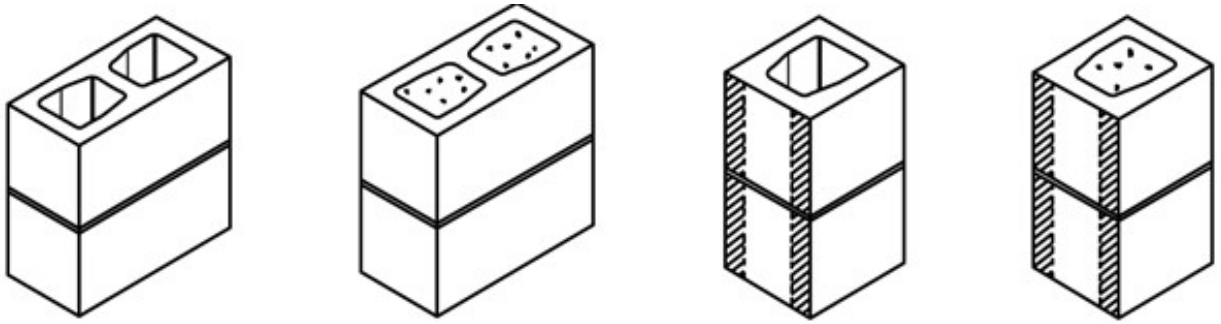
4.2 This test method provides a means of evaluating compressive strength characteristics of in-place masonry construction through testing of prisms obtained from that construction when sampled in accordance with Practice C1532. Decisions made in preparing such field-removed prisms for testing, determining the net area, and interpreting the results of compression tests require professional judgment.

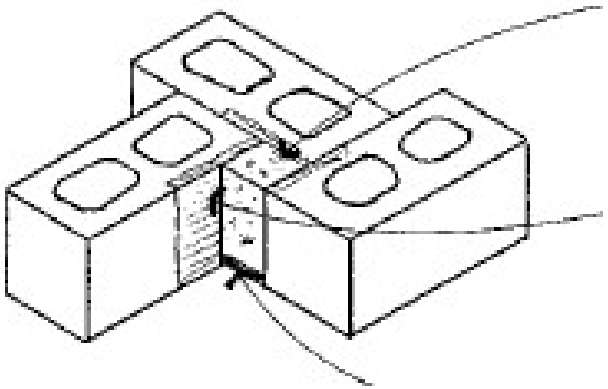
4.3 If this test method is used as a guideline for performing research to determine the effects of various prism construction or test parameters on the compressive strength of masonry,

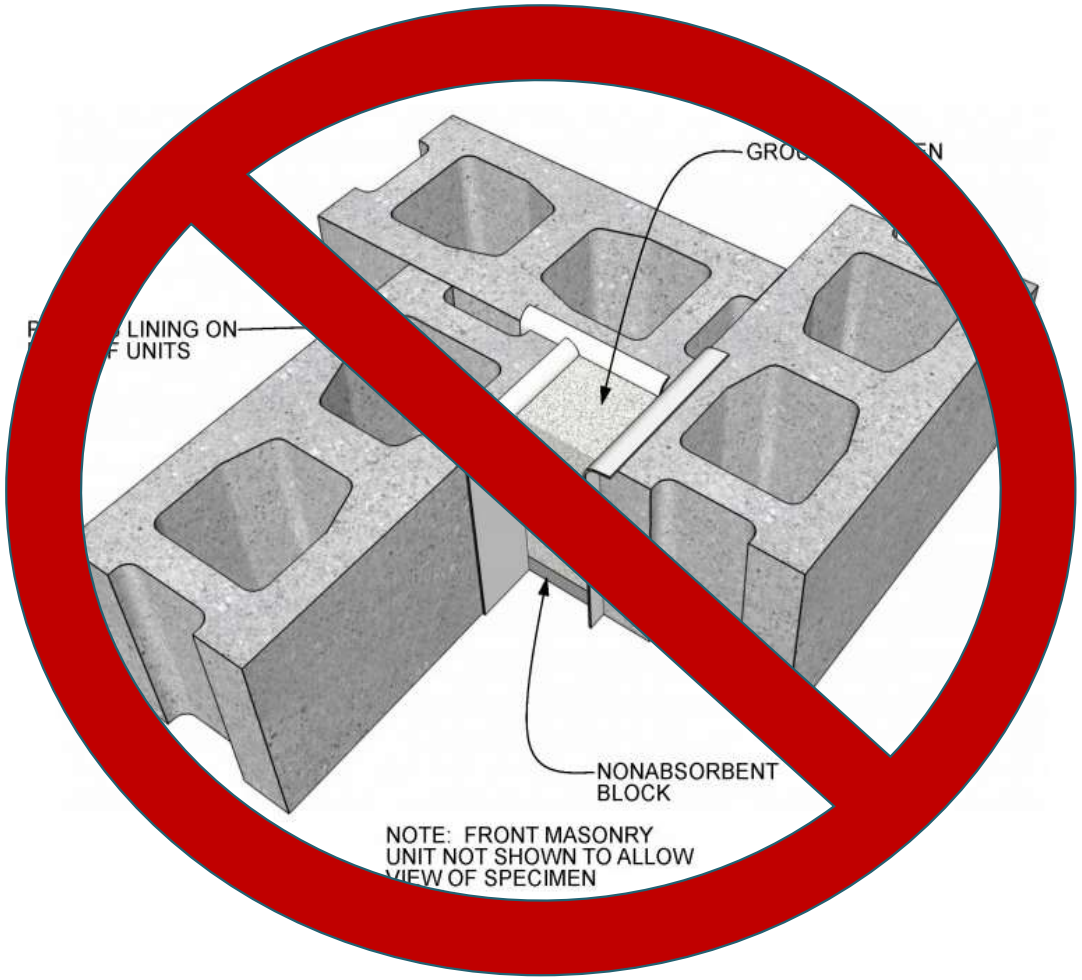
[1] This test method is under the jurisdiction of ASTM Committee C15 on Manufactured Masonry Units and is the direct responsibility of Subcommittee C15.04 on Research.
Current edition approved July 1, 2014. Published August 2014. Originally approved in 1995. Last previous edition approved in 2012 as C1314 – 12. DOI: 10.1520/C1314-14.
[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.

*A Summary of Changes section appears at the end of this standard

TWO TYPES OF PRISMS IN MASONRY TESTING







ASTM C1314-07 PRISM TESTING

C 1314 – STANDARD TEST METHOD FOR COMPRESSIVE STRENGTH OF MASONRY PRISMS

C1314-07 Page 1@3-3.1

3. Terminology

3.1 *Definitions:*

3.1.1 *set*—a set consists of at least three prisms constructed of the same material and tested at the same age.

C1314-07 Page 1@3-3.2

3.2 *Notations:*

3.2.1 f'_m—specified compressive strength of masonry.

3.2.2 f_{mt}—compressive strength of masonry.

3.2.3 h_p—prism height.

3.2.4 t_p—least actual lateral dimension of prism.

f'_m - SPECIFIED COMPRESSIVE STRENGTH

f_{mt}- COMPRESSIVE STRENGTH

ASTM C 1314

C1314-14 Page 2 FIG. 1

C1314

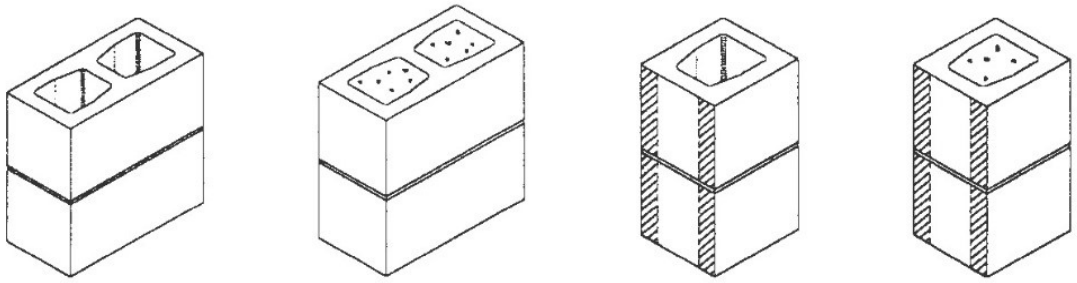


FIG. 1 Masonry Prism Construction

2 BLOCK HIGH ONE JOINT

BUILDING PRISM

ASTM C1314-14

C1314-07 Page 2 @ 5.3

5.3 Build each prism in an opened, moisture-tight bag large enough to enclose and seal the completed prism. Construct prisms on a flat, level base. Construct prisms in a location where they will remain undisturbed until transported for testing.

5.6 Build masonry prisms with full mortar beds (mortar all webs and face shells of hollow units). Use mortar representative of that used in the corresponding construction. Use mortar joint thickness and a method of positioning and aligning units, that are representative of the corresponding construction. Use mortar joints that are cut flush. For prisms to be grouted, remove mortar "fins" that protrude into the grout space.

FULL MORTAR BEDS FULL CROSS WEBS

6. Obtaining and Transporting Masonry Prisms

6.1 For field-removed masonry specimens, select and remove specimens in accordance with Practice C1532.

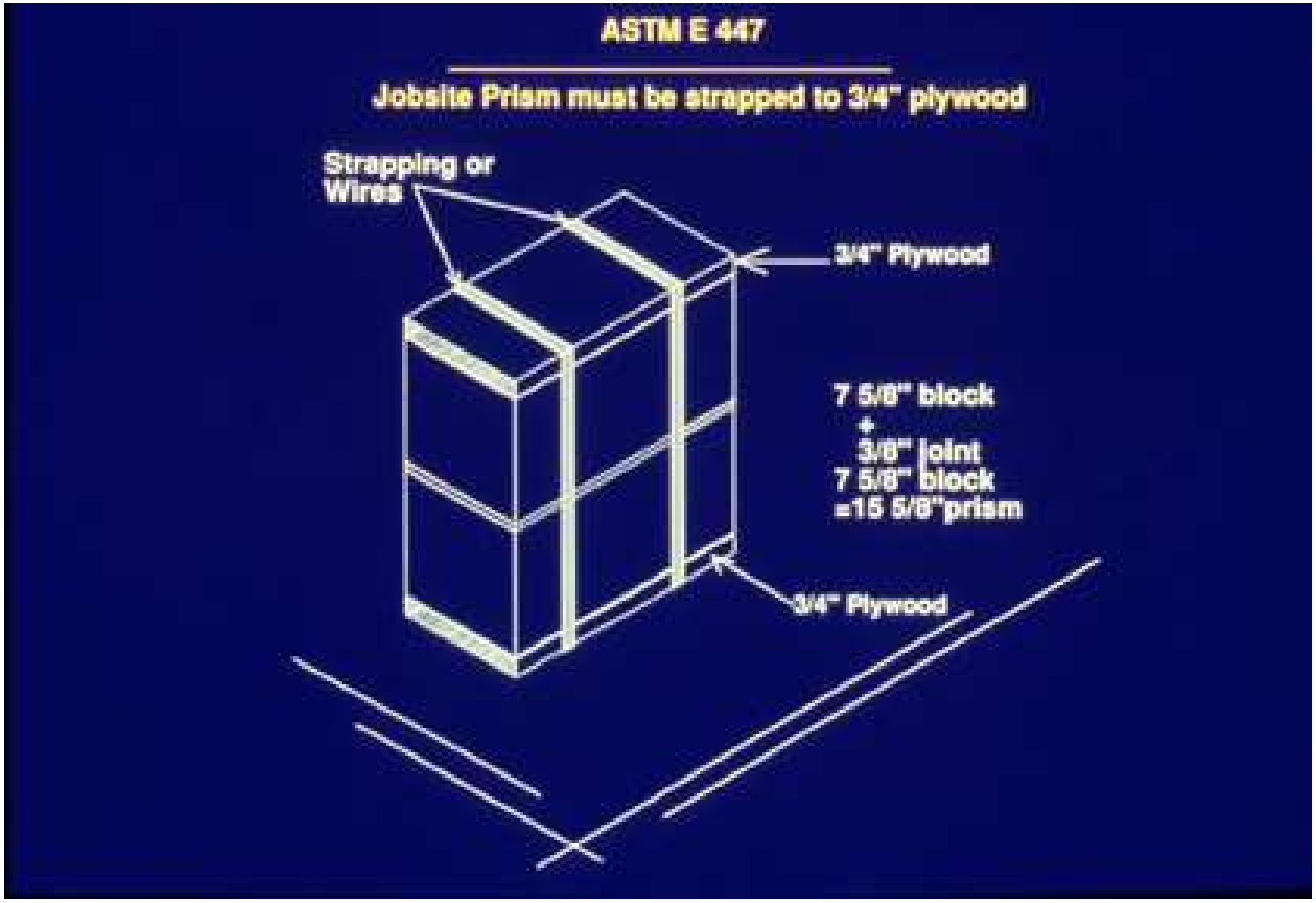
6.2 Prior to transporting constructed prisms and field-removed masonry specimens, strap or clamp each prism or specimen to prevent damage during handling and transportation. Secure prisms and specimens to prevent jarring, bouncing, or tipping over during transporting.

6.3 Transport prisms and masonry specimens in accordance with Practice C1532.

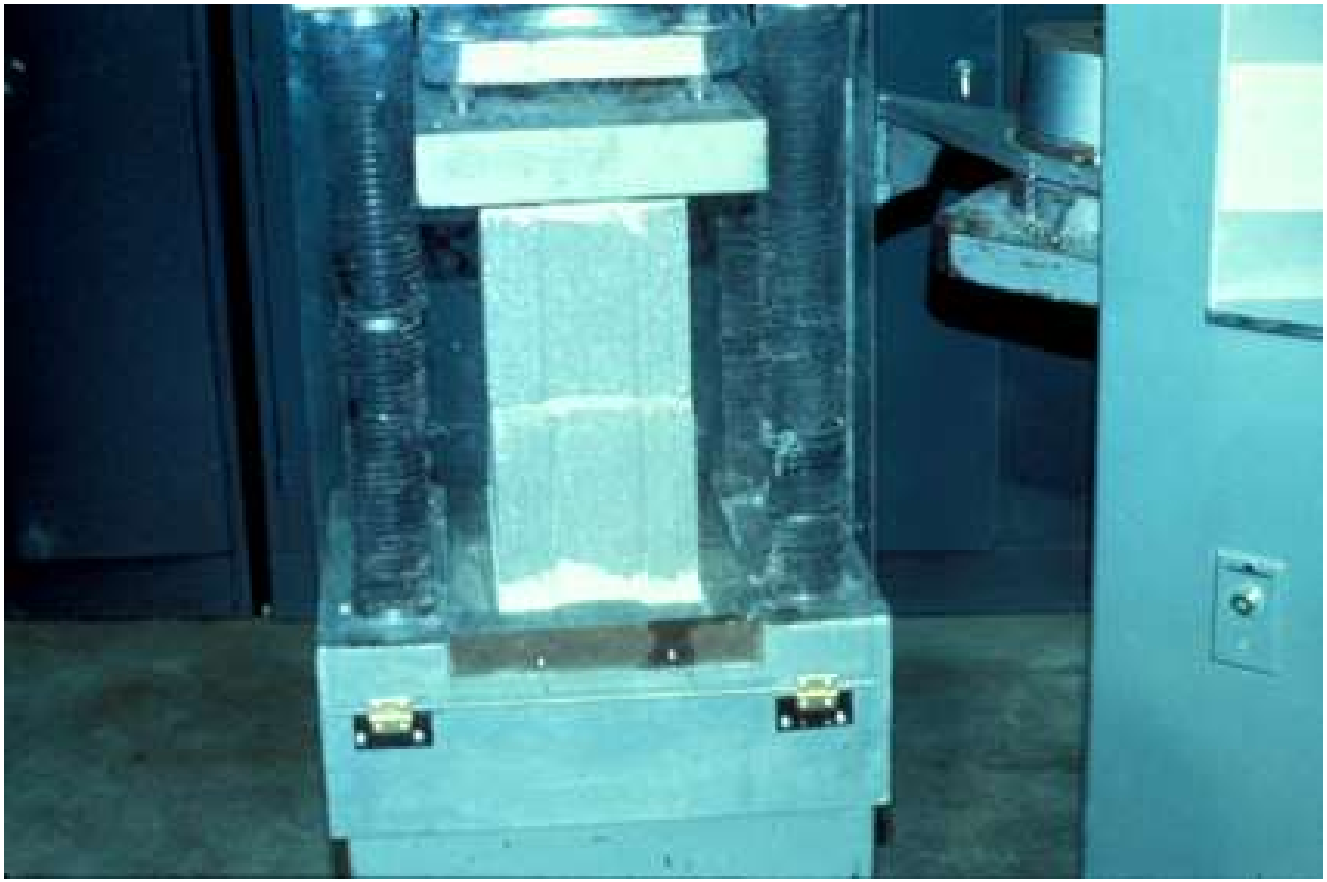
6.4 For field-removed masonry specimens, after the specimens have been transported to the laboratory, obtain prisms from the masonry specimens using procedures outlined in Practice C1587.

ASTM C1314-14 TRANSPORTING

NO JARRING, BOUNCING, TIPPING ….. SURE


ASTM E 447
Jobsite Prism must be strapped to 3/4" plywood
Strapping or Wires
3/4" Plywood
7 5/8" block
+
3/8" Joint
7 5/8" block
=15 5/8"prism
3/4" Plywood

THE PRISM



COMPRESSION TEST OF PRISM

TAKE AWAYS

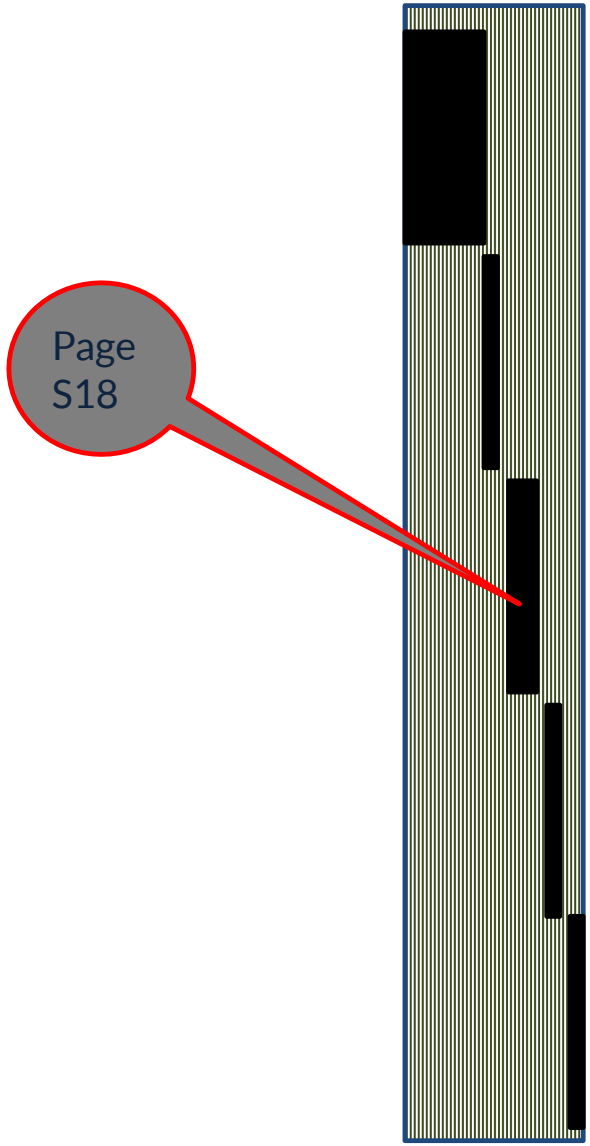
PRISMS ARE NOT FUN.

IF YOU HAVE TO MAKE PRISMS, THEY NEED TO BE PROTECTED.

MOST IMPORTANT, THERE IS A BETTER METHOD!

LAYOUT ~~OF MSJC~~

- Code
  - TMS 402
  - ~~ACI 530~~
  - ~~ASCE 5~~
- Specification
  - TMS 602
  - ~~ACI 530.1~~
  - ~~ASCE 6~~



PREVIOUS MSJC Table 2

Table 2 — Compressive strength of masonry based on the compressive strength of concrete masonry units and type of mortar used in construction

Net area compressive strength of concrete masonry units, psi (MPa)		Net area compressive strength of masonry, psi[1] (MPa)
Type M or S mortar	Type N mortar	
—	1,900 (13.10)	1,350 (9.31)
1,900 (13.10)	2,150 (14.82)	1,500 (10.34)
2,800 (19.31)	3,050 (21.03)	2,000 (13.79)
3,750 (25.86)	4,050 (27.92)	2,500 (17.24)
4,800 (33.10)	5,250 (36.20)	3,000 (20.69)

[1] For units of less than 4 in. (102 mm) height, 85 percent of the values listed.

SPECIFICATION
P. S18 - TABLE 2

Table 2 — Compressive strength of masonry based on the compressive strength of concrete masonry units and type of mortar used in construction

Net area compressive strength of concrete masonry, psi (MPa)	Net area compressive strength of concrete masonry units, psi (MPa)	
	Type M or S mortar	Type N mortar
1,700 (11.72)	---	1,900 (13.10)
1,900 (13.10)	1,900 (13.10)	2,350 (14.82)
2,000 (13.79)	2,000 (13.79)	2,650 (18.27)
2,250 (15.51)	2,600 (17.93)	3,400 (23.44)
2,500 (17.24)	3,250 (22.41)	4,350 (28.96)
2,750 (18.96)	3,900 (26.89)	-----
3,000 (20.69)	4,500 (31.03)	-----

[1]For units of less than 4 in. (102 mm) nominal height, use 85 percent of the values listed.

COMPARING -08 TO -13

$f'm$ Net Area Compressive Strength of Masonry (psi)	TMS 602-08		TMS 602-13	
	Net Area Compressive Strength of Concrete Masonry Units (psi) with Type M or S mortar	Net Area Compressive Strength of Concrete Masonry Units (psi) with Type N mortar	Net Area Compressive Strength of Concrete Masonry Units (psi) with Type M or S mortar	Net Area Compressive Strength of Concrete Masonry Units (psi) with Type N mortar
1,350	------	1,900		
1,500	1,900	2,150		
1,700			------	1,900
1,900			1,900	2,350
2,000	2,800	3,050	2,000	2,650
2,250			2,600	3,400
2,500	3,750	4,050	3,250	4,350
2,750			3,900	-----
3,000	4,800	5,250	4,500	------

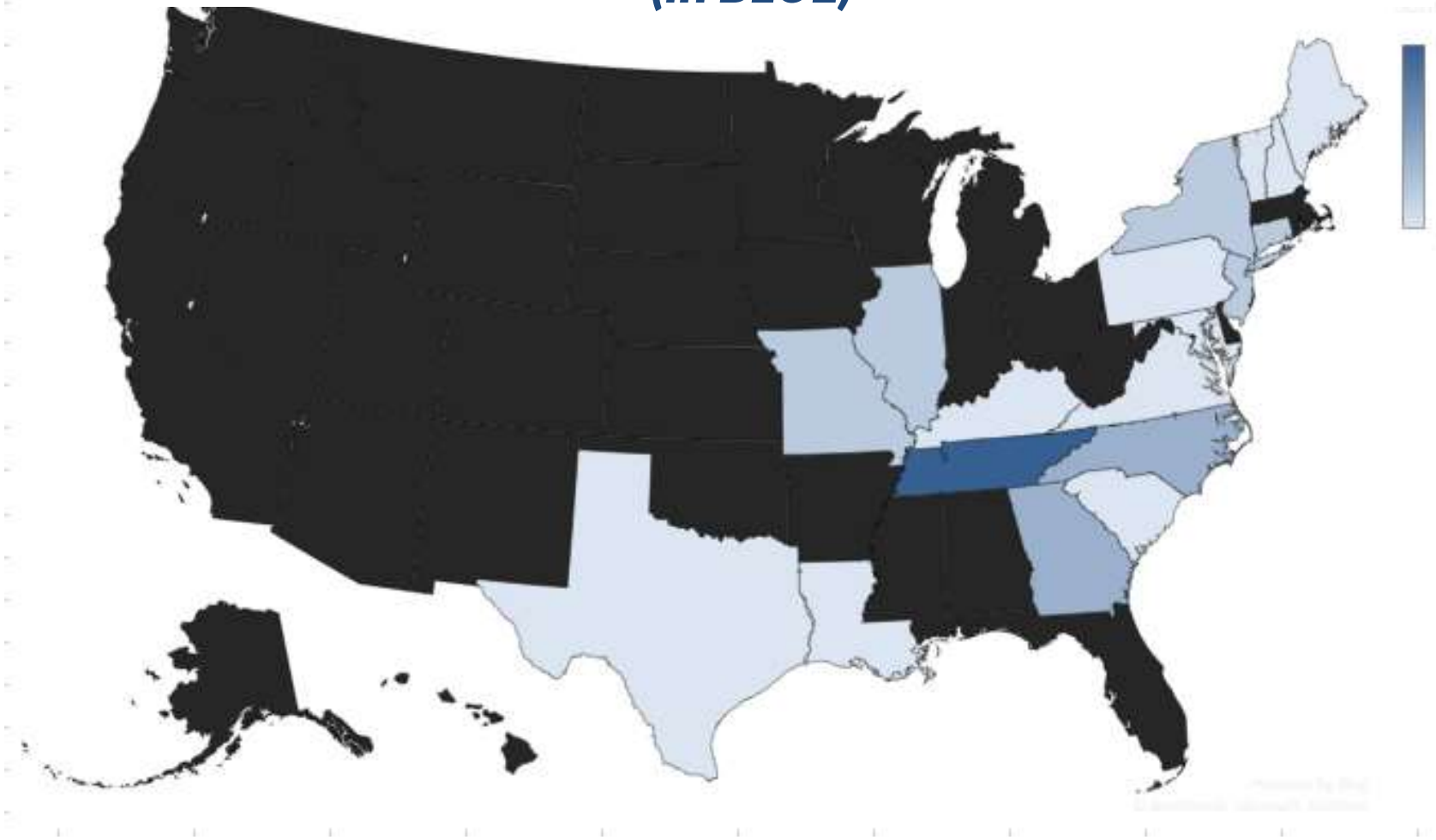
STRENGTH SUMMARY

- **Gross Area Compressive Strength of Concrete Masonry Units** - no longer used under the building code, but often requested.
- **Net Area Compressive Strength of Concrete Masonry Units** - this strength is the result from the lab testing a single block.
- **Net Area Compressive Strength of Masonry ($f'm$)** - this is the strength engineers use to design a building.

FIRE RATING

“UL” CMU ARE NOT READILY AVAILABLE IN FLORIDA

STATES WITH UL-CERTIFIED BLOCK PRODUCERS
(in BLUE)



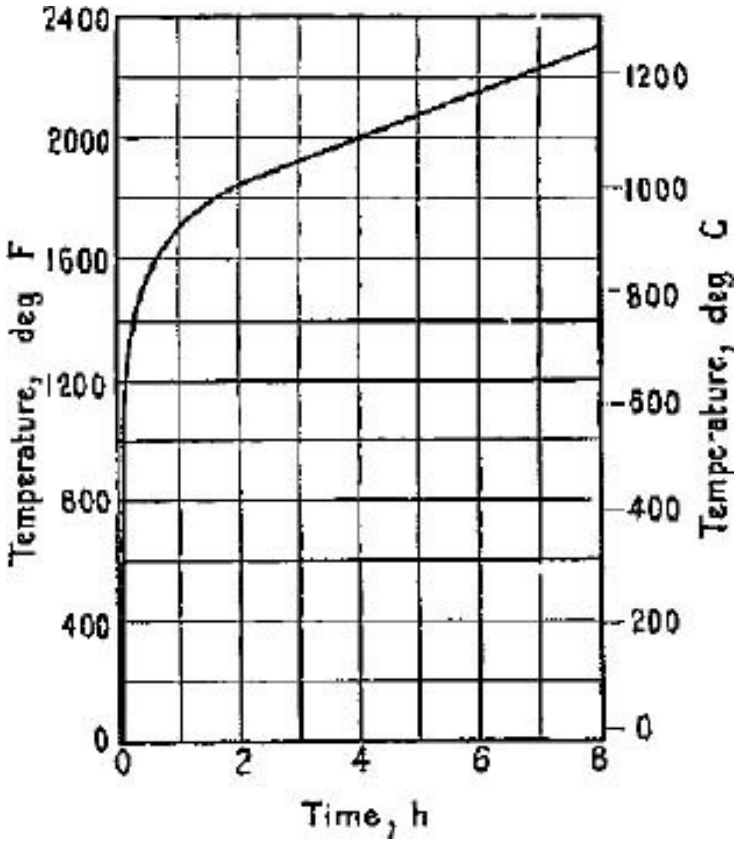
ASTM TEST METHODS E119

- TESTING FOR
  - TRANSMISSION OF HEAT
  - TRANSMISSION OF HOT GASES
    - COTTON PAD ON A LONG POLE
  - LOAD CARRYING ABILITY

ASTM TEST METHODS E119

FIRE EXPOSURE

- GAS FURNACE
- PRESCRIBED TIME-TEMPERATURE CURVE



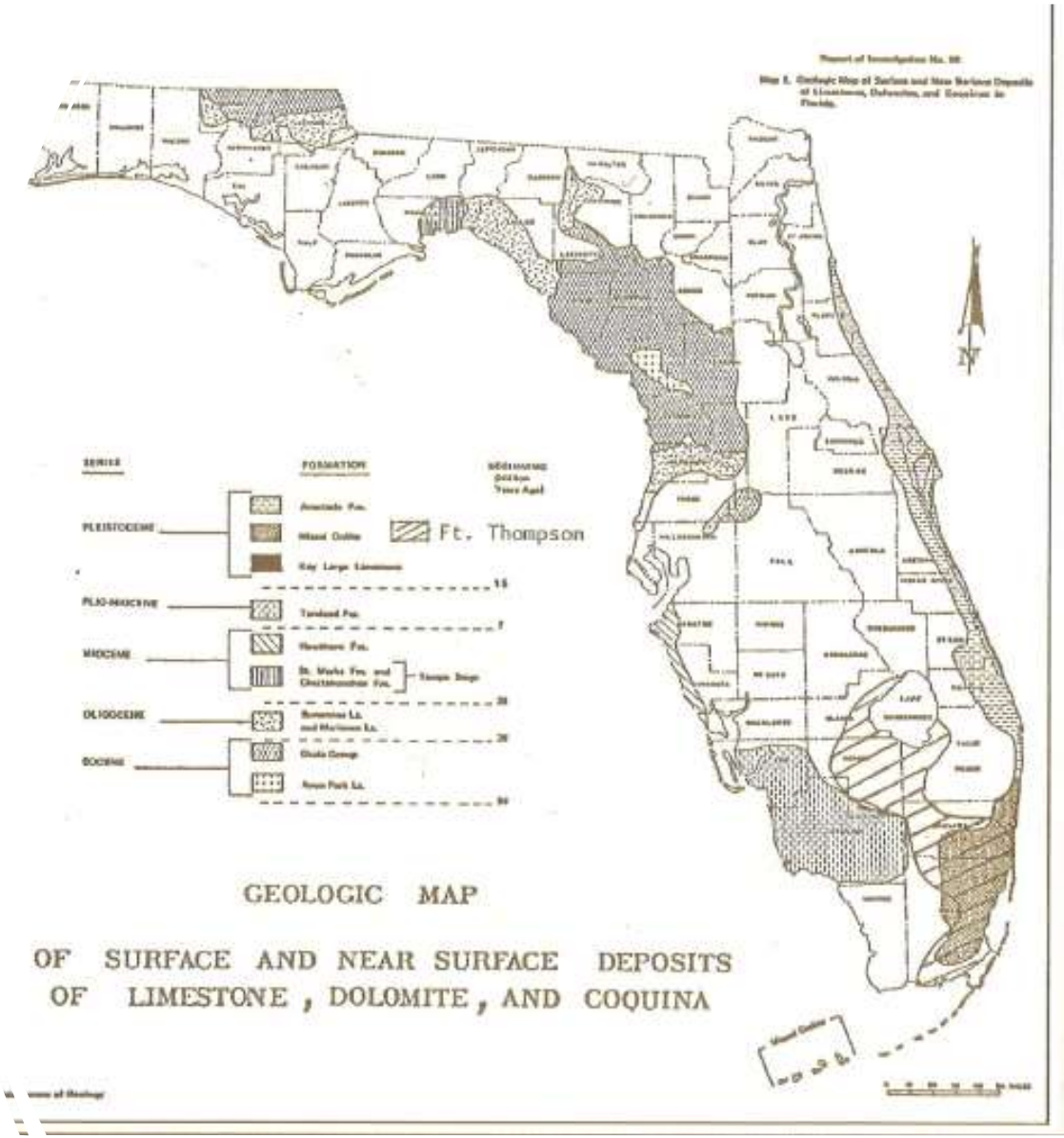
ASTM TEST METHODS E119

WATER HOSE STREAM

FIRE RATING

Type of Aggregate	MINIMUM EQUIVALENT THICKNESS FOR FIRE-RESISTANCE RATING, IN.														
	½ hr	¾ hr	1 hr	1¼ hr	1½ hr	1¾ hr	2 hr	2¼ hr	2½ hr	2¾ hr	3 hr	3¼ hr	3½ hr	3¾ hr	4 hr
Pumice or expanded slag	1.5	1.9	2.1	2.5	2.7	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.5	4.7
Expanded shale, clay or slate	1.8	2.2	2.6	2.9	3.3	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.8	4.9	5.1
Limestone, cinders or unexpanded slag	1.9	2.3	2.7	3.1	3.4	3.7	4.0	4.3	4.5	4.8	5.0	5.2	5.5	5.7	5.9
Calcareous or siliceous gravel	2.0	2.4	2.8	3.2	3.6	3.9	4.2	4.5	4.8	5.0	5.3	5.5	5.8	6.0	6.2

GEOLOGIC MAP



2017 Florida Building Code - Building, Sixth Edition

CHAPTER 7 FIRE AND SMOKE PROTECTION FEATURES

MINIMUM EQUIVALENT THICKNESS (inches) OF BEARING OR NONBEARING CONCRETE MASONRY WALLS[a,b,c,d]

TYPE OF AGGREGATE	FIRE-RESISTANCE RATING (hours)														
	1/2	3/4	1	1 1/4	1 1/2	1 3/4	2	2 1/4	2 1/2	2 3/4	3	3 1/4	3 1/2	3 3/4	4
Pumice or expanded slag	1.5	1.9	2.1	2.5	2.7	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.5	4.7
Expanded shale, clay or slate	1.8	2.2	2.6	2.9	3.3	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.8	4.9	5.1
Limestone, cinders or unexpanded slag	1.9	2.3	2.7	3.1	3.4	3.7	4.0	4.3	4.5	4.8	5.0	5.2	5.5	5.7	5.9
Calcareous or siliceous gravel	2.0	2.4	2.8	3.2	3.6	3.9	4.2	4.5	4.8	5.0	5.3	5.5	5.8	6.0	6.2

For SI: 1 inch = 25.4 mm.

a. Values between those shown in the table can be determined by direct interpolation.

b. Where combustible members are framed into the wall, the thickness of solid material between the end of each member and the opposite face of the wall, or between members set in from opposite sides, shall be not less than 93 percent of the thickness shown in the table.

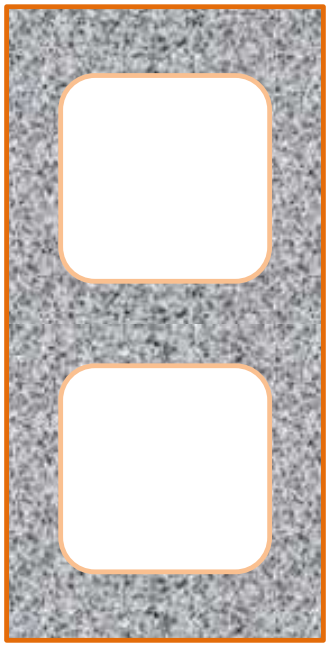
c. Requirements of ASTM C55, ASTM C73, ASTM C90 or ASTM C744 shall apply.

d. Minimum required equivalent thickness corresponding to the hourly *fire-resistance rating* for units with a combination of aggregate shall be determined by linear interpolation based on the percent by volume of each aggregate used in manufacture.

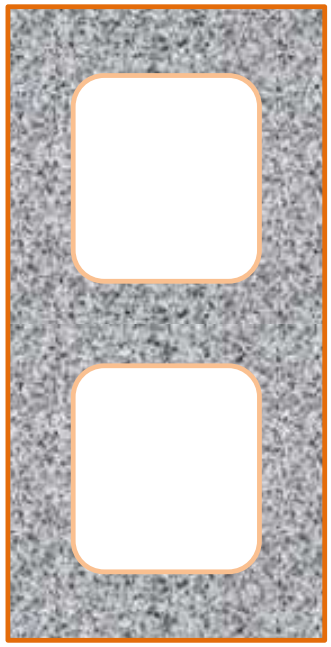
Two things determine fire rating:

1. **Equivalent Thickness**
2. **Type of Aggregate**

Note that neither compressive strength nor density affect the fire rating calculation



“1.6-hour”



“2.0-hour”

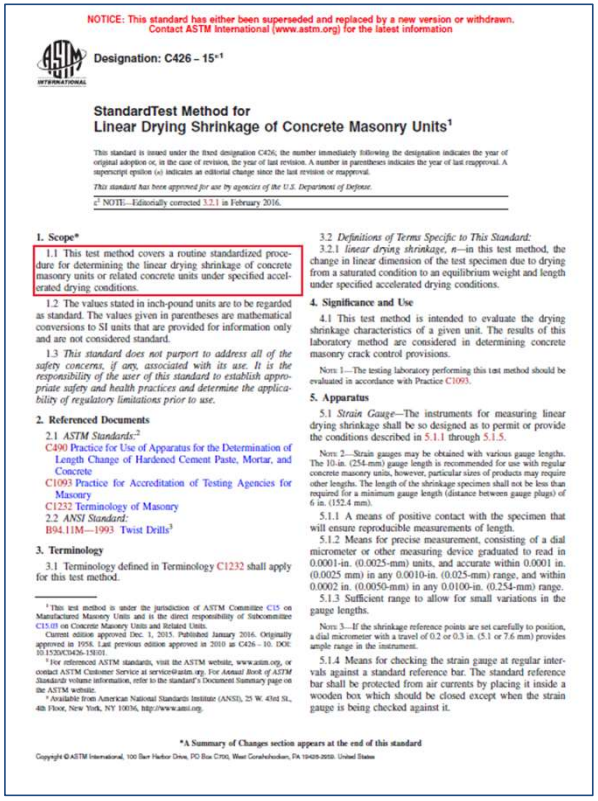
“3.0-hour”

“4.0-hour”

Increasing the Fire-Resistance Rating

- INCREASE ACTUAL THICKNESS OF CMU
- INCREASE EQUIVALENT THICKNESS OF CMU
- FILL THE CORES OF THE HOLLOW CMU (SAND, GROUT, LISTED FILLS)
- USE MULTI-WYTHE MASONRY AND/OR VENEER
- APPLY WALL FINISHES OR COVERINGS

ASTM C426



NOTICE: This standard has either been superseded and replaced by a new version or withdrawn.
Contact ASTM International (www.astm.org) for the latest information

Designation: C426 – 15[ε1]

StandardTest Method for Linear Drying Shrinkage of Concrete Masonry Units[1]

This standard is issued under the fixed designation C426; 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 3.2.1 in February 2016.

1. Scope*

1.1 This test method covers a routine standardized procedure for determining the linear drying shrinkage of concrete masonry units or related concrete units under specified accelerated drying conditions.

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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C490 Practice for Use of Apparatus for the Determination of Length Change of Hardened Cement Paste, Mortar, and Concrete

C1093 Practice for Accreditation of Testing Agencies for Masonry

C1232 Terminology of Masonry

2.2 *ANSI Standard:*

B94.11M—1993 Twist Drills[3]

3. Terminology

3.1 Terminology defined in Terminology C1232 shall apply for this test method.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *linear drying shrinkage, n*—in this test method, the change in linear dimension of the test specimen due to drying from a saturated condition to an equilibrium weight and length under specified accelerated drying conditions.

4. Significance and Use

4.1 This test method is intended to evaluate the drying shrinkage characteristics of a given unit. The results of this laboratory method are considered in determining concrete masonry crack control provisions.

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

5. Apparatus

5.1 *Strain Gauge*—The instruments for measuring linear drying shrinkage shall be so designed as to permit or provide the conditions described in 5.1.1 through 5.1.5.

NOTE 2—Strain gauges may be obtained with various gauge lengths. The 10-in. (254-mm) gauge length is recommended for use with regular concrete masonry units, however, particular sizes of products may require other lengths. The length of the shrinkage specimen shall not be less than required for a minimum gauge length (distance between gauge plugs) of 6 in. (152.4 mm).

5.1.1 A means of positive contact with the specimen that will ensure reproducible measurements of length.

5.1.2 Means for precise measurement, consisting of a dial micrometer or other measuring device graduated to read in 0.0001-in. (0.0025-mm) units, and accurate within 0.0001 in. (0.0025 mm) in any 0.0010-in. (0.025-mm) range, and within 0.0002 in. (0.0050-mm) in any 0.0100-in. (0.254-mm) range.

5.1.3 Sufficient range to allow for small variations in the gauge lengths.

NOTE 3—If the shrinkage reference points are set carefully to position, a dial micrometer with a travel of 0.2 or 0.3 in. (5.1 or 7.6 mm) provides ample range in the instrument.

5.1.4 Means for checking the strain gauge at regular intervals against a standard reference bar. The standard reference bar shall be protected from air currents by placing it inside a wooden box which should be closed except when the strain gauge is being checked against it.

[1] This test method 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.

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[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.

[3] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

*A Summary of Changes section appears at the end of this standard

ASTM INTERNATIONAL

ASTM C426-15e1 SHRINKAGE

C426-10 Page 1 Title

Designation: C426 – 15$^{\varepsilon 1}$

StandardTest Method for Linear Drying Shrinkage of Concrete Masonry Units[1]

This standard is issued under the fixed designation C426; 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 is used to give a value to potential linear shrinkage S_ℓ

ASTM C426-10 SHRINKAGE

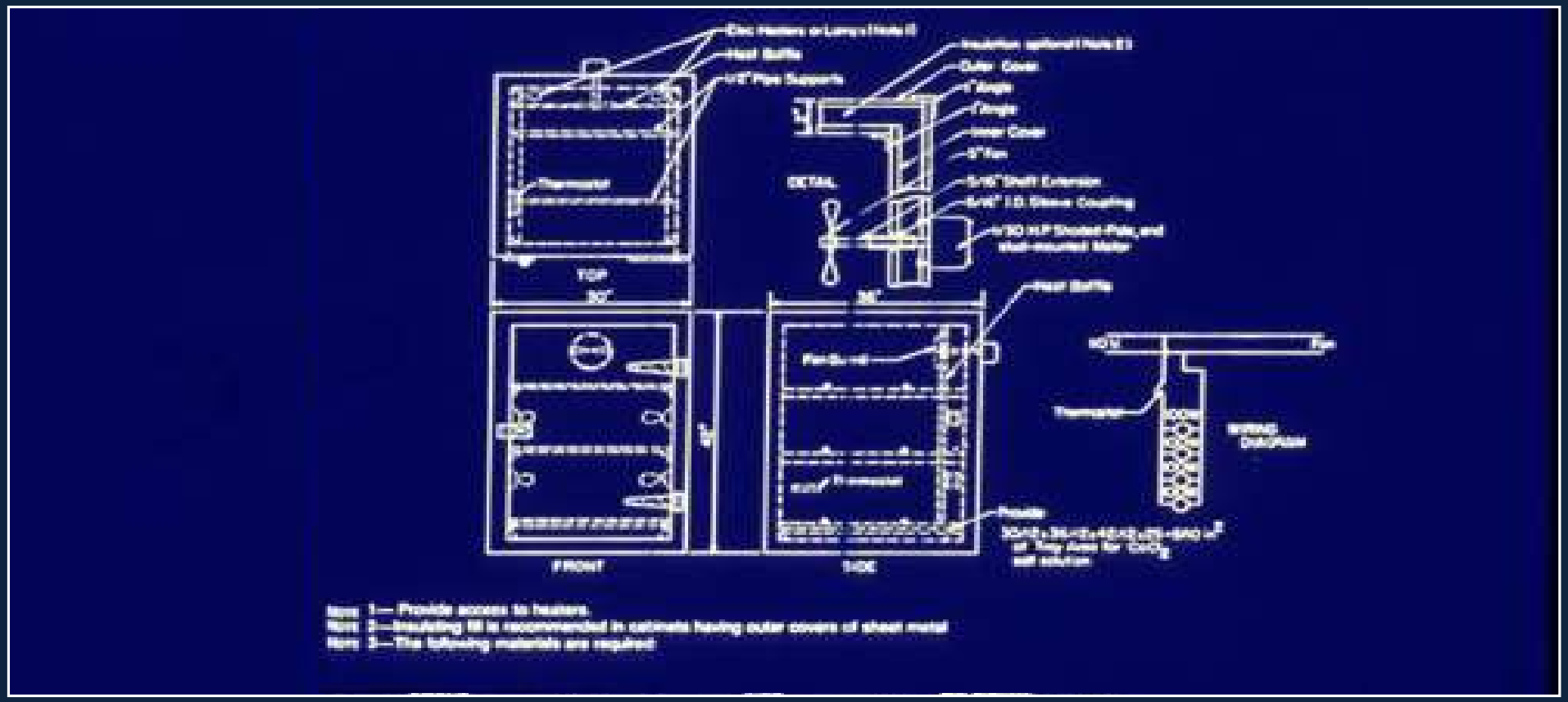
C426-10 Page 1 Scope

1. Scope*

1.1 This test method covers a routine standardized procedure for determining the linear drying shrinkage of concrete masonry units or related concrete units under specified accelerated drying conditions.

ASTM C426-15 SHRINKAGE

ASTM C426-15 SHRINKAGE



ASTM C426-15 SHRINKAGE

ASTM C426-15 SHRINKAGE

CYCLE UNTIL EQUILIBRIUM

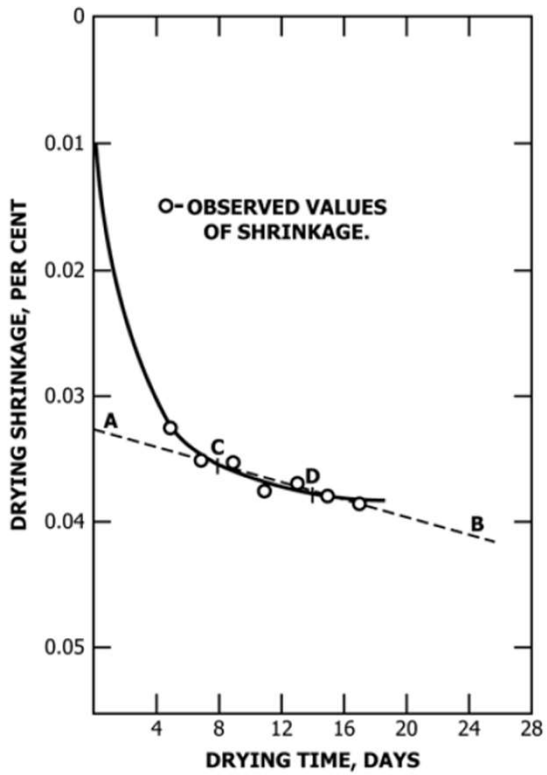
Shrinkage Equilibrium

Length change in six days of drying: 0.002 % or less

AND

Weight loss in 48 hours of drying: 0.2 % or less.

THE TEST NORMALLY TAKES ABOUT ONE MONTH.



NOTE 1—The interval *CD* is 6 days on the time scale and % shrinkage scale. Point *D* defines equilibrium shrinkage valu

FIG. 3 Graphical Method of Determining Equilibrium Shrin

WHAT IS A GOOD VALUE FOR "S", IN FLORIDA?

You may want to check with your concrete masonry producer, however, a good general value for S, (for normal weight units - 125 pounds per cubic foot or more, oven dry weight of concrete), is 0.032%

Example Coefficient of shrinkage for Type II masonry units:

k_m = 0.5 s

= 0.5 (0.32%)

= 1.16%

HOW MUCH SHRINKAGE IN 100 FEET?

Potential linear shrinkage for Type II units for 100 linear feet of wall:

= 0.16% (100')(12")

= 0.016% x 1200"

= 0.92" = about 3/16" (3/16" = 0.1875)

Provide for 3/16 inch of shrinkage in 100 ft.

NATIONAL
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ASSOCIATION

CONCRETE MASONRY TEK NOTES

NCMA TEK 1-4 - Glossary of Concrete Masonry Terms
NCMA TEK 2-5 - CMU Configurations
NCMA TEK 2-6 - Density-Related Properties
NCMA TEK 3-3 - Reinforced Concrete Masonry Construction
NCMA TEK 3-4 – Bracing
NCMA TEK 5-9 - CMU Corner Details
NCMA TEK 6-2 - R-Values for Single Wythe Concrete Masonry Walls
NCMA TEK 6-11 - Insulating CMU Walls
NCMA TEK 7-1 - Fire Resistance of Concrete Masonry Assemblies
NCMA TEK 8-2 - Removal of Stains from Concrete Masonry
NCMA TEK 13-1 - Sound Transmission Class Ratings for CMU Walls

SUMMARY

ASTM C90 - STANDARD SPECIFICATION FOR LOADBEARING CONCRETE MASONRY UNITS

- Limited material sources
- Do not specify Type
- Do not specify Grade
- Web requirement changed in C90-14
- Compressive strength requirement changed from 1,900 psi to 2,000-psi in C90-14.
- Dimensional tolerance is ±⅛”
- 5% of shipment allowed to have imperfections

SUMMARY

ASTM C140 - STANDARD TEST METHODS FOR SAMPLING AND TESTING CONCRETE MASONRY UNITS AND RELATED UNITS

- Net area is calculated
- Equivalent thickness is calculated
- Gross area of an 8” by 8” by 16 CMU is ~119 in^2

MSJC

- Table 2.1 changed in -13

FIRE RATING

- “UL block” is not produced in Florida
- Use FBC Table 722.2.3

Questions?