MASONRY Association of Florida

MORTAR & GROUT

COMPONENT 2

Jeff O'Leary

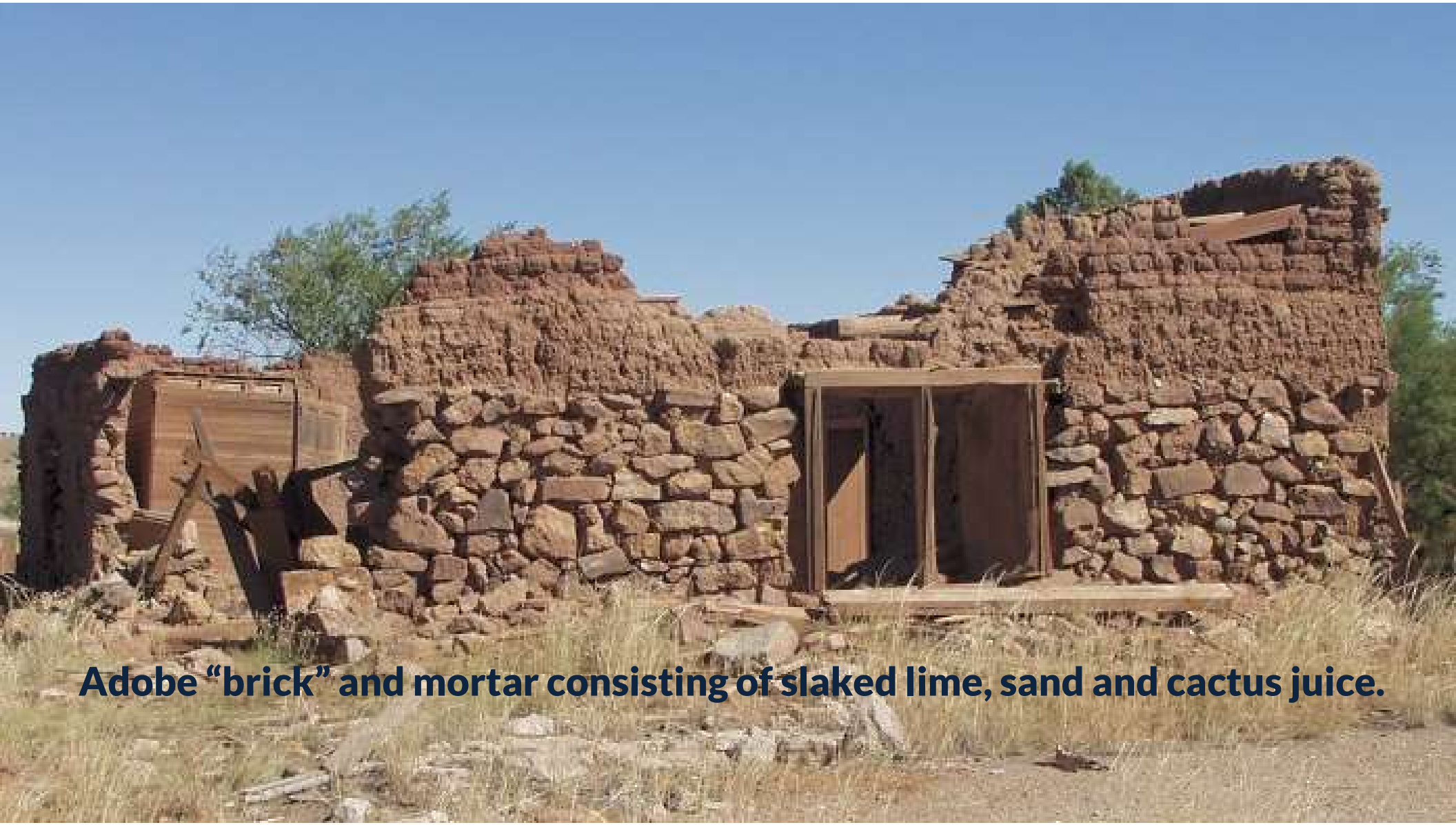
Jeff has worked in concrete materials, primarily production and testing, for over 40 years. Upon graduation from Purdue in 1983, joined on with national construction materials supplier Florida Rock Industries. Employed as Director of Technical Services from 1988 to 2017, responsible for ready-mixed concrete, prestress, precast, masonry units, and circuitously cementitious materials and aggregates.

After subsequent progressions from Florida Rock Industries to Argos, Jeff moved from large corporate employment to work with regional supplier A-1 Block Corp.

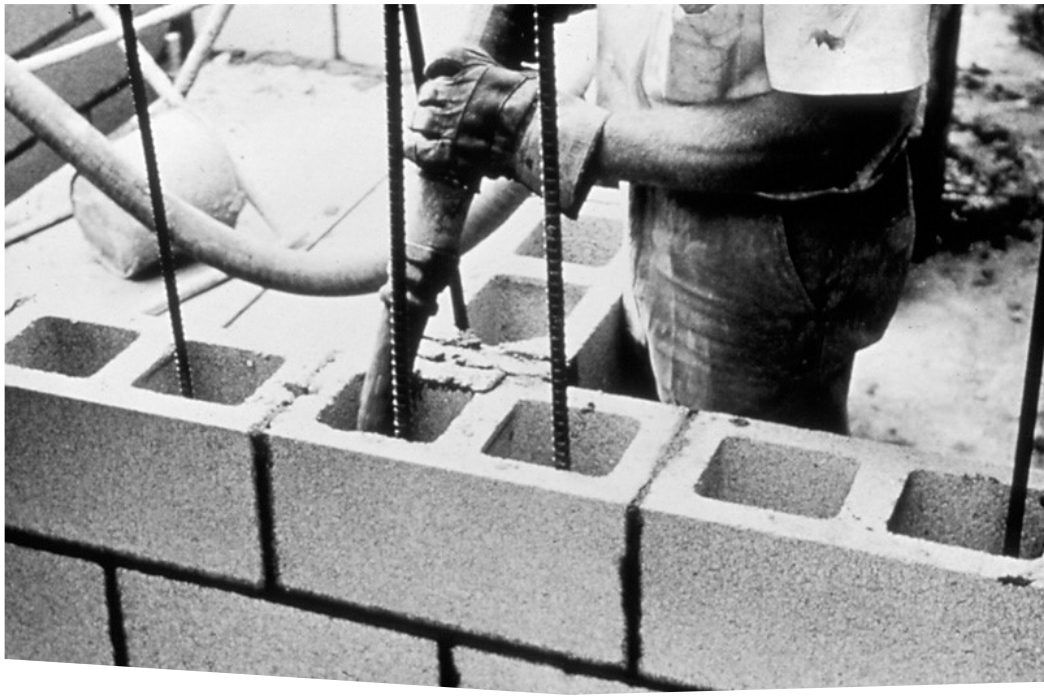
Throughout his career, Jeff remained involved with various trade organizations, such as ASTM, ACI, NRMCA, ASCE, FDOT, FCPA, MAF and CMEC, as well as serving on various committees of these organizations.

A-1 BLOCK CORPORATION
"Concrete Solutions"

“… gaps between blocks are filled with mortar consisting of a gypsum-based matrix and aggregate particles …”



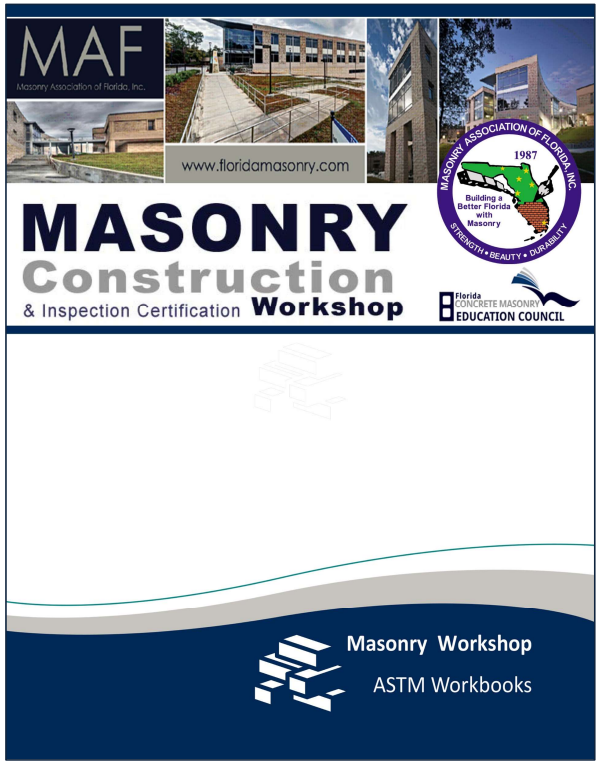
Adobe “brick” and mortar consisting of slaked lime, sand and cactus juice.



MORTARS & GROUTS

Mortar & Grout ASTMs

- ASTM C 270 Specification for Mortar
- ASTM C 144 Specification for Aggregate
- ASTM C 780 Preconstruction & Construction Evaluation of Mortars
- ASTM C 476 Specification for Grout
- ASTM C 1019 Test Method for Grout



REFERENCE BAR – LOOK HERE IF YOU'RE LOST

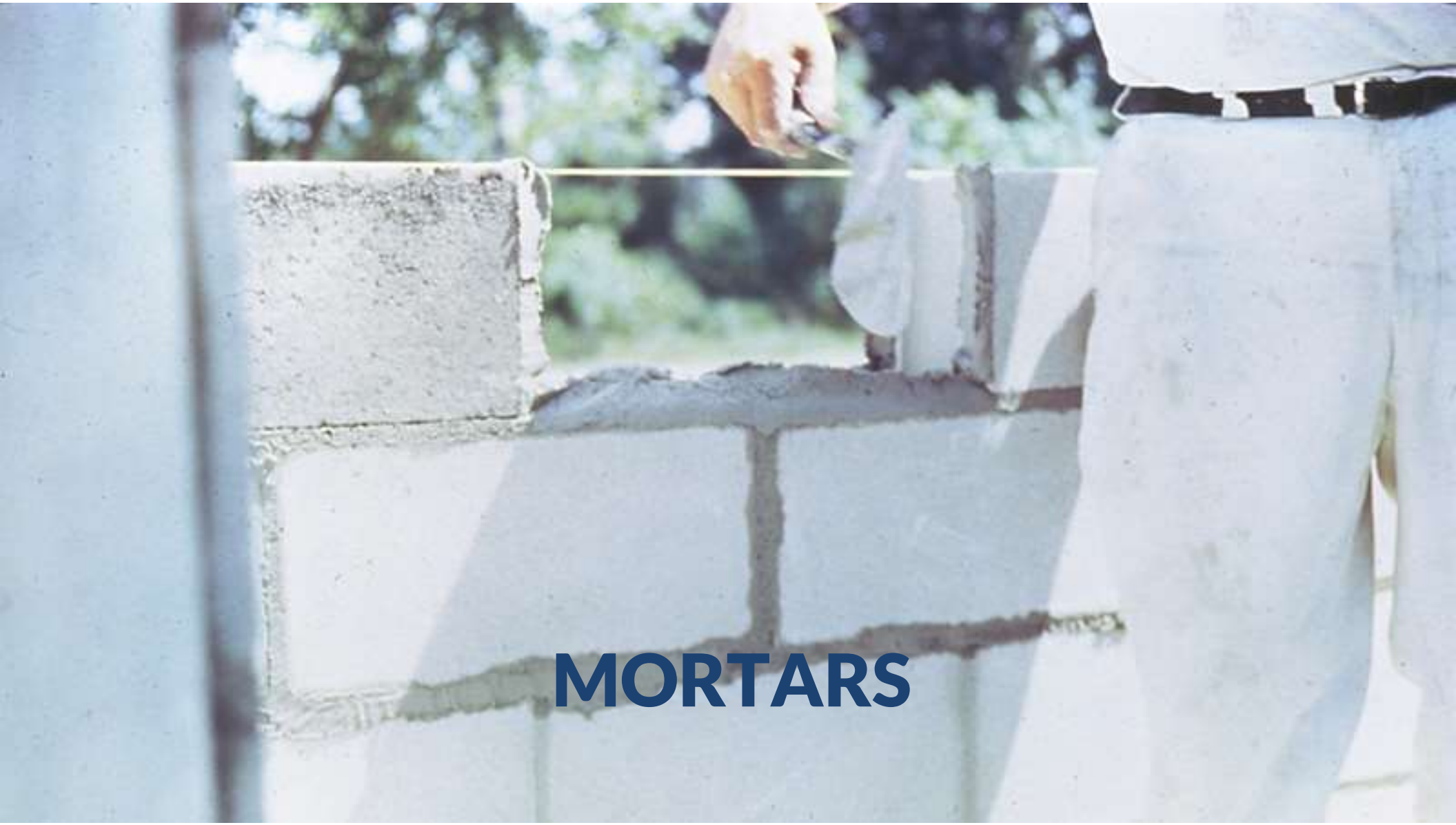
ASTM INTERNATIONAL

American Society for Testing & Materials

Non-profit organization which maintains 12,000 voluntary standards with 150 main committees

+30,000 Members are producers, users, general interest (academia, government, etc.) & consumers

Develop primarily specifications & test methods



MORTARS


What is the volume (%) of mortar which makes up a wall of 8” x 8” x 16” concrete masonry units?


A very small,
but very
important
≈9 %

What does MORTAR do in a wall?

MORTAR

- Bonds the units together
- Seals against the weather
- Compensates for size variations (C-90 allows +/- 1/8” variations in dimensions)
- Adds architectural qualities
- Accommodates small movements

MORTAR EXISTS IN 2 PHASES:

- **Plastic - "wet" phase which is most scrutinized by the masons.**
- **Hardened - phase which has typically been most important to specifiers.**
- ***Must have proper plastic properties to achieve proper hardened properties!***

DESIRED PROPERTIES OF PLASTIC MORTAR:

- Workability - most important but hardest to quantify (trust the mason)
- Adhesion - adhere to trowel & units
- Consistency - uniformity & degree of firmness
- Water retention - must stay plastic while in contact with units to place and adjust
- Board life - must not allow stiffening too soon
- Hydration – not allow too much water loss

DESIRED PROPERTIES OF HARDENED MORTAR:

- **Bond – most important, bond together**
- **Appearance – consistent**
- **Durability – dense, freeze**
- **Strength – COMPRESSIVE strength vs. BOND strength**

The classification of mortars has its roots with compressive strength!

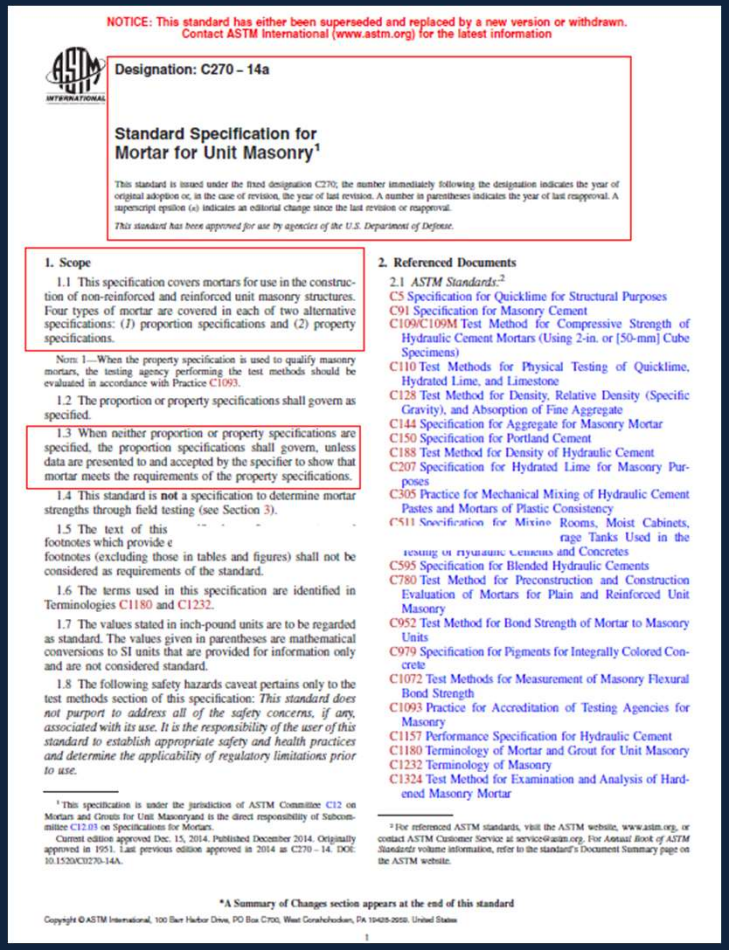
HOW DO WE CLASSIFY MORTARS?

M - 2500 psi
A
S - 1800 psi
O
N - 750 psi

W
O - 350 psi
R
K - 75 psi

WHAT IS THE REQUIRED STRENGTH FOR MORTAR WHEN TESTED ON THE JOBSITE:

A. 2500 psi
B. 1800 psi
C. 750 psi
D. What ever is specified



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: C270 – 14a

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.

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
footnotes which provide e
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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C5 Specification for Quicklime for Structural Purposes
C91 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 Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate
C144 Specification for Aggregate for Masonry Mortar
C150 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, rage Tanks Used in the
Testing of Hydraulic Cements and Concretes
C595 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 Units
C979 Specification for Pigments for Integrally Colored Concrete
C1072 Test Methods for Measurement of Masonry Flexural Bond Strength
C1093 Practice for Accreditation of Testing Agencies for Masonry
C1157 Performance Specification for Hydraulic Cement
C1180 Terminology of Mortar and Grout for Unit Masonry
C1232 Terminology of Masonry
C1324 Test Method for Examination and Analysis of Hardened Masonry Mortar

[1] This specification is under the jurisdiction of ASTM Committee C12 on Mortars and Grouts for Unit Masonryand is the direct responsibility of Subcommittee C12.03 on Specifications for Mortars.
Current edition approved Dec. 15, 2014. Published December 2014. Originally approved in 1951. Last previous edition approved in 2014 as C270 – 14. DOI: 10.1520/C0270-14A.

[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

ASTM C 270 - Standard Specification for Mortar for Unit Masonry

ASTM C 270

Standard Specification for
Mortar for Unit Masonry

To summarize:

*C270 **qualifies** the mortar proportions – either by recipe or as a result of testing in a laboratory. When the C 270 process is complete, only the raw material proportions (cement, sand, etc) and material sources (source of cement, sand, etc) are established for the manufacturing of mortar on the jobsite. While a strength level is referenced within C 270, it is not used beyond the qualification of the mortar by C 270.*

ASTM C 270 Mortar

Designation: C 270 – 14a

Standard Specification for

Mortar for Unit Masonry

1. **Scope** – *what C 270 is all about.*
2. **Referenced Documents** – *other standards used in C 270.*
3. **Specification Limitations** – *how to not be stupid.*
4. **Materials** – *raw materials need to be acceptable.*
5. **Requirements** – *the heart of C 270.*
6. **Test Method** – *pre-qualification of materials only.*
7. **Construction Practices** – *do's & don'ts for the field.*
8. **Quality Assurance** – *how to not be more stupid.*

X1. Selection & Use of Mortar for Unit Masonry – *great stuff, lets start here!*

ASTM C 270 Mortar

C 270 - APPENDIXES

(Nonmandatory Information)

X1. SELECTION AND USE OF MORTAR FOR UNIT MASONRY

X1.3 *Function:*

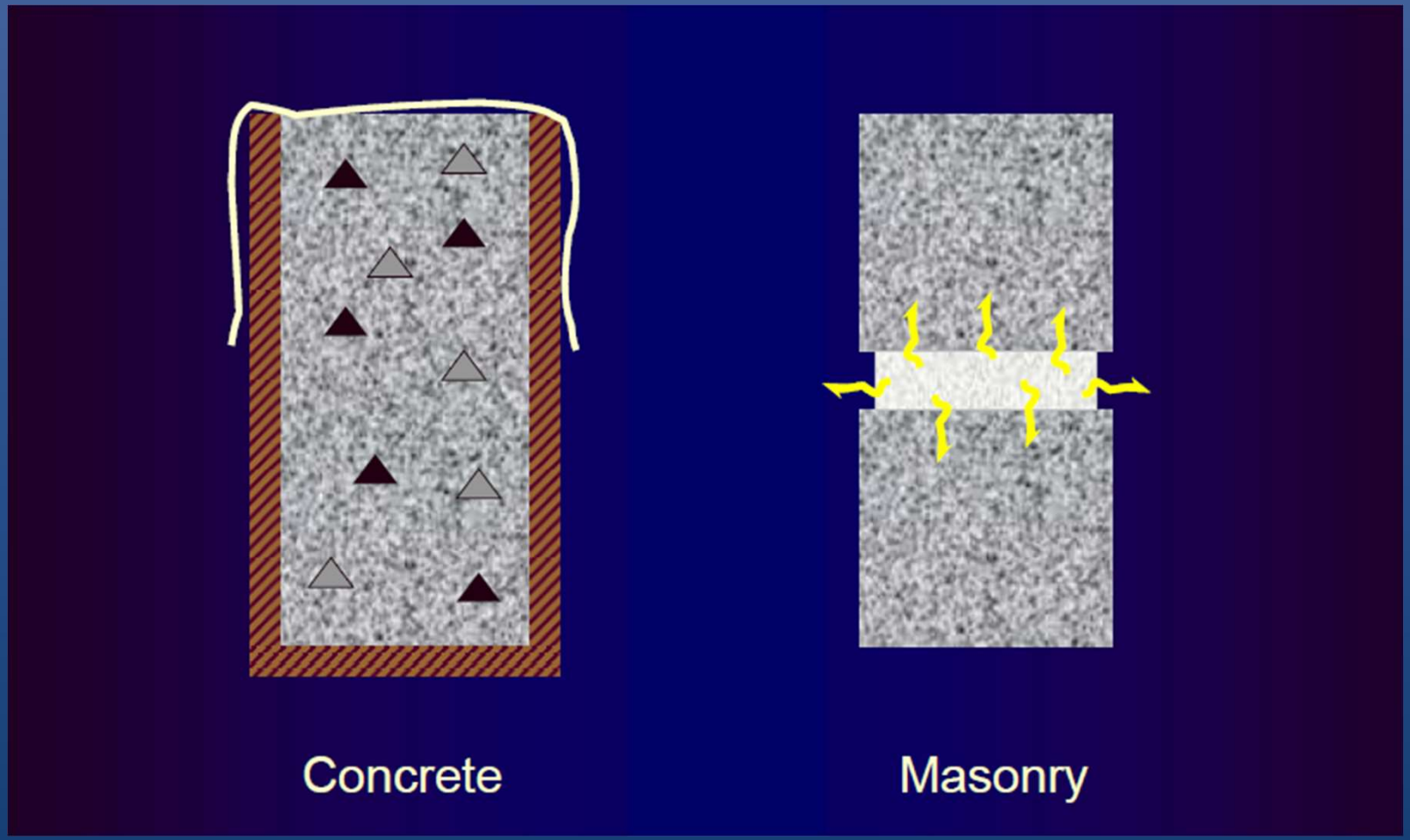
X1.3.1 The primary purpose of mortar in masonry is to **bond** masonry units into an assemblage which acts as an integral element having desired functional performance characteristics.

SECTION & PAGE INFO

ASTM C 270

X1.3.2 Because Portland cement concretes and masonry mortars contain some of the same principal ingredients, it is often erroneously assumed that good concrete practice is also good mortar practice. Realistically, mortars differ from concrete in working consistencies, in methods of placement and in the **curing environment**. Masonry mortar is commonly used to bind masonry units into a single structural element, while concrete is usually a structural element in itself.

X1.3.3 A major distinction between the two materials is illustrated by the manner in which they are handled during construction. Concrete is usually placed in nonabsorbent metal or wooden forms or otherwise treated so that most of the water will be retained. Mortar is usually placed between absorbent masonry units, and as soon as contact is made the mortar loses water to the units. Compressive strength is a prime consideration in concrete, but it is only one of several important factors in mortar.



ASTM C 270 Mortar

X1.5 *Plastic Mortars:*

X1.5.1 *Workability* - **Workability is the most important property of plastic mortar**. Workable mortar can be spread easily with a trowel into the separations and crevices of the masonry unit.

Workability is a combination of several properties, including plasticity, consistency, cohesion, and adhesion, which have defied exact laboratory measurement.

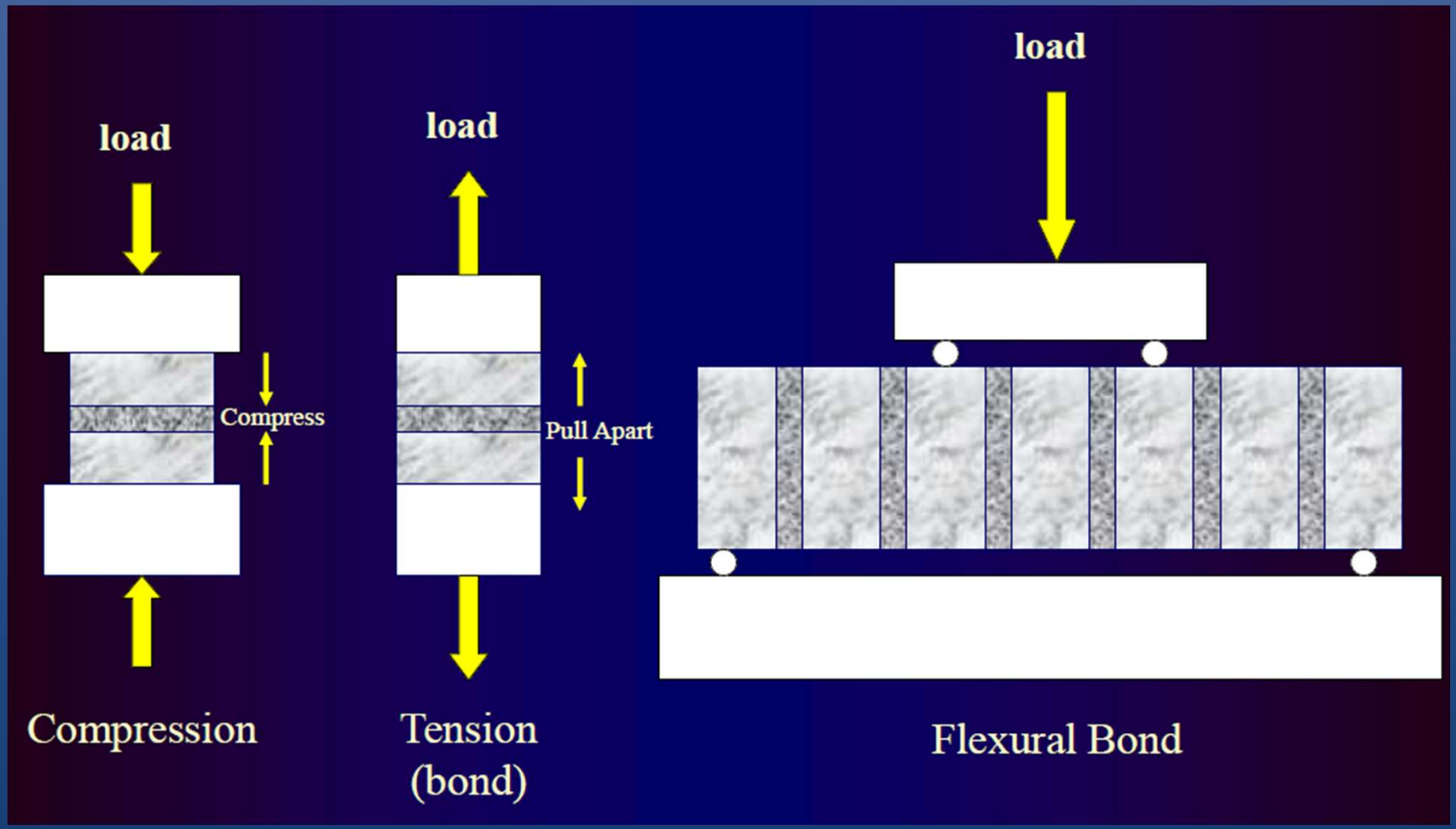
WHAT IS THIS BOND THING?

X1.6 *Hardened Mortars:*

X1.6.1 *Bond* - **Bond is probably the most important single physical property of hardened mortar**. … Bond actually has three facets; strength, extent and durability. Because many variables affect bond, it is difficult to devise a single laboratory test . . .

X1.6.3 *Compressive Strength* - The compressive strength of mortar is sometimes used as a principal criterion for selecting mortar type, since compressive strength is relatively easy to measure . . .\

ASTM C 270 Mortar | Page 7-8



ASTM C 270 Mortar

PCA Since 1916
America's Cement Manufacturers™

PCA
MASONRY INFORMATION

Masonry Mortars

"There is a distinct relationship between mortar flow (water content) and bond strength. For all mortars, bond strength increases as water content increases, within reasonable limits. The optimum bond strength is obtained by using a mortar with the highest water content compatible with workability, even though mortar compressive strength may decrease."

ASTM C 270 Mortar

REMEMBER

To achieve good bond, you must have good workability.

To achieve good workability, you must have sufficient water.

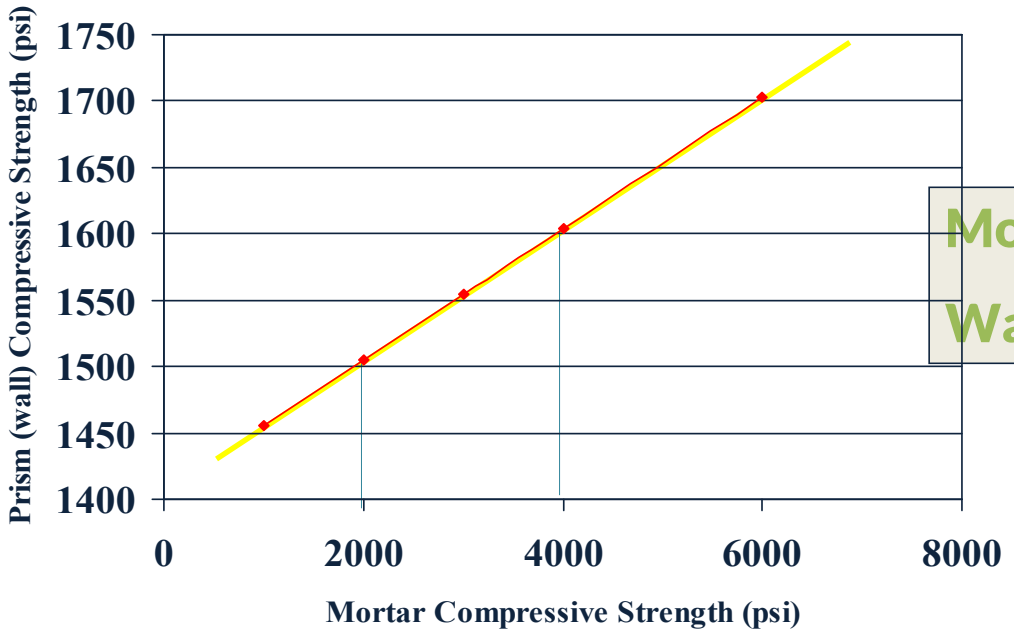
X1.10 *Summary:*

X1.10.2 Bond is probably the most important single property of a conventional mortar.

X1.10.3 Table X1.1 is a general guide for the selection of mortar type for various masonry wall construction.

Table X1.1 Guide for the Selection of Masonry Mortars			
		Mortar Type	
Location	Building Segment	**Recommended**	Alternative
Exterior	load-bearing wall	N	S or M
	non-load bearing wall	O	N or S
	parapet wall	N	S
	foundation wall, retaining wall, manholes, sewers, pavements, walks & patios	S	M or N
Interior	load-bearing wall	N	S or M
	non-bearing partitions	O	N

The National Institute of Standards and Technology (NIST) showed that arbitrarily increasing the strength of the mortar, over that required, does not increase the strength of the wall:



Mortar increase = 100%

Wall increase = 7%

ASTM C 270 Mortar

Designation: C 270 – 14a

Standard Specification for

Mortar for Unit Masonry

Let's get back to the front

1. **Scope** – *what C 270 is all about.*
2. **Referenced Documents** – *other standards used in C 270.*
3. **Specification Limitations** – *how to not be stupid.*
4. **Materials** – *raw materials need to be acceptable or else.*
5. **Requirements** – *the heart of C 270.*
6. **Laboratory Testing** – *for pre-qualification of materials only.*
7. **Construction Practices** – *do's & don'ts for the field.*
8. **Quality Assurance** – *how to not be more stupid.*

X1. Selection & Use of Mortar for Unit Masonry √

ASTM C 270 Mortar

Designation: C 270 – 14a

Standard Specification for
Mortar for Unit Masonry

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

Proportion: *"recipe" detailing the materials to be used and their proportions. No preliminary lab testing to be done – just start building.*

Property: *how the mortar is to perform – based on tests performed in the laboratory only! Prove your mortar will work.*

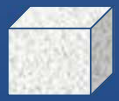
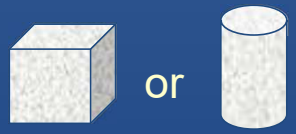
1.3 When neither proportion or property specifications are specified, the proportion specifications shall govern, unless ...

3. Specification Limitations

*Specification C 270 is **not** a specification to determine mortar strengths through field testing.*

3.2 Property specifications requirements in Table 1 shall not be used to evaluate construction site produced mortars,

3.3 The compressive strength values resulting from field tested mortars do not represent the compressive strength of mortar as tested in the laboratory nor that of the mortar in the wall. Physical properties of field sampled mortar shall not be used to determine compliance to this specification and are not intended as criteria to determine the acceptance or rejection of the mortar.

	Lab C 270	Field (mason) C 780	Wall
Mixer Type:			
Flow (fluidity):			
Test Specimen:			(no test available)
Water Content:	low	high	low
Flow:	low	high	low
Comp. Strength:	high	low	~high

ASTM C 270 Mortar

4. Materials

4.1.1 *Cementitious Materials:*

4.1.1.1 ***Portland Cement*** - ASTM C 150

4.1.1.2 Blended Cements - ASTM C 595

4.1.1.3 Blended Cements - ASTM C 1157

4.1.1.4 Slag Cement - ASTM C 595

4.1.1.5 ***Masonry Cement*** - ASTM C 91

4.1.1.6 Mortar Cement - ASTM C 1329

4.1.1.7 Quicklime

4.1.1.8 ***Hydrated Lime*** - ASTM C 207

Typically: Masonry Cement

Portland Cement + Hydrated Lime

Each material must meet a standard

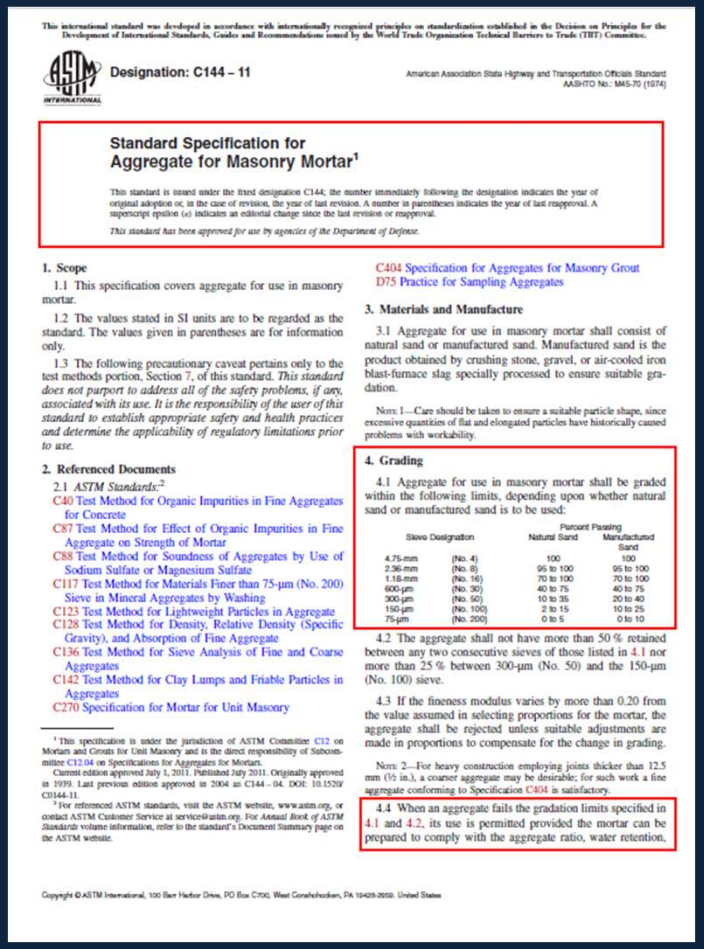
There is little difference between these two – chemically or physically.

ASTM C 270 Mortar | Page 2

4. Materials

4.1.2 *Aggregates* - ASTM C 144

Let's look at **ASTM C 144** (next standard after C 270).



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.

Designation: C144 – 11

American Association State Highway and Transportation Officials Standard AASHTO No.: M45-70 (1974)

Standard Specification for Aggregate for Masonry Mortar[1]

This standard is issued under the fixed designation C144; 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 Department of Defense.

1. Scope

1.1 This specification covers aggregate for use in masonry mortar.

1.2 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.3 The following precautionary caveat pertains only to the test methods portion, Section 7, of this standard. *This standard does not purport to address all of the safety problems, 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]

C40 Test Method for Organic Impurities in Fine Aggregates for Concrete

C87 Test Method for Effect of Organic Impurities in Fine Aggregate on Strength of Mortar

C88 Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate

C117 Test Method for Materials Finer than 75-μm (No. 200) Sieve in Mineral Aggregates by Washing

C123 Test Method for Lightweight Particles in Aggregate

C128 Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate

C136 Test Method for Sieve Analysis of Fine and Coarse Aggregates

C142 Test Method for Clay Lumps and Friable Particles in Aggregates

C270 Specification for Mortar for Unit Masonry

C404 Specification for Aggregates for Masonry Grout

D75 Practice for Sampling Aggregates

3. Materials and Manufacture

3.1 Aggregate for use in masonry mortar shall consist of natural sand or manufactured sand. Manufactured sand is the product obtained by crushing stone, gravel, or air-cooled iron blast-furnace slag specially processed to ensure suitable gradation.

NOTE 1—Care should be taken to ensure a suitable particle shape, since excessive quantities of flat and elongated particles have historically caused problems with workability.

4. Grading

4.1 Aggregate for use in masonry mortar shall be graded within the following limits, depending upon whether natural sand or manufactured sand is to be used:

Sieve Designation		Percent Passing	
		Natural Sand	Manufactured Sand
4.75-mm	(No. 4)	100	100
2.36-mm	(No. 8)	95 to 100	95 to 100
1.18-mm	(No. 16)	70 to 100	70 to 100
600-μm	(No. 30)	40 to 75	40 to 75
300-μm	(No. 50)	10 to 35	20 to 40
150-μm	(No. 100)	2 to 15	10 to 25
75-μm	(No. 200)	0 to 5	0 to 10

4.2 The aggregate shall not have more than 50 % retained between any two consecutive sieves of those listed in 4.1 nor more than 25 % between 300-μm (No. 50) and the 150-μm (No. 100) sieve.

4.3 If the fineness modulus varies by more than 0.20 from the value assumed in selecting proportions for the mortar, the aggregate shall be rejected unless suitable adjustments are made in proportions to compensate for the change in grading.

NOTE 2—For heavy construction employing joints thicker than 12.5 mm (½ in.), a coarser aggregate may be desirable; for such work a fine aggregate conforming to Specification C404 is satisfactory.

4.4 When an aggregate fails the gradation limits specified in 4.1 and 4.2, its use is permitted provided the mortar can be prepared to comply with the aggregate ratio, water retention,

[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 C12.04 on Specifications for Aggregates for Mortars.

Current edition approved July 1, 2011. Published July 2011. Originally approved in 1939. Last previous edition approved in 2004 as C144 – 04. DOI: 10.1520/C0144-11.

[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.

ASTM C 144 - Specification for Aggregate for Masonry Mortar

Designation: C 144 - 11

Standard Specification for

Aggregate for Masonry Mortar

4.1 Aggregate for use in masonry mortar shall be graded within the following limits, …

Sieve Size		Percent Passing	
		Natural	Manufactured
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1.18 mm	(No. 16)	70-100	70-100
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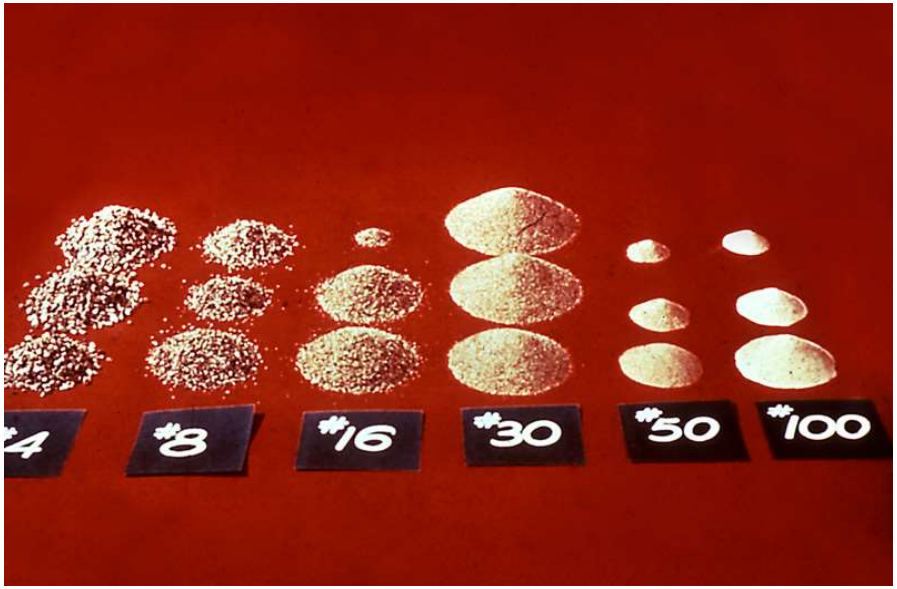
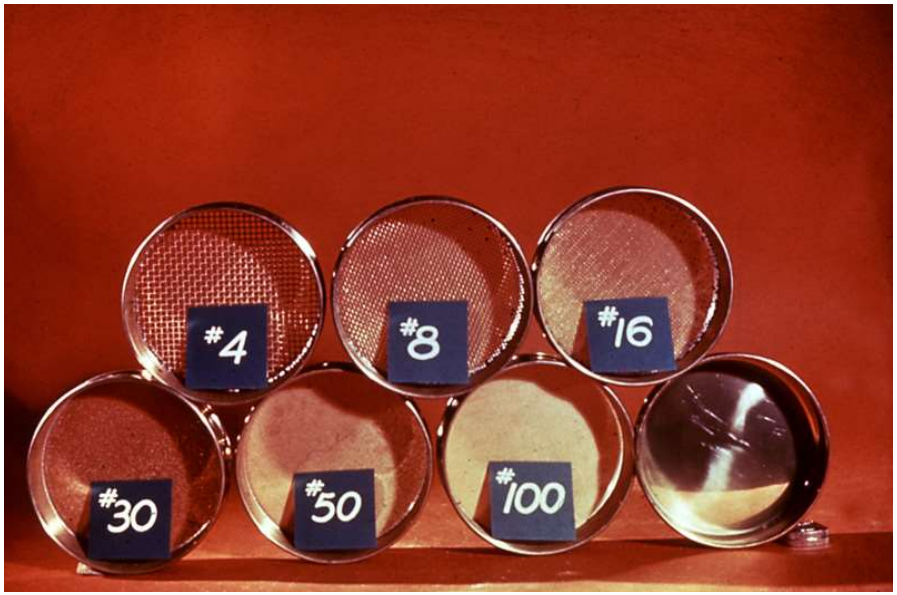
75 µm	(No. 200)	0-5	0-10





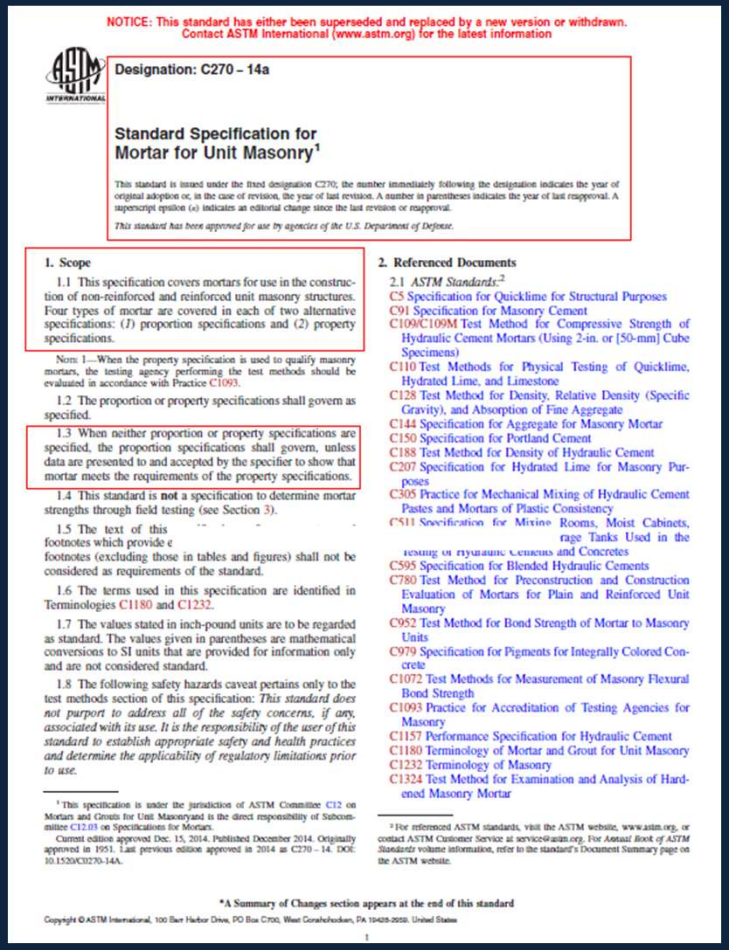
ASTM C 144

Designation: C 144 - 11

Standard Specification for
Aggregate for Masonry Mortar

4.4 When an aggregate fails the gradation limits of 4.1 & 4.2, it may by used provided the mortar can be prepared to comply with the aggregate ratio, water retention and compressive strength requirements of the ***property*** specifications of C 270.

ASTM C 144 | Pages 1-2



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C128 Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate
C144 Specification for Aggregate for Masonry Mortar
C150 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, rage Tanks Used in the
Testing of Hydraulic Cements and Concretes
C595 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 Units
C979 Specification for Pigments for Integrally Colored Concrete
C1072 Test Methods for Measurement of Masonry Flexural Bond Strength
C1093 Practice for Accreditation of Testing Agencies for Masonry
C1157 Performance Specification for Hydraulic Cement
C1180 Terminology of Mortar and Grout for Unit Masonry
C1232 Terminology of Masonry
C1324 Test Method for Examination and Analysis of Hardened Masonry Mortar

[1] This specification is under the jurisdiction of ASTM Committee C12 on Mortars and Grouts for Unit Masonryand is the direct responsibility of Subcommittee C12.03 on Specifications for Mortars.
Current edition approved Dec. 15, 2014. Published December 2014. Originally approved in 1951. Last previous edition approved in 2014 as C270 – 14. DOI: 10.1520/C0270-14A.

[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

ASTM C 270 - Standard Specification for Mortar for Unit Masonry

4.1.3 *Water* - Water shall be clean and free of the bad stuff.

4.1.4 *Admixtures* - Many different kinds!? Take precaution with:

- Calcium chloride – corrosion of metals.
- Water-reducing – don't we want water in the mortar?
- Retarding admixtures – if set retarded, too much water allowed to be absorbed by the block (leave the mortar), possibly not leaving enough for complete hydration.

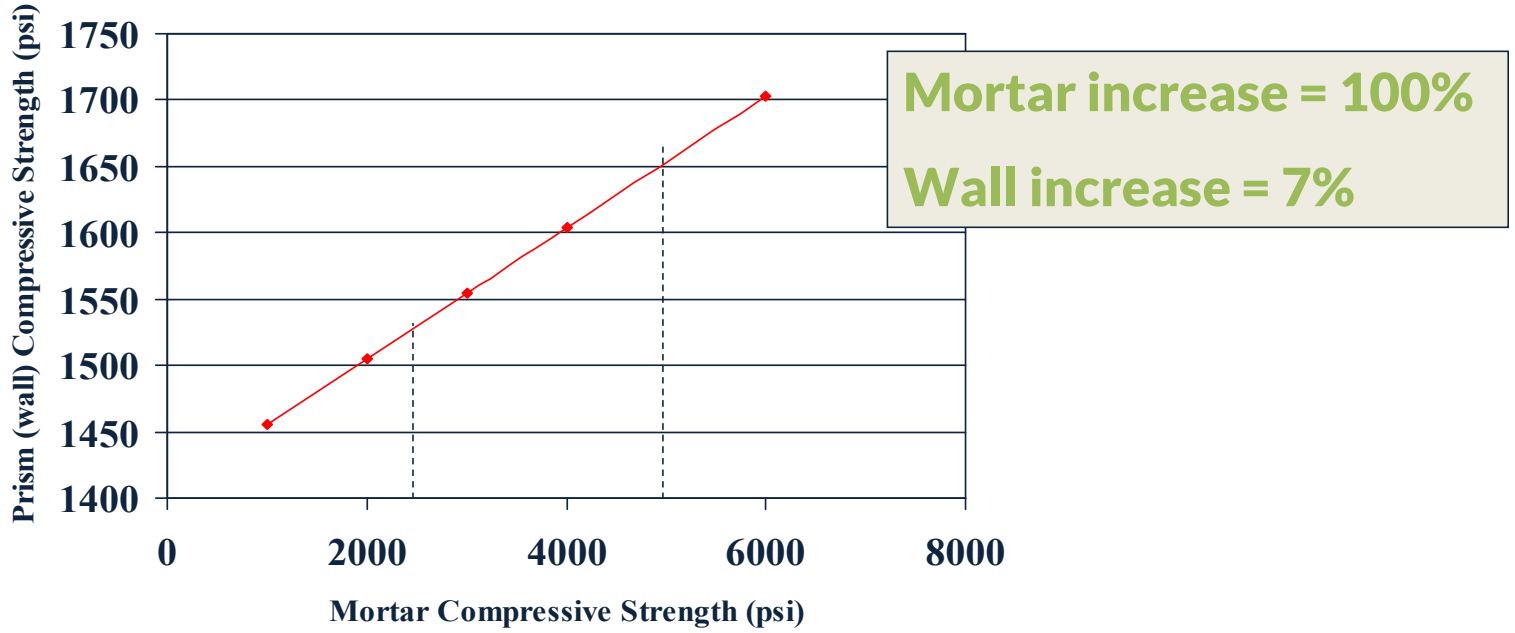
5. Requirements

5.1 Unless . . . Mortar of known higher strength shall not be indiscriminately substituted where a mortar type or anticipated lower strength is specified.

One thing we know about

mortar strength vs wall strength:

The National Institute of Standards and Technology (NIST) showed that arbitrarily increasing the strength of the mortar, over that required, does not increase the strength of the wall:



ASTM C 270 Mortar

Now let's move on to the heart of ASTM C 270:

5.2 *Property Specifications* – **Table 1**

&

5.3 *Proportion Specifications* – **Table 2**

Table 1 Property Specification Requirements

Mortar	Type	Compressive Strength	Water Retention	Air Content	Agg. Ratio
Cement-Lime	M	2500 psi	75 %	12 %	Not less than 2 ¼ and not more than 3 ½ times the sum of the volume of cement.
	S	1800 psi	75 %	12 %	
	N	750 psi	75 %	14 %	
Masonry Cement	M	2500 psi	75 %	18 %	
	S	1800 psi	75 %	18 %	
	N	750 psi	75 %	20 %	

Table 2 Proportion Specification Requirements

Mortar	Type	Proportions by Volume (1 unit = 1 cf) Cem.	Masonry Cement M	S	N	Lime	Agg. Ratio
Cement-Lime	M	1	…	…	…	1/4	Not less than 2 ¼ and not more than 3 times the sum of the volume of cement.
	S	1	…	…	…	1/4-1/2	
	N	1	…	…	…	1/2-1 1/4	
Masonry Cem.	M	1	…	…	1	…	
	M	…	1	…	…	...	
	S	1/2	…	…	1	…	
	S	…	…	1	…	...	

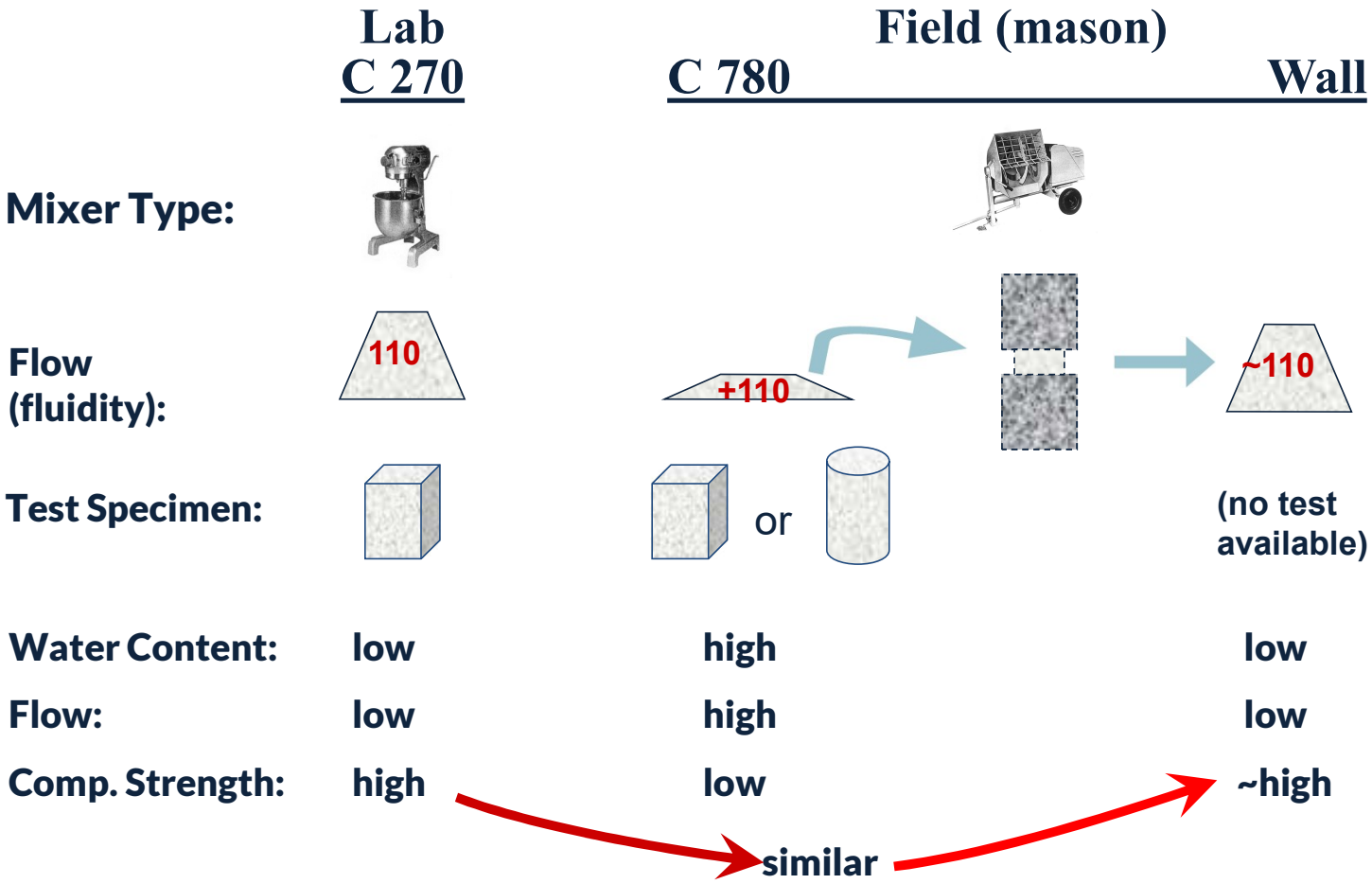
Note 5 - The required properties of the mortar in Table 1 are for laboratory prepared mortar mixed with a quantity of water to produce a flow of 110 +/- 5%. This quantity of water is not sufficient to produce a mortar with a workable consistency suitable for laying masonry units in the field. Mortar for use in the field must be mixed with the maximum amount of water, consistent with workability, in order to provide sufficient water to satisfy the initial rate of absorption (suction) of the masonry units.

The properties of laboratory prepared mortar at a flow of 110 +/- 5, as required by this specification, are intended to approximate the flow and properties of field prepared mortar after it has been placed in use and the suction of the masonry units has been satisfied. The properties of field prepared mortar mixed with the greater quantity of water, prior to being placed in contact with the masonry units, will differ from the property requirements in Table 2. Therefore, the property requirements in Table 2 cannot be used as requirements for quality control of field prepared mortar.

110% of original diameter

>110% of original diameter

What is FLOW of mortar?


Lab
C 270
Field (mason)
C 780
Wall
Mixer Type:
Flow
(fluidity):
110
+110
~110
Test Specimen:
or
(no test
available)
Water Content:
low
high
low
Flow:
low
high
low
Comp. Strength:
high
low
~high
similar

ASTM C 270

6. Test Methods

6.2 Mixing of Mortars



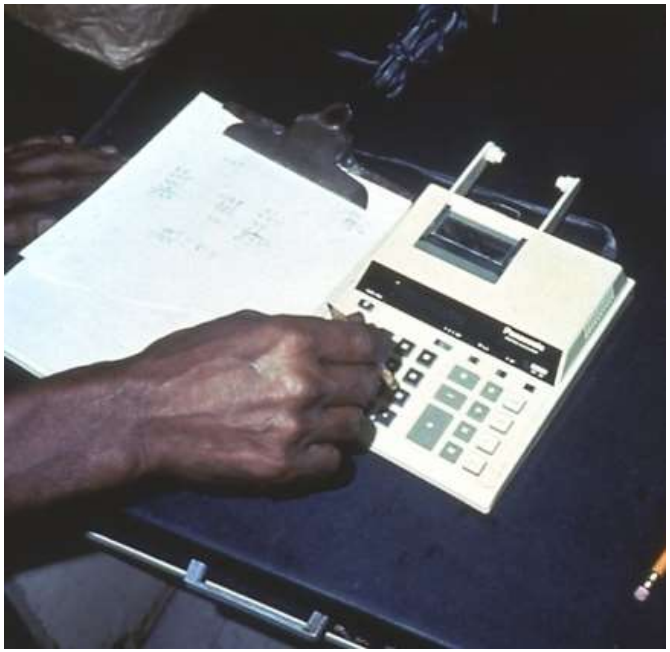
Start with the <u>flow</u> test . . . . .


vacuum/suction . . . **flow test again.**

6.3 WATER RETENTION

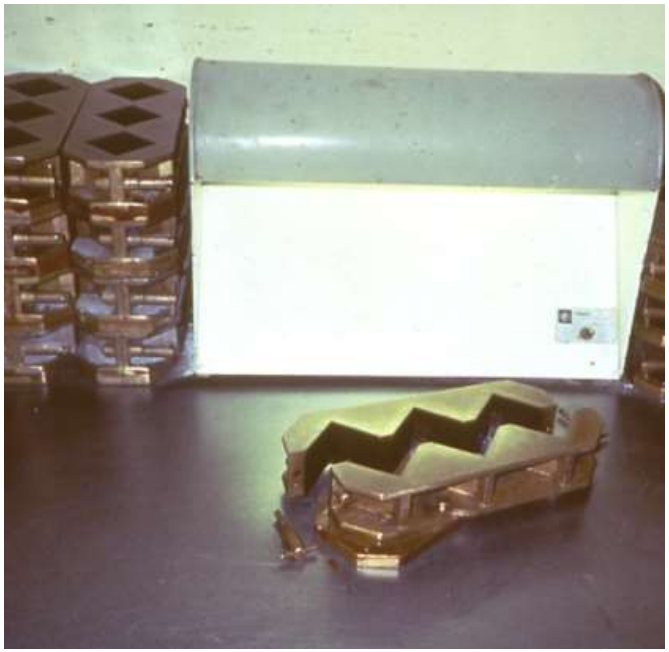
CAST IN
PRECISE MEASURE

WEIGH



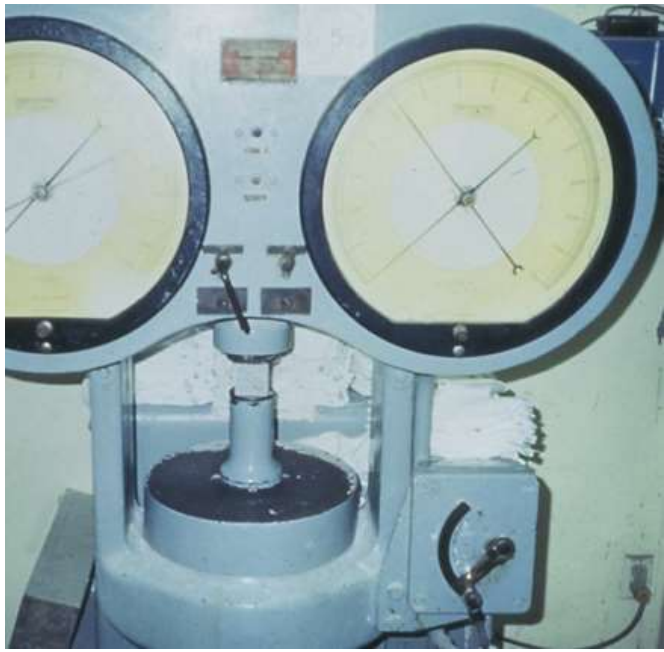
CALCULATE

6.4 AIR CONTENT



THE MOLDS

CASTING SPECIMENS



TESTING

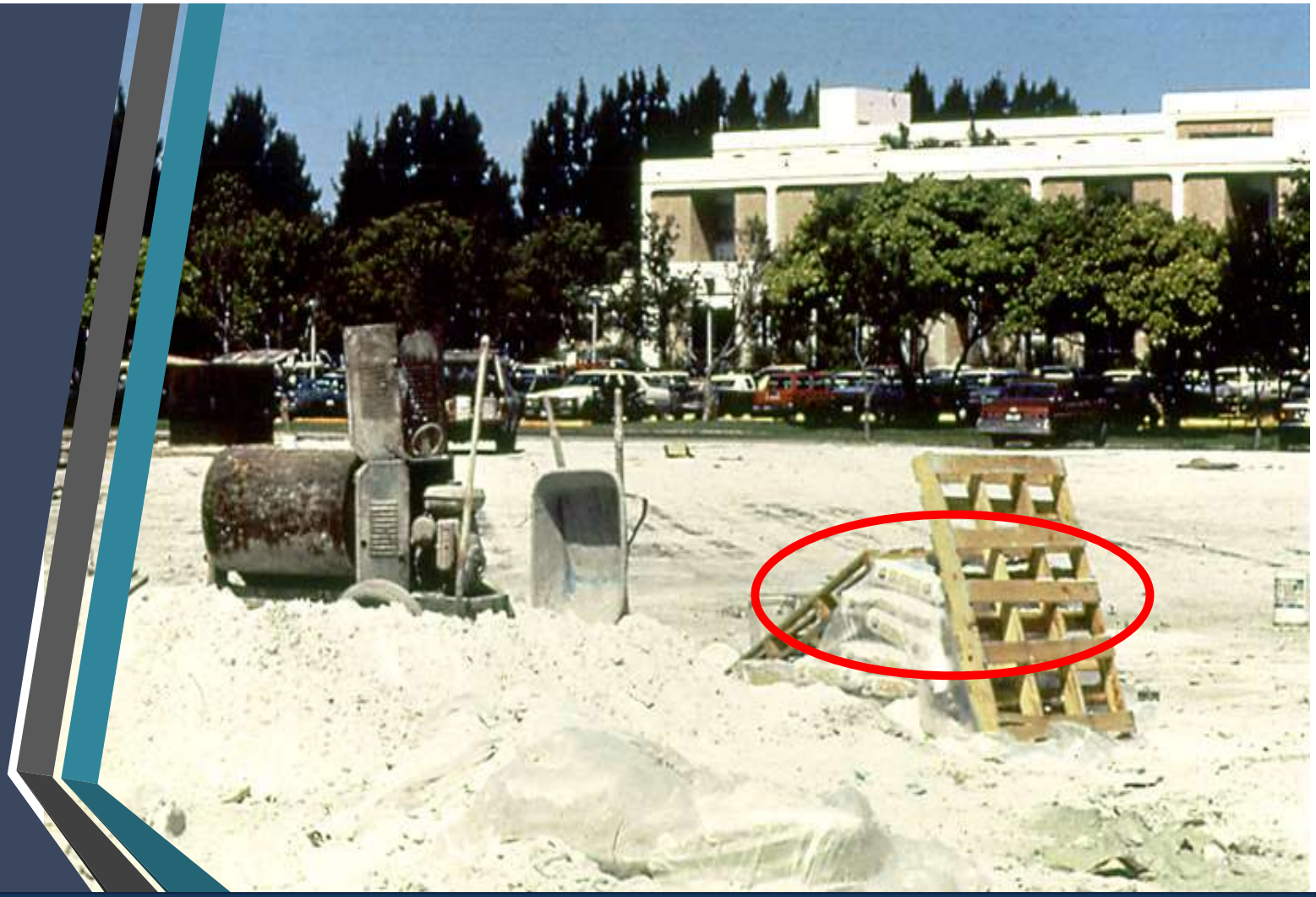
6.5 COMPRESSIVE STRENGTH

7. Construction Practices

7.1 *Storage of Materials*

Cement protected?

Where is the water source?



1 CF MEASURE USED FOR EVERY BATCH?

CALIBRATE DAILY.

7.2 MEASUREMENT OF MATERIALS

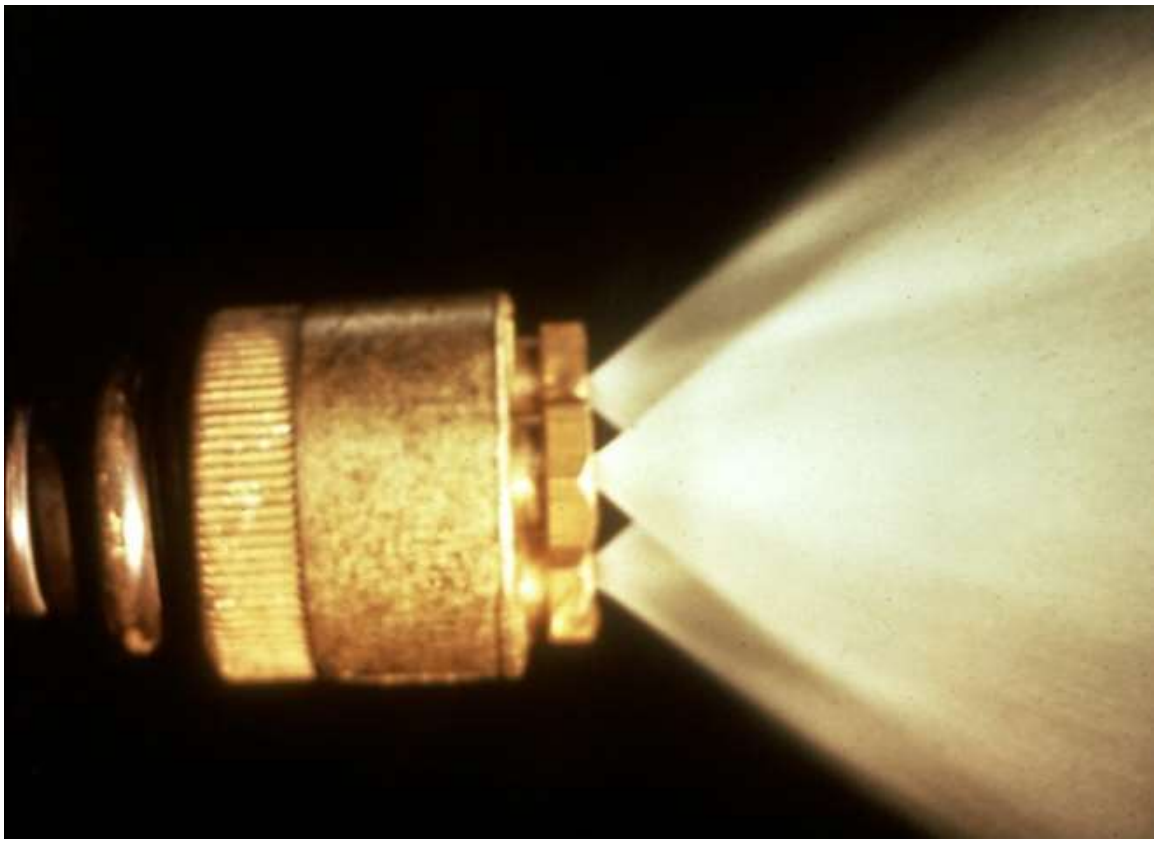
7.3 *Mixing Mortars* - All cementitious materials and aggregate shall be mixed between ***3 and 5 minutes*** in a mechanical batch mixer . . .

7.4 *Tempering Mortars* - Mortars that have stiffened ***shall be*** retempered by adding water ***as frequently as needed*** . . .***up to 2 1/2 hrs*** after mixing.

7.5 *Climatic Conditions*
- Pay attention to cold weather & hot weather. Hot weather causes the mortar to:

- **use more water;**
- **set faster;**
- **require more retempering.**

Keep ingredients cool by shading and dampen *only* the masonry in the wall.



8. Quality Assurance

8.1 Compliance to this specification is verified by confirming that the ***materials used are as specified***, meet the requirements as given in Section 2.1, and ***added to the mixer in the proper proportions***. Proportions of materials are verified by one of the following:

8.1.1 Observe mixing operations for correct proportioning

8.1.2 Use C 780, Annex 4, Mortar Aggregate Ratio test to determine proportions

8. Quality Assurance

8.3 Test method C 780 is suitable for the evaluation of masonry mortars in the field. However, due to the procedural differences between Specification C 270 and C 780, the compressive strength values resulting from ***field sampled mortars are not required nor expected to meet the compressive strength requirements of the property specification of Specification C 270***, nor do they represent the compressive strength of the mortar in the wall.

WHAT IS THE REQUIRED STRENGTH FOR MORTAR ON THE JOBSITE:

A. 2500 psi
B. 1800 psi
C. 750 psi
D. What ever is specified
E. None of the above.

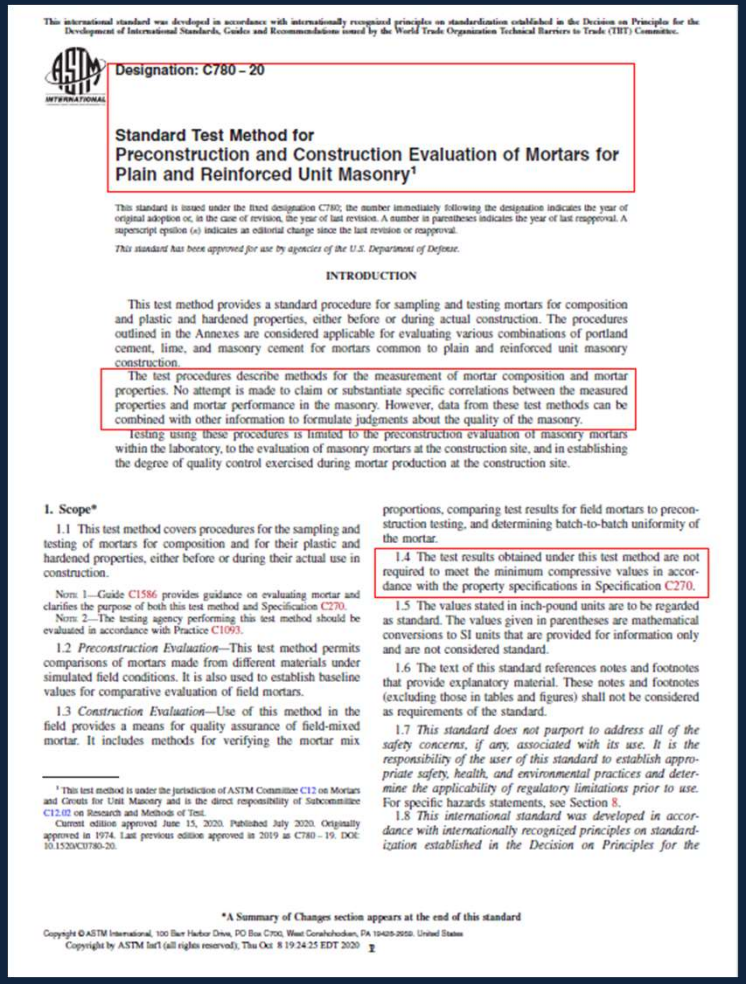
REVIEW OF ASTM C 270

- Most important properties - workability and bond.
- Proportion (recipe) vs property (performance).
- Aggregate not meeting C 144 gradation can be used, if meet property specification.
- Property requirements of Table 2 not required of field mortar.
- Field practice:
  - "Calibrate" shovel daily.
  - Mix mortar for 3 - 5 minutes.
  - Re-temper as needed, up to 2 1/2 hrs.

ASTM SPECIFICATIONS

- ASTM C 270 Specification for Mortar
- ASTM C 144 Specification for Aggregate
- ASTM C 780 Preconstruction & Construction Evaluation of Mortars
- ASTM C 1586 – Standard Guide for Quality Assurance of Mortars
- ASTM C 476 Specification for Grout
- ASTM C 1019 Test Method for Grout

ASTM INTERNATIONAL



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.

Designation: C780 – 20

Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry[1]

This standard is issued under the fixed designation C780; 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.

INTRODUCTION

This test method provides a standard procedure for sampling and testing mortars for composition and plastic and hardened properties, either before or during actual construction. The procedures outlined in the Annexes are considered applicable for evaluating various combinations of portland cement, lime, and masonry cement for mortars common to plain and reinforced unit masonry construction.

The test procedures describe methods for the measurement of mortar composition and mortar properties. No attempt is made to claim or substantiate specific correlations between the measured properties and mortar performance in the masonry. However, data from these test methods can be combined with other information to formulate judgments about the quality of the masonry.

Testing using these procedures is limited to the preconstruction evaluation of masonry mortars within the laboratory, to the evaluation of masonry mortars at the construction site, and in establishing the degree of quality control exercised during mortar production at the construction site.

1. Scope*

1.1 This test method covers procedures for the sampling and testing of mortars for composition and for their plastic and hardened properties, either before or during their actual use in construction.

Note 1—Guide C1586 provides guidance on evaluating mortar and clarifies the purpose of both this test method and Specification C270.

Note 2—The testing agency performing this test method should be evaluated in accordance with Practice C1093.

1.2 *Preconstruction Evaluation*—This test method permits comparisons of mortars made from different materials under simulated field conditions. It is also used to establish baseline values for comparative evaluation of field mortars.

1.3 *Construction Evaluation*—Use of this method in the field provides a means for quality assurance of field-mixed mortar. It includes methods for verifying the mortar mix proportions, comparing test results for field mortars to preconstruction testing, and determining batch-to-batch uniformity of the mortar.

1.4 The test results obtained under this test method are not required to meet the minimum compressive values in accordance with the property specifications in Specification C270.

1.5 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.

1.6 The text of this standard 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.

1.7 *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.* For specific hazards statements, see Section 8.

1.8 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the*

[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 Test.

Current edition approved June 15, 2020. Published July 2020. Originally approved in 1974. Last previous edition approved in 2019 as C780 – 19. DOI: 10.1520/C0780-20.

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

ASTM C 780 – Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry

Designation C 780 – 20

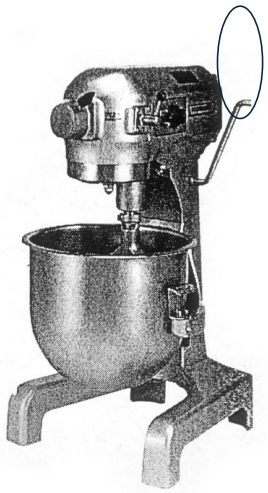
Standard Test Method for Preconstruction and Construction Evaluation of Mortars ...

INTRODUCTION

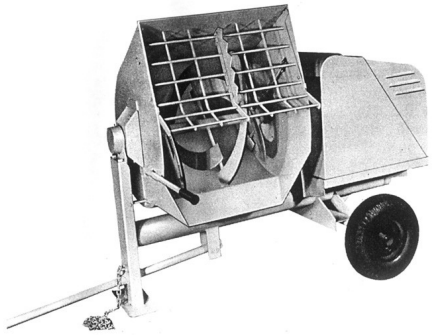
… No attempt is made to claim or substantiate specific correlations between the measured properties and mortar performance in the masonry. However, data from these test methods can be combined with other information to formulate judgements about the quality of the masonry.

1. Scope

1.4 The test results obtained under this test method ***are not*** required to meet the minimum compressive values in accordance with the property specifications in Specification C 270.



C 270 - Laboratory



C 780 - Construction site

4. Summary of Test Method

4.3 The following test methods may be singly or collectively incorporated into the testing to establish mortar composition, …

4.3.1 Annex A1 - Consistency by Cone Penetration ...

4.3.2 Annex A2 - Consistency Retention ...

4.3.3 Annex A3 - Initial Consistency and Consistency

4.3.4 Annex A4 - Mortar Aggregate Ratio Test Method

4.3.5 Annex A5 - Mortar Air Content Test Method

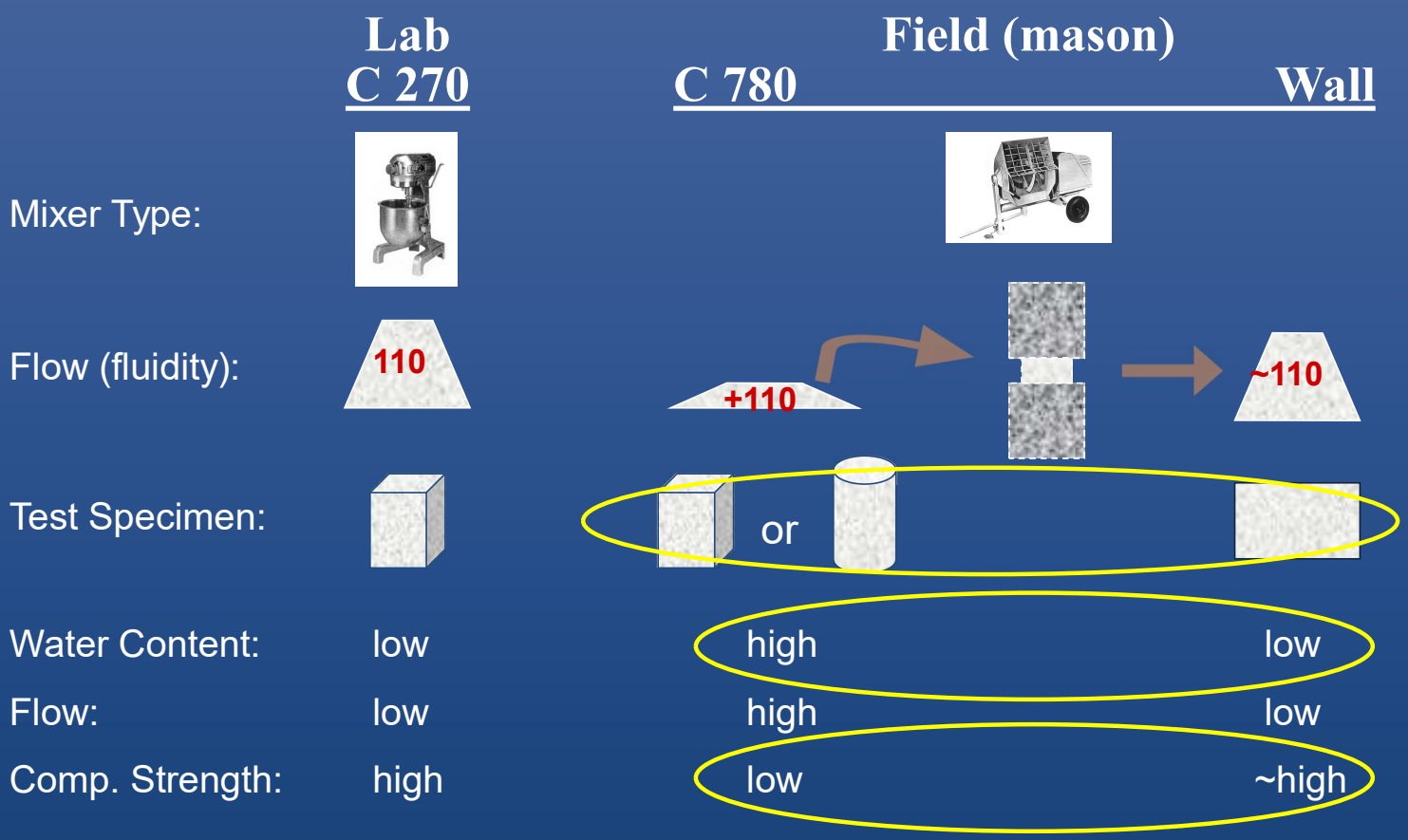
4.3.6 Annex A6 - Compressive Strength of Molded Cylinders …

Which one(s) should we use?

4.3.6 Annex A6 - Compressive Strength of Molded Masonry Mortar Cylinders and Cubes

If we want to know the strength of the mortar in the wall, do these nonabsorbent molds give us that information? What about a cylinder that is twice as tall as it is wide, is this different than the mortar in the wall?

Let's look at the problems with A7:


Lab
C 270
Field (mason)
C 780
Wall
Mixer Type:
Flow (fluidity):
110
+110
~110
Test Specimen:
or
Water Content:
low
high
low
Flow:
low
high
low
Comp. Strength:
high
low
~high

ASTM C 780

LET'S LOOK AT WHAT SOME OF THE EXPERTS SAY:

TROUBLESHOOTING

By Norbert V. Krogstad

Mortar quality control

Q. As an architect, I would like to be able to perform quality control checks on the mortar mixing. In the past I have required the contractor to prepare mortar cubes for every 5,000 square feet of masonry and, on most projects, this has worked out well. On a few, however, the seven-day test results came back very low. We waited three more weeks to test the remaining cubes from that batch at 28 days. These results also were low, as were the results of subsequent cube tests from other batches. By this time, much of the masonry had been completed. The contractor felt the problem was in the method of fabricating and curing the cubes, not in the masonry work itself. So we cut prisms from the wall and tested mortar bond by using the bond wrench test (ASTM C 1072) and compressive strength by using ASTM E 447. The results of these tests were within normal ranges.

This experience has made me rethink the whole quality control process. What can we do to evaluate the mortar mixing that will give timely results and be less dependent on the method of fabrication and curing?

A. The best way to monitor the mortar is to watch it being mixed. Obviously, this is not always convenient. An alternate approach would be to determine the mortar aggregate ratio in accordance with A4 of ASTM C 780. This test determines the ratio of cementitious components to sand in the mortar mix. It should be performed in conjunction with A5 in ASTM C 780, which is the test for mortar water content. These tests can be performed on any fresh mortar, either out of the mixer or off the board. They do not, however, determine the ratio of portland cement to lime when portland cement/lime mortars are used. This could be monitored by recording the number of bags of each that are used throughout the project.

Another test that may be useful is the mortar air content test described in A6 of ASTM C 780. With it, you can monitor the mortar mixing time and efficiency. Large variations in the air content may indicate a problem with the mixing procedures.

For a masonry quality control program to be meaningful, it should be conducted in conjunction with a preconstruction testing program. Preconstruction tests should be done on the same materials that will be used in the construction. Changes in the mortar air content can be studied by varying the mixing time during preconstruction tests. The mortar aggregate ratio can be evaluated using sand with different moisture contents. Both these tests can be performed on the mortar being used to build prisms for preconstruction compression or flexural testing.

Retempering grout

Q. Can more water be added to grout for masonry walls after it is mixed initially?

A. You can add some water to grout to increase the slump, as long as the grout is still in the mixer and has not begun to set up. Adding water to grout after it is removed from the mixer is not practical because it cannot be mixed thoroughly. As with mortar, the grout should be discarded after 2½ hours. Grout may need to be discarded earlier than 2½ hours in very hot weather because it will set up faster.

Norbert V. Krogstad is a consultant at Wiss, Janney, Elstner Associates, Inc., Northbrook, Ill.

Q. As an architect, I would like to be able to perform quality control checks on the mortar…what can I do to evaluate the mortar that will give me timely results and be less dependent on method of fabrication and curing?

A. The best way is to watch all of the mortar being mixed. An alternate approach would be to determine the mortar aggregate ratio.

ASTM C 780 Mortar

4. Summary of Test Method

4.3 The following test methods may be singly or collectively incorporated into the testing to establish mortar composition, …

4.3.1 Annex A1 - Consistency by Cone Penetration ...

4.3.2 Annex A2 - Consistency Retention ...

4.3.3 Annex A3 - Initial Consistency and Consistency

4.3.4 Annex A4 - Mortar Aggregate Ratio Test Method

4.3.5 Annex A5 - Mortar Air Content Test Method

4.3.6 Annex A6 - Compressive Strength of Molded Cylinders …

4.3.4 Annex A4 - Mortar Aggregate Ratio Test Method

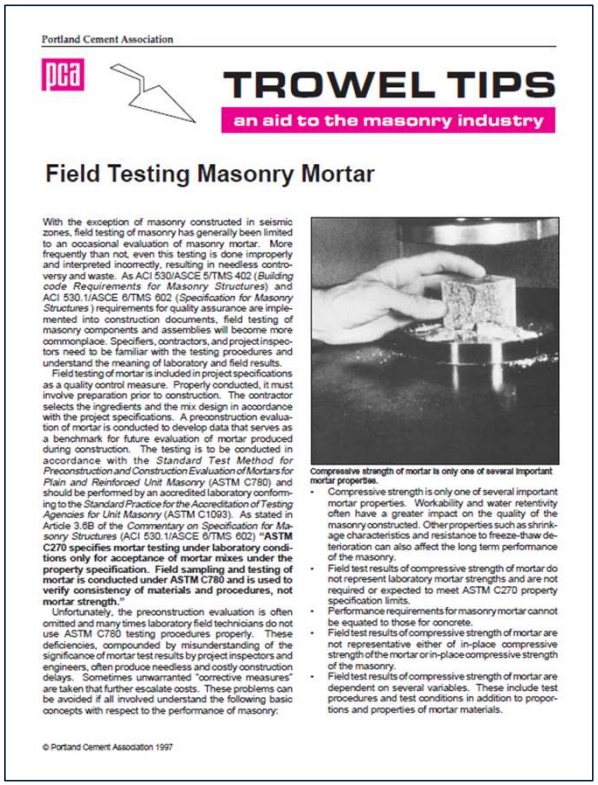
It is simple, inexpensive and you get the results within 1 day!

LA-0766

6. Test Method Limitations

6.3 There is no ASTM standard method for measuring the *composition* or ***physical properties*** of hardened mortars removed from a structure.

SOME GOOD LITERATURE ON FIELD TESTING MORTARS.



Portland Cement Association

pca

TROWEL TIPS

an aid to the masonry industry

Field Testing Masonry Mortar

With the exception of masonry constructed in seismic zones, field testing of masonry has generally been limited to an occasional evaluation of masonry mortar. More frequently than not, even this testing is done improperly and interpreted incorrectly, resulting in needless controversy and waste. As ACI 530/ASCE 5/TMS 402 (*Building code Requirements for Masonry Structures*) and ACI 530.1/ASCE 6/TMS 602 (*Specification for Masonry Structures*) requirements for quality assurance are implemented into construction documents, field testing of masonry components and assemblies will become more commonplace. Specifiers, contractors, and project inspectors need to be familiar with the testing procedures and understand the meaning of laboratory and field results.

Field testing of mortar is included in project specifications as a quality control measure. Properly conducted, it must involve preparation prior to construction. The contractor selects the ingredients and the mix design in accordance with the project specifications. A preconstruction evaluation of mortar is conducted to develop data that serves as a benchmark for future evaluation of mortar produced during construction. The testing is to be conducted in accordance with the *Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry* (ASTM C780) and should be performed by an accredited laboratory conforming to the *Standard Practice for the Accreditation of Testing Agencies for Unit Masonry* (ASTM C1093). As stated in Article 3.6B of the *Commentary on Specification for Masonry Structures* (ACI 530.1/ASCE 6/TMS 602) **"ASTM C270 specifies mortar testing under laboratory conditions only for acceptance of mortar mixes under the property specification. Field sampling and testing of mortar is conducted under ASTM C780 and is used to verify consistency of materials and procedures, not mortar strength."**

Unfortunately, the preconstruction evaluation is often omitted and many times laboratory field technicians do not use ASTM C780 testing procedures properly. These deficiencies, compounded by misunderstanding of the significance of mortar test results by project inspectors and engineers, often produce needless and costly construction delays. Sometimes unwarranted "corrective measures" are taken that further escalate costs. These problems can be avoided if all involved understand the following basic concepts with respect to the performance of masonry:

Compressive strength of mortar is only one of several important mortar propertiee.

- Compressive strength is only one of several important mortar properties. Workability and water retentivity often have a greater impact on the quality of the masonry constructed. Other properties such as shrinkage characteristics and resistance to freeze-thaw deterioration can also affect the long term performance of the masonry.
- Field test results of compressive strength of mortar do not represent laboratory mortar strengths and are not required or expected to meet ASTM C270 property specification limits.
- Performance requirements for masonry mortar cannot be equated to those for concrete.
- Field test results of compressive strength of mortar are not representative either of in-place compressive strength of the mortar or in-place compressive strength of the masonry.
- Field test results of compressive strength of mortar are dependent on several variables. These include test procedures and test conditions in addition to proportions and properties of mortar materials.

Structural Engineer

www.gostructural.com

April 2000 Vol.1 No.3

The most common misunderstanding in masonry

By Jim Gulde

Engineering course work usually includes steel and concrete and sometimes wood, but it almost always neglects masonry. In fact, most practicing engineers did not take any masonry courses in college. Since 70 percent of all existing construction in the world includes masonry, this absence of education is a real detriment to the profession and to society.

It is not surprising, therefore, that many misunderstandings exist. In this article, I will clarify what I believe are the most widespread misunderstandings about codes, mortar strength and testing, grout strength and testing, and the prism test.

■ Referenced documents are part of code too

The consensus document, "Building Code Requirements for Masonry Structures" (ACI-530, ASCE-5, TMS-402) governs masonry construction for most of this country, with the exception of those who use the Uniform Building Code (UBC). Although the Masonry Standards Joint Committee (MSJC) released a new version of this code in 1999, we are going to discuss the 1995 version since it is used more prevalently.

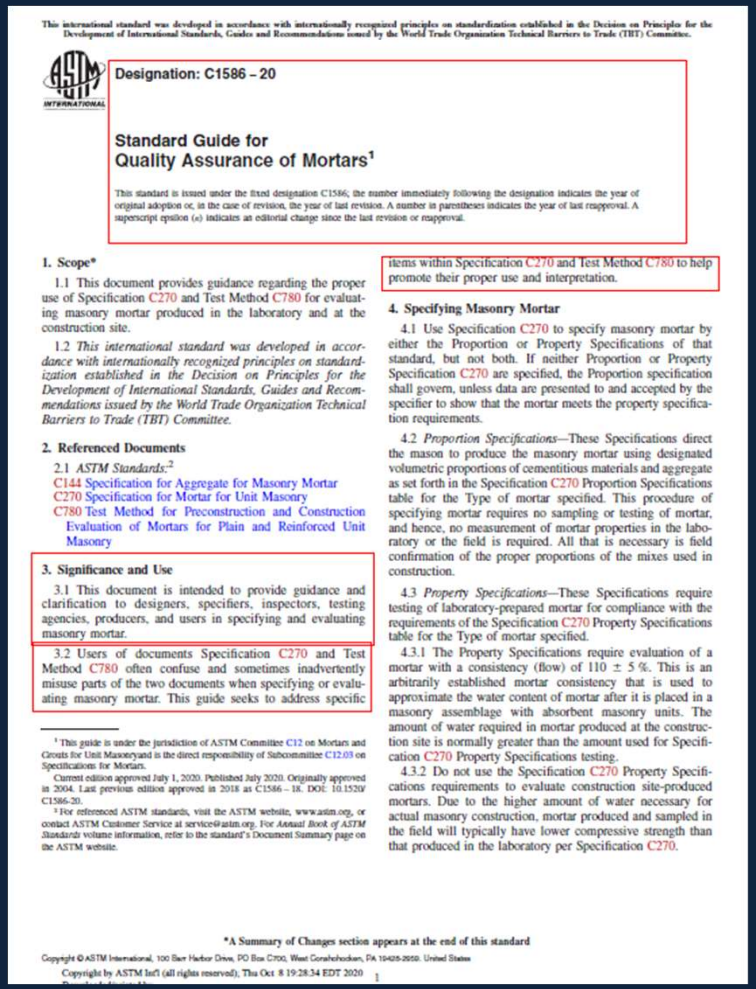
This code covers it all: design, construction and inspection. It even has its own specifications. This requires all members of the masonry construction team, including the architect, engineer, contractor, mason contractor, mason, and the inspector, to understand this document.

Too often, people ignore the fact that the MSJC code references many other documents (ASTM, ACI, ASCE, TMS, and ANSI/AWS), which "are declared to be a part of the code as if fully set forth in the document" (MSJC 1.3.1.). This neglect is a problem since it is arguable that the real content of the code is found in the footnotes of the tables and in the appendix of the referenced documents. Unless one is familiar with the

ASTM SPECIFICATIONS

- ASTM C 270 Specification for Mortar
- ASTM C 144 Specification for Aggregate
- ASTM C 780 Preconstruction & Construction Evaluation of Mortars
- ASTM C 1586 – Standard Guide for Quality Assurance of Mortars
- ASTM C 476 Specification for Grout
- ASTM C 1019 Test Method for Grout

ASTM INTERNATIONAL



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.

Designation: C1586 – 20

Standard Guide for
Quality Assurance of Mortars[1]

This standard is issued under the fixed designation C1586; 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 document provides guidance regarding the proper use of Specification C270 and Test Method C780 for evaluating masonry mortar produced in the laboratory and at the construction site.

1.2 *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]
C144 Specification for Aggregate for Masonry Mortar
C270 Specification for Mortar for Unit Masonry
C780 Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry

3. Significance and Use

3.1 This document is intended to provide guidance and clarification to designers, specifiers, inspectors, testing agencies, producers, and users in specifying and evaluating masonry mortar.

3.2 Users of documents Specification C270 and Test Method C780 often confuse and sometimes inadvertently misuse parts of the two documents when specifying or evaluating masonry mortar. This guide seeks to address specific items within Specification C270 and Test Method C780 to help promote their proper use and interpretation.

4. Specifying Masonry Mortar

4.1 Use Specification C270 to specify masonry mortar by either the Proportion or Property Specifications of that standard, but not both. If neither Proportion or Property Specification C270 are specified, the Proportion specification shall govern, unless data are presented to and accepted by the specifier to show that the mortar meets the property specification requirements.

4.2 *Proportion Specifications*—These Specifications direct the mason to produce the masonry mortar using designated volumetric proportions of cementitious materials and aggregate as set forth in the Specification C270 Proportion Specifications table for the Type of mortar specified. This procedure of specifying mortar requires no sampling or testing of mortar, and hence, no measurement of mortar properties in the laboratory or the field is required. All that is necessary is field confirmation of the proper proportions of the mixes used in construction.

4.3 *Property Specifications*—These Specifications require testing of laboratory-prepared mortar for compliance with the requirements of the Specification C270 Property Specifications table for the Type of mortar specified.

4.3.1 The Property Specifications require evaluation of a mortar with a consistency (flow) of 110 ± 5 %. This is an arbitrarily established mortar consistency that is used to approximate the water content of mortar after it is placed in a masonry assemblage with absorbent masonry units. The amount of water required in mortar produced at the construction site is normally greater than the amount used for Specification C270 Property Specifications testing.

4.3.2 Do not use the Specification C270 Property Specifications requirements to evaluate construction site-produced mortars. Due to the higher amount of water necessary for actual masonry construction, mortar produced and sampled in the field will typically have lower compressive strength than that produced in the laboratory per Specification C270.

[1] This guide is under the jurisdiction of ASTM Committee C12 on Mortars and Grouts for Unit Masonryand is the direct responsibility of Subcommittee C12.03 on Specifications for Mortars.
Current edition approved July 1, 2020. Published July 2020. Originally approved in 2004. Last previous edition approved in 2018 as C1586 – 18. DOI: 10.1520/C1586-20.

[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.

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

ASTM C 1586 – Standard Guide for Quality Assurance of Mortars

Designation C 1586 - 20

Standard Guide for
Quality Assurance of Mortars

1. Scope

1.1 This document provides guidance regarding the proper use of specification C 270 and Test Method C 780 for evaluating masonry mortar produced in the laboratory and at the construction site.

4. Specifying Masonry Mortar (C 270 to specify, establish materials & proportions - not evaluate during construction)

5. Quality Assurance of Masonry Mortar (C 780 to test during construction and evaluate - not pass/fail based on C 270)

ASTM C 1586 | Pages 1-2

Designation C 1586 - 20

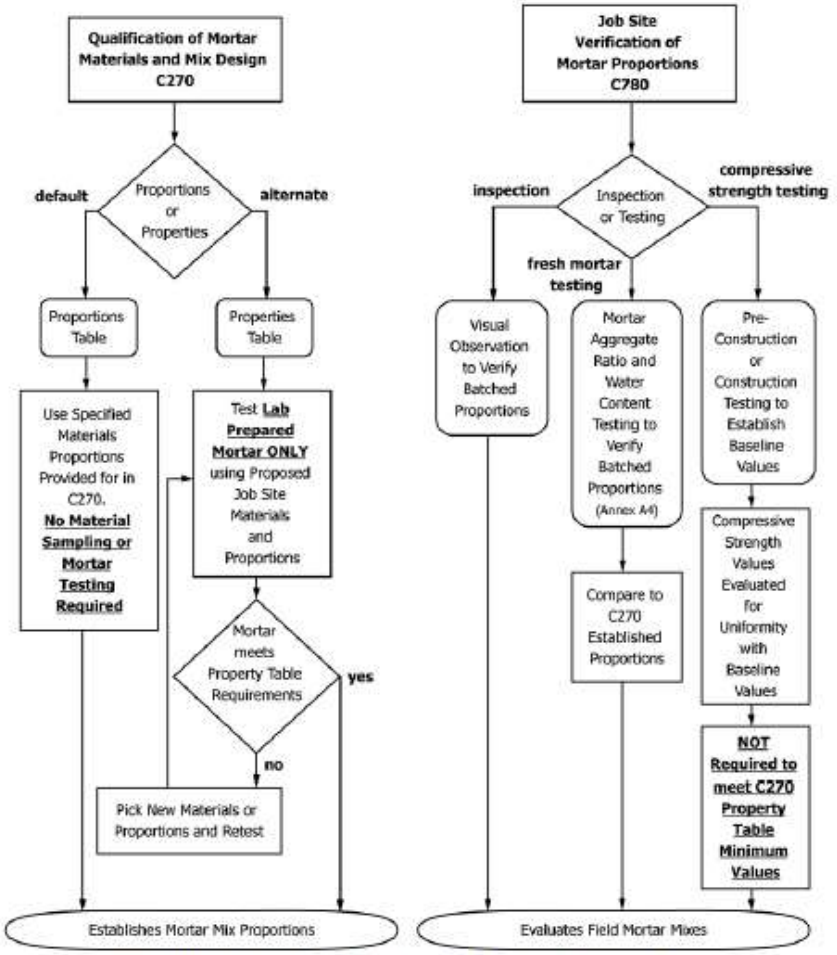


FIG. X1.1 Proper Use of C270 and C780 in a Quality Assurance Program

ASTM SPECIFICATIONS

- ✓ ASTM C 270 Specification for Mortar
- ✓ ASTM C 144 Specification for Aggregate
- ✓ ASTM C 780 Preconstruction & Construction Evaluation of Mortars
- ✓ ASTM C 1586 – Standard Guide for Quality Assurance of Mortars
- → ASTM C 476 Specification for Grout
- ASTM C 1019 Test Method for Grout

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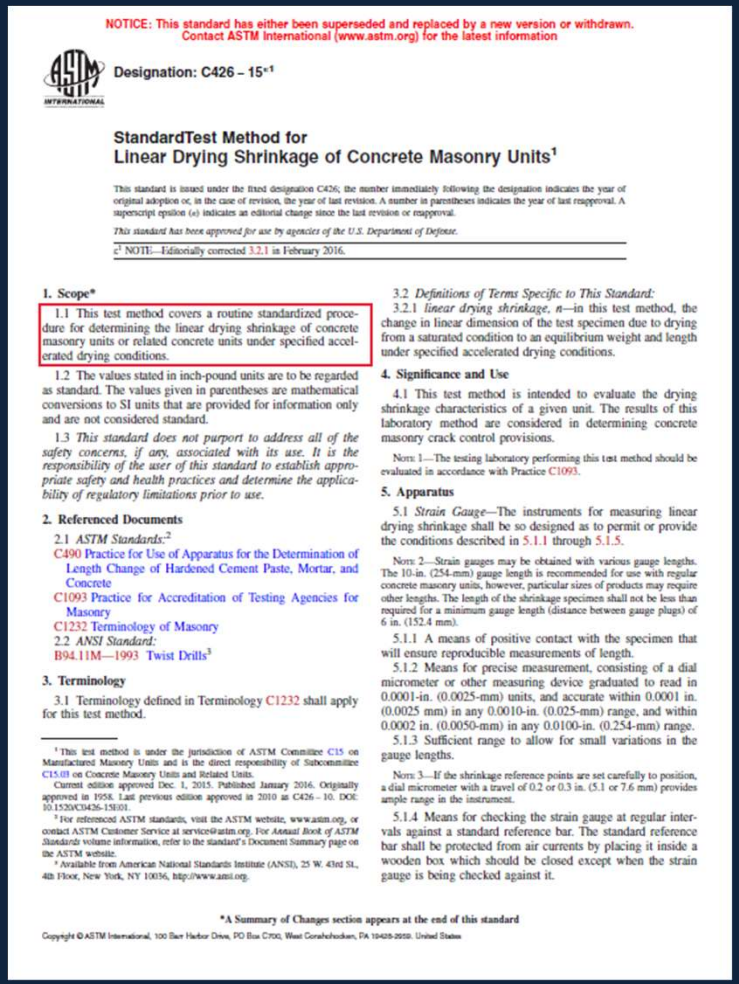


NOTICE: This standard has either been superseded and replaced by a new version or withdrawn.
Contact ASTM International (www.astm.org) for the latest information

Designation: C426 – 15ε1

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.

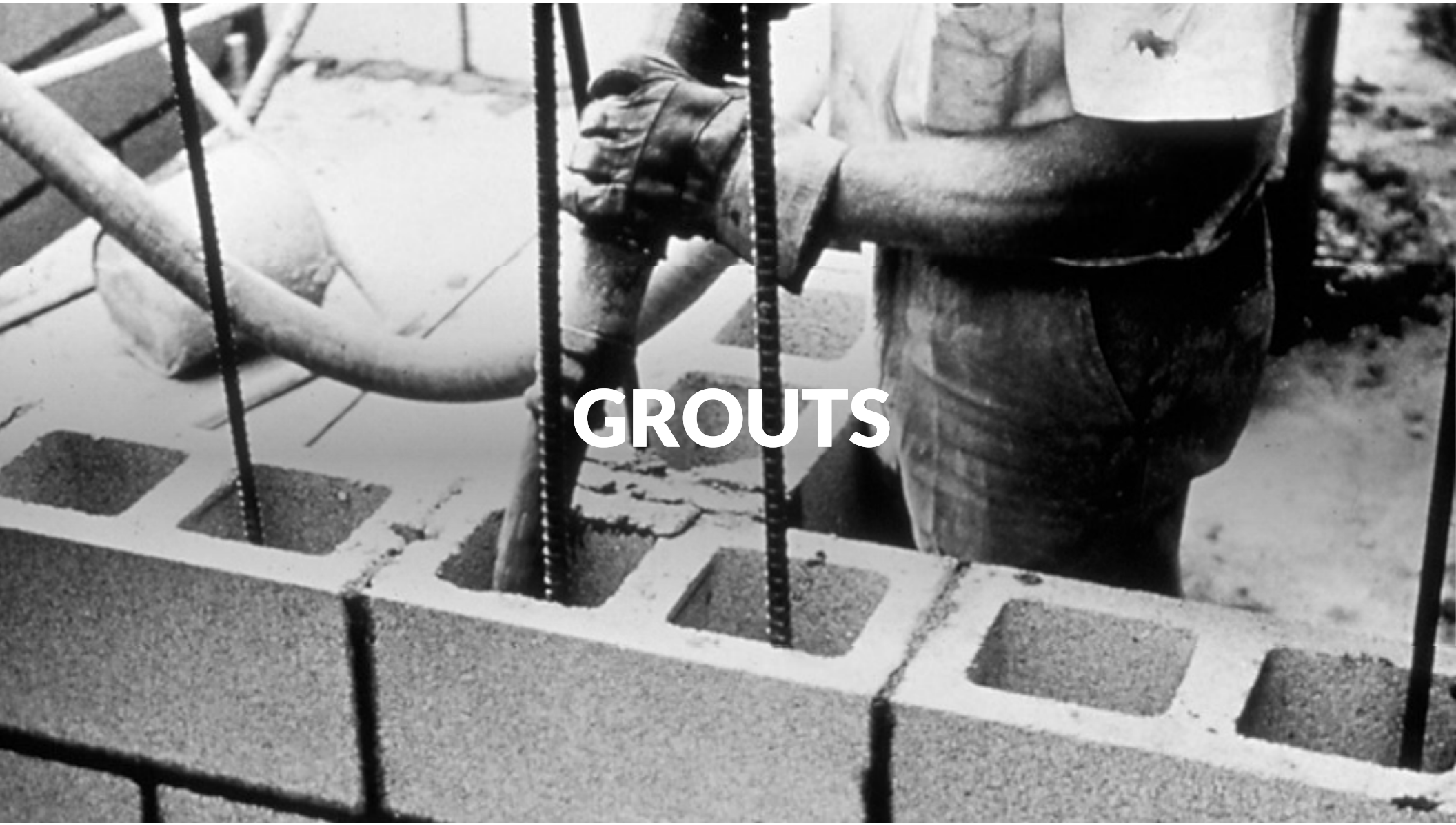
Current edition approved Dec. 1, 2015. Published January 2016. Originally approved in 1958. Last previous edition approved in 2010 as C426 – 10. DOI: 10.1520/C0426-15E01.

[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 C 476 - Specification for Grout


GROUTS

Designation: C 476 - 19

Standard Specification for Grout for Masonry

1. Scope

1.1 *Proportion vs Strength (property)*

3. Materials

3.1 *Typical materials (ready-mix producers already have)*

- *Cementitious Materials*
- *Aggregates*
- *Admixtures*
- *etc.*

4. Grout Type and Proportions

4.1 *Type* – Grout type shall be specified as fine or coarse.

4.2 *Proportions of Ingredients* – Grout proportions shall be determined by one of the following methods:

4.2.1 ***Conventional Grout***

4.2.1.1 ***Table 1 (proportions)***

4.2.1.2 ***Specified Compressive Strength (property):***

- slump shall be 8 to 11 in. (using ASTM C 143)
- minimum strength shall be 2000 psi at 28 days
- tested in accordance with ASTM C 1019

TABLE 1 Grout Proportions by Volume

Type	Parts by Volume			
	Cement	Lime	Fine Agg	Coarse Agg
Fine	1	0 - 1/10	2 1/4 - 3 x cem.	
Coarse	1	0 - 1/10	2 1/4 - 3 x cem.	1 - 2 x cem.

4. Grout Type and Proportions

4.1 *Type* – Grout type shall be specified as fine or coarse.

4.2 *Proportions of Ingredients* – Grout proportions shall be determined by the following method:

4.2.2 ***Self-consolidating Grout***

4.2.2.1 ***Specified Compressive Strength:***

- slump flow shall be 24 to 30 in. (using ASTM C 1611)
- Visual Stability Index ≤ 1
- minimum strength shall be 2000 psi at 28 days
- tested in accordance with ASTM C 1019

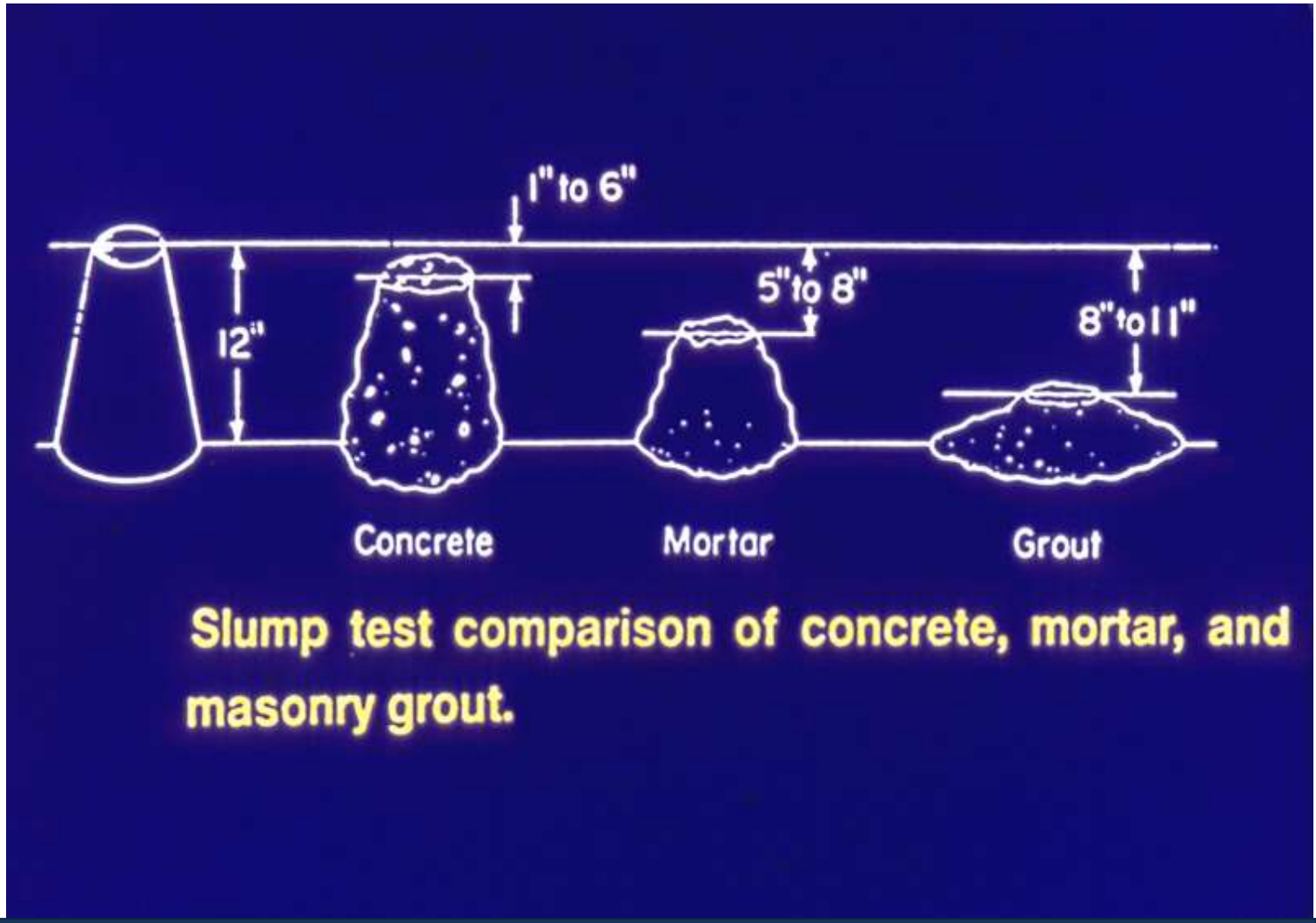
5. Measurement and Production

5.2.1 *Materials Mixed at Job Site*

5.2.1.1 Individual cementitious materials and aggregates stored at the job site shall be mixed in a mechanical mixer for a **minimum of 5 min** with sufficient water to achieve the desired consistency.

Notice how "wet" the grout shall be when compared to concrete and mortar. It must get to the bottom of the cells!

Remember, the masonry units will absorb the "excess" water as it does with mortar!



ASTM C 476 GROUT

ASTM SPECIFICATIONS

- ✓ ASTM C 270 Specification for Mortar
- ✓ ASTM C 144 Specification for Aggregate
- ✓ ASTM C 780 Preconstruction & Construction Evaluation of Mortars
- ✓ ASTM C 1586 – Standard Guide for Quality Assurance of Mortars
- ✓ ASTM C 476 Specification for Grout
- → ASTM C 1019 Test Method for Grout

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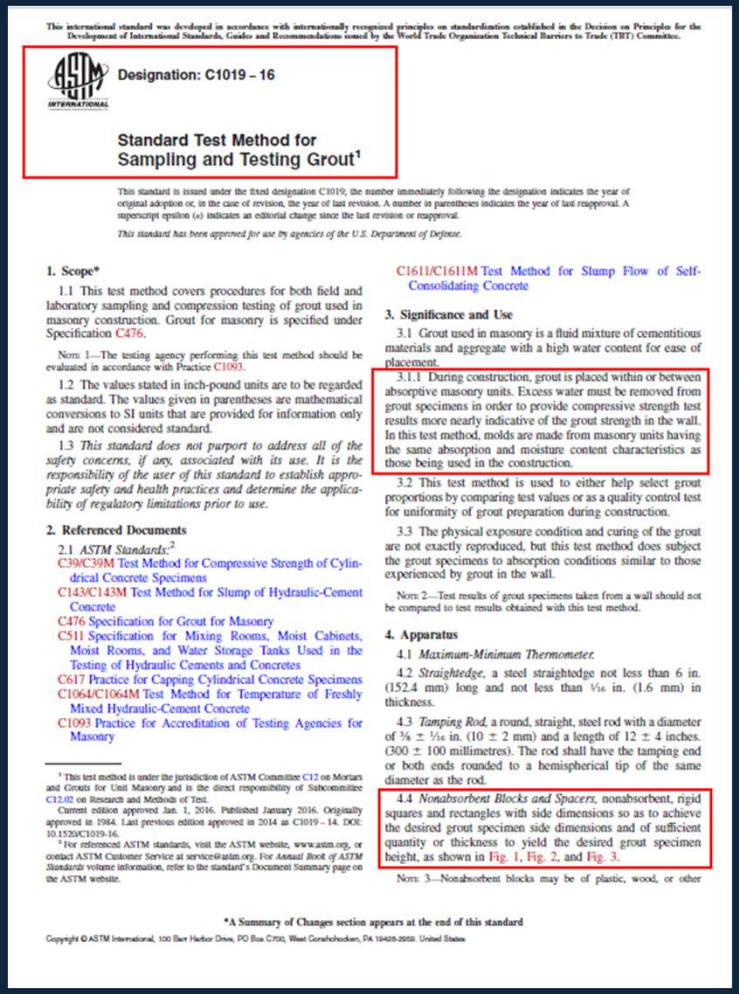


This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade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

Designation: C1019 – 16

Standard Test Method for Sampling and Testing Grout[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 and health practices and determine the applicability of regulatory limitations prior to use.*

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.

4.4 *Nonabsorbent Blocks and Spacers,* nonabsorbent, rigid squares and rectangles with side dimensions so as to achieve the desired grout specimen side dimensions and of sufficient quantity or thickness to yield the desired grout specimen height, as shown in Fig. 1, Fig. 2, and Fig. 3.

NOTE 3—Nonabsorbent blocks may be of plastic, wood, or other

[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 Test.

Current edition approved Jan. 1, 2016. Published January 2016. Originally approved in 1984. Last previous edition approved in 2014 as C1019 – 14. DOI: 10.1520/C1019-16.

[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

ASTM C 1019 - Test Method for Grout

Designation: C 1019 - 16

Standard Test Method for

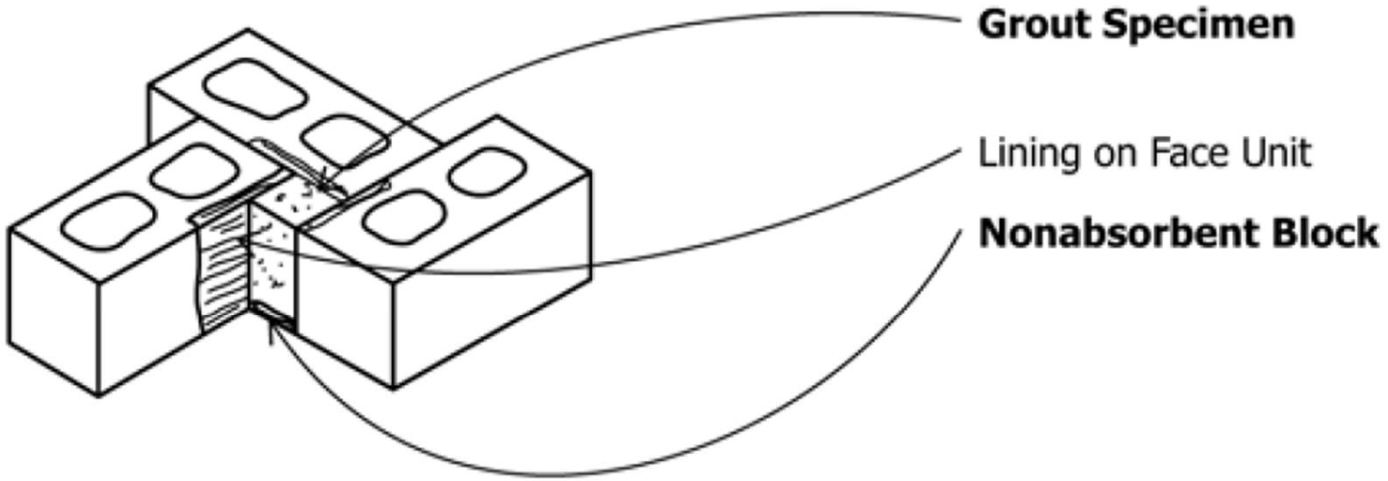
Sampling and Testing Grout

3. Significance and Use

3.1.1 During construction, grout is placed 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.

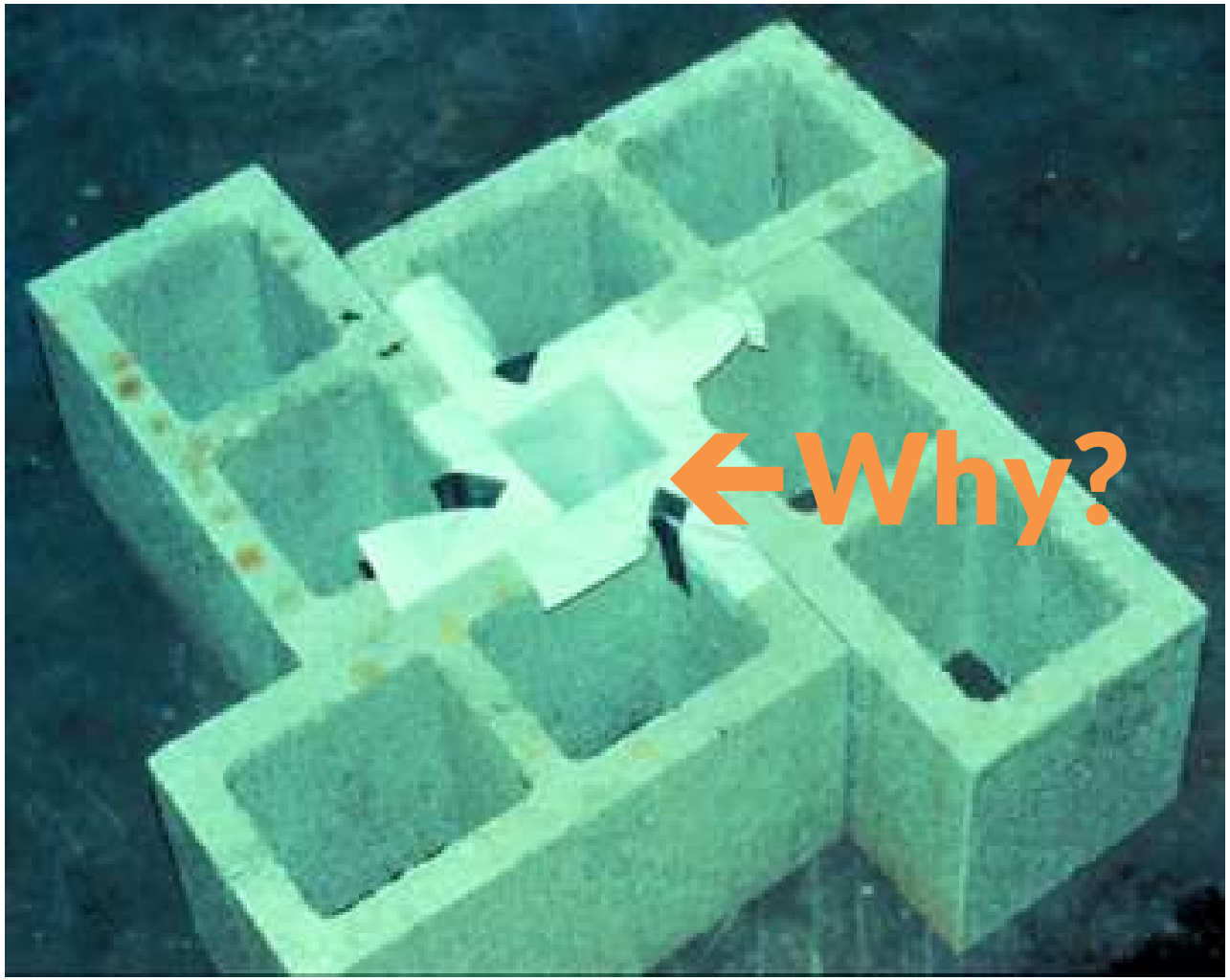
4. Apparatus

4.4 *Nonabsorbent Blocks* - provide for 2:1 ratio & 3" min width (within 5% tolerance).



NOTE 1—Front masonry unit not shown to allow view of specimen.

FIG. 2 Grout Mold (Units Greater than 6 in. (152.4 mm) High, 8 in. (203.2 mm) High Concrete Masonry Unit Shown)



5. Test Specimens

5.1 Widths are to be 3” min

5.2 Test at least three specimens at each age specified.

6. Mold Construction

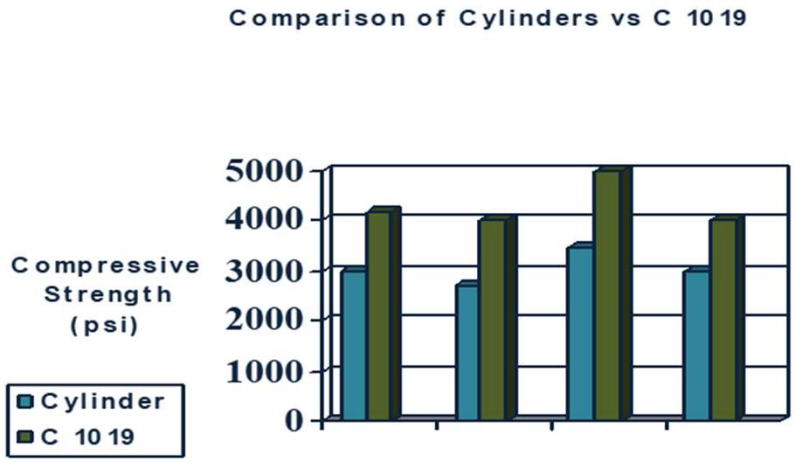
6.1.4 Line the masonry surfaces with thin permeable material.

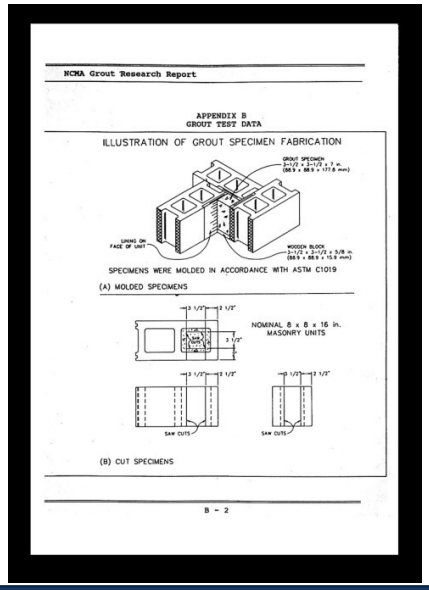
ASTM C 1019 GROUT | Page 2

6.2 Alternative Methods

Note 7 - *Alternative methods commonly used – but does not meet C 1019 or C 476:*

- *cores taken from filled cells – costly.*
- *cylinders /non-absorbent molds–* ***absolutely not allowed!***
- *cardboard boxes – yields a "different result", evaluates grout between batches.*
- *manufactured units*




NCMA Grout Research Report

APPENDIX B
GROUT TEST DATA

ILLUSTRATION OF GROUT SPECIMEN FABRICATION

SPECIMENS WERE MOLDED IN ACCORDANCE WITH ASTM C1019

(A) MOLDED SPECIMENS

NOMINAL 8 x 8 x 16 in. MASONRY UNITS

(B) CUT SPECIMENS

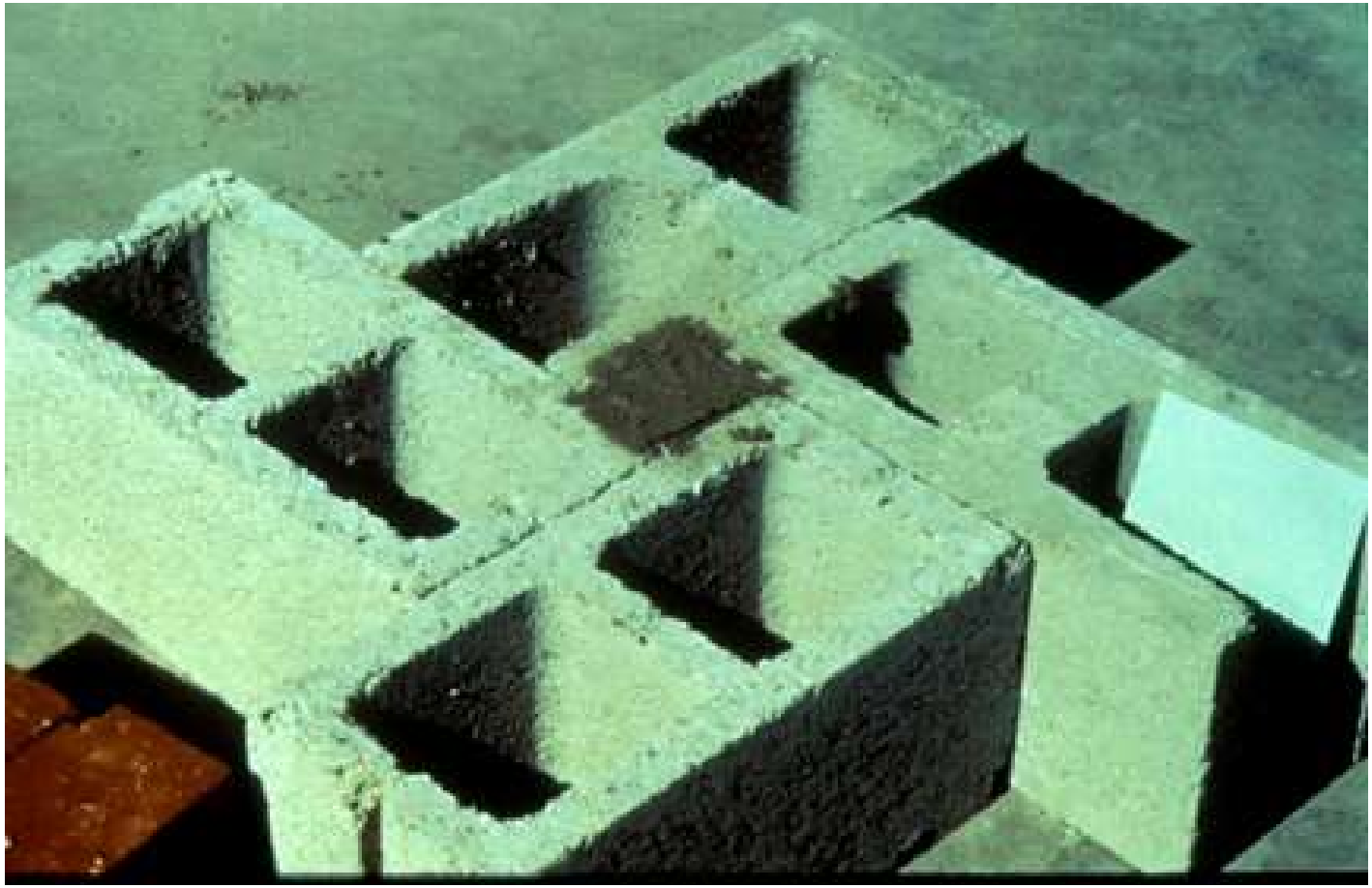
B - 2

ASTM C 1019 GROUT | Page 2

9. Compressive Test Specimen

9.2 Fill mold in two equal-depth layers:

- rod bottom layer through its depth 15 times
- slightly overfill mold
- rod second layer penetrating bottom layer ½”
- distribute all strokes over the cross section of the mold



10. Transportation, Curing and Testing of the Specimens

10.1 Remove from molds at 24-48 hrs after casting

10.2 Place specimens in container within 30 min. and keep damp

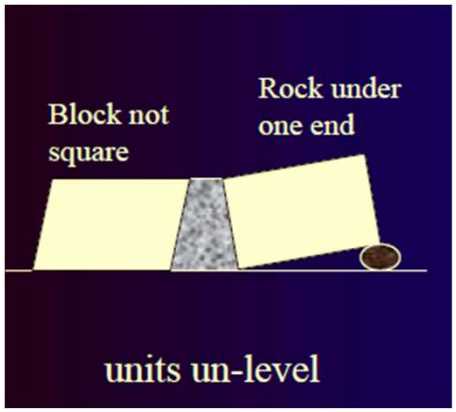
10.3 Transport to lab within 8 hrs.

10.4 Specimens into laboratory curing within 8 hrs after removal

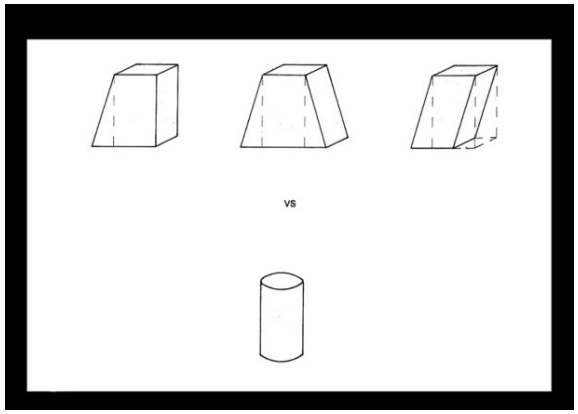
ASTM C 1019 GROUT | Pages 3-4

Potential problems with this test method include:

- units unlevel when specimens cast
- specimen shape not correct
- capping difficult



UNITS UN-LEVEL



POOR SHAPE

SPECIAL CAPPING EQUIPMENT

ASTM C 1019 GROUT

Are there any questions?

ASTM INTERNATIONAL

American Society for Testing & Materials

Non-profit organization which maintains 12,000 voluntary standards with 150 main committees

+30,000 Members are producers, users, general interest (academia, government, etc.) & consumers

Develop primarily specifications & test methods