About Mr. Farny

- Director, Building Marketing of the Portland Cement Association
- Holds a B.S. degree in Civil Engineering from the Illinois Institute of Technology and has experience testing a variety of construction materials.
- Chair of TMS's Administrative Committee Team and past Chair of TMS's Sustainability Committee and Certification Committee

THE MASONRY SOCIETY

SPECIFYING THE RIGHT MORTAR AND GROUT FOR YOUR MASONRY PROJECTS

Jamie Farny
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Portland Cement Association
October 11, 2018

Four Learning Objectives

1. Understand similarities and differences of portland, blended, and other cements for masonry
2. Review the cementitious materials and standards for mortar and grout
3. Review mortar and grout properties and evaluation techniques (testing, QA)
4. Discuss effective specifications for cements for mortar and grout

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Structural Masonry and Veneers

Purpose of Mortar

- Holds units together
- Holds them apart
- Carries loads (compressive, flexural strength)
- Accommodates small movements
- Seals joints against air and moisture penetration
- Bonds to joint reinforcement, ties, anchors
- Creates an attractive appearance

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Purpose of Grout

- Grout is used to fill masonry cavities
- Bonds units, mortar, and reinforcement into a single composite assemblage
- Is an **essential component of reinforced masonry**
- Is an optional component of unreinforced masonry
- Is "fine" or "coarse" based on aggregates

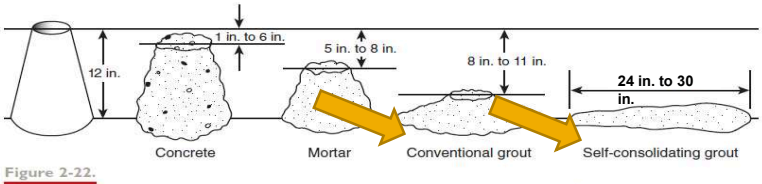

Figure 2-22.
Slump test comparison of concrete, mortar, conventional masonry grout, and self-consolidating grout (slump flow) (1 in. = 25.4 mm).

Self-Consolidating Grout (SCG)

- "Flowing" grout
- No/very little consolidation
- May have faster placement
- Quieter placement
- Better core filling

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Some Key Documents

Code & Spec

Material standards

Testing and material standards

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Learning Objectives 1 and 2

1. Understand similarities and differences of portland, blended, and other cements for masonry
2. Review the cementitious materials and standards for mortar and grout

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Definition from ASTM C219

- **Hydraulic cement** – a cement that sets and hardens by chemical interaction with water and that is capable of doing so under water

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Portland Cement ASTM C150

- Type I – Normal, general purpose
- Type II – Moderate sulfate resistance, low heat of hydration
- Type II(MH) – Moderate heat of hydration and moderate sulfate resistance
- Type III – High early strength
- ~~Type IV – Low heat of hydration~~ **→No longer produced in US**
- Type V – High sulfate resistance
- Add an "A" for air-entraining, for example Type IA, IIA, etc.

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Blended Hydraulic Cement ASTM C595

The materials listed here are known as supplementary cementing materials (SCMs) and work with portland cement

- ggbf slag/slag cement
- fly ash
- calcined clay
- silica fume
- calcined shale
- other pozzolans
- limestone

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ASTM C595 Cement Designations

- Type IS - Portland blast-furnace slag cement
- Type IP - Portland-pozzolan cement
- Type IL - Portland-limestone cement (added in 2012)
- Type IT - Ternary blended cement (added in 2009)

- Use suffixes to designate special properties:

  A (air), MS or HS (moderate/high sulfate resistance), MH or LH (moderate/low heat of hydration)
- Types IS, IP, IL are binary blended cements (2 ingredients)
- Type IT is a ternary blended cement (3 ingredients)

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C595 Portland-Limestone Cements

- PLCs are blended hydraulic cements that contain 5% to 15% limestone
- …and limestone can help obtain desired performance and **improve sustainability** of cement-based materials like mortar, grout, and concrete
- Types IL and sometimes IT

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Performance Cement ASTM C1157

(few restrictions on the composition of the cement or its constituents)

- Type GU – general use
- Type HE – high early strength
- Type MS – moderate sulfate resistance
- Type HS – high sulfate resistance
- Type MH – moderate heat of hydration
- Type LH – low heat of hydration
- C1157 can be PLCs and can have any amount of limestone as long as they can achieve properties

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Masonry Cement ASTM C91

- Type N
- Type S
- Type M

- Masonry cements are only for use in mortar, not grout

3.1.1 *masonry cement*—a hydraulic cement, primarily used in masonry and plastering construction, consisting of a mixture of portland or blended hydraulic cement and plasticizing materials (such as limestone, hydrated or hydraulic lime) together with other materials introduced to enhance one or more properties such as setting time, workability, water retention, and durability.

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Mortar Cement ASTM C1329

- Type N
- Type S
- Type M

- Mortar cements are only for use in mortar, not grout

Discussion—Mortar cement is similar to masonry cement in use and function (See Specification C91). However, this specification includes a flexural bond strength requirement.

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Which Cements can be used in Mortar and Grout?

- Those 5 cement standards include more than 20 cement Types
- ASTM C270, Standard Specification for Mortar for Unit Masonry
- ASTM C476, Standard Specification for Grout for Masonry

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C270 Cementitious Materials

- C150
- C595
- C1157
- C91
- C1329

4.1.1 *Cementitious Materials*—Cementitious materials shall conform to the following ASTM specifications:

4.1.1.1 *Portland Cement*—Types I, IA, II, IIA, III, IIIA, or V of Specification C150.

4.1.1.2 *Blended Hydraulic Cements*—Types IS(<70), IS(<70)-A, IP, IP-A of Specification C595.

4.1.1.3 *Hydraulic Cements*—Types GU, HE, MS, and HS of Specification C1157 (Types MH and LH are limited to use in the property specifications only).

4.1.1.4 *Portland Blast-Furnace Slag Cement (for Use in Property Specifications Only)*—Types IS(≥70) or IS(≥70)-A of Specification C595.

4.1.1.5 *Masonry Cement*—See Specification C91.

4.1.1.6 *Mortar Cement*—See Specification C1329.

4.1.1.7 *Quicklime*—See Specification C5.

4.1.1.8 *Hydrated Lime*—Specification C207, Types S or SA. Types N or NA limes are permitted if shown by test or performance record to be not detrimental to the soundness of the mortar.

4.1.1.9 *Lime Putty*—See Specification C1489.

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C476 Cementitious Materials

- C150
- C595
- C1157

- Keep this in mind for high-volume SCM grouts
- 40% fly ash
- 70% slag

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

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

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

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

3.1.1.4 *Quicklime*—Specification C5.

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

3.1.1.6 *Coal Fly Ash or Raw Calcined Natural Pozzolan*—Specification C618. Addition rates shall be in an amount governed by the portland-pozzolan cement category of Specification C595/C595M. The grout produced with blends of portland cement and fly ash or raw calcined natural pozzolan shall have the compressive strength specified (4.2.1.2 or 4.2.2.1).

3.1.1.7 *Granulated Blast Furnace Slag*—Specification C989/C989M. Addition rates shall be as governed by the portland blast furnace slag cement category of Specification C595/C595M. Grouts produced with blends of portland cement and granulated blast furnace slag shall have the compressive strength specified (4.2.1.2 or 4.2.2.1).

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Learning Objectives 1 and 2

1. Understand similarities and differences of portland, blended, and other cements for masonry
    1. C150, C595, C1157, C91, and C1329 are all hydraulic cements
    2. C595 DOES and C1157 CAN contain SCMs
2. Review the cementitious materials and standards for mortar and grout
    1. C150, C595, C1157 can be used in mortar or grout
    2. C91 and C1329 are only for use in mortar
    3. Any limitations are clearly identified in C270, C476

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Learning Objective 3

3. Review mortar and grout properties and evaluation techniques

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Mortar and Grout Properties

- Selecting the right material requires a balanced approach to good fresh and hardened properties
- Mortar
  - Workability and board life
  - Strength and durability
  - Appearance
- Grout
  - Placeability
  - Compressive strength

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Fresh Mortar should have Good Workability

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Fresh Mortar should have Good Board Life

- Goal is to have a workable, plastic, consistent mixture
- Board life indicates length of time that mortar retains adequate workability
- Mortar typically can be used for up to 2-1/2 hours after initial mixing

Retempering, or adding water to restore workability, is good practice

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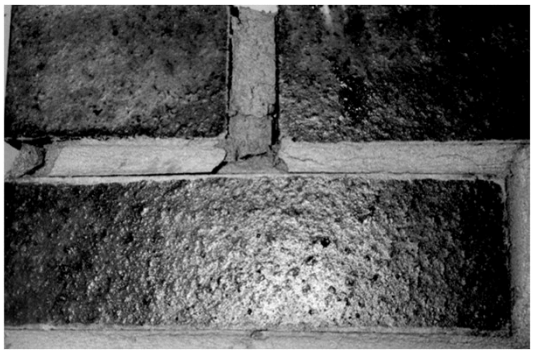
Hardened Mortar should be Durable

- Freeze-thaw durability (air entrainment)
- Sulfate resistance may be required for certain exposures (sulfate-resistant cements)



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Hardened Mortar should Look Good

- Aesthetics: mortar joint shape, color, and texture
- Best joint shapes for weather resistance

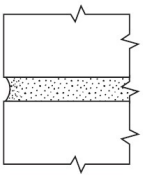

Fig. 9-7.
Concave joint.

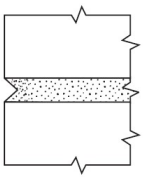

Fig. 9-8.
V-joint.

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Assessing Mortar Properties by C270

TABLE 1 Property Specification Requirements[A]

Mortar	Type	Average Compressive Strength at 28 days, min, psi (MPa)	Water Retention, min, %	Air Content, max, %[B]	Aggregate Ratio (Measured in Damp, Loose Conditions)
Cement-Lime	M S N O				
Mortar Cement	M S N O				an 2 ¼ and not 3 ½ times the separate cementitious
Masonry Cement	M S N O				

[A]Laboratory prepared mortar only (see Note 5).
[B]See Note 6.
[C]When structural reinforcement is incorporated in cement-lime or mortar cement mortar, the maximum air content shall be 12 %.
[D]When structural reinforcement is incorporated in masonry cement mortar, the maximum air content shall be 18 %.

After testing your mix design, convert back to proportions for field

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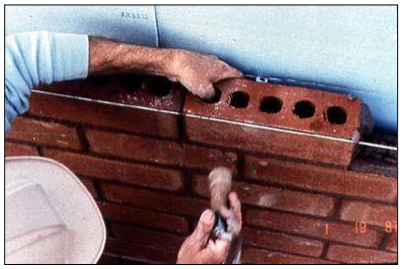
Fresh Property: Mortar Water Retention



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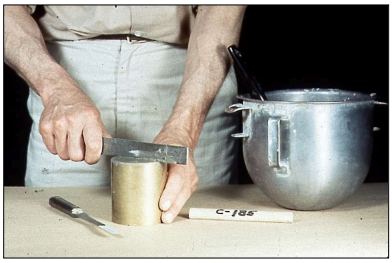
Fresh Property: Mortar Air Content



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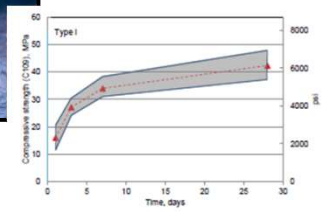
Hardened Property: Strength by Mortar Cubes

ASTM C 109



This test is just an indicator test, showing that cement can gain strength, how strength gain progression occurs, in other words, “that cement does its job”

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Rather than testing, we could use Proportion Requirements instead

- Property vs. Proportion Requirements

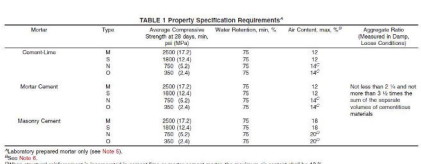

TABLE 1 Property Specification Requirements[A]

Mortar	Type	Average Compressive Strength at 28 days, min, psi (MPa)	Water Retention, min, %	Air Content, max, %[B]	Aggregate Ratio (Measured in Damp, Loose Conditions)
Cement-Lime	M	2500 (17.2)	75	12	
	S	1800 (12.4)	75	12	
	N	750 (5.2)	75	14[C]	
	O	350 (2.4)	75	14[C]	
Mortar Cement	M	2500 (17.2)	75	12	Not less than 2 ¼ and not more than 3 ½ times the sum of the separate volumes of cementitious materials
	S	1800 (12.4)	75	12	
	N	750 (5.2)	75	14[C]	
	O	350 (2.4)	75	14[C]	
Masonry Cement	M	2500 (17.2)	75	18	
	S	1800 (12.4)	75	18	
	N	750 (5.2)	75	20[C]	
	O	350 (2.4)	75	20[C]	

[A]Laboratory prepared mortar only (see Note 6).
[B]See Note 4.
[C]When structural reinforcement is incorporated in cement-lime or mortar cement mortar, the maximum air content shall be 12 %.
[D]When structural reinforcement is incorporated in masonry cement mortar, the maximum air content shall be 18 %.

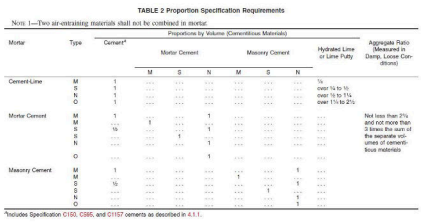

TABLE 2 Proportion Specification Requirements

Note 1—Two air-entraining materials shall not be combined in mortar.

Mortar	Type	Proportions by Volume (Cementitious Materials)							
		Cement[A]						Hydrated Lime or Lime Putty	Aggregate Ratio (Measured in Damp, Loose Conditions)
		Mortar Cement			Masonry Cement				
		M	S	N	M	S	N		
Cement-Lime	M	1	...	...	...	...	...	¼	
	S	1	...	...	...	...	...	over ¼ to ½	
	N	1	...	...	...	...	...	over ½ to 1¼	
	O	1	...	...	...	...	...	over 1¼ to 2½	
Mortar Cement	M	1	...	...	1	...	...	...	Not less than 2¼ and not more than 3 times the sum of the separate volumes of cementitious materials
	M	...	1	...	...	...	...	...	
	S	½	...	1	...	...	...	...	
	S	...	...	...	1	...	...	...	
	N	...	1	...	...	...	...	...	
	O	...	...	1	...	...	...	...	
Masonry Cement	M	1	...	...	...	...	1	...	
	M	...	...	...	1	...	...	...	
	S	½	...	...	...	...	1	...	
	S	...	...	...	...	1	...	...	
	N	...	...	...	...	...	1	...	
	O	...	...	...	...	...	1	...	

[A]Includes Specification C150, C595, and C1157 cements as described in 4.1.1.

- Only one shall govern
- If neither is specified, proportion specification governs
- Recipe vs. testing mortar mixes

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C270 — Proportion Specification

TABLE 2 Proportion Specification Requirements

NOTE 1—Two air-entraining materials shall not be combined in mortar.

Mortar	Type	Proportions by Volume (Cementitious Materials)				Aggregate Ratio (Measured in Damp, Loose Conditions)
		Cement[A]	Mortar Cement	Masonry Cement	Hydrated Lime or Lime Putty	
Cement-Lime	M	1	...	...	1/4 to 1/2	not less than 2¼ and not more than 3 times the sum of
	S	1	...	...	over 1/2 to 1¼	
	O	1	...	...	over 1¼ to 2½	
Mortar Cement	M	1	1	...	...	
	S	½	1	...	...	
	O	...	1	...	...	
Masonry Cement	M	1	...	1	...	
	S	½	...	1	...	
	O	...	...	1	...	

[A] Includes Specification C150, C595, and C1157 cements as described in 4.1.1.

1 part cementitious x 2-1/4 = 2-1/4 parts sand
up to
1 part cementitious x 3 = 3 parts sand

Type N MC

1 cement = 1 part cementitious materials

"1 - 3"
(Masonry Cement - Sand)

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Evaluating Mortar at the Site

- We have to make sure that the mortar being placed is what we specified
  - Use field observation
  - Maybe mortar-aggregate ratio
  - Compressive strength is not recommended

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QA: Proper Proportions – Field Observation

- Inspect batching and mixing
- A 1 cu ft box is a simple way to check sand additions
- Observe mixing (3 to 5 minutes per C270)
- These are “periodic” observation activities

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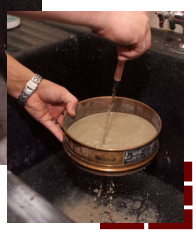
QA: Proper Proportions – Mortar-Aggregate Ratio

- A C780 test method for evaluating the proportions of fresh mortar mix
- Amount of sand relative to cementitious materials
- Best method to determine if the proper proportions were used in the field mix



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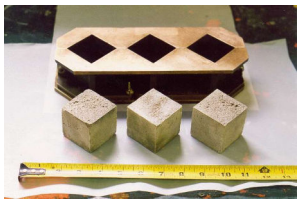
QA: Compressive Strength?

- C780 test method
- Molded cubes or cylinders
- Not representative of actual compressive strength of mortar in the assembly
- Not appropriate for use in predicting strength of mortar in the assembly



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Why C270 Strength Requirements are not Correct for Field Testing

- Why can't C270 property requirements be applied to field mortar?
- Because preparation of materials and mixed consistency are specified in C270, and are different than a field mix.
- Differences:
  - Oven-dry sand
  - Bench-top mixer
  - Water content

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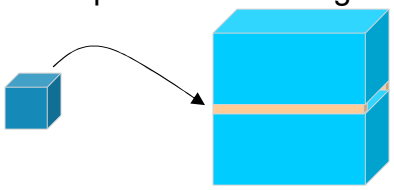
C270, C780, and C1586 all say the same thing about mortar strength…

Does the strength of a mortar cube represent the strength of the mortar in the wall ?

NO !



The mortar in the wall will be much stronger than the tested strength of the cube because of …

- Smaller aspect ratio of mortar joint
- Lower water to cement ratio for mortar joint
- **So why test it? We shouldn't.**

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Fresh Grout should have Good Workability

Conventional grout
Slump

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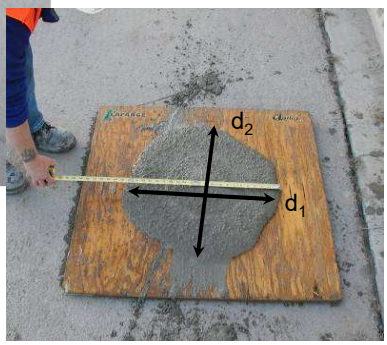
Fresh SCG Workability

Self-consolidating grout
Slump Flow



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Additional Fresh Property for SCG: Visual Stability Index (VSI)

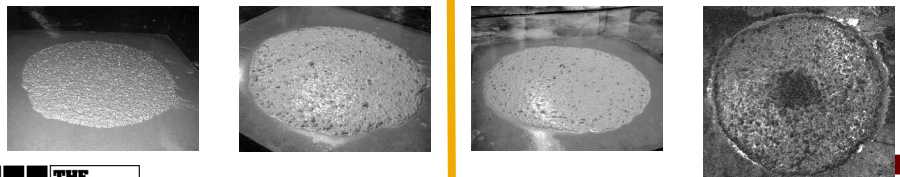
TABLE X1.1 Visual Stability Index Values

VSI Value	Criteria
0 = Highly Stable	No evidence of segregation or bleeding.
1 = Stable	No evidence of segregation and slight bleeding observed as a sheen on the concrete mass.
2 = Unstable	A slight mortar halo ≤ 10 mm [≤ 0.5 in.] and/or aggregate pile in the of the concrete mass.
3 = Highly Unstable	Clearly segregating by evidence of a large mortar halo > 10 mm [> 0.5 in.] and/or a large aggregate pile in the center of the concrete mass.

- Visual examination is a qualitative assessment

Stable mix ← | → Unstable mix

VSI = 0 **VSI = 1** **VSI = 2** **VSI = 3**



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Images courtesy of ASTM

ASTM C476

- Two approaches for specifying conventional grout
  - Proportion requirements or specified compressive strength
- For self-consolidating grout
  - Can ONLY specify by compressive strength
- Most cementitious materials can be used for either approach (limitations are provided in the standard)
  - No C150 Type V
  - No C595 Type IS with more than 70% slag content
  - No C1157 Type MH, LH

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Specifying Grout by C476

- Proportion Requirements
  - Conventional grout MAY be specified by proportions
  - SCG CANNOT be specified by proportions
- Decide on fine or coarse grout (cell size)
- Select aggregate proportions
  - Maximum 1:3 for fine grout or 1:5 for coarse grout

TABLE 1 Conventional Grout Proportions by Volume

Type	Parts by Volume of Portland Cement or Blended Cement	Parts by Volume of Hydrated Lime or Lime Putty	Aggregate, Measured in a Damp, Loose Condition	
			Fine	Coarse
Fine grout	1	0–1/10	2¼ –3 times the sum of the volumes of the cementitious materials	...
Coarse grout	1	0–1/10	2¼ –3 times the sum of the volumes of the cementitious materials	1–2 times the sum of the volumes of the cementitious materials

Specifying Grout by C476

- Property Requirements
  - Conventional grout MAY be specified by property
  - SCG MUST be specified by property
- Compressive strength @ 28 days
  - Equal or exceed f'm
  - 2000 psi minimum
- Additionally, conventional grout requires
  - 8-11 in. slump
- And self-consolidating grout requires
  - 24-30 in. slump flow
  - VSI not greater than 1

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Specifying Grout by C476

- Why use Property Requirements for grout?
- Greater economy
  - Greater aggregate proportions/more economical use of cement
  - Higher SCM content (exceed the C595 limits of 40% fly ash, 70% slag cement)
- High-volume SCM grout
  - Grout is the easiest way to introduce SCMs to masonry
  - SCMs reduce environmental impact

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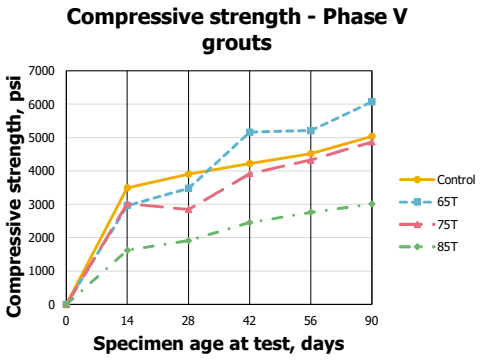
Research on High Volume SCM Grout

- Started in 2009
- Studied fly ash and slag cement
- Equivalent performance (at 28 days)
  - Up to 40% fly ash
  - Up to 80% fly ash + slag
- Acceptable performance (at 56 days)
  - Up to 60% fly ash
  - Up to 85% fly ash + slag



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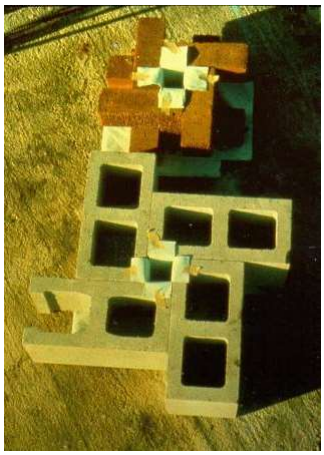
Preparing Grout Compressive Strength Specimens



C1019 pinwheels

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Learning Objective 3

3. Review mortar and grout properties and QA techniques
    1. Both fresh and hardened properties
    2. Mortar workability
    3. Balance the required strength of mortar with the workability and durability needs
    4. Field testing of mortar strength NOT recommended
    5. Grout consistency
        - Slump (conventional) or slump flow AND VSI (SCG)
    6. Compressive strength of grout

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Learning Objective 4

4. Discuss effective specifications for cements for mortar and grout

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Developing Your Specification

- Part 1 – General
- Part 2 – Products
- Part 3 – Execution
- Mortar has **mandatory** and **optional requirements**
- Grout only has **optional requirements**
- Building codes set minimum requirements but project specs can be more restrictive (A/E decides)

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Mortar and Grout Specifications

- Part 1 - General
  - References
  - Submittals
  - Quality assurance
  - Delivery, storage, handling
- Part 2 – Products
  - Materials, including admixtures
- Part 3 – Execution
  - Mortar mixing
  - Grout mixing

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What Content is Needed to Specify Mortar and Grout?

- Know the standards that apply
- Choose an appropriate strength level for your needs
  - Mortar - Type M, S, N, O
  - Grout - f'm but 2000 psi minimum
- Choose the property or portion method
  - (Proportion method is the default and it's easier)
- Select how to assess mortar/grout for quality (observation, testing)

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Specifying Mortar

C270 – 14a

APPENDIXES

(Nonmandatory Information)

X1. SELECTION AND USE OF MORTAR FOR UNIT MASONRY

- Location + segment = mortar type (strength)

TABLE X1.1 Guide for the Selection of Masonry Mortars[A]

Location	Building Segment	Mortar Type	
		Recommended	Alternative
Exterior, above grade	load-bearing wall	N	S or M
	non-load bearing wall	O[B]	N or S
	parapet wall	N	S
Exterior, at or below grade	foundation wall, retaining wall, manholes, sewers, pavements, walks, and patios	S[C]	M or N[C]
Interior	load-bearing wall		
	non-bearing partitions		
Interior or Exterior	tuck pointing		

[A] This table does not provide for many specialized mortar uses, such as chimney, reinforc
[B] Type O mortar is recommended for use where the masonry is unlikely to be frozen when s
ds. Type N or S mortar should be used in other cases.
[C] Masonry exposed to weather in a nominally horizontal surface is extremely vulnerable to

TABLE X3.1 Guide for Selection of Tuck Pointing Mortar[A]

Location or Service	Mortar Type	
	Recommended	Alternate
Interior	O	K,N
exterior, above grade exposed on one side, unlikely to be frozen when saturated, not subject to high wind or other significant lateral load	O	N,K
exterior, other than above	N	O

[A] In some applications, structural concerns may dictate the use of mortars other than those recommended. This table is not applicable to pavement applications.

- Choose proportion (default) or property
  - No need to limit cement types

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Proportion Specification is Easiest

- Verify that your materials meet their respective standards (cement, aggregate, water, admixtures)
- Follow the proportions table
- That's it

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ASTM C1714 Preblended Dry Mortar Mix for Unit Masonry

1. Scope*

1.1 This specification covers masonry mortars whose materials and design requirements are governed by Specification C270 but are preblended dry in a factory instead of produced from individual raw materials delivered to the job-site.

An increasingly popular way of specifying mortar:

- Meets C270 just by adding water at site
- For proportion mixes, verify batch tickets + test sand for C144 compliance
- For property mixes, field mixes sampled dry can be compared to performance values from point of manufacture

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Property Specification is More Work but Offers Incentives

- Verify that materials meet their respective standards (cement, aggregate, water, admixtures)
- For mortar, test compressive strength, water retention, air content
  - These tests establish proportions
  - Why choose property specification for mortar?
    - Sometimes, for larger projects, this can result in a more economical mix design
- For grout, test compressive strength
  - This can be more economical due to increased aggregate content or high volume of SCM content

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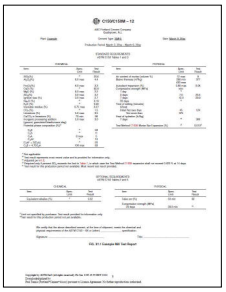
Quality Assurance for Mortar

1. Right materials
   - Material certificates (manufacturer, brand, type)
2. Materials meet standards
   - Material certificates or product data
3. Proper proportions for mortar
   - Observation
   - Mortar aggregate ratio



- DON'T USE MORTAR STRENGTH FOR QA

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Quality Assurance for Grout

1. Right materials
   - Material certificates (manufacturer, brand, type)
2. Materials meet standards
   - Material certificates or product data
3. For SCG, verify slump flow and VSI
4. For conventional grout
   - Verify proportions of materials delivered

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TMS 402 Code Assigns Minimum QA Levels

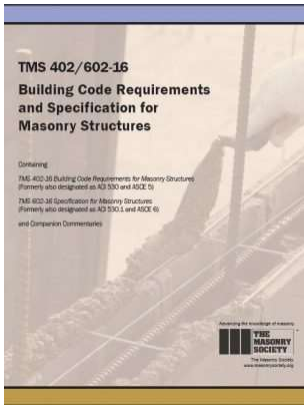

Table 3.1 Minimum Quality Assurance Level

Designed in accordance with	Risk Category I, II or III	Risk Category IV
Part 3 or Appendix B or Appendix C	Level 2	Level 3
Part 4	Level 1	Level 2

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TMS 602 Provides QA Minimum Verification Requirements

Table 3.1 Minimum Quality Assurance Level

	Designed in accordance with	Risk Category I, II or III	Risk Category IV
Engineered, infill, limit design	Part 3 or Appendix B or Appendix C	Level 2	Level 3
Prescriptive	Part 4	Level 1	Level 2

Table 3 — Minimum Verification Requirements

Minimum Verification	Required for Quality Assurance[a]			Reference for Criteria
	Level 1	Level 2	Level 3	TMS 602
Prior to construction, verification of compliance of submittals.	R	R	R	Art. 1.5
Prior to construction, verification of f'_m and f'_{AAC}, except where specifically exempted by the Code.	NR	R	R	Art. 1.4 B
During construction, verification of Slump flow and Visual Stability Index (VSI) when self-consolidating grout is delivered to the project site.	NR	R	R	Art. 1.5 & 1.6.3
During construction, verification of f'_m and f'_{AAC} for every 5,000 sq. ft. (465 sq. m).	NR	NR	R	Art. 1.4 B
During construction, verification of proportions of materials as delivered to the project site for premixed or preblended mortar, prestressing grout, and grout other than self-consolidating grout.	NR	NR	R	Art. 1.4 B

(a) R=Required, NR=Not Required

TMS 602 Provides QA Minimum Special Inspection Requirements

Table 4 — Minimum Special Inspection Requirements

Inspection Task	MINIMUM SPECIAL INSPECTION Frequency [a]		
	Level 1	Level 2	Level 3
1. As masonry construction begins, verify that the following are in compliance:			
a. Proportions of site-prepared mortar	NR	P	P
b. Grade and size of prestressing tendons and anchorages	NR	P	P
c. Grade, type and size of reinforcement, connectors, anchor bolts,and prestressing tendons and anchorages	NR	P	P
d. Prestressing technique	NR	P	P
e. Properties of thin-bed mortar for AAC masonry	NR	C[b]/P[c]	C
f. Sample panel construction	NR	P	C
2. Prior to grouting, verify that the following are in compliance:			
a. Grout space	NR	P	C
b. Placement of prestressing tendons and anchorages	NR	P	P
c. Placement of reinforcement, connectors, and anchor bolts	NR	P	C
d. Proportions of site-prepared grout and prestressing grout for bonded tendons	NR	P	P
3. Verify compliance of the following during construction:			
a. Materials and procedures with the approved submittals	NR	P	P
4. Observe preparation of grout specimens, mortar specimens, and/or prisms	NR	P	C

(a) Frequency refers to the frequency of inspection, which may be continuous during the listed task or periodically
NR=Not Required, P=Periodic, C=Continuous

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Learning Objective 4

4. Discuss effective specifications for cements for mortar and grout
    1. We considered three parts of specifications: General, Products, Execution
    2. Compared proportion and property requirements
    3. We looked at QA needed for mortar, grout
    4. We looked at TMS 602 Specification for Minimum Requirements and Special Inspection Requirements for mortar and grout

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Recap

- We discussed cements that are appropriate for masonry construction
- We described cements allowed by the standards C270 (mortar) and C476 (grout)
- We considered properties for mortar and grout that are important and how to evaluate them
- We looked at what to include in our specifications for mortar and grout with an understanding of how cements are covered by those standards

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Effective Specifications for Mortar and Grout

- Thank You!
- Jamie Farny, jfarny@cement.org

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