SPEAKING IN CODE

The Lowdown on Testing and Special Inspection Topics *September 2026*

MORTAR MATTERS

When it comes to project special inspections and code compliance, masonry sand and mortar are both largely ignored and disrespected, masonry sand more so than mortar. Code compliance standards exist that govern whether a particular masonry sand can be used to produce mortar. Ample code acceptance criteria that govern whether mortar produced at the project complies with the building code also exist. Many projects (more than 60%) throughout the Mid-Atlantic use local sands to produce their mortar. Local masonry sands generally do not comply with ASTM C144, "*Standard Specification for Aggregate for Masonry*," and almost all are too fine in particle size. The majority are gap-graded, which is undesirable for masonry sand.

ASTM C144, Section 4.4, states, "*When an aggregate fails the gradation limits specified in Sections 4.1 and 4.2, its use is permitted provided the mortar can be prepared to comply with the aggregate ratio, water retention, air content, and compressive strength requirements of the 'Table 1 property specifications' of ASTM C270, 'Standard Specification for Mortar for Unit Masonry.'*" It is imperative to understand that this section mandates that a sand that doesn't comply with the grading requirements of ASTM C144 can only be used on the project if a laboratory mortar mix is developed and the resulting mortar (from the noncompliant sand) meets the requirements in Table 1 of ASTM C270. This is mandatory language. ASTM C144 and C270 are adopted by TMS 402/602, the masonry code, which sets forth the minimum requirements for masonry structures. These requirements are just as binding as any other TMS 402/602 code acceptance criteria and should be enforced in practice.

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[D]	
	O	350 (2.4)	75	20[D]	

[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 %.

Regardless of these ASTM code requirements, most masonry projects use local sands for masonry sand and mortar mixes, which are often noncompliant with ASTM C144. Laboratory mortar mixes are rarely developed, and the required special inspections and tests on the masonry, sand, and mortar are also rarely performed. Project after project is completed using noncompliant masonry sands, and the condition of the in-situ mortar is never known Remember, both masonry sand and mortar code criteria matter!

Why does this lackadaisical attitude exist when local sands are used to produce masonry mortar for local projects? This dynamic is one of the most critical, yet widely ignored, systemic issues in masonry construction quality control. Treating masonry sand as a passive filler rather than a primary structural component of the masonry system is a massive blind spot in the industry. Here are some reasons for the "winking and nodding" attitude toward local masonry sands.

- **Dirt Mentality:** Many A/E firms, inspectors, field supervisors, and laborers view sand simply as dirt or a cheap bulk commodity. They assume that if it looks clean, passes through a #4 sieve, and you can shovel it, it is acceptable. (Shoveling masonry sand into the mixer is not allowed by code.)
- **Logistical Complexity:** Unlike pre-blended bagged mortar, bulk sand is dumped in a pile on the ground at the project site. It is often exposed to rain, wind, and tracking from site equipment, making it a moving target.
- **Shifting the Blame:** Contractors often assume that the ready-mix or aggregate supplier has already certified the sand and furnished a submittal. Conversely, the supplier often provides a generic, outdated data sheet that does not represent the actual pile of sand delivered to the site.
- **ASTM C 270 Loophole:** Many project teams do not understand the relationship between ASTM C144 (aggregates) and ASTM C270 (mortar). They assume that using a standard "Proportion Specification" automatically guarantees a compliant code mix, ignoring the fact that the sand itself must comply with ASTM C144 for a "Proportion Mortar Mix" to be legally valid.
- **Confusion of Design Professionals & Special Inspection Agencies:** While there may be some degree of "winking and nodding" going on, a lot of legitimate confusion exists about the relationship between ASTM C144 and ASTM C270, not to mention confusion about mortar proportioning methods and code-required acceptance criteria.

Mortar just doesn't get the proper respect during project construction phases. Mortar masonry sand gets even less respect. The relatively small portion of masonry sand in the masonry system significantly influences the overall performance of the masonry structural element. A mortar joint is not just a cosmetic gap filler; it is an integrated structural component providing multiple functions, some of which are listed as follows:

- **Bonding Units:** Gluing bricks or blocks together so they act as one strong wall. A good bond also prevents water penetration through the masonry assembly.
- **Weight Distribution:** The joint compensates for physical irregularities in masonry units, creating a uniform bed that acts as a cushion and reduces point loading between masonry units in the wall.
- **Shear and Flexural Tensile Strength:** It provides the crucial bond strength required to transfer lateral forces (such as wind or seismic loads) between masonry courses.
- **Sacrificial Buffer:** It acts as a flexible element designed to absorb thermal and moisture movement, reducing structural stresses that could cause the stiffer masonry to fracture. This is an example of why it is desirable to have a mortar joint weaker than the masonry portion of the wall.

Manufacturers of Factory Preblended Mortar

Project mortar throughout the Mid-Atlantic region appears to use job-site mixed mortar approximately 60% of the time, while factory preblended mortar is used approximately 40% of the time. This ratio is very difficult to determine due to the lack of definitive or scientific surveys on the subject. Even when preblended mortar mixes are used on projects (in the Mid-Atlantic region), the sands used at the factories producing the preblended mortar are probably noncompliant with ASTM C144, since most Mid-Atlantic masonry sands are too fine to meet the grading criteria of ASTM C144. Preblended mortar manufacturers do a very good job of in-plant quality control to meet C144 and C270 requirements. They almost exclusively certify their mortar products in accordance with the ASTM C270 property specifications. Most preblended mortar manufacturers offer submittal packages and data sheets that document compliance with ASTM C144 (if required) and ASTM C270 property requirements, as required by code.

Legendary Folklore Surrounding ASTM C 144, ASTM C 270, and the ASTM C-12 Subcommittee

ASTM C144 (standard for aggregate for masonry mortar) was created in 1939, and ASTM C270 (standard for making masonry mortar) was created in 1951. The current ASTM C144 specifies grading requirements for natural or manufactured sand used to produce masonry mortar. The original C144 allowed only natural sands (due to gradation criteria) to be used in mortar mixes; manufactured masonry sands were allowed only after Section 4.4 was added to the standard in the 1980s, allowing the use of sands that did not comply with the grading requirements of C144.

Even though C144 was created in 1939 and C270 was not published by ASTM until 1951, these two ASTM standards were destined to have a lifelong relationship, albeit a turbulent one. Enter the C-12 subcommittee formed by ASTM in 1931, whose primary purpose was the formulation of specifications and test methods relating to the use of mortars and grouts for unit masonry. One of C-12's main goals was to create a masonry mortar property specification which did not exist at the time. The C-12 adventure would be a long, bitter battle among C-12 committee members, with engineers, scientists, and architects lining up against masons, material suppliers, and contractors in a gridlock that would endure for years. The C-12 committee chair's vision was to create a property specification for masonry mortar based on compressive strength, water retention, air content, and other empirical laboratory data. The dissenters wanted a "recipe" method (proportion mix) for the mortar mix that could be produced in the field, by measuring "approximate" volumes of applicable materials. This protracted feud continued for decades, and project masonry mortar was produced (during this period) according to the proportion methodology stipulated by a temporary ASTM C161, which dictated volumetric mixes.

The C-12 committee successfully created the property mix specification (ASTM C270) as requested. Still, it was forced to include "proportion mix" verbiage in the ASTM C270 narrative to gain consensus from ASTM and obtain ASTM approval for C270 in 1951. While C 270 contained a mortar property mix criteria and Table 1 "Property Specification Requirements" as envisioned, the C-12 subcommittee also had to include Table 2 "Proportion Specification Requirements as well as C144 Section 4.4 language to allow sands that failed C144 gradation limits to be used to produce mortar. The bitter "property mix versus proportion mix" war continues to this day (90 years later) and touches all of us in the masonry industry.

ASTM C270 is a standard born out of a shotgun wedding between "property mix purists" and a "construction site mentality" group that refused to give up their comfort with the mortar proportion mix methodology, which was allowed (even dictated) by the old ASTM C161 that would be integrated into the new C270 for the most part. This dual-table framework (ASTM Table 1 and Table 2) remains a point of confusion to the entire design and construction industry even today. One of those points of confusion that was forced upon the C-12 committee is Section 1.3 of

C270, which states, "*when neither proportion nor property specifications are specified, the proportion specifications shall govern…*" The masonry code, through C144, does not allow the C270 default to the proportion specification if the masonry sand does not comply with the required C144 grading. The design and construction industry continues to act as if Section 4.4 of ASTM C144 doesn't even exist, even though C144 is adopted by TMS 602, which makes the C144 requirements code law.

Code Inspection and Testing Requirements on Project Work (That are OFTEN not provided)

1. Any project masonry sand being used to produce mortar cannot be used if it does not comply with ASTM C 144 grading requirements UNLESS a laboratory mix design has been submitted showing that the resultant mortar from that sand complies with Table 1 of ASTM C 270.
2. Prior to construction, verify compliance of project submittals (TMS 602, Table 3)
3. Prior to construction, verify the f'm of all components of the masonry system according to Article 1.4B of TMS 602.
4. During masonry construction, verify proportions of materials as delivered to the project site for preblended mortar and masonry grout (TMS 602, Table 3).
5. Verify proportions of site-prepared mortar (TMS 602, Table 4, Articles 2.1 & 2.6).
6. Inspect joint reinforcement, ties, and anchors in accordance with TMS 602, Article 4.
7. Construct masonry sample panels in accordance with TMS 602, Articles 1.6D and 3.3F. Sample panels will also be required when verifying f'm (prior to construction) as required by TMS 602, Table 3, using the unit strength method (Article 1.4B).
8. Placement of reinforcement, connectors, and anchor bolts prior to grouting (TMS 602, Table 4).
9. During construction, verify compliance of materials and procedures with approved submittals. This code stipulation requires the sampling and testing of project masonry units and mortar. (Table 4, Article 1.5)
10. During construction, observe the type, size, and location of anchors, including anchorage of masonry to structural members, frames, or other construction. (TMS 602, Table 4)
11. During construction, provide continuous inspection of all reinforcement welding (TMS 602, Table 4).
12. During construction, observe the preparation, construction, and protection of masonry in hot and cold weather. (TMS 602, Table 4 and Articles 1.8C and 1.8D)
13. During construction, provide continuous presence of grout placements (Table 4, Articles 3.2, 3.5, and 3.6). Includes grout spaces, grout proportions, grout lifts, consolidation, and strength specimens.
14. During construction, prepare grout specimens, mortar specimens, and/or prisms. Code calls for continuous inspections for Level 3 QA & periodic inspections for Level 2 QA. (TMS 602, Table 4)
15. Observe mortar joint thicknesses for compliance with code requirements (TMS 602, Article 3.3).

16. Observe tooling of mortar joints for code compliance. Code requires that tooling be done with a round jointer (unless otherwise required) when the mortar joint is thumbprint hard. (TMS 602, Article 3.3B)
17. Observe that masonry walls comply with code requirements for dimensional tolerances such as “true to line” and “variation from plumb” and other specific tolerances. (TMS 602, Article 3.3)
18. During construction, observe mortar mixing procedures for code compliance. (TMS 602, Article 2.6). No shoveling is allowed for masonry sand. Calibrated units of measure must be used, such as 12” x 12” boxes, properly calibrated 5-gallon buckets, etc.

Cover the Masonry Sand at the Job Site

Masonry sand inventory at the job site must be covered when mortar is not being mixed to protect it from rain and other weather conditions that could increase its moisture. The materials in a mortar mix are proportioned by volume, and when masonry sand moisture content increases, the wetter sand bulks. At this point, much less sand is placed into the calibrated measure used to charge the mortar mixer than at the previous moisture content, before getting wetter. Statistics show that a 5% increase in sand moisture can increase the sand volume by 20% to 40% due to bulking.

Attempting to produce mortar under these conditions would result in an undersanded masonry mortar. These under-sanded mixes could experience excessive shrinkage, leading to cracking. The excessive shrinkage could also cause bond failures between the mortar and the masonry units. Under-sanded mortar mixes can negatively impact the masonry system in many other ways, including potential freeze-thaw damage, efflorescence, and excessive hardness.

ASTM C270, Section 7.2 Measurement of Materials – The method of measuring materials for the mortar used in construction shall be such that the specified proportions of the mortar materials are controlled and accurately maintained.

But wait! We have a lot more to say! *For a complete picture of the Code and how it relates to Special Inspections, F&R would love to provide a virtual AIA-accredited Lunch & Learn presentation to the professionals at your firm.*

Trouble Deciphering the Code? **Contact the Experts at F&R!**

Alan S. Tuck, Director of Code Compliance & Training
E atuck@fandr.com
T 540.344.7939
M 540.798.4440

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