

PRODUCT NAME

Mortar Cement: Type N, Type S,
and Type M

MANUFACTURER

Represented by:
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PRODUCT DESCRIPTION

Basic Use: Mortar cement is specially formulated and manufactured to produce masonry mortar for use in brick, block, and stone masonry construction. Mortar cement mortars have similar attributes to masonry cement mortars, but they have lower air contents than masonry cements, and the mortar cement specification includes a minimum bond strength requirement. Mortar cement mortars are appropriate for use in structural applications that require masonry with high flexural bond strength.

Composition and Materials: Mortar cement consists of a mixture of portland cement or blended hydraulic cement and plasticizing materials (such as limestone or hydrated lime), together with other materials introduced to enhance one or more properties such as setting time, workability, water retention and durability. These components are proportioned at the cement plant under controlled conditions to assure uniformity of performance.

Table 1. Recommended Guide for
Selection of Mortar Type

Building Segment	Type
Exterior, above grade, load-bearing	N or S
non-load bearing parapet wall	N
Exterior, at or below grade	N or S
Interior	S or M
load-bearing	N or S
non-load bearing	N

Masonry Information

MORTAR CEMENT: PRODUCT DATA SHEET



Masonry constructed using mortar cement mortar and three brick colors conveys a sense of security and permanence for students of the Buffalo High School in Buffalo Minnesota, designed by Abendroth, Rego & Youngquist.

Types: Mortar cements are produced in Type N, Type S, and Type M classifications for use in preparation of ASTM Specification C 270 Type N, S, or M mortar, respectively, without further addition of cements.

Table 1 is a general guide for selection of mortar type. Other factors, such as type and absorption of masonry unit, climate and exposure, applicable building codes, and engineering requirements, should also be considered.

Limitations: Mortar cements are designed to be mixed with sand and water to produce a masonry mortar. The addition of hydrated lime to a mortar cement mortar at the job site is not required or recommended for conventional unit masonry construction.

TECHNICAL DATA

Applicable Standards: Mortar cements conform to ASTM C1329, the "Standard Specification for Mortar Cement." Mortar cements are used to produce ASTM C 270 Type O, Type N, Type S, and Type M mortars as outlined in either the property specification or the proportion specification require-

ments of ASTM C 270. Requirements for sand to be used with mortar cement to produce ASTM C 270 mortars are found in ASTM C 144.

Physical Properties: Mortar cement mortars conform to the physical properties listed in Table 2.

These property requirements assure consistent performance of the product with respect to bond strength, compressive strength, workability, and durability.

Bond Strength: The mortar cement specification is the only ASTM masonry material specification that includes bond strength performance criteria. The bond strength criteria were established to assure comparable bond strength performance of the mortar cement to non-air-entrained portland cement-lime

¹ Melander, J. M., and Ghosh, S. K., "Development of Specifications for Mortar Cement," *Masonry: Esthetics, Engineering, and Economy*, ASTM STP 1246, D. H. Taubert and J. T. Conway, Eds., ASTM, West Conshohocken, PA, pp 88-99.

² Borchelt, J. G., and Tann, J. A., "Bond Strength and Water Penetration of Low IRA Brick and Mortar," *Proceedings of the Seventh North American Masonry Conference*, The Masonry Society, Boulder, CO, pp. 206-216.

Table 2. Physical Properties of Mortar Cements (ASTM C 1329)

Mortar Cement Type	N	S	M
Fineness, residue on a 45- μ m (No. 325) sieve, maximum %	24	24	24
Autoclave expansion, maximum, %	1.0	1.0	1.0
Time of Setting			
Initial Set, minimum, hr.	2	1½	1½
Final Set, maximum hr.	24	24	24
Compressive strength minimum, MPa (psi)			
7 days	3.4 (500)	9.0 (1300)	12.4 (1800)
28 day	6.2 (900)	14.5 (2100)	20.0 (2900)
Bond strength minimum, MPa (psi)			
28 days	0.5 (70)	0.7 (100)	0.8 (115)
Air content, volume, %			
Minimum	8	8	8
Maximum	17	15	15
Water retention, flow after suction as % of original flow			
Minimum	70	70	70

Table 3. Physical Properties of Mortar Cement Mortars (ASTM C 270)

Mortar Type	Compressive Strength Minimum, MPa (psi)	Water Retention Minimum, %	Air Content Maximum, %
M	17.2 (2500)	75	12
S	12.4 (1800)	75	12
N	5.2 (750)	75	14*
O	2.4 (350)	75	14*

*When structural reinforcement is incorporated in (cement-lime or) mortar cement mortar, the maximum air content shall be 12%.

Note: Physical properties listed in Table 2 and Table 3 are measured in accordance with prescribed laboratory test procedures. Conformance to compressive strength, bond strength, air content, and water retention requirements of Table 2 is determined using standard testing sand (ASTM C 778). Conformance to Table 3 requirements is established using a masonry sand (ASTM C144) that is intended to be used in construction. Mortar made using masonry sand typically has lower compressive strength, lower air content, and higher water retention as compared to that achieved using standard sand. This fact is reflected in the differences between Table 2 (ASTM C 1329) and Table 3 (ASTM C 270) requirements for these properties.

combinations of equivalent mortar type designation¹. As shown in Fig. 1, subsequent research has confirmed that mortar cement mortars provide excellent bond strengths².

The procedure utilized in determining conformance of mortar cement to bond strength criteria seeks to eliminate, insofar as possible, the effects of workmanship, curing, and unit properties on measured bond strength. Therefore, standard mixing, specimen fabrication, curing, and testing procedures are outlined, including the use of standard testing units. It should be noted that there are many factors that affect the bond of mortar to unit in actual construction, including properties of the unit and mortar, ambient conditions, and the quality of workmanship involved.

Compressive Strength: By simplifying mortar materials batching at the job site, the use of mortar cement assures consistent strengths between batches

and jobs. Mortar cement mortars mixed according to the property requirements of ASTM C 270 provide strengths that exceed the values listed in Table 3. High strength Type S and Type M mortar cements allow the specifier to accommodate special application requirements related to load bearing masonry, masonry below grade level, and masonry for paving, without compromising the advantages of simplified batching.

Workability: Workability is the mason's appraisal of the mortar's ability to cling to head joints, slide smoothly off the trowel, and evenly support the placement of units. Mortar of proper workability is soft but has good body; it spreads readily and extrudes from joints without smearing or dropping. Additionally, the masonry mortar needs to retain these properties for a reasonable length of time at whatever ambient conditions exist at the job site. That length of time that the mortar retains its workability is often termed its board life. The plasticiz-

ers contained in mortar cements contribute to their workability and board life. Fineness, time of setting, air content, and water retention requirements for mortar cements are specification properties that relate to consistent performance with respect to workability. The importance of workability is apparent when one considers that workmanship is a key element in achieving quality masonry construction.

Durability: Expansion of mortars due to unsound ingredients can cause serious disintegration of masonry. Soundness of a cementitious material is measured by the autoclave expansion test. This test produces reactions in any unsound ingredients and simulates a long period of exposure for the cementitious material. Conformance of mortar cement to the autoclave expansion limits of ASTM C 1329 assures that there will be no significant expansion of hardened mortar in a wall due to unsoundness.

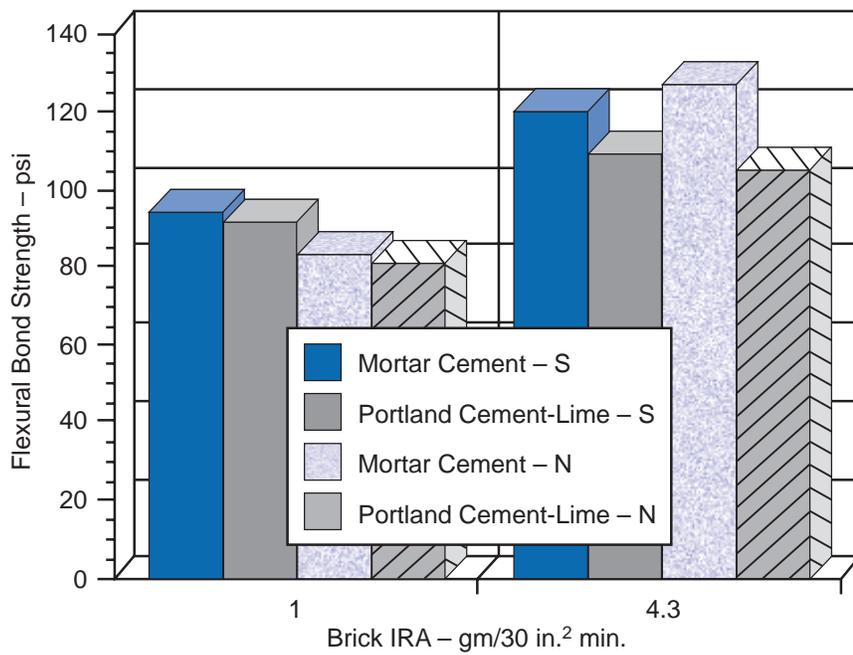


Fig. 1 – Bond Strengths of Mortar Cement and Portland Cement-Lime Mortars (Data from Ref. 2).

Mortar cements include air-entraining agents that provide advantages of improved freeze-thaw durability and workability associated with air-entrained mortars. Air content of mortar cement is limited to between 8% and 15% for Type M and S and 8% and 17% for Type N. Conformance to these limits is determined using laboratory testing procedures and standard testing sand. Air contents achieved using field sand and field mixing procedures are typically lower by one or two percent, although certain field sands may increase air content.

Water Penetration: Water penetration resistance of masonry is primarily related to workmanship and design. It is generally recognized that a single 4-inch wythe of masonry is susceptible to water penetration and that the design and detail of the masonry construction

must accommodate this fact. Important workmanship factors include achieving full head and bed joints, following proper tooling techniques, careful installation of flashing and weep holes, and maintaining clean cavities. The excellent workability, strength, and durability of mortar cement mortars assure that the designers' and masons' needs are met in regard to achieving watertight masonry construction. Research² has confirmed the excellent performance of mortar cement mortars in water penetration tests.

Appearance: The color of the masonry joint is a crucial component in the appearance of the entire wall. Since mortar cement color is laboratory-controlled and mortar cement offers the simplicity of the one bag system of batching, it is easier to achieve a consistent appearance in the finished job.

INSTALLATION

Preparation: Mortar cement mortar materials mixed according to the proportion specifications of ASTM C 270 should be accurately proportioned in accordance with Table 4.

Under the property requirements of ASTM C 270, sand-to-cement proportions for the job mixed mortar are the same as those established by laboratory tests of the mortar. The ratio of sand to mortar cement is to be no less than 2¼:1 and no more than 3½:1.

Machine mixing should be used whenever possible. First, with mixer running, add most of the water and half the sand required. Next, add the mortar cement and the balance of sand. After one minute of continuous mixing, slowly add the rest of the water. Mixing should continue for at least 3 minutes. Extending the mixing time up to 5 minutes improves the mortar, resulting in better workability and water-retention. In mixing, as much water should be used as practical, without impairing the workability of the mortar.

Application: The practice of good workmanship principles is required for successful application. This includes proper filling of head and bed joints, careful placement of units, appropriate tooling of the joint, modification of construction procedures and/or schedules to adapt to extreme weather conditions^{3,4}, and proper cleaning⁵ procedures. Good workmanship coupled with proper detailing and design assures functional, durable, watertight masonry construction.

Fresh mortar should be prepared at the rate it is used, so that it does not stiffen in mortar boxes and on mortar boards. If necessary to restore workability, mortar should be retempered by adding water and remixing thoroughly. While the addition of water reduces mortar strength slightly, this effect is

Table 4. ASTM C 270 Proportion Specification Requirements for Mortar Cement Mortars

Mortar Type	Portland or Blended Cement	Mortar Cement Type			Sand
		M	S	N	
M	—	1	—	—	2¼ - 3
M	1	—	—	1	4½ - 6
S	—	—	1	—	2¼ - 3
S	½	—	—	1	3¾ - 4½
N	—	—	—	1	2¼ - 3
O	—	—	—	1	2¼ - 3

³ *Trowel Tips: Hot Weather Masonry Construction*, PCA Publication Code IS243, PCA, Skokie, IL.

⁴ *Trowel Tips: Cold Weather Masonry Construction*, PCA Publication Code IS248, PCA, Skokie, IL.

⁵ *Trowel Tips: Cleaning Masonry*, PCA Publication Code IS244, PCA, Skokie, IL.

preferable to the poor contact between brick and mortar that will result from using dry stiff mortar. Mortar over 2½ hours old should not be retempered or used. It should be discarded and replaced with freshly mixed mortar.

Emphasis should be placed in masonry construction to minimize the amount of cleaning required. Precautions to minimize the amount of mortar splatter that is left on a wall include the practice of good basic workmanship, dry brushing the face of the masonry wall after tooling with a soft bristle brush, and turning back the inside scaffold board at the end of the day to avoid rain splatter of mortar droppings from the board getting on the wall. Such mortar protrusions and splatters should be removed before they adhere to the masonry surface (preferably the morning after laying) using stiff nonmetallic brushes, nonmetallic scrapers, burlap,

rags, or other appropriate means of removal.

If, despite efforts to maintain clean masonry during construction, it is felt that the use of masonry cleaning solutions are required, selection of cleaning technique and solution should be compatible with the units, and damage to the mortar joint surface must be avoided. Follow the instructions of the manufacturer of the cleaning solution in its application on trial cleaning of inconspicuous areas to assure proper selection of method and solution. Cleaning with chemical solutions should not be attempted until the mortar has thoroughly cured. Generally, about two weeks' curing is recommended.

AVAILABILITY

Availability: Mortar cements are regionally available in the United States and Canada from a network of dealers

and distributors representing PCA member producers. For a complete list of PCA member mortar cement manufacturers contact PCA headquarters at 847.966.6200, by fax at 847.966.9781, or at the Web site: www.cement.org.

CERTIFICATION

Mortar cement meets the requirements of ASTM C 1329, The Standard Specification for Mortar Cement, for the type specified. Written manufacturer's certifications to that effect may be obtained from PCA member company producers of mortar cement upon request.

MAINTENANCE

Avoid use of harsh chemical cleaners or strong acid solutions in cleaning masonry (refer to Installation).

TECHNICAL SERVICES

Technical information and services are available from PCA and member manufacturers.

The following related publications are also available from PCA:

Masonry Mortars – IS040

Masonry Cement Mortars – IS181

Trowel Tips: Hot Weather Masonry Mortar – IS243

Trowel Tips: Cleaning Masonry – IS244

Trowel Tips: Cold Weather Masonry Mortar – IS248

Selecting and Specifying Mortar and Grout for Unit Masonry – IS275

Bond Strength Testing of Masonry – IS277

Factors Affecting Bond Strength of Masonry – IS278

Quality Assurance for Masonry Mortar – IS279

Concrete Masonry Handbook – EB008

Recommended Practices for Laying Concrete Block – PA043



Architects Smith, Hinchman & Grylls used mortar cement mortar and brick of differing color and texture to define distinct building areas within a unified visual theme on the Veterans Administration Hospital in Detroit.