Masonry Information

MASONRY CEMENT: PRODUCT DATA SHEET

PRODUCT NAME

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

MANUFACTURER

Represented by:
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PRODUCT DESCRIPTION

Basic Use: Masonry cement is specially formulated and manufactured to produce masonry mortar for use in brick, block, and stone masonry construction. Masonry cements are also used to produce stucco.

Composition and Materials: Masonry cement consists of a mixture of portland cement or blended hydraulic cement and plasticizing materials (such as limestone or hydrated or hydraulic 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.

Types. Masonry cements are produced in Type N, Type S, and Type M strength levels for use in preparation of ASTM Specification C270 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.

Table 1. Recommended Guide for Selection of Mortar Type

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

The Crump Firm, architects on the Econocom-USA Corporate Headquarters Building, used masonry cement mortar in contrasting brick masonry panels to achieve a dramatic visual effect.

Colors. Masonry cements are available in a variety of colors as well as natural gray. As an alternative to the use of colored masonry cements, mineral oxide pigments may be added to the job site mixer to produce the color of mortar desired.

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

TECHNICAL DATA

Applicable Standards. Masonry cements conform to ASTM C 91, the Standard Specification for Masonry Cement. Masonry 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 requirements of ASTM C 270. Requirements for sand to be used with masonry cement to produce ASTM C 270 mortars are found in ASTM C 144.

Physical Properties. Over the past sixty years, masonry cement has become the masonry mortar material of choice for most masonry construction in the United States because it provides the basic advantages of consistent workability, strength, color, and durability. This consistency of performance is assured by conformance to the physical property requirements for masonry cements as listed in Table 2.

Masonry cement mortars provide an excellent level of performance in the functional areas of workability, strength, durability, and appearance that are so important to the mason, owner, and designer.

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. Additionally, the 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 plasticizers contained in masonry cements contribute to their excellent workability, board life, and water retention. The importance of

workability is apparent when one considers that workmanship is a key element in achieving quality masonry construction.

Strength. By simplifying mortar materials batching at the job site, the use of masonry cement assures consistent strengths between batches and jobs. Masonry cement mortars prepared according to the property requirements of ASTM C 270 provide compressive strengths that exceed the values listed in Table 3. High Strength Type S and Type M masonry 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.

In addition to compressive strength, bond strength is also an important consideration in masonry construction. 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. Masonry cement mortars provide the mason with a highly plastic mortar which readily flows into the surface irregularities of the unit, assuring that the bond strength potential of the materials is realized in the field when combined with good workmanship. In an extensive laboratory study of over 20 different masonry cements representing a cross section of producers throughout the United States, Ribar and Dubovoy[1] confirmed that masonry cements yield excellent flexural bond strengths. Seventy-five percent of these masonry cement mortars tested with a brick unit having an IRA of 9 g/min·194 cm^2 (9 g/m·30 in^2) yielded flexural bond strengths in excess of 690 kPa (100 psi). None of these masonry cement mortars produced values lower than 450 kPa (65 psi).

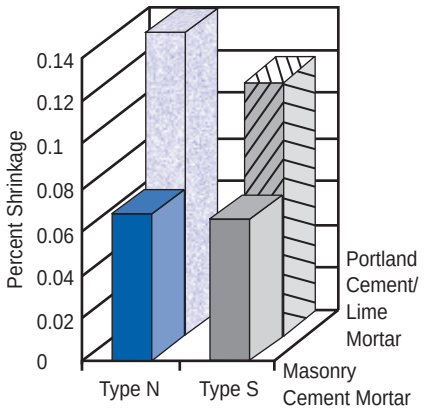

Fig. 1 – Drying shrinkage of masonry mortars at 28 days.

Table 2. Physical Properties of Masonry Cements (ASTM C 91)

Mortar Cement Type	N	S	M
Fineness, residue on a 45-µm (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)
Air content, volume, %			
Minimum	8	8	8
Maximum	21	19	19
Water retention, flow after suction as % of original flow			
Minimum	70	70	70

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

Mortar Type	Compressive Strength Minimum, MPa (psi)	Water Retention Minimum, %	Air Content Maximum, %
M	17.2 (2500)	75	18
S	12.4 (1800)	75	18
N	5.2 (750)	75	20*
O	2.4 (350)	75	20*

*When structural reinforcement is incorporated in masonry cement mortar, the maximum air content shall be 18%.

Durability. Properties of masonry mortar related to its durability include:

- Resistance to freeze thaw deterioration,
- Drying shrinkage characteristics,
- Resistance to sulfate attack,
- Water absorption characteristics, and
- Soundness

Masonry cement mortars provide significant performance advantages in these important areas.

The ability to endure the extremes of repeated freeze-thaw cycles without deterioration is critical to the long-term performance of mortar. Research[2,3] shows that air entrainment levels of at least 10 to 12 percent are needed to provide effective resistance to freeze-thaw deterioration in masonry mortars. Masonry cement mortars have greater resistance to freeze-thaw deterioration than non-air-entrained-portland cement-lime mortars. This superior performance can be attributed to the controlled air content of masonry cement mortars.

Several factors influence drying shrinkage of masonry mortars, including water content, rate of drying, sand properties, moisture content and absorption of the masonry units, and cementitious material properties. Results of laboratory tests shown in Fig. 1 indi-

[1] Dubovoy, V. S., and Ribar, J. W., *Masonry Cement Mortars-A Laboratory Investigation,* Research and Development Bulletin RD095, PCA, Skokie, IL, 1990, 26pp.

[2] Davison, J. I., "Effect of Air Entrainment on Durability of Cement-Lime Mortars," *Durability of Building Materials,* Elsevier Publishing Co., Amsterdam, 1981.

[3] Zamatis, W. L., "Factors Affecting Performance of Unit Masonry Mortar," *ACI Journal,* Proc. Vol. 56, No. 6, American Concrete Institute, Detroit, 1959.

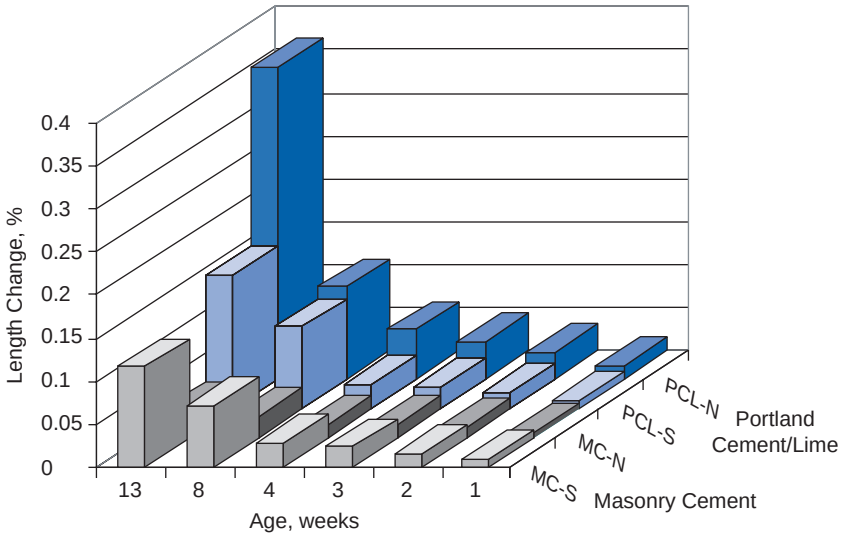

Fig. 2 – Sulfate expansion of masonry mortars.

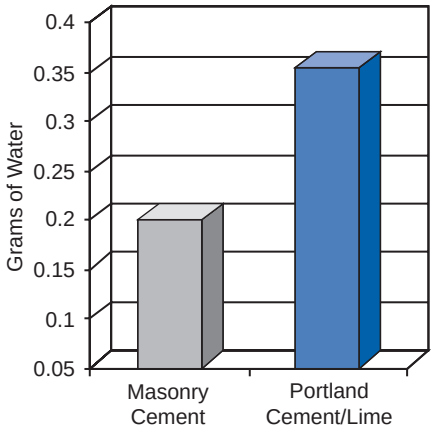

Fig. 3 – Water absorption of mortars.

cate that the drying shrinkage of masonry cement mortars is about half that of portland cement-lime mortars.

When sulfates come in contact with masonry mortar, subsequent expansion can cause deterioration of the mortar. Thus resistance to sulfate expansion should be considered where seawater or sulfate-bearing soils come in contact with masonry mortar. Masonry cement mortars demonstrate significantly greater sulfate resistance than portland cement-lime mortars (see Fig. 2).

Mortar can better resist chemical attack, staining, and freeze-thaw damage if it is less absorbent. Tests shown in Fig. 3 indicate that masonry cement mortars absorb only about half as much water as a comparable non-air entrained portland cement-lime mortar.

Expansion of mortars due to unsound ingredients can cause serious deterioration of masonry. Soundness of a cementitious material is measured by the autoclave expansion test. This test produces reactions in any unsound ingredient and simulates a long period of exposure for the cementitious material. Conformance of masonry cement to the autoclave expansion limits of ASTM C 91 assures that there will be no significant expansion of hardened mortar in a wall due to unsoundness.

Water Permeance. Water permeance of masonry is primarily related to workmanship and design. It is generally recognized that a single 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 weepholes, and maintaining clean cavities. The excellent workability, strength, and durability of masonry cement mortars assure that the designers' and masons' needs are met in regard to achieving watertight masonry construction. Careful laboratory research has confirmed the excellent performance of masonry cement mortars in water permeance tests. These laboratory tests are backed up with a record of over sixty years of excellent field performance.

Appearance. The color of masonry mortar is a crucial component in the appearance of a masonry wall. Since masonry cement color is laboratory controlled and masonry cement offers the simplicity of the one-bag system of batching, it is easier to achieve a consistent appearance in the finished job when using masonry cements. Colored masonry cements are also available to match, contrast, or complement the masonry units and enhance the architectural effect of the masonry.

INSTALLATION

Preparation. Masonry cement mortar materials mixed according to the proportion specifications of ASTM C 270 should be accurately proportioned as indicated in 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 cement is to be in the range of 2¼:1 to 3½:1 by volume.

Machine mixing should be used whenever possible. First, with mixer running, add most of the water and half of the sand required. Next, add the masonry 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

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

Mortar Type	Portland or Blended Cement	Mortar Cement Type M	S	N	Sand
M	—	1	—	—	2¼ - 3
M	1	—	—	1	4½ - 6
S	—	—	1	—	2¼ - 3
S	½	—	—	1	3⅜ - 4½
N	—	—	—	1	2¼ - 3
O	—	—	—	1	2¼ - 3

to 5 minutes improves the workability and water retentivity of the mortar. In mixing, use as much water 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,[4,5] and proper cleaning[6] 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 mortarboards. 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 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 on minimizing 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 as occur should be removed before they tenaciously 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.

William Wardlaw Center, Georgia Institute of Technology—Architect: Jova/Daniels/Busby, Inc.

AVAILABILITY

Availability: Masonry 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 masonry cement manufacturers contact PCA headquarters at 847. 966.6200, by fax at 847.966.9781, or at the Web site: www.cement.org.

CERTIFICATION

Masonry cement meets the requirements of ASTM C 91, The Standard Specification for Masonry Cement, for the type specified. Written manufacturer's certifications to that effect may be obtained from PCA member company producers of masonry 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

Quality Assurance for Masonry Mortar – IS279

Concrete Masonry Handbook – EB008

Recommended Practices for Laying Concrete Block – PA043

[4] *Trowel Tips: Hot Weather Masonry Construction,* IS243, PCA, Skokie, IL.

[5] *Trowel Tips: Cold Weather Masonry Construction,* IS248, PCA Skokie, IL.

[6] *Trowel Tips: Cleaning Masonry,* IS244, PCA, Skokie, IL.