

Masonry is a versatile medium for architectural expression. Fluted, split-faced, ground-faced, and custom prefaced architectural concrete masonry units are available in a myriad of textures and colors. Fired clay masonry units are manufactured in numerous color and texture options. White or colored mortars can provide a color contrast or harmony between masonry units and joints. Combining finishes and colors allows a limitless range of visual statements the designer can make with masonry.



Figure 1. Visually, mortar can represent a significant portion of a masonry façade. Where a white masonry wall finish is desired, white units should be assembled with white mortars.

White Mortars

White mortar is made with either white masonry cement or mortar cement, or with a combination of white portland cement, hydrated lime or lime putty, and white sand. White cements for masonry should meet the same ASTM specifications as their gray counterparts. Masonry cement should meet the requirements of ASTM C91 for Type N, S, or M masonry cement. Mortar cement should meet the requirements of ASTM C1329 for Type N, S, or M mortar cement. Portland cement should meet the requirements of ASTM C150 for Type I portland cement, although Type II or Type III cements can also be used in mortar.

White mortar, just like gray and colored mortars, should meet the requirements of ASTM C270 for the type designated (N, S, or M). Sand should meet the requirements of ASTM C144 and be free of silt or clay fines. Buff or brown sands used to produce white mortar will impart a darker undertone to mortar color. This effect may become more pronounced over time, or with cleaning, as sand particles are exposed due to erosion of the white mortar paste. To assure whitest mortar color, use only white sand.



Figure 2. White cement provides a neutral base for mortars whether they are white or tinted. The sand can have a tinting effect on mortar, so it should also be carefully selected for color.

Colored Mortars

For colored mortars, the use of white masonry cement or white portland cement instead of the normal gray cements not only produces cleaner, brighter colors, but is essential for making pastel colors such as buff, cream, ivory, pink, and rose. Integrally colored mortar may be obtained through the use of colored masonry or mortar cements, pigments, or colored sand. Mortar color is sensitive to pigment content. Consistent color is best accomplished by using pre-pigmented cements, preblended mortar, or by careful proportioning with pre-weighed pigment packages. The color of the mortar joints will depend not only on the pigment, but also on the cementitious materials, sand, water-cement ratio, and tooling.

Inorganic mineral oxide pigments (usually natural or synthetic metal oxides) are recommended for colored mortars. They are compatible with cement and lime and provide color stability in the finished mortar joint. Pigments should conform to ASTM C979, Specification for Pigments for Integrally Colored Concrete. Mineral oxide pigment addition rates are based on the weight of cement and should not exceed 10% dosage for portland cement-lime mortars, nor 5% dosage for mortars formulated with masonry or mortar cements.

Inorganic pigments are preferred for use in mortar and concrete because they deliver durable, consistent, UV stable colors. Organic pigments are generally not used in cement-based materials and should not be used in exterior applications or interior applications exposed to moisture. If organic pigments such as carbon black are used in interior masonry, addition rates should not exceed 2% by weight of portland cement or 1% by weight of masonry or mortar cement content.



Selecting White or Colored Mortar Materials

Initial selection of mortar color may be made on the basis of color charts or mortar samples that are typically available from manufacturers of white and colored cements and pigments. However, final selection of mortar color should be determined on the basis of evaluation of a sample panel or mockup constructed using the units, mortar materials, mixing procedures, workmanship, tooling technique, and cleaning and sealing procedure that is proposed for use in the final project. The purchaser (owner) and provider (mason) should review the sample panel together and establish a clear understanding of expectations of masonry and mortar appearance. The sample panel should be retained for reference until the masonry is completed and accepted by the owner.

Figure 3. A sample panel, or mockup, allows owners, designers, and builders an opportunity to agree on the appearance of the wall before construction begins.

Controlling Mortar Color

To assure consistent color on a project, the variables that determine mortar color (materials, mortar preparation, installation, and cleaning) must be controlled.

The same brand of masonry cement, mortar cement, or portland cement and hydrated lime or lime putty and pigments should be used throughout construction of a project. Sand should be from the same source. Care must be taken to assure that the sand is not contaminated with clay or dirt at the job site. White and light-colored mortars are particularly sensitive to such contamination.

Proper and consistent proportioning and mixing procedures need to be established. Masonry cement, mortar cement, portland cement, and hydrated lime are typically delivered in pre-weighed packages. Thus, consistent proportioning is assured by adding these ingredients to the mixer in bag increments, or sometimes in increments of a simple fraction of a bag. Positive control should be established to assure that a consistent, proper amount of sand is used. This can be accomplished by using a container of known volume to measure sand. Alternatively, pre-blended mortars from the same supplier and batch provide a consistent basis for mortars.

Mechanical mixing of mortar is recommended. Pre-blended mortars should be mixed according to the manufacturer's recommendations. For other mortars, use instructions provided by the mortar supplier. If no mixing instructions are given, experience has shown that good results can be obtained when about 3/4 of the required water, 1/2 the sand, and all the pigments and cementitious materials are briefly mixed together. The balance of the sand and the remaining water are then added to bring the mortar to optimum working consistency. The amount of water added should be the maximum that is consistent with satisfactory workability. After all the mortar materials are combined together, they should be mixed for 3 to 5 minutes. It is advisable to mix the full 5 minutes when producing pigmented mortars.



Figure 4. Made with one batch of mortar, these joints show the effect of mortar consistency and tooling time on mortar color. The top mortar joint was tooled immediately after placement of the unit. Remaining mortar joints were tooled at progressively greater time intervals and thus stiffer consistency, resulting in darker colors.

Quality Assurance Checklist

Masonry appearance is affected by conditions at the project site during construction. Although the wall may be a structural, load-bearing assembly, it's important to exercise care because the wall surface is often exposed to view. When specifying masonry, some items that could form the basis for a quality assurance checklist include the following:

- **Material Storage** - Brick, concrete masonry units and stone are finish products, and must be handled with great care. They must be stored to remain dry and clean. Masonry units stored on the ground can be damaged by site conditions, such as mud in staging areas.
- **Moisture Control** - Consistency is the key to maintaining moisture control. Mortar joint color will be adversely affected by masonry units with widely varying moisture contents.
- **Tooling** – The timing of and method of tooling, or “striking,” mortar joints is important to the appearance of masonry projects. The wetter the joint when tooled, the lighter the joint will appear. Joints should be tooled when the mortar is “thumbprint hard.” Laying masonry units of variable moisture content together may require several passes at the same wall section to produce consistent joint color.
- **Protect the Wall** – Cover unfinished walls at the end of work each day. Protect the finished base of the wall from debris, mud splatter, and from mortar droppings from above. Remove standing water from previously built masonry before continuing to build the wall.

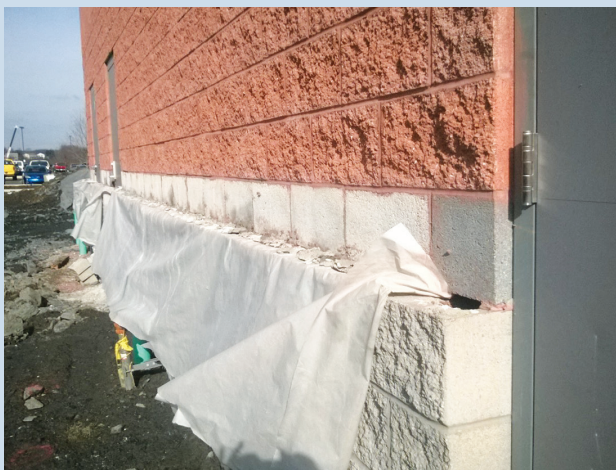


Figure 5. To prevent unwanted buildup and additional cleaning, protecting tops of walls and previously completed work is an essential best practice.

Mortar production should be scheduled to keep pace with the progress of construction. Mortar that has been mixed but not used immediately tends to dry out and stiffen. Avoid producing mortar too far ahead of expected use to minimize retempering, which can cause color differences and should be avoided or done with great caution with white or colored mortars. Water content and mortar stiffness at time of tooling will affect color.

Different joint finishes can be selected to provide a desired appearance in the completed masonry. Concave or V-joints are preferred for optimum weather resistance. Special care must be taken with white or very light-colored mortars to assure that joint surfaces are not “burned” or discolored with metallic deposits from the jointer. The mason should use ceramic, stainless steel, or plastic jointers to prevent mortar discoloration.

When it comes to cleaning masonry, less is better. Careful workmanship includes implementing skills that minimize mortar droppings and smears on the face of the masonry. Covering the tops of walls at the end of each working day will prevent rain from entering walls and help reduce the possibility of efflorescence.

If cleaning is necessary, use the least aggressive technique(s) possible. First, make certain that the cleaning materials and procedures are consistent with the recommendations of the manufacturer of the units. Pre-qualify the procedure on the sample panel and a small test area of the building. Allow the area to dry, and closely examine mortar joint surfaces to ascertain that the procedure has not etched the surface. If acid based cleaning solutions are used, the mortar should be allowed to cure at moderate temperatures for about a week prior to cleaning. Always pre-wet the masonry before applying a cleaning solution.



Figure 6. Pre-wetting and careful rinsing are key steps for successful cleaning with a cleaning solution. Photo courtesy of PROSOCO.

Summary

White cements and colored masonry cements or pigments expand the range of available mortar colors. Coupled with the variety of masonry unit colors and textures available, white and colored mortars afford the designer virtually unlimited creative options. With selection of the right mortar materials, verification of mortar color in field panels, and observance of proper construction practices, the creative vision of the designer can be made a reality.

Related PCA Publications

- *Masonry Mortars*, IS040
- *Masonry Cement Mortars*, IS181
- *Trowel Tips: Cleaning Masonry*, IS244
- *Trowel Tips: Efflorescence*, IS239
- *Trowel Tips: Mortar Color*, IS247
- *What is White Cement?*, WC001

Other Resources

ASTM International: American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, Pennsylvania; phone: 610.832.9500; fax: 610.832.9555; web site: astm.org

BIA: Brick Industry Association, 1850 Centennial Park Drive, Suite 301, Reston, Virginia 20191; phone: 703.620.0010; fax: 703.620.3928; web site: gobrick.com

MCAA: Mason Contractors Association of America, 1481 Merchant Drive, Algonquin, Illinois 60102; phone: 224-678-9709; fax: 224-678-9714; web site: masoncontractors.org

NCMA: National Concrete Masonry Association, 13750 Sunrise Valley Drive, Herndon, Virginia 20171-4662; phone: 703.713.1900; fax: 703.713.1910; web site: ncma.org

TMS: The Masonry Society, 105 South Sunset Street, Suite Q, Longmont, Colorado, 80501-6172; phone: 303.939.9700; fax: 303.541.9215; web site: masonrysociety.org



America's Cement Manufacturers™

Portland Cement Association

1150 Connecticut Avenue, NW, Suite 500
Washington, DC 20036-4104
202.408.9494 Fax 202.408.0877

5420 Old Orchard Road
Skokie, Illinois 60077-1083
847.966.6200 Fax 847.966.9781
www.cement.org