

## **Optimizing Mortar Formulations for Maximum Performance**

Concrete masonry units (CMUs) and mortar go together like bread and butter. For thousands of years engineers, architects and tradesmen have married these two components to form a system used to build everything from the ancient Egyptian pyramids to local schools. Even though masonry is one of the oldest and most proven methods of construction, the past few decades has brought major technological innovations that has not only improved labor practices but also the integrity and aesthetic value of the actual building materials.

Prior to the advent of factory preblended mortars in the late 20<sup>th</sup> century, mason contractors required a specified formula for measuring the proper ratios of cements and aggregates to be mixed on a jobsite based on *ASTM C270 TABLE 1 Proportion Specification Requirement* written by architects and engineers. The Proportion Specification, commonly referred to as the “recipe” method, allowed an onsite laborer to meter each individual mortar ingredient based on a cubic foot measurement system. This approach does not allow for regional variance in raw materials and severely challenged the ability of specifiers and mason contractors to achieve prescription mortars that aligned with the performance and characteristics of the CMUs.

That all changed with the introduction of preblended masonry mortar, which replaces the guess work of field-mixing with predetermined mix formulations based on clearly defined raw material weights measured according to strict tolerances for performance and quality control. Producing mortars in a controlled environment utilizing computerized batching equipment allows for customized formulations specifically designed to complement the unique properties of the masonry units specified and the controlled addition of performance enhancing admixtures. Moreover, from the perspective of a project designer, specifier or engineer responsible for selecting the best mortar for a project, preblended mortar offers endless customizable mix possibilities that match CMU properties while supporting the mason’s need to increase productivity.

### **Matching Preblended Mortars and Masonry Units**

All masonry units are not created equally and come in almost limitless colors, textures and finishes, each with different physical properties. However, the mortars available have generally been limited to type S or N, and then further limited to a single recipe when field mixing. Factory controlled preblended mortars allow for the full use of *ASTM C 270 TABLE 2 Property Specification* while specifically matching the performance of the mortar to the CMU. When the mortars are not properly matched to the CMUs’ properties, the mason will struggle with productivity when constructing a masonry wall. Why?

Brick are manufactured with different clays and baked at different temperatures to create different colors, textures, densities and hardness. They also absorb water at different rates, which is tested and reported as the initial rate of absorption (IRA) of the brick. A low IRA brick (5 grams per minute) will tend to swim or float if placed with a high water retention mortar, which is common in standard field mixed type S or N mortars. In addition, the mason will have to wait extended periods of time for the mortar joints to harden before finishing, which slows productivity. Conversely, a high IRA brick (greater than 30 grams per minute) may require the mason to tool every few brick immediately before the mortar joints lose moisture to the unit, harden quickly and become unworkable for tooling. Water retentions of factory preblended mortars can be pre-engineered to match the absorption rates of bricks on a project, eliminating tooling issues and shrinkage cracking while increasing productivity for the mason and color consistency on the wall through consistent tooling times.

CMUs and mortars that share similar properties should be matched together on projects. For example, architectural CMUs are densified in the manufacturing process to help create a unique finished appearance. This process makes the CMU less permeable and prone to swim or float when being installed by mason, slowing down the installation process. This also leads to onsite tooling and curing difficulties including unsightly surface mottling of the masonry joints, a condition where the cement paste cures at uneven rates at the surface of the joint only.



*Surface Mottling of Mortar Joint*

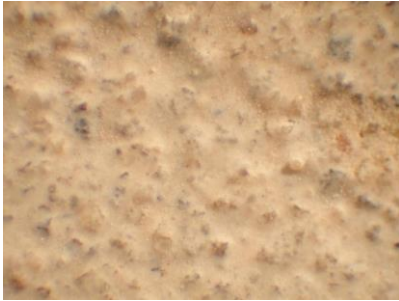
Stone masonry construction can benefit tremendously by transitioning beyond simple type S and N mortars designed for basic brick and block construction to performance designed mortars that match the properties of stone masonry units. When classifying stone used in masonry construction, stone falls generally into two basic categories, hard dense stone or soft porous stone. By factory controlling known mix designs and testing for water retentions and compressive strength properties, mortars can be designed to match the properties of the stone masonry units very closely. When this is done properly, shrinkage cracking is eliminated and more stone can be laid in a single day thanks to preblended mortar that will support the units properly so the wall can “set up” quickly.

#### **High Performance Ingredients in Preblended Mortar**

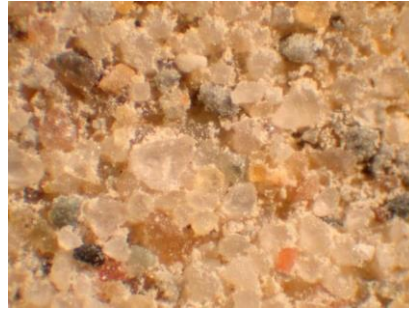
Performance enhancing admixtures introduced into masonry mortars can be used to increase durability and flexibility or to help the installer extend the range of conditions that masonry walls can be constructed. It’s important to note that the inclusion of admixtures in masonry mortars change the chemistry, which directly changes the performance of the mortar and often its final appearance. As mortars continue to evolve through the use of improved and higher-performing admixtures, controlling the addition rates in a factory setting ensures a consistent outcome on site.

The most common admixtures used in masonry today are water repellents, which are generally used in the production of architectural CMUs . Due to the water repellent properties incorporated into

architectural CMUs, they tend to act more like a plate of glass than a standard CMU making cleaning them particularly tricky. If the mortar joint is not properly enhanced with a water repellent and does not act in a similar manner to the CMU, it will absorb the cleaning solution at a much higher rate than the CMU. If untreated or improperly dosed, the cleaning process can cause the cementitious paste to be eaten away, exposing the aggregate in the mortar. To help avoid this undesirable discoloration, factory preblended mortar can be enhanced with a controlled dosage of water repellent to ensure performance from batch to batch.



*Mortar joint with cementitious paste intact*



*Mortar joint chemically etched in washing process*

Admixtures are also used in mortars designed to install thin masonry veneer, one of the most popular masonry claddings today. Incorporating admixtures that increase bond strength can double the flexural bond properties of standard mortars while increasing its flexibility to accommodate movement and deflection common in this type of application.

Another invaluable admixture in preblended mortar is set accelerators. There is no such thing as “anti-freeze” for mortar, but set accelerators speed up the set time of mortar, so mason contractors can work in colder conditions. Specifically, the set accelerators allow the mortar to use the mixing water at an accelerated rate, hydrating the cement before temperatures drop enough to freeze the water in the mortar. Similarly, the use of set delaying admixtures can slow down the hydration of the cement in the mortar on hot days to keep the cement from drying out before full hydration of the cement occurs. If the addition rates are not properly controlled, the outcome can be catastrophic. Only factory preblended facilities can guarantee that these admixtures have been properly weighed and controlled to achieve the desired result.

### **Conclusion**

The introduction of factory preblended mortar is arguably one of the most significant developments impacting the way building owners, designers and mason contractors select and construct masonry projects today. Whether the architectural drawings call for brick, CMU, building stone or thin masonry veneer, preblended mortar manufacturers are able to engineer mix designs for structural wall or veneer system with optimal mechanical bond, compressive strength and mortar joint color allowing the designers vision to be translated onto the building.