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ABSTRACT:
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KEYWORDS:
Concrete Masonry, cement, mortar, brick, CMU, stone.

REFERENCES:
American Concrete Institute (ACI).
Brick Industry Association (BIA)
Portland Cement Association (PCA)
ASTM C270, Standard Specification for Mortar for Unit Masonry.
ASTM C780, Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced unit Masonry.
ASTM C1586, Standard Guide for Quality Assurance of Mortars.

Choosing Mortar Types

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Mortar

Mortar makes it possible to build up strong walls, veneers, and structures out of smaller, unitized masonry components. Concrete block, brick, stone, and other types of products are installed using mortar to bind them together and to their substrate. Mortar is made up of portland cement or other cement blends and plasticizing materials such as lime. Aggregate (sand), and water complete the list of ingredients. Blended masonry and mortar cements may also be used, the properties discussed later.
The strength of mortar relative to the materials being installed is critical. Mortar must be strong enough and flexible enough to allow the structure to function as designed. The choice of what mortar to use is an important design consideration.

Mortar Types

ASTM C270 defines four mortar types, listed from greatest to least strength and from least to most workable:
Type M is a high strength mortar that is most often used in load bearing applications or where severe freeze-thaw conditions will be a factor.
Type S is used in load bearing and exterior applications, normally at or below grade.
Type N mortar is a general purpose mortar with good workability and strength for exterior above grade and interior applications.
Type O mortar is low strength mortar used for some interior applications and repointing.

Various sub-types and colors of specialty mortar exist as well, but for this discussion we will stay with the basics. Mortar specifications can be written either as property specifications or proportion specifications. These are discussed in more detail, below. The proportion method is the default, when not specified.
Building Code requirements may limit the use of some types of mortar. Include a code review prior to the assessment and selection of a mortar.

Mortar Properties

The strength of mortar, like concrete, is based on the ratio of cement to aggregate. Water is added to create a chemical reaction with the cement, and must be carefully measured to avoid excess shrinkage of the mortar while allowing workability.
Other design considerations are the building materials (brick, CMU, etc.), flexibility, and weather exposure conditions. The mortar cannot be too rigid in an assembly that is subject to forces that cause movement, and must also be strong enough to withstand freeze-thaw cycles. An appropriate balance of strength, workability, serviceability, and flexibility is the design goal.

Cements

A discussion on various types of cement and their properties would be an article in itself, so we will just briefly touch on the basic types of cements used in mortars. See PCA Glossary for definitions.
Portland cement (ASTM C150) is the principal ingredient for cement-lime

mortar. Three types of portland cement are recommended for use in mortars: Type I, recommended for general use and where other types are not required; Type II for use where sulfate resistance or special hydration needs are a factor; and Type III for use when high early strength is required.
Other types of cement may be blended with portland cement. These may include slag cement and pozzolan cement, that may be blended in to enhance certain properties of the mortar.
Masonry cement (ASTM C91) consists of portland cement blended with various fillers or additives and is most commonly used as the basis of prepackaged products (see below).
Mortar cement (ASTM C1329), similar to masonry cement, differs in that it is specially blended to have lower air content than masonry cement, and is most often used in structural applications that require high flexural bond strength.
Prepackaged mortars (ASTM C387) are often used in lieu of **site mixed mortar** (ASTM C270). Prepackaged mortars are factory blended for particular applications and uses. Mortar may contain any cement listed above and others, unless the type is specified. ASTM specifications do not set a default. Be sure to consult masonry unit manufacturers for their recommendations on what mortar type will best suit their materials.

Specification of Mortar

The Portland Cement Association website has a simple, "Quality Mortar" guide featuring a decision flow chart from ASTM C1586. This standard explains how to use specification ASTM C270 (for preconstruction lab testing for mix design) and test method ASTM C780 (for field inspection and testing).
ASTM C270 contains two tables. The first a "proportion" table that contains "recipes" for mortar that achieve established, consistent results. Mortars specified in this fashion require no preconstruction testing. The second table is a "property" table that sets compressive strength for mortar (shown below). When specifying performance preconstruction lab testing is required
to verify the mix design.

Mortar Type	Compressive Strength
M	2,500 psi
S	1,800 psi
N	750 psi
O	350 psi

Environmental factors can also affect the mix required to achieve a certain result. Monitoring and testing of the mortar are always advised during construction. Observe proportions and test aggregate ratio for proportion mortar spec. Test for mortar uniformity and generally compare to preconstruction strength values for performance mortar spec.

Industry Support

Industry groups that provide support for each type of material: American Concrete Institute (ACI) www.concrete.org, the Brick Industry Association (BIA) www.bia.org, National Concrete
Masonry Association (NCMA) www.ncma.org, and Portland Cement Association www.cement.org, to name a few.
Each industry group provides technical information for the products they represent as well as recommendations for accessory materials, such as mortar. Any design should start with a reference to the appropriate trade associations for guidance.

Conclusion

Not all mortars are equal. There are relatively simple general guidelines for mortar use, but careful assessment of the work must be a part of the design of the masonry system and the selection of the best mortar for the job. Strongest is not always the best. Careful initial assessment of the work and reference to the plentiful technical data available from the industry will result in good masonry design. Careful observation and testing of the mortar during construction should result in a quality installation.

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