TROWEL TIPS *Information*

Hot Weather Masonry Construction

Hot weather poses some special problems for masonry construction. These arise from higher temperatures of materials and equipment, more rapid evaporation of the water required for cement hydration, and accelerated cement hydration. The Masonry Standards Joint Committee document *Specification for Masonry Structures (ACI 530.1/ASCE 6/TMS602)*, hereafter referenced as the *MSJC Specification*, defines hot-weather construction as occurring when ambient temperature exceeds 100°F (37.8°C), or 90°F (32.2°C) when the wind velocity is greater than 8 mph (12.9 km/h). Factors compounding hot-weather problems include low relative humidity and direct sunshine.

As the temperature of mortar increases:

- Workability is reduced; or, for a given workability, more water is required.
- A given amount of air-entraining agent yields less entrained air.
- Initial and final set occur earlier, and evaporation rates are generally faster.
- Units absorb more moisture from the mortar.

As a result, the mason will find it more difficult to place mortar and units. However, in addition to affecting workability, rapid drying can result in a lack of sufficient water for hydration of cement in the mortar. Since hydration of cement is necessary for normal strength development of mortar, a marked reduction in strength may occur under rapid drying conditions. Exposed mortar surfaces are particularly vulnerable. Evaporation removes moisture more rapidly from the outer surface of a mortar joint, while the interior retains moisture longer and develops greater strength. This difference in strength across the thickness of the wall can reduce the wall's buckling strength and resistance to wind or other horizontal loads.

Recognizing these potential problems is the first step in avoiding them. With careful planning and preparation, steps can be taken to minimize or compensate for the effects of hot weather on masonry construction.

Fig. 1. Use a workable, water-retentive mortar. (IMG13629)

Scheduling

Many of the problems associated with hot-weather masonry can be minimized by scheduling construction to avoid hot, midday periods. Use the early morning hours during the extended daylight season associated with hot weather. This will provide the benefit of working with materials that have cooled overnight. Also, the more comfortable working temperatures usually result in improved workmanship and productivity. In some instances, night construction may be an effective alternative—provided adequate lighting and support services are available.

Selecting a Mortar Mix

In hot-weather construction, properties such as water retentivity and workability should be given careful consideration when selecting mortar type and materials. For example, provided Type N and Type S mortars are both structurally adequate for a given masonry application, the increased water retentivity and workability generally associated with a Type N mortar make it a better choice for hot-weather construction.

The proportion and property specifications of ASTM C270 permit selection of mortar mix designs within prescribed ranges of sand contents. The sand content of a specific combination of sand and masonry cement or sand and portland cement-lime can be adjusted within these limits to optimize the board life, water retentivity, and

workability of the mortar. However, there is often a trade-off between different mortar properties. For example, increasing sand content tends to increase board life but can reduce water retentive properties and strength development of mortar. Reducing the sand content tends to reduce board life but increases the level of hydration achieved before water is lost by evaporation, thereby accelerating early strength gain. Mortar materials and proportions should be selected to provide balanced performance compatible with units used in construction and prevailing weather encountered. Whenever mortar is accepted under the property specifications, laboratory tests must be performed to confirm that the selected mortar materials and proportions meet ASTM C270 requirements.

The use of retarding admixtures in conventional mortar systems is not recommended. Retarders delay set time of the mortar, but they do not reduce evaporation rates. Therefore, don't expect retarders to solve all hot-weather problems. Proper curing is still needed to develop required hardened mortar properties.

Storage and Preparation of Materials

Keep materials as cool as possible. Cover or shade units and mortar materials from direct sunlight, whenever practical. Maintain sand in a damp, loose condition, both to provide evaporative cooling and to assure consistent batching of mortar materials when proportioning by volume. Whenever sand moisture drops below the 4% to 8% that is typical for sand delivered in a damp, loose condition, the stockpile should be sprinkled to restore moisture and increase evaporative cooling.

Fig. 2. Retemper mortar as needed to maintain a workable consistency. (IMG13630)

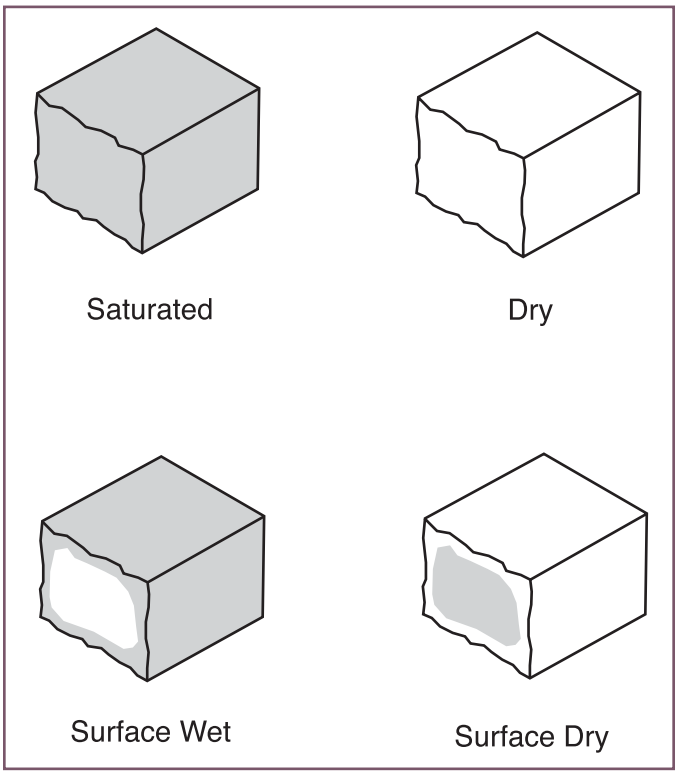

Fig. 3. Moisture Conditions of Clay Brick.

Use cool water to mix the mortar. Water stored in a light colored, open barrel is cooled to some extent by surface evaporation. Coupled with shading of the barrel from direct sunlight, evaporative cooling may be sufficient. Water can also be cooled by maintaining a steady flow or adding ice. Avoid using water from an unshaded water hose of any significant length. When exposed to sunlight, long water hoses become effective water heaters, compounding difficulties associated with hot-weather construction.

Mortar can also absorb heat from contact with metal equipment. Cooling mixers, wheelbarrows, mortar pans, and other metal equipment by flushing with cool water helps reduce such heat gain. Wooden mortar boards tend to be quite absorptive and should also be flushed with water prior to contact with fresh mortar.

Mix mortar from three to five minutes in a mechanical mixer using the maximum amount of water consistent with good workability. It should also be retempered as needed to maintain a workable consistency. Discard mortar that has not been used within 2 hours and mix fresh mortar.

Clay brick units having a high initial rate of absorption (IRA) can contribute to the rapid dry-out of mortars in hot weather. Wetting of units having an IRA of over 30 g/min•30 sq in. (30 g/min•194cm^2) is recommended to reduce the suction of the brick. As indicated in Fig. 3, brick can be fully saturated, surface wet, surface dry, or completely dry. The optimum condition for hot-weather construction is the surface dry condition where the unit has sufficient suction to establish good bond with the mortar without contributing to rapid drying of the

mortar. The surface wet condition may also yield desired performance—provided adequate depth of moisture exists and the surface is not dripping wet. A saturated condition will inhibit good bond between mortar and unit and, as noted previously, dry units with high IRAs contribute to the rapid dry-out of mortars in hot weather.

Concrete masonry units should not be wetted before use. They expand when wet and shrink as they dry. Thus, placing wet concrete masonry units in a wall contributes to increased shrinkage. When necessary to assure adequate curing moisture, apply a fog spray after the concrete masonry wall is in place.

Other Construction Practices

During hot-weather construction, avoid spreading mortar too far ahead of the masonry being placed. Masonry units should be placed on mortar bed as quickly as possible. Since wind and low relative humidities increase evaporation, the use of wind screens and fog sprays can effectively reduce the severe effects of hot, dry, windy weather. Also covering walls immediately after construction will slow the rate of loss of water from the masonry. Damp-curing (either covering to keep moisture in the wall, fog spraying to replace moisture lost by evaporation, or both) is very effective, and helps development of tensile bond strength. Damp curing should be considered in applications where bending stresses may be significant.

MSJC Specification Requirements

The *MSJC Specification* requires implementation of certain hot-weather construction procedures based on ambient temperature and wind. When ambient temperature exceeds 100°F (37.8°C) or 90°F (32.2°C) with a wind velocity greater than 8 mph (12.9 km/h), the *MSJC Specification* directs the contractor to: maintain sand piles in a damp, loose condition; assure that mortar temperatures are below 120°F (48.9°C); flush the mixer, mortar transport containers, and mortar boards with cool water before they come into contact with mortar ingredients or mortar; maintain mortar consistency by retempering with cool water; and use mortar within 2 hours of initial mixing. If ambient temperatures are above 115°F (46.1°C) or 105°F (40.6°C) with a wind velocity greater than 8 mph (12.9 km/h), in addition to the requirements noted above, masonry materials and mixing equipment are to be shaded from direct sunlight, and cool water is to be used to mix mortar.

Whenever mean daily temperature is above 100°F (37.8°C) or above 90°F (32.2°C) with a wind velocity greater than 8 mph (12.9 km/h), the *MSJC Specification* further requires fog spraying all newly constructed masonry until damp, at least three times a day until the masonry is three days old. Note that this requirement is indexed to mean daily temperature whereas other requirements of the *MSJC Specification* are indexed to ambient temperatures.

Fig. 4. Avoid spreading mortar too far ahead of units. Place unit on mortar bed as quickly as possible. (IMG13631)

MSJC Specification requirements are minimum requirements intended to avoid dryout and assure proper curing. The mason may find it desirable to implement preparation, construction, and protection requirements of the *MSJC Specification* at lower temperatures or to incorporate additional measures discussed in this *Trowel Tips* publication to optimize productivity and quality.

Summary

Advanced planning and preparation are key to the successful construction of masonry in hot weather. Important elements to consider in developing such plans:

- Schedule construction to avoid hot, midday periods.
- Select workable, water-retentive mortar mixes.
- Minimize exposure of materials and equipment to direct sunlight.
- Use cool water to mix mortar.
- Maintain sand piles in damp, loose condition.
- Flush metal equipment and wooden mortar boards with cool water before contact with fresh mortar.
- Pre-wet high IRA clay masonry units.
- Don't spread mortar too far ahead of work. Place top unit on mortar bed as quickly as possible.
- Under extreme drying conditions, use windbreaks, fog sprays, or wall coverings to assure adequate moisture for curing of mortar.

References

1. *Specification for Masonry Structures (ACI 530.1-05/ASCE 6-05/TMS 602-05)* and *Commentary on Specification for Masonry Structures (ACI 530.1-05/ASCE 6-05/TMS 602-05)*, American Concrete Institute, Farmington Hills, Michigan, American Society of Civil Engineers, Reston, Virginia, The Masonry Society, Boulder, Colorado, 2005.
2. Panarese, W. C., Kosmatka, S. H., and Randall, F. A., Jr., *Concrete Masonry Handbook for Architects, Engineers, Builders*, EB008, Portland Cement Association, 1991, pp. 121-123.
3. *Hot and Cold Weather Masonry Construction*, The Masonry Industry Council, PCA Publication Code LT232, 1999.

Related Publications

Readers of this publication may also be interested in the following publications available for purchase from the Portland Cement Association. A complete listing of PCA publications is given in the free PCA Catalog (MS414). To order, write or call Customer Service, Portland Cement Association, 5420 Old Orchard Road, Skokie, Illinois 60077-1083, phone 800.868.6733, Web site www.cement.org.

Concrete Masonry Handbook, EB008

Masonry Mortars, IS040

Masonry Cement Mortars, IS181

Trowel Tips: Efflorescence, IS239

Trowel Tips: Tuckpointing, IS240

Trowel Tips: Mortar Sand, IS241

Trowel Tips: Field Testing Masonry Mortar, IS242

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Trowel Tips: Mortar Color, IS247

Trowel Tips: Cold Weather Masonry Construction, IS248

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Mortar Cement: Product Data Sheet, IS281

Masonry Cement: Product Data Sheet, IS282

Recommended Practices for Laying Concrete Block, PA043

Masonry Cement: Beauty to Last a Lifetime, PA163

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