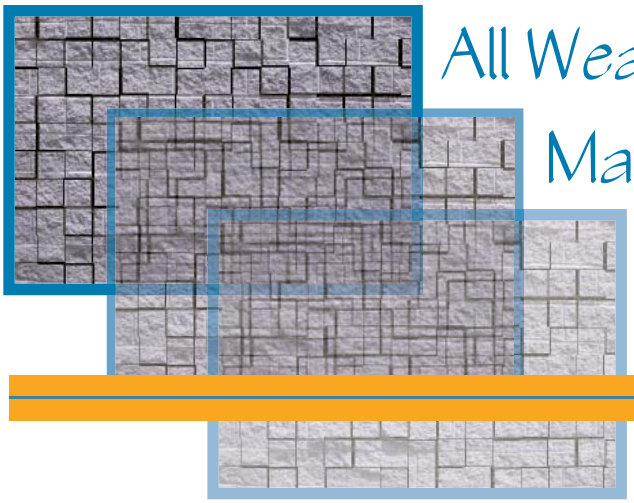

All Weather Masonry Part 1

Hot Weather Requirements

By Diane Throop, P.E.

Neither snow, nor rain, nor heat…shall keep masonry from being built well.

With an apology to the United States Postal service for altering their motto, this phrase makes a perfect maxim for masonry construction. Masonry is a site built system permitting the accommodation of project tolerances and offering diverse flexibility in design and construction. As such, the installation is done under diverse weather conditions. Procedures have been developed to permit construction to continue in all weather. Let's discuss hot weather related procedures including code mandates in both the USA and Canada. Cold weather procedures will be addressed in Part 2 in a future article.

Water, Water Everywhere

Water is a necessary ingredient in masonry construction. Water is required in mortar and grout to make installation possible. It makes mortar workable and grout fluid enough to pour. When water in mortar and grout comes in contact with masonry units, it migrates into the absorptive units carrying with it cementious fines facilitating the bonding of the units into masonry assemblies. Sand is damp, units have moisture content - water is everywhere and makes the system work. It is as necessary to masonry construction as are masons.

Both masonry mortar and grout are Portland cement based, gaining strength from the hydration of the cementious materials. Hydration requires water and is minimal at temperatures below 40 degrees F (40°C). At temperatures above 120 degrees F (49°C) flash set occurs. To get good hydration and desired compressive strength from the masonry, mortar and grout must carry enough water to meet both the hydration and unit absorption demands. It is also necessary that the temperature be kept at between approximately 40 degrees F (40°C) and 120 degrees F (49°C) during the early hydration and strength gain stages. During much of the year, this is not a difficult task. During hot weather however, there can be challenges.

Cement hydration is not the only concern when weather meets water. Hot units may absorb so much moisture that there is not enough left to hydrate the mix resulting in flash sets. Highly absorptive units may remove the moisture from the mortar so fast that joints hardly can be strung. Sand can carry more or less moisture depending on its temperature again, affecting the properties of the finished system. Masons can adapt to temperature extremes, but better performance can be expected if conditions are moderate and units aren't too hot to handle.

What Can Be Done?

Changing the weather is not an option. Removing water from the system is not an option. The challenge then is to understand the dynamics of masonry systems, and manage both water and weather to insure that the materials function properly. We've established that hydration must take place for proper strength gain. The good news, as far as all-weather masonry construction is concerned, is that strength gain in both mortar and grout is fairly rapid. This means the protection period for the newly constructed work can be relatively short. Fog spraying during extremely hot weather need only be done for approximately 3 days.

Strategies permitting work to continue in all weather are numerous. The guidelines below provide a good basis for establishing project specific methods to meet the code requirements. While not updated to current code requirements, a good source on all-weather masonry construction techniques can be found in *Hot & Cold Weather Masonry Construction* (The Masonry Industry Council, 1999).

Handling & Storage

- Keep materials off the ground on pallets, water proof membranes, etc. to prevent contamination or infiltration by ground water, snow, ice, etc.
- Cover materials to protect from water. In hot or windy weather, this keeps the materials from drying excessively.
- Sprinkle the sand pile to restore moisture, if necessary, to maintain it in a damp, loose condition – typically 4% to 8% moisture.

Cooling

- Shade materials from direct sunlight to keep them cool.
- Store water in light colored containers, maintain a steady flow, or add ice. Ice should not be added to mortar or grout, only to water.
- Cool metal equipment such as mixers, wheel barrows, mortar pans, etc. by flushing with cool water and shade them when not in use.
- Mortar boards can be absorptive so flush prior to adding mortar to reduce absorption.

Materials

- Some mortars are more water-retentive than others. Generally higher lime

content or finer sands tend to produce mortar with high water retentivity. This may make them better choices for hot weather construction.
- Type N mortar is generally more water-retentive and more workable than Type S mortar. Assuming both are structurally suitable, the more water-retentive Type N would be a better hot weather choice.
- Grout has high water content and is poured into absorptive units. It is critical to maintain enough slump to permit it to completely fill core spaces and flow around protrusions, reinforcing, etc. Standards specify slumps between 8 and 11 inches. During hot weather, or when using highly absorptive units, higher slumps are generally indicated.

Workmanship

- Permit high absorption brick to be wet during hot weather to reduce the amount of water they pull from the mortar or grout.
- Permit tempering of the mortar, especially during hot weather. Mortar boards can be absorptive and hot, dry or windy weather speeds the evaporation of water from the mortar. Retempering replaces lost water and improves workability – both good things.
- Limit the amount of bed joint mortar placed ahead during hot weather as the exposed mortar surface looses moisture quickly.

Admixtures & Additives

- During hot weather, retarders, if specified, may be used to extend the set time. They do not reduce evaporation. Hot weather construction practices still must be used.

Protection

- Enclosures moderate the weather immediately surrounding work under construction and limit the effects of wind.
- Fog spraying newly constructed masonry keeps it cool and moist while curing. It helps prevent flash set of the mortar and grout.

Rules & Regulations

Codes and standards mandate hot weather requirements for masonry under construction and protection requirements for time periods immediately following installation.

Retempering. Photo courtesy of PCA

The table that follows outlines hot weather provisions found in the *2003 International Building Code (IBC)*, *NFPA 5000 Building Construction and Safety Code, 2003 Edition (NFPA)*, the *Masonry Standards Joint Committee (MSJC) Specification for Masonry Structures (ACI 530.1/ASCE 6-02/TMS 602-02)* and *Canadian Standard Association (CSA) Standard A371-94(99) Masonry Construction for Buildings*. NFPA adopts the MSJC requirements in their entirety. IBC 2003 offers the option of using the MSJC 2002 provisions or the ones listed within the IBC 2003. Regarding weather concerns, there are few differences between the MSJC and the IBC. MSJC includes requirements for grouted prestressed masonry bonded tendons. The two standards use different SI conversion styles. The table shows the hot weather requirements from the 2002 MSJC – the latest published version as of this writing. The 2005 MSJC modifies these provisions by the addition of Autoclaved Aerated Concrete (AAC) masonry unit construction requirements.▪

See table on next page

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References

1.) Hot & Cold Weather Masonry Construction, The Masonry Industry Council; 1999.
2.) 2003 International Building Code, International Code Council, Inc., Country Club Hills, Illinois; 2002.
3.) NFPA 5000 Building Construction and Safety Code, 2003 Edition, National Fire Protection Association, Quincy, Massachusetts; 2002.
4.) Specification for Masonry Structures (ACI 530.1-02/ASCE 6-02/TMS 602-02), American Concrete Institute, Farmington Hills, Michigan, American Society of Civil Engineers, Reston, Virginia, The Masonry Society, Boulder, Colorado; 2002.
5.) Standard A371-94 (reaffirmed 1999) Masonry Construction for Buildings, Canadian Standards Association, Rexdale, Ontario Canada; 1994 (1999).

Hot weather requirements. *Requirements are cumulative. As temperatures rise, the requirements for lower temperatures still apply. Temperatures are ambient air temperatures unless noted. For simplicity, the SI values given in the requirements column are from the IBC 2003 or CSA A371-94.*

Construction Requirements	MSJC 2002 & NFPA 5000	IBC 2003**	CSA A371-94(99)
Prestressing grout temperatures maintained below 90˚F (32.2˚ C) during mixing & pumping	All weather	-	-
Provide necessary conditions & equipment to produce mortar having a temperature below 120˚F (49˚C)	Above 100˚F (37.8˚C) or above 90˚F (32.2˚C) with wind velocity greater than 8 mph (12.9 km/h)	Above 100˚F (38˚C) or above 90˚F(32˚C) with wind velocity greater than 8 mph (13 km/h)	-
Mortar & grout maintained at temperatures below 120˚F (49˚C)	Above 100˚F (37.8˚C) or above 90˚F(32.2˚C) with wind velocity greater than 8 mph (12.9 km/h)	Above 100˚F (38˚C) or above 90˚F(32˚C) with wind velocity greater than 8 mph (13 km/h)	-
Mortar temperatures shall not exceed 50˚C to avoid flash set	-	-	All weather
Grout shall be placed in masonry at max. temperature of 50˚C	-	-	All weather
Spread of mortar beds limited to 1.2 m	-	-	38˚C or 32˚C with wind velocity greater than 12 km/h
Units set within 1 minute of spreading mortar	-	-	38˚C or 32˚C with wind velocity greater than 12 km/h
Maintain sand pile in damp, loose condition	Above 100˚F (37.8˚C) or above 90˚F(32.2˚C) with wind velocity greater than 8 mph (12.9 km/h)	Above 100˚F (38˚C) or above 90˚F (32˚C) with wind velocity greater than 8 mph (13 km/h)	-
Flush mixers, mortar transport containers and boards with cool water before contact with materials	Above 100˚F (37.8˚C) or above 90˚F (32.2˚C) with wind velocity greater than 8 mph (12.9 km/h)	Above 100˚F (38˚C) or above 90˚F (32˚C) with wind velocity greater than 8 mph (13 km/h)	-
Retemper mortar with cool water to maintain consistency	Above 100˚F (37.8˚C) or above 90˚F (32.2˚C) with wind velocity greater than 8 mph (12.9 km/h)	Above 100˚F (38˚C) or above 90˚F (32˚C) with wind velocity greater than 8 mph (13 km/h)	-
Use mortar within 2 hours of initial mixing	Above 100˚F (37.8˚C) or above 90˚F (32.2˚C) with wind velocity greater than 8 mph (12.9 km/h)	Above 100˚F (38˚C) or above 90˚F (32˚C) with wind velocity greater than 8 mph (13 km/h)	-
Shade materials and mixing equipment from direct sunlight	Above 115˚ F (46.1˚C) or above 105˚F (40.6˚C) with wind velocity greater than 8 mph (12.9 km/h)	Above 115˚ F (46˚C) or above 105˚F (40˚C) with wind velocity greater than 8 mph (13 km/h)	-
Use cool mixing water for mortar and grout. Ice permitted in the mixing water prior to use but not when added to the other mortar or grout materials	Above 115˚ F (46.1˚C) or above 105˚F (40.6˚C) with wind velocity is greater than 8 mph (12.9 km/h)	Above 115˚ F (46˚C) or above 105˚F (40˚C) with wind velocity greater than 8 mph (13 km/h)	-
* **Protection Requirements** *			
Fog spray newly constructed masonry until damp at least three times a day for three days	Above 100˚F (37.8˚C) or above 90˚F (32.2˚C) with wind velocity greater than 8 mph (12.9 km/h)	Above 100˚F (38˚C) or above 90˚F (32˚C) with wind velocity greater than 8 mph (13 km/h)	-

**See standard for exact language and detail.*
***The IBC 2003 permits the use of the MSJC 2002 cold weather provisions as an option.*