All-Weather Masonry-Part 2

By Diane Throop, PE

In the May 2005 issue of STRUCTURE, we discussed hot weather procedures for masonry. That article is available on-line at **www.structuremag.org** and lists all the references used in this article. This month, we will continue the discussion specifically related to cold weather provisions in both the USA and Canada.

Water – A Key Ingredient

In the previous article, we stated that water is necessary in masonry construction to make mortar and grout installation possible. It makes mortar workable and grout fluid enough to pour. Water migrates into the absorptive units carrying with it cementious fines facilitating the bonding of the units into masonry assemblies. However, the need for water produces the challenges inherent in cold weather construction.

There must be sufficient water to get good hydration and meet the demands of unit absorption. In addition, it is preferable that the water is above 40°F (4°C). During much of the year, this is not a difficult task. During cold weather, however, there are challenges.

Cement hydration is not the only concern when cold weather meets water. Frozen water in units, mortar, and grout can cause disruptive expansion, and cold units do not absorb as much moisture which can affect bond. Low absorption units may "float" during cold snaps as their ability to pull the moisture from the mortar or grout is lessened. Masons can adapt to temperature extremes, but better performance can be expected if conditions are moderate and units aren't too cold to install.

How Do We Do It?

Removing water from the system is not an option. The goal is to understand the dynamics of masonry systems and manage both water and weather to insure that the materials function properly.

In discussing hot weather, we established that hydration must take place for proper strength gain. Fortunately, the strength gain of both mortar and grout is fairly rapid. This means the protection period for the newly constructed work during cold weather can be relatively short – usually 24 to 48 hours.

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*. Here are a few tips followed by the code requirements.

Handling & Storage

- Keep materials off the ground on pallets or water proof membranes to prevent contamination or infiltration by ground water, snow, or ice.
- Cover materials to protect from ice, rain, snow or sleet.
- Remove visible ice from any material before it is used.

Heating

- If given a choice, heating water is typically easier than heating sand or aggregate.
- Do not heat water above 140°F (60°C) as flash set can occur.
- Add heated water to cold sand in the mixer before adding cement to avoid flash set.
- Heating sand can often be accomplished with heating blankets or pads, heated pipes buried in the sand, or steam heating.
- Units can be warmed on pallets or stored in heated areas.

Materials

- Type III Portland cement is a well known cold weather option. It gains strength rapidly which lessens the amount of time the fresh mortar or grout is exposed to cold temperatures. This is recognized in codes by a reduction in protection time when (only) Type III is used in grout.
- As a caution, changing materials part way through a job may affect the appearance. Type III cement in the mortar will likely result in different color joints than Type I. The same can be said for switching mortar types or aggregates.
- 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. Cold weather and/or low absorption units may dictate using lower slump grout.

Workmanship

- Retempering replaces lost water and improves workability – both good things. It is not as necessary in cold weather, but it is still an acceptable practice enhancing mortar workability.
- During cold weather, masons may string shorter mortar beds to limit exposure to cold temperatures by the fresh mortar.
- Mortar takes longer to set in the cold, so masons may need to wait to lay up the next course, and also wait before tooling the joints.

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*Table 1: Cold Weather Masonry **Construction** Requirements**

Construction Requirements*	MSJC 2005 & NFPA 5000	IBC 2003**	CSA A371-94 (99)
Cover unfinished work	All weather	All weather	All weather
Protect materials from contaminants and so not wetted by rain, snow or ground water	-	-	All weather
Grout placed in masonry at min. temperature of 20°C and max of 50°C and maintained above 0°C for 24 hours following placement of grout	-	-	All weather
Unit temperature when laid is not less than 20°F (-7°C)	Below 40°F (4.4°C)	Below 40°F (4°C)	-
No visible ice, snow on materials	Below 40°F (4.4°C)	Below 40°F (4°C)	-
Remove visible ice and snow from top of foundation or masonry receiving new construction. Heat surface above freezing	Below 40°F (4.4°C)	Below 40°F (4°C)	-
Do not lay glass unit masonry	Below 40°F (4.4°C)	Below 40°F (4°C)	-
Heat water *or* sand (not above 140°F (60°C)) to produce mortar temperature between 40°F (4°C) and 120°F (49°C)	40°F (4.4°C) to 32°F (0°C)	Between 40°F (4°C) & 32°F (0°C)	-
Heat sand *or* water to min. of 20°C and max. of 70°C	-	-	0°C to 4°C
Heat water *or* aggregate for grout (not above 140°F (60°C))	When material(s) temperature is below 32°F (0°C)	When material(s) temperature is below 32°F (0°C)	-
Mortar temperature maintained above freezing until used	32°F (0°C) to & 25°F (-3.9°C)	Between 32°F (0°C) & 25°F (-4°C)	-
Heat water *and* sand (not above 140°F (60°C)) to produce mortar temperature between 40°F (4°C) and 120°F (49°C)	32°F (0°C) to & 25°F (-3.9°C)	-	-
Heat sand and water to min. of 20°C and max. of 70°C	-	-	0°C and below
Heat water and aggregate so grout is between 70°F (21°C) & 120°F (49°C) at time of mixing	32°F (0°C) to & 25°F (-3.9°C)	Between 32°F (0°C) & 25°F (-4°C)	-
Grout temperature above 70°F (21°C) during placement	32°F (0°C) to & 25°F (-3.9°C)	Between 32°F (0°C) & 25°F (-4°C)	-
Masonry surfaces under construction heated to 40°F (4°C)	25°F (-3.9°C) to 20°F (-6.7°C)	Between 25°F (-4°C) & 20°F (-7°C)	-
Masonry heated to 40°F (4°C) min. prior to grouting	25°F (-3.9°C) to 20°F (-6.7°C)	Between 25°F (-4°C) & 20°F (-7°C)	-
Heat provided on both sides of walls under construction	-	-	-7°C to -4°C
Wind breaks or enclosures provided	25°F (-3.9°C) to 20°F (-6.7°C) AND wind velocity exceeding 15 mph (24 km/h)	Between 25°F (-4°C) & 20°F (-7°C) AND wind velocity exceeding 15 mph (24 km/h)	-7°C to -4°C AND wind in excess of 25 km/h
Enclosures & heat provided so air temperatures within enclosure above 32°F (0°C)	20°F (-6.7°C) and below	Below 20°F (-7°C)	-7°C and below
Unit temperature when laid not less than 7°C	-	-	-7°C and below

Requirements are cumulative. As temperatures drop, the requirements for higher temperatures still apply. All 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.
**See standard for exact language and detail.*
***The IBC 2003 permits the use of the 2002 MSJC cold weather provisions as an option.*

Admixtures & Additives

- *"Heat, don't treat"* is a good rule of thumb for cold weather masonry. Use of certain accelerators may be helpful, but none replace the need to use the cold weather practices mandated in codes and standards.
- Do not use "anti-freezes" in mortar or grout. These products do not depress the freezing point enough to reduce exposure time and may adversely impact assembly strength.
- Accelerators are additives which speed the set of mortar or grout, thus limiting its exposure to cold temperatures. Non-chloride based products, as certified by the manufacturer, can be used if specified.
- Calcium chloride is an accelerator and usually is inexpensive, but is generally not encouraged for use in masonry. It corrodes metals and should not be used in masonry containing metal such as ties, reinforcing, and anchors. If used, when no metal is present, limit amounts to no more than 2% of the portland cement by weight.

Protection

- Enclosures moderate the weather immediately surrounding work under construction. They are heated and limit the effects of wind, rain or snow. They can be as elaborate as a temporary structure, or as simple as weather resistant sheets draped from scaffolding. Mason productivity and workmanship are generally improved within an enclosure.
- Insulated blankets are used to protect walls from freezing and also can be used to thaw sand piles or warm units. They serve to keep snow and ice from forming on newly constructed work or foundations.

Rules & Regulations

Codes and standards mandate all-weather requirements for masonry under construction, and protection requirements for time periods immediately following installation. The tables that follow outline the cold weather provisions 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 530.1-02/ASCE 6-02/TMS 602-02), *the 2005 edition of the MSJC Specification for Masonry Structures (ACI 530.1-05/ASCE 6-05/TMS 602-05),* and *Canadian Standard Association (CSA)Standard A371-94(99) Masonry Construction for Buildings*. NFPA adopts the 2002 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, and the 2005 MSJC includes protection requirements for AAC masonry. The two standards use different SI conversion styles. *Tables 1* and *2* show the cold weather requirements from the 2002 MSJC. The 2005 MSJC modifies these provisions by the addition of Autoclaved Aerated Concrete (AAC) masonry unit construction requirements.

Conclusion

Masonry construction adapts to all weather conditions and with a little bit of planning, work can continue throughout the year. Understanding the dynamics of the system permits designers and masons to specify and construct buildings that function structurally and aesthetically in spite of what snow or rain or heat may bring.▪

See Table 2 on next page

As principal of her own firm, Ms. Throop is a civil engineer specializing in masonry construction. Diane is Chairman of ASTM Committee C15 Manufactured Masonry Units and Chairman of the MSJC Construction Requirements Subcommittee. She is an ASTM Fellow and a registered professional engineer in both Ohio and Michigan.

*Table 2: Cold Weather Masonry **Protection** Requirements**

Protection Requirements*	MSJC 2002 & NFPA 5000 MSJC 2005**	IBC 2003**	CSA A371-94(99)
Glass masonry kept above 40°F (4°C) for 48 hours after construction	All weather	All weather	-
Protect masonry from rain or snow for 24 hours*****	-	-	0°C to 4°C
Cover new masonry for 24 hours***** with weather-resistive membrane	40°F (4.4°C) to 25°F (-3.9°C)****	Between 40°F (4°C) & 25°F (-4°C)****	-4°C to 0°C
Cover new, ungrouted masonry for 24 hours with weather-resistive insulating blankets or equal	25°F (-3.9°C) to 20°F (-6.7°C)****	Between 25°F (-4°C) & 20°F (-7°C)****	-
Cover new, grouted masonry for 48 hours with weather-resistive insulating blankets or equal	25°F(-3.9°) to 20°F (-6.7°C)****	Between 25°F (-4°C) & 20°F (-7°C)****	-
Cover new, grouted masonry using only Type III Portland cement for 24 hours with weather-resistive insulating blankets or equal	25°F(-3.9°) to 20°F (-6.7°C)****	Between 25°F (-4°C) & 20°F (-7°C)****	-
Cover masonry completely with insulating blankets for 24 hours*****	-	-	-7°C to -4°C
Maintenance new, ungrouted masonry at temperatures above 32°F (0°C) for 24 hours using heated enclosures, electric blankets, infared lamps or equal	20°F (-6.7°C) and below****	Below 20°F (-7°C)****	-
Maintain new, grouted masonry at temperatures above 32°F (0°C) for 48 hours using heated enclosures, electric blankets, infared lamps or equal	20°F (-6.7°C) and below****	Below 20°F (-7°C)****	-
Maintain new, grouted masonry using only Type III Portland cement at temperatures above 32°F (0°C) for 24 hours using heated enclosures, electric blankets, infared lamps or equal	20°F (-6.7°C) and below****	Below 20°F (-7°C)****	-
Maintain masonry temperature above 0°C for 24 hours ***** by enclosure and supplementary heat	-	-	-7°C and below
When grouting bonded tendons (prestressed masonry)	Maintain masonry temperature above 35°F (1.7°C) at time of grouting AND until field-cured cubes of grout reach 800 psi (5.52 Mpa)	-	-
Maintain AAC masonry temperature for first 4 hours after thin bed mortar application**	Above 32 °F (1.7°C)	-	-

Requirements are cumulative. As temperatures drop, the requirements for higher temperatures still apply. All 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.

**See standard for exact language and detail.*

***AAC masonry protection was added in the 2005 MSJC and is not included in the 2002 MSJC or NFPA 5000.*

****The IBC 2003 permits the use of the 2002 MSJC cold weather provisions as an option.*

*****Based on anticipated minimum daily temperature for grouted masonry and anticipated mean daily temperature for ungrouted masonry.*

******Increase protection period from 24 hours to 48 hours unless high-early-strength Portland cement, Type 30 (CSA CAN/CSA-A5) and Type S hydrated lime are used in mortar and grout. Where Types N or O mortars are used, all protection periods are increased by 24 hours.*