Cold Weather Masonry Construction

Introduction

Successful cold weather masonry construction requires knowledge of code requirements, workforce and planning capabilities, along with the capacity to be flexible and innovative. Building codes mandate certain procedures when constructing masonry during cold weather when the ambient air temperature is 40^0F and below. The requirements are grouped within temperature ranges, and while the provisions are prescriptive in nature, there is considerable latitude given for the contractor to use individual methods to satisfy the code requirements. This is in recognition of the wide variety of winter construction site conditions possible, and the fact that material, equipment and methods of construction technology advance rapidly.

Code Requirements

Due to the redundancies created by publishing the cold (and hot) weather requirements in both the International Building Code (IBC) and the Building Code and Specification for Masonry Structures (MSJC[1]), recent editions of the IBC reference the MSJC solely for these cold weather requirements. This practice began with the IBC-2009/MSJC-2008 and continues with the IBC-2012/MSJC-2011 and the IBC-2015/MSJC-2013.

Table 1, found on page 4 of this Technical Brief, contains the general provisions, construction requirements and protection requirements applicable to both these editions. (Previous Technical Briefs cover past IBC/MSJC editions.) Table 1 is to be read top-to-bottom for each temperature range, with the requirements in each range downward applied cumulatively. The items are separated into columns -– one for construction and one for protection requirements. Provisions are the same for the IBC-2012/MSJC-2011 and the IBC-2015/MSJC-2013.

The primary objectives of the cold weather provisions of the code are:

- Installing masonry assemblies that perform well no matter the weather during construction.
- Protecting materials from moisture and the potential for freezing.
- Eliminating installation of units that are too cold or contain frozen moisture, ice or snow.
- Producing and maintaining mortar and grout at mandated temperatures.
- Protecting the completed, or partially completed, masonry for the prescribed period of time.

[1] Masonry Standards Joint Committee – Building Code Requirements for Masonry Structures TMS 402/ACI 530/ASCE 5 and Specification for Masonry Structures TMS 602/ACI 531.1/ASCE 6.

A well-organized site makes it easy to setup for cold weather

Planning

A cold weather masonry construction and protection plan must be provided as a project submittal if job site temperatures are anticipated to drop below 40oF at any time during the masonry installation. With unanticipated delays, even a job that was supposed to be completed prior to Fall can easily slip below this target temperature. Planning for this possibility is crucial if cold weather requirements must be implemented.

Understanding Temperatures

There is a clear distinction between construction and post-construction (protection) requirements for cold weather masonry work. Understanding temperature terminology and ranges are critical to correctly apply the code mandated provisions.

Ambient Temperature - 54⁰F
Current outdoor temperature at the time considered.

Anticipated Daily Minimum – 36⁰F
Lowest temp forecast for the upcoming 24 hrs.

Mean Daily Temperature – 54° + 36° / 2 = **45°**
Average of the projected maximum and minimum daily temperature, midnight to midnight

Understanding temperature terminology is crucial to proper execution of cold weather requirements.

- Construction-phase temperature ranges are based on ambient temperatures -- the temperature at the site at the time of masonry installation.
- Post-construction protection requirements for grouted masonry are based on anticipated daily minimum temperatures -- the forecast low for the upcoming 24 or 48 hour period -- depending on what type cement is used in the grout.
- Post-construction protection requirements for ungrouted masonry are based on anticipated mean daily temperatures -- the forecasted average temperature for the upcoming 24 hour period.

Many contractors will use the more conservative anticipated daily minimum temperature for both grouted and ungrouted masonry to simplify their planning for the next day's work, even though it may be slightly more restrictive.

Heating Materials

The code allows heating water and/or aggregates to achieve the required mortar temperatures at the time of mixing. At the temperature range of 40⁰F to 32⁰F heating either the sand OR the water is expected to produce the desired result of mortar between 40⁰F and 120⁰F. At the next temperature range, below 32⁰F to 25⁰F, heating BOTH sand and water is needed to accomplish the goal. Below 25⁰F to 20⁰F not only do the sand and water require heating, but any masonry surface under construction must be at least 40⁰F and wind breaks or enclosures are required if the wind speed exceeds 15 mph. Below 20⁰F, a heated enclosure is mandated.

Heating the water is probably the most effective technique for achieving the desired mortar temperature because of water's ability to retain heat and impart it to the other ingredients. When dry mortar ingredients are delivered in bulk and mixed from silos, it's a good practice to at least partially enclose the silo and provide auxiliary heat to the silo or the mixing area to keep the dry ingredients as warm as possible.

Caution must be taken to not overheat the water or sand, as sand that is too hot can scorch, causing discoloration of the mortar, and water that's too hot can cause flash setting of the mortar – both undesirable consequences.

Heating Work Areas

When temperatures reach 25^{0}F, windbreaks or enclosures are required.

While enclosures and heat are not required at all temperatures, heated enclosures can be used to meet required material temperature targets, provide for better quality masonry, improved conditions for craftworkers, and working conditions uninterrupted by weather. If an enclosure means being able to close out a job rather than accept a weather shut down, it may mean savings in the long run.

Enclosures are installed to suit project needs - multi-story as shown above or a small 'move-as-you-go' option shown at the right are just two options

Keeping Materials Dry

Keeping materials dry and free of ice and snow may require no more than storing them on pallets covered with a heavy tarp. The code prohibits laying units with visible ice or snow, or those having a temperature of 20^{0}F or less. While there are many low-tech methods of removing the ice, "torching" the units can be risky, as it could cause thermal shock which can crack the units. Moving the proper number of units into the heated enclosure at the end of the day will provide warm units for work, but requires a accurate prediction of productivity and adequate interior storage space. Pre-warming units in a separate enclosure may be an attractive option when combined with "just-in-time" delivery to the scaffold. While it may appear more expensive, the practice can result in time saved from removing ice and snow from units and waiting for them to warm above 20^{0}F, and a better end product costing less overall.

Store units and materials to produce mortar and grout off the ground and covered to keep them free from ice, snow, containments, and moisture intrusion.

Protection

Under the general requirements for construction, the code requires that, at the end of the work day, all completed, or partially completed, masonry must be covered to prevent moisture intrusion at the end of the day. This is required regardless of the job site temperature. Masonry can also be 'covered' by being inside an enclosure.

Insulating blankets may serve to meet both cover and heat requirements. When high winds are anticipated, hold downs may be needed to keep covers in place.

The requirements for protection of grouted vs ungrouted masonry described in the Understanding Temperatures section of this document may be confusing because of the differing time periods involved and whether Type III cement (often called 'high-early') has been used in the grout. The basis for protection requirements for ungrouted masonry is the anticipated

mean daily temperature at the construction site. Ungrouted masonry requires protection for 24 hours. Grouted masonry protection however, is based on the anticipated daily minimum temperature forecast for 24 or 48 hours based on the cement type used in the grout. If the grout is produced solely with Type III portand cement, then the protection period is 24 hours. Type III portland cement provides higher strength at early stages, so grout produced with it needs protection for a shorter period of time. If other than Type III cement has been used, the protection period is 48 hours. Extended protection for grouted masonry is to avoid the possibility of grout freezing which may reduce the compressive strength and/or bonding to reinforcement and units. Protection options commonly include, but are not limited to, heated enclosures or insulating blankets. Masonry veneers that do not utilize mortar or grout generally do not require temporary heat.

Mortar or Grout Admixtures

Admixtures used to accelerate mortar or grout setting are sometimes used, but only with caution, as some can cause corrosion of embedded metals or color changes. In addition, admixtures of any kind may only be used with the permission of the design professional of record. The use of accelerators does NOT negate the prescriptive cold weather requirements such as cover, heat, protection, etc. Note the following:

- No 'anti-freeze' as it doesn't depress the freezing point sufficiently and it can reduce compressive and bond strength of the mortar or grout.
- Set accelerators are admixtures used to speed the set time of mortar and grout. They may be used only with prior approval.
- If an admixture is approved, non-chloride, non-corrosive accelerators are recommended.
- Using calcium chloride is not recommended as it causes corrosion to steel and metal accessories.
- All the prescriptive cold weather requirements are still required even if accelerators are used.

Grout Options to Consider

In cold weather situations, the mason contractor may consider adjusting the grout to accommodate the weather. These considerations may include:

- Decreasing the slump to reduce water content.
- Requesting approval for the addition of an additive such as an accelerator. This may require additional testing and submittals prior to use.
- Using Type III portand cement.
- Using self-consolidating grout which has a lower water content over high-slump, conventional grout.

Good Practice Summary

- Include a cold weather plan with the submittals.
- Plan ahead so when the temperature hits 40^0F, cold weather procedures can be implemented.
- Keep units covered and off the ground and don't lay frozen units.
- Use materials only at mandated temperatures.
- Cover and protect masonry from freezing after construction for the mandated time.
- Consider enclosures even if not required.

Temperature Ranges	Construction Requirements Ambient Temperature	Protection Requirements Anticipated mean daily temperature for ungrouted masonry. Anticipated daily minimum temperature for grouted masonry.
General Requirements Below 40°F (4.4°C)	Do not lay glass unit masonry. Do not lay units with temperatures below 20°F (-6.7°C) or those with frozen moisture, visible ice, or snow on their surface. Remove visible ice and snow from surface of foundations or masonry to receive new construction. Heat these surfaces above freezing without causing damage. Do not heat water or aggregates used in mortar or grout above 140°F (60°C).	Maintain temperature of glass unit masonry above 40°F (4.4°C) for 48 hr after construction. Maintain the temperature of AAC masonry above 32°F (0°C) for 48 hr after thin-bed mortar application.
40°F to 32°F (4.4°C to 0°C)	Heat sand OR water to produce mortar between 40°F (4.4°C) and 120°F (49°C) at time of mixing. Heat grout materials when their temperatures are below 32°F (0°C).	Protect newly laid masonry with weather-resistant membrane for 24 hr.
Below 32°F to 25°F (0°C to -3.9°C)	Heat sand AND water to produce mortar between 40°F (4.4°C) to 120°F (49°C) at time of mixing. Maintain mortar above freezing until used. Heat grout aggregates AND water to produce grout between 70°F (21°C) to 120°F (49°C) at time of mixing. Maintain grout above 70°F (21°C) at placement.	Protect newly laid masonry with weather-resistant membrane for 24 hr.
Below 25°F to 20°F (-3.9°C to -6.7°C)	Heat masonry surfaces under construction to 40°F (4.4°C) prior to grouting. Use windbreaks or enclosures when wind exceeds 15 mph (24 km/h). Heat masonry to minimum of 40°F (4.4°C) prior to grouting.	Cover new masonry with insulating blankets, or equal, for 24 hr. Increase to 48 hr for grouted masonry unless only Type lll cement is used.
20°F and below (-6.7°C and below)	Provide an enclosure AND auxiliary heat to maintain enclosed area above 32°F (0°C).	Maintain new masonry temperature above 32°F (0°C) for 24 hr by using heated enclosures, electric heating blankets, infrared lamps, etc. Extend to 48 hr for grouted masonry unless only Type lll cement is used.