

Section 2.5.6

COLD WEATHER MASONRY CONSTRUCTION

INTRODUCTION

Successful cold weather masonry construction requires knowledge of code requirements and planning capabilities, along with the capacity to be flexible and innovative. The code provides prescriptive requirements that must be met when the ambient air temperature is below 40°F. The requirements are grouped within temperature ranges, and while the provisions are prescriptive in nature, there is also considerable latitude given to 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 technology, equipment and methods of construction advance rapidly.

CODE REQUIREMENTS

Due to the redundancies created by publishing the extreme weather requirements in both the International Building Code (IBC) and (MSJC)¹, the requirements are found SOLELY in the MSJC beginning with the 2009 IBC/2008 MSJC editions. Table 1 found on page 4 contains the general provisions, construction requirements and protection requirements applicable to both IBC and MSJC from the 2003 IBC/2002 MSJC editions through the 2009 IBC/2008 MSJC. The table is to be read top-to-bottom for each temperature range, with the requirements in each range downward applied cumulatively. The items read horizontally separate the temperature ranges from the construction and protection requirements. It is important to check which edition of the code is applicable in your area and understand that:

IBC 2003 references the MSJC 2002

IBC 2006 references the MSJC 2005

IBC 2009 references the MSJC 2008

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

- Installation of masonry assemblies that perform well in spite of the weather during construction.
- Maintenance of mortar temperatures between 40°F and 120°F at the time of mixing.
- To produce grout temperatures between 70°F and 120°F at the time of mixing.
- To protect materials from moisture and the potential for freezing.
- To eliminate installation of frozen units (those with temperatures of 20°F and below).
- To protect the completed, or partially completed, masonry for the prescribed period of time to prevent freezing of mortar and grout, and the intrusion of excess water from rain or snow.

PLANNING

The MSJC Code and Specification indicates that a **plan for cold weather masonry construction must be supplied as one of the project submittals if the job site temperatures are anticipated to drop below 40°F at any time during the job.** With unanticipated delays, even a job that was supposed to be completed in late summer can easily slip below this target temperature, therefore planning is crucial to success and the wise contractor will have considered all contingencies and will be prepared. While requirements for enclosures and heat are not required at all temperatures, contractors, designers and construction managers should consider that enclosures and heated working spaces provide for better quality masonry, improved conditions for craftworkers and continuous working conditions.

¹ Masonry Standards Joint Committee - Building Code Requirements and Specifications for Masonry Structures TMS 402-08/ACI 530-08/ASCE 5-08, TMS 602-08/ACI 530.1-08/ASCE 6-08

UNDERSTANDING TEMPERATURE RANGES

Both the MSJC and the IBC make a clear distinction between the construction requirements and the post-construction protection provisions for cold weather masonry work.

- Construction-phase temperature ranges are based on *ambient temperatures*, that is, the temperature at the site at the time of construction.
- Post-construction protection requirements are based on anticipated daily minimum temperatures for *grouted masonry*, the forecast low for the upcoming 24- or 48-hour period, depending on what type cement is used in the grout.
- Post-construction protection for *ungrouted masonry* is based on anticipated mean daily temperatures, that is, the forecast 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 40°F to 32°F heating either the sand OR the water is expected to produce the desired result of mortar between 40°F and 120°F. At the next temperature range, below 32° to 25°F, heating BOTH sand and water is needed to accomplish the goal. Below 25°F, not only do the sand and water require heating, but any masonry surface under construction must be at least 40°F and wind breaks are required if the wind speed exceeds 15 mph. Below 20°F, an additional requirement of a heated enclosure is stipulated.

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's 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.



Heated mortar silo enclosure.

HEATING WORK AREAS

Heating the enclosure may be viewed as an expensive requirement, but considering that it may be used to keep the materials warm, as well as the craftworkers, it is probably a good investment. The increased productivity from masons who are working in a protected and warmer environment can be a side benefit of the code provision. Additionally, if it means being able to close out the job sooner rather than shut down and complete it later, it could mean savings in the long run.



Winter protection for smaller masonry jobs, or smaller areas of large ones, can be a move-as-you-go enclosure.



Weather protection and heated enclosures are a good investment.

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°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, resulting in cracked units. Moving the proper number of units into the heated enclosure at the end of the day will provide warmed units for work, but requires an accurate prediction of productivity and adequate interior storage space. Pre-warming the masonry 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 may result in time saved from removing ice and snow from units exposed to the weather, and a better end product might result that could cost less overall. Additionally, proper protection of materials complies with LEED IEQ Credit 3.1, Construction Indoor Air Quality Management Plan, that calls for the protection of construction materials from moisture damage.

PROTECTION

Under the general requirements for construction, the code requires that all completed, or partially completed masonry must be covered at the end of the day. *This is required regardless of the job site temperature when the masonry is not inside a covered enclosure.* This common-sense protection provision helps prevent efflorescence due to excess water and other contaminants from entering the system, either from the top or the side.

The requirements for the post-construction protection of grouted vs ungrouted masonry described in the Understanding Temperature Ranges section of this document can be confusing because of the differing time periods involved for each, and whether Type III cement has been used in the grout. As indicated in Table 1, the basis for protection requirements for ungrouted masonry is the mean daily temperature at the construction site, that is, the average temperature forecast for the upcoming 24-hour period. Grouted masonry protection, on the other hand, is based on the anticipated daily minimum temperature forecast for 24, or 48, hours. For example, if the average low temperature forecast is to be below 25°F, the masonry is grouted, and Type III cement has been used in the grout, protection is only required for the completed masonry for 24 hours. If a different type of cement has been used, the protection period is 48 hours. Ungrouted masonry, however, only needs the protection of insulating blankets for 24 hours.



These brick are not properly protected. Protect masonry units from ice and snow and keep dry.



Do not torch units to remove snow and ice. Thermal shock could crack masonry units.



Protect unfinished and finished work.

The reason for extended protection for grouted masonry below 25°F is to avoid any possibility of the mortar or grout freezing. Frozen mortar and grout will develop microscopic fissures from the water expanding as it freezes. This can result in reduced compressive strength and can inhibit proper bonding of materials.

Admixtures used to accelerate mortar setting are sometimes used, but only with great caution, as some can cause corrosion of imbedded metals. *In addition, admixtures of any kind may ONLY be used with the permission of the design professional of record.*

REDUCE GROUT SLUMP

Reducing grout slump, especially with low absorption units or units with integral water repellants, can be a valuable technique because with colder temperatures, there is less water to be lost to the atmosphere and units are colder so the water in the grout can be more efficiently used for hydration of the cement. With the low absorption units this is just amplified. The goal during cold weather is to get the grout cured and part of that is absorption of the water that isn't needed for hydration.

USE COLD WEATHER REQUIREMENTS FROM ONE SOURCE

Since the format of the requirements is slightly different in different places, use one source such as the 2008 MSJC but have additional resources available, such as the table below. The requirements in the table simply organize the information from the MSJC in a convenient tabular form.

PERFORMANCE TARGETS

- Be prepared for when the ambient temperature will reach 40°F.
- Keep the mortar between 40°F and 120°F.
- Don't lay frozen units or allow the masonry to freeze before initial set.
- Protect the masonry from freezing after construction.
- Result: The masonry will perform as expected.

Table 1 - MSJC 2002, 2005 and 2008 Requirements for Cold Weather Construction

General Preparation and Construction Requirements: Store units and other materials in dry conditions off the ground. Do not lay frozen units (those with temperatures below 20°F (6.7°C) or those with visible ice or snow. Do not heat water or aggregates above 140°F (60°C). It's not necessary to heat grout materials unless their temperatures are below 32°F (0°C).		
Temperature Ranges	Construction Requirements Ambient Temperatures (Temperatures during construction)	Protection Requirements (Based on mean daily temperatures for ungrouted masonry and anticipated daily minimums for grouted masonry for period following construction)
40°F to 32°F (4.4°C to 0°C)	Do not lay glass units in temperatures below 40°F (4.4°C). Heat sand or water to achieve mortar temperatures of 40°F (4.4°C) to 120°F (49°C) at time of mixing.	Maintain glass unit masonry above 40°F (4.4°C) for 48 hrs. Protect newly laid masonry with weather-resistant membrane for 24 hours.
32°F to 25°F (0°C to to -3.9°C)	Heat sand and water to achieve mortar temperatures of 40°F (4.4°C) to 120°F (49°C) at time of mixing. Maintain materials above 32°F (0°C) until used. Heat grout aggregates and water, keeping grout above 70°F (21°C).	Protect newly laid masonry with weather-resistant membrane for 24 hours.
25°F to 20°F (-3.9°C to -6.7°C)	Add windbreaks or enclosures when wind exceeds 15 mph (24.1 km/h). Heat masonry to 40°F (4.4°C) prior to grouting.	Cover new masonry completely with insulating blankets, or equal, for 24 hours. Increase to 48 hours for grouted masonry unless Type III cement only is used.
20°F and below (-6.7°C and below)	Add auxiliary heat to enclosures. Keep enclosed area above 32°F (0°C).	Maintain new masonry temperature above 32°F (0°C) for 24 hours with heated enclosures, lamps, etc. Increase to 48 hours for grouted masonry unless Type III cement only is used.

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