# Cold and Hot Weather Construction

**Abstract:** This *Technical Note* defines cold and hot weather conditions related to brick masonry construction and describes the unfavorable effects of these conditions on masonry materials and their performance. It provides information on weather prediction necessary for construction planning and recommends practices to achieve optimum performance of masonry constructed during periods of extreme temperatures.

**Key Words:** absorption, ambient temperature, climatology, cold weather, evaporation, freezing, grout, hot weather, meteorology.

## SUMMARY OF RECOMMENDATIONS:

- Comply with cold and hot weather requirements of applicable building codes
- Follow requirements given in Table 1

## INTRODUCTION

Adequate planning and preparation can make brick construction possible in virtually all weather conditions. Cold and hot weather can negatively affect masonry materials and the quality of constructed masonry. However, implementing recommended changes to construction practices can usually ensure quality construction. Although “normal,” “cold,” and “hot” are relative terms, normal, used in this *Technical Note,* is any temperature between 40 ºF and 100 ºF (4.4 ºC and 37.8 ºC). Cold is defined as temperature below 40 ºF (4.4 ºC); and hot, any temperature above 100 ºF (37.8 ºC).

## BUILDING CODE REQUIREMENTS

In many instances, building codes include mandatory measures intended to ensure the quality of masonry constructed during cold or hot weather. The *International Building Code* (IBC) [Ref. 1] includes a list of required cold and hot weather construction provisions for masonry that are essentially identical to those found in *Specification for Masonry Structures* (ACI 530.1/ASCE 6/TMS 602) [Ref. 11] and required by *Building Code Requirements for Masonry Structures* (ACI 530/ASCE 5/TMS 402) [Ref. 6], both of which are referenced by the IBC. The *Specification for Masonry Structures* provisions differ from those of the IBC in that they also require the submittal and acceptance of a description of the hot and cold weather construction program prior to its use. The mandatory cold and hot weather construction practices required by the IBC and *Building Code Requirements for Masonry Structures* are summarized in Table 1.

Specific cold and hot weather provisions are not included within the *International Residential Code* (IRC) [Ref. 2]. However, the IRC states that mortar for use in masonry construction shall comply with ASTM C 270, which requires mortar for other than masonry veneer to be prepared in accordance with the Masonry Industry Council's "Hot and Cold Weather Masonry Construction Manual" [Ref. 8]. Hot and cold weather provisions apply to brick veneer when the provisions of *Building Code Requirements for Masonry Structures* are used in lieu of the IRC masonry provisions.

## PLANNING FOR EXTREME WEATHER

To successfully build during periods of extreme weather conditions, designers and contractors utilize knowledge of local meteorological conditions, as well as historic climatological information for a given area. During project planning, designers are concerned with *climatological* data such as the average and extreme daytime and nighttime temperatures or average wind velocity for use in designing mechanical or structural systems. Contractors, however, are more concerned with *meteorological* conditions during construction, such as hourly temperatures and mean daily temperature, as well as the predicted temperatures and wind velocities for the next few days. Mean daily temperature is determined by adding together the maximum temperature for each day (24 hours, midnight to midnight) and the minimum temperature for the same day and dividing by two. Ambient temperature as used in this *Technical Note* is the outdoor temperature at the time considered.

## TABLE 1

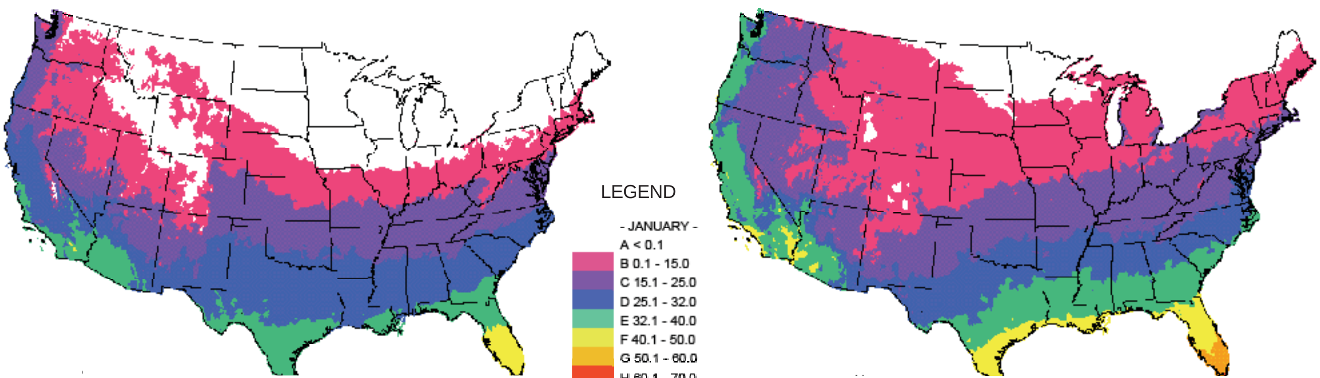
## Requirements for Masonry Construction in Hot and Cold Weather

| | Temperature[1] | Preparation Requirements (Prior to Work) | Construction Requirements (Work in Progress) | Protection Requirements (After Masonry Is Placed) |
|---|---|---|---|---|
| **Hot Weather** | Above 115 ºF or 105 ºF with a wind velocity over 8 mph (46.1 ºC or 40.6 ºC with a 12.9 km/hr wind) | Shade materials and mixing equipment from direct sunlight.<br><br>Comply with hot weather requirements below. | Use cool mixing water for mortar and grout. Ice must be melted or removed before water is added to other mortar or grout materials.<br><br>Comply with hot weather requirements below. | Comply with hot weather requirements below. |
| | Above 100 °F or 90 °F with 8 mph wind (above 37.8 °C or 32.2 °C with a 12.9 km/hr wind) | Provide necessary conditions and equipment to produce mortar having a temperature below 120 ºF (48.9 ºC).<br><br>Maintain sand piles in a damp, loose condition. | Maintain mortar and grout at a temperature below 120 ºF (48.9 ºC).<br><br>Flush mixer, mortar transport container, and mortar boards with cool water before they come into contact with mortar ingredients or mortar.<br><br>Maintain mortar consistency by retempering with cool water.<br><br>Use mortar within 2 hr of initial mixing. | Fog spray newly constructed masonry until damp, at least three times a day until the masonry is three days old. |
| **Normal Weather** | 100 °F to 40 °F (37.8 °C to 4.4 °C) | Normal Procedures. | Normal Procedures. | Normal Procedures. |
| **Cold Weather** | 40 °F to 32 °F (4.4 °C to 0 °C) | Do not lay masonry units having either a temperature below 20°F (-6.7°C) or containing frozen moisture, visible ice, or snow on their surface.<br><br>Remove visible ice and snow from the top surface of existing foundations and masonry to receive new construction. Heat these surfaces above freezing, using methods that do not result in damage. | Heat mixing water or sand to produce mortar between 40 °F (4.4 ºC) and 120 °F (48.9 ºC).<br><br>Do not heat water or aggregates used in mortar or grout above 140 ºF (60 ºC).<br><br>Heat grout materials when their temperature is below 32 ºF (0 ºC). | Completely cover newly constructed masonry with a weather-resistive membrane for 24 hr after construction. |
| | 32 °F to 25 °F (0 °C to -3.9 °C) | Comply with cold weather requirements above. | Comply with cold weather requirements above.<br><br>Maintain mortar temperature above freezing until used in masonry.<br><br>Heat grout materials so grout is at a temperature between 70 ºF (21.1 ºC) and 120 ºF (48.9 ºC) during mixing and placed at a temperature above 70 ºF (21.1 ºC). | Comply with cold weather requirements above. |
| | 25 °F to 20 °F (-3.9 °C to -6.7 °C) | Comply with cold weather requirements above. | Comply with cold weather requirements above.<br><br>Heat masonry surfaces under construction to 40°F (4.4°C) and use wind breaks or enclosures when the wind velocity exceeds 15 mph (24 km/h).<br><br>Heat masonry to a minimum of 40°F (4.4°C) prior to grouting. | Completely cover newly constructed masonry with weather-resistive insulating blankets or equal protection for 24 hr after completion of work. Extend time period to 48 hr for grouted masonry, unless the only cement in the grout is Type III portland cement. |
| | 20 °F and Below (-6.7 °C and Below) | Comply with cold weather requirements above. | Comply with cold weather requirements above.<br><br>Provide enclosure and heat to maintain air temperatures above 32 ºF (0 ºC) within the enclosure. | Maintain newly constructed masonry temperature above 32°F (0°C) for at least 24 hr after being completed by using heated enclosures, electric heating blankets, infrared lamps, or other acceptable methods. Extend time period to 48 hr for grouted masonry, unless the only cement in the grout is Type III portland cement. |

1. **Preparation** and **Construction** requirements are based on *ambient temperatures.* **Protection** requirements, after masonry is placed, are based on *mean daily temperatures*.

Meteorological information can be obtained from the National Weather Service, a branch of the National Oceanographic and Atmospheric Administration (NOAA). The National Weather Service has information centers located at major airports in cities throughout the country. These centers provide current weather information and regularly scheduled weather forecasts for the surrounding region.

Climatological information can be obtained from the National Climatic Data Center, also a branch of NOAA. The National Climatic Data Center usually provides climatic information in the form of maps as shown in Figure 1. These maps contain daily, monthly and annual data for a region and may be obtained free online or by contacting the Center [Ref. 7].




January Mean Daily Minimum Temperature

January Mean Daily Maximum Temperature

**Figure 1**
**Examples of Climatic Data Available**

# NEGATING THE EFFECTS OF COLD WEATHER

Successful construction considers the effects of cold weather on masonry materials in the planning, scheduling and set up of the masonry work and protection of the completed work. This section describes the properties of masonry and masonry materials that are changed by low temperatures and code prescribed construction procedures that overcome these effects. In addition to anticipating specific weather conditions, these provisions, presented in Table 1, assist the contractor in determining how to protect building materials, unfinished and newly constructed masonry.

In regard to the quality of masonry constructed during cold weather, perhaps the most critical factor is ensuring that mortar and grout maintain adequate heat for normal cement hydration. Without sufficient heat, cement hydration slows and may stop completely, arresting the development of the masonry's compressive and bond strengths.

## Heating Materials

**Masonry Units.** Masonry units are the components of a masonry assembly least affected by below-normal temperatures. The physical properties of masonry units are essentially unchanged by cold weather, however, the temperature of brick and their absorption characteristics influence the rate of freezing of masonry. A cold masonry unit will have a slightly smaller volume than one at normal temperatures.

Cold units draw heat from mortar and more rapidly reduce the temperature of mortar to points at which normal cement hydration is retarded and freezing occurs. Preheating masonry units prior to laying helps to maintain heat within the mortar and minimize the effect of cold temperatures on mortar hydration. When ambient temperatures are below 20 ºF (-6.7 ºC), masonry units must be heated to a temperature of at least 40 ºF (4.4 ºC) prior to laying. Masonry units having either a temperature below 20 °F (-6.7 °C) or containing frozen moisture, visible ice or snow on their surface must not be laid. Frozen masonry units must be thawed and should by dried before use. Unit temperature can be measured using a metallic surface contact thermometer or flat, instant-read thermometer.

It may be advantageous to heat brick even when ambient temperatures are above 20 ºF (-6.7 ºC). Preheated brick will exhibit the same absorption characteristics as those laid at normal temperatures. Brick with higher Initial Rates of Absorption (IRAs) more rapidly absorb water from mortar or grout, thereby reducing the risk of damage from the expansive forces of freezing water in the mortar.

**Mortar.** Mortar mixed using cold materials has different properties from mortar mixed with materials at normal temperatures. Low temperatures retard the hydration of the cement in mortar. Mortar mixed during cold weather often has lower water content, increased air content, and reduced early strength compared with mortar mixed at normal temperatures.

In freezing weather, ice may be present in mixing water and moisture in the sand may turn to ice. Ice in the mixing water must be melted or removed before the water can be added to the mixer. Do not use sand containing frozen particles or frost. At a minimum, any ice must be melted and additional heating may further improve mortar performance.

Avoid freezing of mortar during construction in all cases. In cold weather, mix mortar in smaller amounts so it can be used before it cools. In any case, use mortar within 2½ hours from the time of initial mixing. Mortar that freezes may experience significant reductions in compressive strength. Further, bond strength, extent of bond and water penetration resistance of masonry may be reduced. Mortar having a water content exceeding six percent of the total volume may be damaged due to the increase in volume as freezing water is converted to ice.

Mortar mixed with heated materials can approximate the performance characteristics of mortar mixed at normal temperatures. For these reasons, the codes include requirements for heating mortar materials.

When ambient temperatures fall below 40 ºF (4.4 ºC) sand or mixing water must be heated to produce mortar that is between 40 ºF (4.4 ºC) and 120 ºF (48.9 ºC) at the time of mixing. Ideal temperatures for mortar are between 60 ºF (15.6 ºC) and 80 ºF (26.7 ºC). Mortar temperatures over 120 ºF (48.9 ºC) may lead to flash set, resulting in lower compressive strength and reduced bond strength. Thus, do not heat sand or water above 140 ºF (60.0 ºC).

Water is the easiest and best material to heat because it does not lose heat readily. Heating prepackaged materials such as portland, mortar and masonry cements and hydrated lime can be difficult. If the air temperature is below 32 ºF (0 ºC), maintain the temperature of mortar above freezing until used.

Consider altering mortar constituents or proportions within permissible ranges to reduce the impacts of cold weather. Increasing sand content provides a stiffer mortar that better supports the weight of subsequently laid masonry. Using masonry or mortar cements, or reducing lime content allows mortars to lose water more rapidly, thus reducing the potential for freezing. High-early-strength (Type III) portland cement may also be used to increase the rate of early strength gain. If a brick with a low IRA is used, the water content of the mortar should be the minimum necessary for workability. Set accelerating admixtures, as discussed later in **Other Cold Weather Considerations** may also be used, however heating and protection measures are still required.

Avoid freezing of mortar during construction in all cases, and protect mortar in newly completed masonry from freezing. Specific requirements for protection of mortar are found in Table 1.

**Grout.** High water content is necessary in grout for ease of flow, but it greatly increases the amount of volumetric expansion which can occur upon freezing. Thus grout, like mortar, must be mixed with heated materials if the temperature of the materials is below 32 ºF (0 ºC), to prevent the damaging effects of freezing. If the ambient temperature is below 32 ºF (0 ºC), grout aggregates and mixing water must be heated to produce a grout temperature between 70 ºF (21.1 ºC) and 120 ºF (48.9 ºC) at the time of mixing. Do not heat grout aggregates and mixing water above 140 ºF (60.0 ºC) and keep the grout temperature above 70 ºF (21.1 ºC) when it is placed. High-early-strength (Type III) portland cement may be used to increase the rate of early strength gain of grout. Admixtures may also be used, but heating and protection of the grouted masonry is still required. All grout must be placed within 1½ hours of mixing.

**Newly Constructed and Completed Masonry.** Because the hydration of cement is a process that continues for an extended period, it is necessary to ensure that masonry surfaces under construction do not extract excessive heat from mortar and grout. Code provisions address this by requiring masonry under construction, or that is to receive grout, to be heated to a minimum temperature of 40 ºF (4.4 ºC) when the ambient temperature reaches 25 ºF (-3.9 ºC) or below. If wind velocities exceed 15 mph, wind breaks or enclosures must be used during construction. In addition to these measures, if the ambient temperature falls to 20 ºF (-6.7 ºC) or below, the masonry under construction must be enclosed and the air within the enclosure maintained at a temperature above 32 ºF (0 ºC). Newly constructed masonry that is frozen may be moistened after thawing to reactivate the hydration process and continue to develop strength.

If snow or ice is visible on existing foundations or masonry, the codes prohibit building new masonry on them. There is danger of movement when the base thaws, and bond cannot be developed between the mortar bed and frozen supporting surfaces. Ice and snow must be removed and the top surface must be heated to above freezing, in a manner that does not damage the masonry.

## Protecting Materials and Masonry

In addition to heating materials to adjust for cold weather, the IBC and *Building Code Requirements for Masonry Structures* require protection of masonry constructed in cold weather. Protection is one of the most effective adjustments that can be made to construction practices.

**Material Storage.** Careless material storage can increase the cost of laying masonry if removal of ice and snow from materials and thawing of masonry units is necessary before construction begins. Measures to consider include covering masonry materials with tarpaulins or polyethylene sheets to keep them dry and free of ice and snow, locating sand so that water does not drain into it and storing masonry units on raised platforms to avoid contact with the ground.

**Newly Constructed Masonry.** As mentioned, the development of strength and bond in masonry continues for some time after the masonry is completed, and may be compromised if freezing occurs. Therefore, newly constructed masonry must be protected so that it maintains enough heat for cement hydration. When the mean daily temperature falls to 40 ºF (4.4 ºC) or below, a series of protective measures are required, beginning with covering newly constructed masonry with a weather-resistive membrane for 24 hr after completion. As temperatures decrease, more stringent protection is required. Specific provisions for the progressively colder temperatures are presented in Table 1.

Materials used to cover brickwork should be weighted or otherwise fixed in place and extend a minimum of 2 ft (0.6 m) down each side of the wall, as shown in Photo 1, to prevent contamination by water, ice or snow.

**Photo 1**
**Cover Protecting Newly Constructed Masonry**

# HEATING METHODS AND EQUIPMENT

## Individual Materials

There are many types of equipment are available as sources of heat for cold weather construction. The type selected will depend upon availability of equipment, fuel source, economics, size of project and severity of exposure. A few common methods for heating individual materials are described below. Materials may also be heated by placing them within heated enclosures prior to use.

**Photo 2**
**Heating of a Sand Pile with an Electric Blanket**

Both water and sand used in mortar and grout may be heated to provide proper temperatures for construction. Sand may be heated by placing an electric heating pad on top of the sand pile and covering with a weather-resistant tarpaulin, as shown in Photo 2. The electric pad can safely heat the sand overnight without exceeding a temperature of 100 ºF (37.8 ºC). A more labor intensive method of heating the sand is to place over a heated pipe or to pile the sand around a horizontal metal culvert or smoke stack section in which a slow fire is built, as shown in Photo 3.

**Photo 3**
**Sand Pile Warmed by Heated Pipe**

Other methods for heating sand involve the use of a steam lance or other steam heaters. Pay careful attention to the fire or other heat source and the sand as it should be heated slowly to avoid scorching.

Alternatively, an electric rod can be used to heat mixing water and sand simultaneously. The electric heating rod is placed in a drum of water in the center of a sand pile. The rod heats the water over several hours. The sand surrounding the drum slowly absorbs heat from the drum and insulates the drum from further heat losses.

Mortar may also be placed on electrically heated mortar boards to help maintain proper temperature. Be careful to avoid excessive drying of the mortar.

## Newly Constructed Masonry (Enclosures)

Contractors have used several different methods to provide heat and protection for newly constructed masonry, including complete and partial enclosures. Large tents, temporary wood structures covered with clear plastic, and shelters built of prefabricated panels covered with clear plastic sheets are examples of complete enclosures. Partial enclosures often consist of enclosed scaffolds which may be moved from floor to floor when necessary, as shown in Photo 4. Commercial electric blankets may also be used to cover walls and provide heat during the curing period.

Forced air heaters (sometimes called torpedo heaters or salamanders) are widely used as a source of heat within enclosures. When complete enclosure of the work area is provided, space heaters are recommended, as shown in Photo 5. Cold weather provisions require circulation of warm air on both sides of the masonry wall within the enclosure.

**Photo 4**
**Scaffold Enclosures**

**Photo 5**
**Space Heater in Enclosure**

# OTHER COLD WEATHER CONSIDERATIONS

## Admixtures

**Accelerators.** Accelerators are admixtures used to speed the setting time of mortar and grout. By increasing the rate of cement hydration, accelerators increase the rate of early strength gain. The most common accelerators are inorganic salts such as calcium chloride, calcium nitrate, soluble carbonates and some organic compounds. Evaluate any accelerator for deleterious effects on masonry strength and materials. Admixtures that contribute to staining or efflorescence or cause corrosion of metal accessories are not desirable for use in masonry construction. Indiscriminate use of accelerators can adversely affect the performance of the completed masonry. Using accelerators alone does not address all concerns related to cold weather construction and is not recommended. Masonry constructed using accelerators in mortar or grout must still be protected from freezing as cement hydration essentially stops at temperatures below 40 ºF (4.4 ºC).

Calcium chloride, while highly effective as an accelerator and widely used in the past, is not recommended as it causes corrosion of metals used in masonry such as ties, anchors and reinforcement. For this reason, admixtures with more than 0.2 percent chloride ions are prohibited for use in mortar when masonry is constructed under the provisions of *Building Code Requirements for Masonry Structures*. The incidence of efflorescence may also increase if the accelerator contains excessive salts.

Calcium nitrite and calcium nitrate are inorganic non-chloride compounds also used as accelerators. These compounds require higher dosages by weight and are more costly than calcium chloride, but will not corrode metals or contribute to efflorescence.

**Antifreeze.** Do not use antifreeze compounds. These admixtures are alcohols or combinations of salts. If used in the quantities required to be effective, significant reductions in mortar compressive and bond strengths usually result. Most commercial mortar "antifreeze" admixtures do not lower the freezing point of mortar or grout, but are actually accelerators. However, some true antifreeze admixtures are available.

# NON-MANDATORY COLD WEATHER RECOMMENDATIONS

In addition to the mandatory requirements for cold weather masonry construction found in Table 1, the following items can be incorporated in the specifications of the project manual where applicable:

- Protect masonry units, cementitious materials and sand so that they are not contaminated by rain, snow or ground water.
- Units with higher initial rates of absorption (up to 40 g/min/30 in.$^2$ (40 g/min/194 cm$^2$)) may be used to resist mortar freezing. However, units with suctions in excess of 30 g/min/30 in.$^2$ (30 g/min/194 cm$^2$) should be wetted, but not saturated, with heated water just prior to laying. Water used for wetting should be above 70 ºF (21.1 ºC) when units are above 32 ºF (0 ºC). If units are 32 ºF (0 ºC) or below, water temperature should be above 120 ºF (48.9 ºC).

If walls are properly covered when work is halted, ice or snow removal from walls should not be necessary. However, in the event that the covering is displaced, the top course may be thawed with steam or a carefully applied portable blowtorch. The heat should be sustained long enough to thoroughly dry the masonry. If portions of the masonry are frozen or damaged, replace defective parts before progressing with new work.

# NEGATING THE EFFECTS OF HOT WEATHER

This section describes the properties of masonry and masonry materials that are changed by high temperatures and the code prescribed procedures that overcome these effects.

Periods of hot weather may also adversely affect the construction of masonry. The contractor must ensure that the quality of masonry construction does not suffer from the effect of high temperatures. The IBC and *Building Code Requirements for Masonry Structures* define hot weather as temperatures above 100 ºF (37.8 ºC); however, wind speed, relative humidity and solar radiation also influence the absorption of masonry units, the rate of set, and the drying rate of mortar.

High temperatures and high humidity are not as damaging to the performance of the masonry as are low temperatures and low humidity. The increased rate of cement hydration and favorable curing conditions in hot, humid weather will help develop masonry strength if sufficient water is present at the time of construction.

The primary concern during hot weather is rapid evaporation and absorption of water from the mortar. Without sufficient water, cement hydration slows or stops and the bond strength and extent of bond between brick and mortar is reduced. The integrity of the masonry may also be compromised if mortar that is too hot flash sets before it completes hydration.

The adjustments to construction practices required by the IBC and *Building Code Requirements for Masonry Structures* further improve the quality of masonry constructed in hot weather. These mandatory provisions, triggered when the ambient air temperature reaches 100 ºF (37.8 ºC), or 90 ºF (32.3 ºC) with a wind velocity greater than 8 mph (12.9 km/hr), are presented in Table 1 and are discussed below along with additional non-mandatory recommendations for successful hot weather construction.  Keeping materials cool during periods of hot weather provides the best results.

## Cooling Materials

Lowering the temperature of materials may be the easiest approach to achieving performance characteristics associated with masonry constructed at normal temperatures.

**Masonry Units.** Masonry units are not significantly affected by hot weather. However, the interaction between the masonry units and the mortar or grout is critical. Masonry units that are hot absorb more water from mortar and increase the temperature of the masonry. Lower bond strength and extent of bond result if not enough water is present in the mortar when the units are laid.

Keep masonry units cool by storing them in a shaded area. Shading of masonry units from direct sunlight is required when ambient temperatures exceed 115 ºF (46.1 ºC) or 105 ºF (40.6 ºC) with a wind velocity over 8 mph (12.9 km/hr).

Brick with field IRAs over 30 g/min/30 in.$^2$ (30 g/min/194 cm$^2$) may be required to be wetted prior to laying to reduce their rate of absorption. Otherwise, they can draw too much water from the mortar too quickly. Brick may be required to be surface dry at the time of laying and have an IRA less than 30 g/min/30 in.$^2$ (30 g/min/194 cm$^2$). Brick may be wetted immediately before laying, but the preferred method is to wet them 3 to 24 hours before use.

**Mortar.** Mortar mixed at high temperatures often has a higher water content, lower air content, and a shorter board life than mortar mixed at normal temperatures. It also tends to lose plasticity rapidly due to evaporation of water and the increased rate of cement hydration. Consider using mortar with a high lime content and high water retention. Rapid stiffening of hot mortar, or flash set, occurs if mortar plasticity is lost before the cement hydrates sufficiently. To avoid this, be sure mortar used during hot weather maintains a temperature less than 120 ºF (48.9 ºC).

Retempering of mortar with cool water should always be permitted, and is required for maintaining consistency during hot weather. Use mortar within 2 hr of initial mixing. Hot weather provisions require that all mortar materials be shaded from direct sunlight when the ambient temperature exceeds 115 ºF (46.1 ºC) or 105 ºF (40.6 ºC) with a wind velocity over 8 mph (12.9 km/hr).

**Sand.** When ambient temperatures exceed 100 ºF (37.8 ºC) or 90 ºF (32.2 ºC) with winds exceeding 8 mph (12.9 km/hr), keep sand in a damp, loose condition. This can be achieved by sprinkling sand piles with water, and leaving them uncovered, which also reduces the temperature of the sand through evaporative cooling. Damp sand takes longer to heat up.

**Water.** Cool water may be used to help control the temperature of mortar and grout. Cool mixing water for mortar and grout are required by hot weather provisions when the ambient temperature exceeds 115 ºF (46.1 ºC) or 105 ºF (40.6 ºC) with a wind velocity of 8 mph (12.9 km/hr). Ice is highly effective in reducing the temperature of the mix water. Ice must be completely melted or removed before combining the water with any other ingredients.

**Grout.** Grout reacts to hot weather in a manner similar to mortar. Water evaporates more rapidly and thereby reduces the water-cement ratio. Because grout requires a slump of at least 8 in. (203 mm) for use in masonry, maintain a high water-cement ratio by initially mixing grout with adequate water to offset evaporation. *Building Code Requirements for Masonry Structures* requires grout to be used within 1½ hours of mixing. As with mortar, ice may be used to lower the mix water temperature.

**Admixtures.** The use of admixtures to increase plasticity is not recommended unless their full effect on the mortar is known. Admixtures for grout that increase the flow rate or reduce the water content are not recommended. Shrinkage compensating admixtures are recommended.

**Equipment.** A significant amount of heat can be absorbed by equipment that is exposed to sunlight for extended periods during hot weather. Mixers, wheelbarrows and mortar pans can impart this heat to mortar, raising its temperature. Mortar boards made of wood may also absorb more water from mortar. To prevent this from compromising the quality of masonry, the IBC and *Building Code Requirements for Masonry Structures* require mixers, containers and mortar boards to be flushed with cool water before they come in contact with mortar or mortar materials. As with mortar materials, equipment is also required to be shaded from direct sunlight when the ambient temperature exceeds 115 ºF (46.1 ºC) or 105 ºF (40.6 ºC) with an 8 mph (12.9 km/hr) wind velocity.

## Protecting Materials and Masonry

Wet curing or fog spraying may further improve masonry strength development during periods of high temperatures and low relative humidity. Hot weather provisions require fog spraying of newly constructed masonry until damp, at least three times a day for three days when the mean daily temperature exceeds 100 ºF (37.8 ºC) or 90 ºF (32.2 ºC) with a wind velocity over 8 mph (12.9 km/hr.)

Use wind breaks to prevent rapid drying of mortar during and after placement, and cover walls with a weather-resistant membrane at the end of the work day to prevent rapid loss of moisture from the masonry assemblage.

# SUMMARY

Construction and protection requirements in both cold and hot weather help ensure uninterrupted, quality masonry construction. Performance characteristics associated with materials mixed and constructed during normal temperatures can be achieved by following recommendations in this *Technical Note*. Table 1 summarizes practices required by building codes for cold and hot weather construction.



# REFERENCES

1. 2003 *International Building Code*, International Code Council, Inc., Falls Church, VA, 2003.
2. 2003 *International Residential Code for One- and Two-Family Dwellings*, International Code Council, Inc., Falls Church, VA, 2003.
3. ASTM C 270, Standard Specification for Mortar for Unit Masonry, *Annual Book of ASTM Standards*, Vol. 04.05, ASTM International, West Conshohocken, PA, 2006.
4. Brown, M.L., “Speeding Mortar Setting in Cold Weather,” *The Magazine of Masonry Construction,* Vol. 2, No. 10, Addison, IL, October 1989.
5. Bigelow, O., “Cold Weather Masonry Construction,” *Masonry Magazine,* Schaumburg, IL, October 2005.
6. *Building Code Requirements for Masonry Structures* (ACI 530/ASCE 5/TMS 402), The Masonry Society, Boulder, CO, 2005.
7. Color Climate Atlas Maps, National Climatic Data Center, retrieved March 20, 2006 from http://gis.ncdc.noaa.gov/website/ims-climatls/index.html.
8. "Hot and Cold Weather Masonry Construction Manual," Masonry Industry Council, Schaumburg, IL, 1999.
9. Randall, Jr., F.A., and W.C. Panarese, *Concrete Masonry Handbook*, Portland Cement Association, Skokie, IL, 1991.
10. Schierhorn, C., “Preventing Hot-Weather Construction Problems,” *The Magazine of Masonry Construction*, Vol. 7, Addison, IL, June 1994.
11. *Specification for Masonry Structures* (ACI 530.1/ASCE 6/TMS 602), The Masonry Society, Boulder, CO, 2005.
12. Suprenant, B.A., “Laying Masonry in Cold Weather,” *The Magazine of Masonry Construction*, Vol. 1, No. 9, Addison, IL, December 1988.
13. Van der Klugt, L.J.A.R., “Frost Damage to the Pointing and Laying Mortar of Clay Brick Masonry,” *TNO Building Construction and Research*, 9th International Brick/Block Masonry Conference, Rijswijk, The Netherlands, October 1991.