Hot and Cold Weather Construction

Abstract: This *Technical Note* defines hot and cold 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:

Planning for Weather
- Refer to the Climate Prediction Center during planning to help determine the likelihood that hot or cold weather provisions will be necessary on the project
- Obtain and monitor the most current weather information for the project site through the National Weather Service

Applying Hot and Cold Weather Requirements
- Use typical masonry construction practices during “normal” temperatures between 40 °F and 100 °F (4.4 °C and 37.8 °C)
- When temperature exceeds 100 °F or 90 °F with a wind velocity greater than 8 mph (above 37.8 °C or 32.2 °C with a wind velocity greater than 12.9 km/hour), implement hot weather requirements
- When the temperature is below 40 °F (4.4 °C), implement cold weather requirements
- Comply with hot and cold weather requirements of applicable building codes
- For specific hot and cold weather requirements, refer to Table 1

INTRODUCTION

Adequate planning and preparation can make brick construction possible in virtually all weather conditions. Hot and cold 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”, as used in this *Technical Note*, is any temperature between 40 °F and 100 °F (4.4 °C and 37.8 °C). “Cold” is defined as any temperature below 40 °F (4.4 °C), and “hot” is any temperature above 100 °F (37.8 °C).

BUILDING CODE REQUIREMENTS

In many instances, building codes and standards include requirements or reference the mandatory measures intended to ensure the quality of masonry constructed during hot or cold weather. TMS 602, *Specification for Masonry Structures* (TMS Specification) [Ref. 13], includes a list of required cold and hot weather construction provisions for masonry. The *International Building Code* (*IBC*) [Ref. 1] and TMS 402, *Building Code Requirements for Masonry Structures* (TMS Code) [Ref. 12], both require masonry construction to comply with the requirements of the TMS Specification. The mandatory hot and cold weather construction practices required by the TMS Specification are summarized in Table 1. If hot and cold weather provisions will be necessary for the project, then the TMS Specification requires the submittal and acceptance of a plan or program describing the hot and cold weather construction procedures to be used.

Specific hot and cold weather provisions are not included within the *International Residential Code* (*IRC*) [Ref. 2]. However, the *IRC* states that mortar for use in masonry construction must comply with ASTM C270, which requires mortar to be prepared in accordance with the Masonry Industry Council’s “Hot and Cold Weather Masonry Construction Manual” (MIC Manual) [Ref. 7]. The information in the MIC Manual is similar to that in the TMS Specification, except that it is provided as guidance. Hot and cold weather requirements apply to brick veneer when the TMS Code requirements are used in lieu of the *IRC* masonry provisions.

TABLE 1

Requirements for Masonry Construction in Hot and Cold Weather per the TMS Specification

	Temperature[1]	Preparation Requirements (Prior to Work)	Construction Requirements (Work in Progress)	Protection Requirements (After Masonry Is Placed)
Hot Weather	Above 115 °F, or 105 °F with a wind velocity over 8 mph (46.1 °C, or 40.6 °C with a wind velocity greater than 12.9 km/hour)	Shade materials and mixing equipment from direct sunlight. Comply with hot weather requirements below.	Use cool mixing water for mortar and grout. Ice is permitted in the mixing water prior to use. Do not permit ice in the mixing water when added to the other mortar or grout materials. Comply with hot weather requirements below.	Comply with hot weather requirements below.
Hot Weather	Above 100 °F, or 90 °F with a wind velocity greater than 8 mph (above 37.8 °C, or 32.2 °C with a wind velocity greater than 12.9 km/hour)	Provide necessary conditions and equipment to produce mortar having a temperature below 120 °F (48.9 °C). Maintain sand piles in a damp, loose condition.	Maintain temperature of mortar and grout below 120 °F (48.9 °C). Flush mixer, mortar transport container, and mortar boards with cool water before they come into contact with mortar ingredients. Maintain mortar consistency by retempering with cool water. Use mortar within 2 hours 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	Below 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. Remove visible ice and snow from the 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 and 120 °F (4.4 °C and 48.9 °C). Do not heat water or aggregates used in mortar or grout above 140 °F (60 °C). Heat grout materials when their temperature is below 32 °F (0 °C).	Protect newly constructed masonry by covering with a weather-resistive membrane for 24 hours after being completed.
Cold Weather	Below 32 °F to 25 °F (0 °C to −3.9 °C)	Comply with cold weather requirements above.	Comply with cold weather requirements above. Maintain mortar temperature above freezing until used in masonry. Heat grout materials so grout is between 70 °F and 120 °F (21.1 °C and 48.9 °C) during mixing and placed at a temperature above 70 °F (21.1 °C). Maintain grout temperature above 70 °F (21.1 °C) at the time of grout placement.	Comply with cold weather requirements above.
Cold Weather	Below 25 °F to 20 °F (−3.9 °C to −6.7 °C)	Comply with cold weather requirements above.	Comply with cold weather requirements above. Heat masonry surfaces on both sides to 40 °F (4.4 °C). Use windbreaks or enclosures when the wind velocity exceeds 15 mph (24 km/hour). Heat masonry to a minimum of 40 °F (4.4 °C) prior to grouting.	Cover newly constructed masonry completely with weather-resistive insulating blankets, or equal protection, for 24 hours after completion of work. Extend time period to 48 hours for grouted masonry, unless the only cement in the grout is Type III portland cement.
Cold Weather	Below 20 °F (−6.7 °C)	Comply with cold weather requirements above.	Comply with cold weather requirements above. Provide an enclosure and auxiliary heat to maintain air temperature above 32 °F (0 °C) within the enclosure.	Maintain newly constructed masonry temperature above 32 °F (0 °C) for at least 24 hours, by using heated enclosures, electric heating blankets, infrared lamps or other methods. Extend time period to 48 hours 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 are based on *mean daily temperatures*.

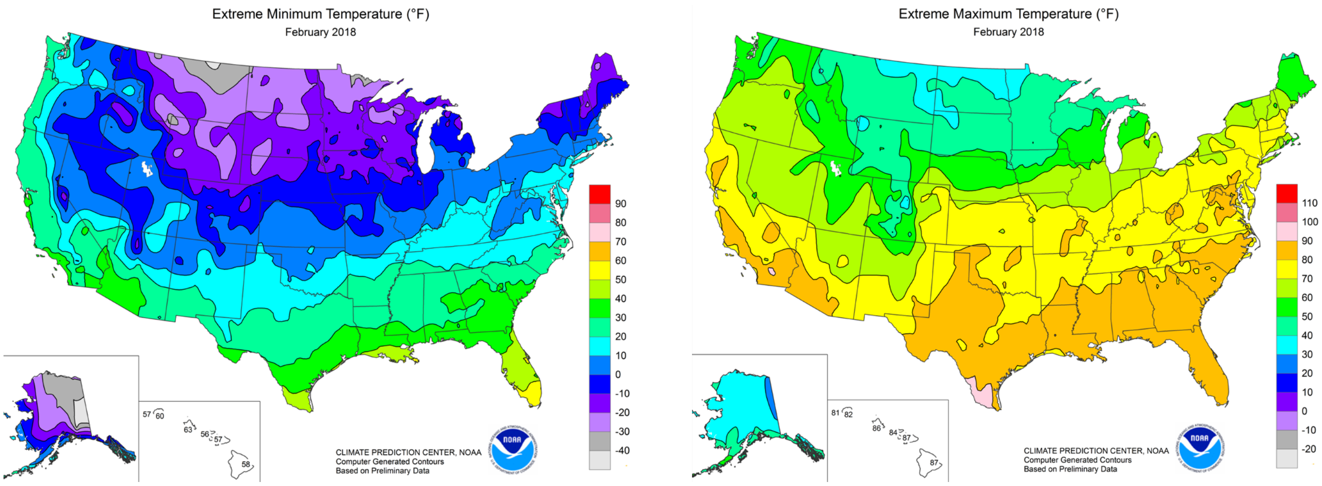

Figure 1
Examples of Climatic Data Available

PLANNING FOR WEATHER

To successfully build during periods of extreme weather conditions, designers and contractors use 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 temperatures, 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 2. The term “ambient temperature” as used in this *Technical Note* is the outdoor temperature at the time considered.

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 Climate Prediction Center, also a branch of NOAA. The Climate Prediction 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. 6].

NEGATING THE EFFECTS OF HOT WEATHER

This section describes the properties of masonry and masonry materials that are changed by high temperatures, and the procedures required by the TMS Specification to overcome these effects.

Although high temperatures and high humidity are not as damaging to the performance of masonry as are low temperatures and low humidity, periods of hot weather may adversely affect the quality of masonry construction. The primary concern during hot weather is rapid evaporation and absorption of water from the mortar. Rapid water loss due to evaporation reduces the amount of water available for hydration and reduces the strength development of the mortar. Without sufficient water, cement hydration slows or stops, which reduces the bond strength and extent of bond between brick and mortar. The integrity of the masonry may also be compromised due to mortar that flash sets before completing hydration. However, if sufficient water is maintained at the time of construction, then the increased rate of cement hydration and favorable curing conditions in hot, humid weather will help develop masonry strength.

The TMS Specification defines hot weather as a temperature above 100 °F (37.8 °C), or 90 °F (32.3 °C) with a wind velocity greater than 8 mph (12.9 km/hour). This is because wind speed, relative humidity and solar radiation also influence the absorption of masonry units, the rate of set and the drying rate of mortar. The adjustments to construction practices required by the TMS Specification allow masons to maintain quality construction in hot weather. These mandatory provisions are presented in Table 1 and are discussed in the following sections, along with additional recommendations for successful hot weather construction.

Cooling Materials

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

Masonry Units. Masonry units are not significantly affected by hot weather. All masonry materials selected for construction in normal temperatures may be used for hot weather construction. However, the interaction between the masonry units and the mortar or grout is critical and will be heavily influenced by the effects of hot weather. Brick that are hot will absorb more water from the mortar. Lower bond strength and lower extent of bond will result if inadequate water is present in the mortar when the units are laid.

To reduce the risk of overheating brick, it is important to protect them from high temperatures. Shading of masonry units from direct sunlight is required when ambient temperatures exceed 115 °F (46.1 °C), or 105 °F (40.6 °C) with a wind velocity over 8 mph (12.9 km/hour).

Brick should be surface-dry at the time of laying and have an initial rate of absorption (IRA) less than 30 g/min/ 30 sq in. (30 g/min/194 cm²). Brick with a field IRA greater than 30 g/min/30 sq in. (30 g/min/194 cm²) at the time of laying may be required to be wetted to reduce their rate of absorption when exposed to high temperatures. Otherwise they can draw too much water from the mortar too quickly. Brick may be wetted immediately before laying, but it is important to ensure that the brick surface is not saturated. A saturated brick surface is likely to impact the bond development between the brick and mortar. The preferred method is to wet brick 3 to 24 hours before use.

Mortar. Water content and board life are two important factors to consider when mixing mortar for hot weather construction. Mortar ingredients that will increase the water retention or water demand, such as lime or evenly graded particle sands, are recommended for hot weather construction. Mortar mixed at high temperatures typically has a higher water content but a lower air content and a shorter board life than mortar mixed at normal temperatures. However, mortar mixed at high temperatures also tends to lose its plasticity rapidly due to the evaporation of water. Rapid stiffening of hot mortar, or flash set, occurs if mortar plasticity is lost before the cement hydrates sufficiently. To prevent this, mortar should be retempered with cool water to maintain a workable consistency during hot weather. For hot weather construction, mortar is required to be used within 2 hours of initial mixing.

Hot weather provisions require that the temperature of the mortar not exceed 120 °F (48.9 °C) and that all mortar materials be shaded from direct sunlight when the ambient temperature exceeds 115 °F (46.1 °C), or 105 °F (40.6 °C) with a wind velocity over 8 mph (12.9 km/hour).

Sand. Sand piles should be kept cool and damp when ambient temperatures exceed 100 °F (37.8 °C), or 90 °F (32.2 °C) with winds exceeding 8 mph (12.9 km/hour). 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.

Water. Cool mixing water for mortar and grout is required by hot weather provisions when the ambient temperature exceeds 115 °F (46.1 °C), or 105 °F (40.6 °C) with a wind velocity of 8 mph (12.9 km/hour). Ice is highly effective in reducing the temperature of the mix water. The 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 and slump of the material. 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. While this may seem counterintuitive, the masonry absorption helps offset the increased water, resulting in adequate compressive strength. The TMS Specification requires grout to be used within 1½ hours of mixing. As with mortar, ice may be added to the mixing water to lower its temperature.

Admixtures. Admixtures can be added during the mixing process to change the properties of the mortar. The use of admixtures is generally not recommended unless their compatibility with the other mortar ingredients has been demonstrated by laboratory tests. 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 TMS Specification requires equipment used to mix, transport or store masonry materials, including mortar boards, to be flushed with cool water before contacting mortar or mortar materials. As with mortar materials, equipment is also required to be shaded from direct sunlight when the ambient temperature exceeds 115 °F (46.1 °C), or 105 °F (40.6 °C) with an 8 mph (12.9 km/hour) wind velocity.

Protecting Materials and Masonry

The use of windscreens and/or fog spraying may further improve masonry strength development during periods of high temperatures and low relative humidity and protect the wall from drying out. 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 °F (37.8 °C), or 90 °F (32.2 °C) with a wind velocity over 8 mph (12.9 km/hour). Once the masonry has been sprayed, the wall should be covered to prevent moisture loss to the environment.

To prevent rapid drying of the mortar during and after placement, windscreens or windbreaks are recommended. Common windscreen materials include reinforced polyethylene or synthetic vinyl. Windscreens should be properly designed and constructed to withstand wind loads. At the end of the workday, the top of the wall should be covered to prevent rapid moisture loss with a weather-resistant membrane that extends at least 2 ft (0.6 m) down all sides of the masonry.

NEGATING THE EFFECTS OF COLD WEATHER

Successful construction considers the effects of cold weather on masonry materials in the planning, scheduling and setup of the masonry work and the 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, the provisions presented in Table 1 can assist the contractor in determining how to protect building materials, unfinished masonry and newly constructed masonry.

The primary purpose of the cold weather construction procedures is to achieve complete hydration of the cement, which occurs only when material temperatures are 40 °F (4.4 °C) or higher. Mortar and grout rely on the chemical reaction between cement and water to cure properly. Fortunately, some heat is generated by this reaction, which can keep the material above 40 °F (4.4 °C) when the ambient temperatures are slightly lower. However, as ambient temperatures fall, the chemical reaction slows and may stop completely unless adequate heat is maintained in the mortar or grout. Incomplete cement hydration can result in soft, friable mortar with reduced durability. Similarly, grout will be weaker.

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. If a cold masonry unit is wet and frozen, then the absorption qualities may be decreased because the pores within the unit will be blocked with ice.

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. Heating masonry units before laying helps to maintain heat within the mortar and minimizes the effect of cold temperatures on mortar hydration. However, preheated masonry units may increase the absorption of the unit by drawing more water from the mortar during construction. When ambient temperatures are below 20 °F (−6.7 °C), masonry units must be heated to a temperature of at least 40 °F (4.4 °C) before laying. Masonry units that have a temperature below 20 °F (−6.7 °C), contain frozen moisture, or have visible ice or snow on their surface must not be laid. Frozen masonry units must be thawed and should be dried before use. Unit temperature can be measured using a metallic surface contact thermometer or a flat, instant-read thermometer.

It may be advantageous to heat brick even when ambient temperatures are above 20 °F (−6.7 °C). Preheated brick will exhibit the same absorption characteristics as those laid at normal temperatures. Brick with a low IRA remove less water from the mortar and may require longer protection to allow the mortar to reach a water content low enough to prevent freezing expansion. On the other hand, brick with a higher IRA more rapidly absorb water from the mortar or grout, which reduces the risk of damage from freezing water in the mortar.

Mortar. Mortar mixed using cold materials has different properties from mortar mixed with materials at normal temperatures. Mortar mixed during cold weather often has lower water content, increased air content and reduced early strength compared with mortar mixed at normal temperatures. This results in reduced compressive strength, bond strength, and extent of bond, as well as reduced water penetration resistance of the mortar. Therefore, proper preparation of the mortar materials is critical to performance during cold weather construction. Specific requirements for protection of mortar are summarized in Table 1. Avoid freezing of mortar during construction, and protect mortar in newly completed masonry from freezing. When mortar freezes, its water content, strength development, durability, etc. will be negatively affected. For example, mortar with a water content greater than 6 percent (wet condition) will likely be damaged by the volumetric expansion of the water during freezing. In freezing weather, ice may be present in the 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.

In cold weather, mix mortar in smaller amounts so it can be used before it cools. During cold weather, avoid extended mixing times, which will increase the air content of the mortar. A mixing time of 3 minutes should provide a workable mortar in cold weather construction. Use mortar within 2½ hours after initial mixing, the same length of time allowed during normal weather conditions. Mortar mixed with heated materials can approximate the performance characteristics of mortar mixed at normal temperatures. For these reasons, the TMS Specification includes requirements for heating mortar materials.

Cold weather provisions require heating the water or sand used in mortar in order to provide proper temperatures for mortar during construction. When ambient temperature ranges from 32 °F to 40 °F (0 °C to 4.4 °C), the sand or water must be heated to produce mortar that is between 40 °F and 120 °F (4.4 °C and 48.9 °C) at the time of mixing. If the ambient temperature falls below 32 °F (0 °C), then the temperature of the mortar is required to be maintained above 40 °F (4.4 °C) until used in the masonry. Ideal temperatures for mortar are between 60 °F and 80 °F (15.6 °C and 26.7 °C). Mortar temperatures over 120 °F (48.9 °C) may lead to flash setting, resulting in lower compressive strength and reduced bond strength. Thus, do not heat sand or water above 140 °F (60.0 °C).

Heating water can be more effective than heating sand because water does not lose heat readily. If the sand is to be heated, then do so slowly to avoid scorching it. Scorched sand should not be used. Heating prepackaged materials such as cement, hydrated lime and premixed mortars can be difficult. Consider keeping these materials in enclosed spaces if possible.

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. High early strength (Type III) portland cement may be used to increase the rate of early strength gain. If brick with a low IRA are used, the water content of the mortar should be the minimum necessary for workability. Mortar constituents that increase the water retention or water demand, such as lime or fine particle sands, are not recommended for cold weather construction. Using masonry or mortar cements or reducing lime content allows mortars to lose water more rapidly, reducing the potential for freezing.

Set-accelerating admixtures, as discussed later in “Other Cold Weather Considerations” may also be used; however, heating and protection measures are still required.

Grout. Grout has similar material components to mortar but has a higher water content. High water content is important to achieve the slump needed to place grout in the wall, but it greatly increases the amount of volumetric expansion that can occur upon freezing. When grout freezes, it may lose the ability to adequately bond to the masonry and may fracture the masonry during expansion. To reduce the potential for any negative effects caused by freezing, grout must be mixed with heated materials if the temperature of the materials is below 32 °F (0 °C). If the ambient temperature is below 32 °F (0 °C), then both grout aggregates and mixing water must be heated to produce a grout temperature between 70 °F and 120 °F (21.1 °C and 48.9 °C) at the time of mixing. Grout aggregates and mixing water should not be heated to temperatures above 140 °F (60.0 °C).

When placing grout in the wall, the grout should have a minimum temperature of 70 °F (21.1 °C). Type III portland cement may be used to increase the rate of early strength gain of grout. Admixtures may also be used to accelerate the setting time, but heating and protection of the grouted masonry is still required. All grout must be placed within 1½ hours of mixing. The temperature of the grout is required to be maintained above freezing for 48 hours after placement unless the grout includes only Type III portland cement. In that case, the recommended duration of protection against freezing can be reduced to 24 hours.

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. The TMS Specification addresses this by requiring masonry under construction to be heated to a minimum temperature of 40 °F (4.4 °C) when the ambient temperature reaches 25 °F (−3.9 °C) or below. If wind velocities exceed 15 mph (21.4 km/hour), then windbreaks or enclosures are required during construction. In addition, if the ambient temperature falls below 20 °F (−6.7 °C), then a heated enclosure must be provided for masonry under construction. The enclosure can be left in place with heaters to maintain a temperature above 32 °F (0 °C). If newly constructed masonry is frozen, it may be moistened after thawing to reactivate the hydration process and to allow the masonry to continue to develop strength.

If snow or ice is visible on existing foundations or masonry, the TMS Specification prohibits 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 or other substrate material.

Protecting Materials and Masonry

In addition to heating materials to adjust for cold weather, the TMS Specification requires protection of masonry constructed in cold weather. Protection is one of the most effective adjustments that can be made to construction practices.

Material Storage. All masonry materials must be properly stored when delivered to the construction site. Bagged materials and masonry units should be covered and stored on raised platforms to avoid contact with the ground to prevent contamination from groundwater or runoff. Coverings such as tarps, polyethylene sheets or other water-resistive materials should be placed over the materials to keep them dry and free of snow and ice. Careless material storage can increase the cost of masonry construction, if removing ice and snow and thawing of masonry units is necessary before construction begins.

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, either completed or partially completed, must be protected for a period of time so that it maintains enough heat for cement hydration. When the mean daily temperature falls to 40 °F (4.4 °C) or below, a series of protective measures is required, beginning with covering newly constructed masonry with a weather-resistive membrane for at least 24 hours after completion. As temperatures decrease, more stringent protection is required. Specific provisions for progressively colder temperatures are presented in Table 1.

Materials such as water-resistive barriers that are used to cover brickwork should be weighted down and/or otherwise fixed in place and should 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
Covering Protecting Newly Constructed Masonry

HEATING METHODS AND EQUIPMENT

Individual Materials

Many types of equipment are available as sources of heat for cold weather construction. The type selected will depend upon many factors, including availability of equipment, fuel source, economics, size of project and severity of exposure. A few common methods for heating individual materials are described in this section.

Materials other than sand or water, such as the brick and pre-bagged mortar components, can be placed within heated enclosures before use in order to raise their temperature to the appropriate value.

Water is typically heated using a large drum with a heat source placed below. Water can also be heated using immersion heaters, flame guns or steam probes. Other safe heating methods that do not add deleterious matter to the water during heating may also be used.

Sand can be heated in a variety of ways. The more common methods include using electric blankets or heated pipes placed underneath the sand. Sand heated by placing an electric heating pad or blanket on top of the sand pile should be covered and protected with a tarp or other weather-resistant material, as shown in Photo 2. As temperatures decrease overnight, providing heat and protection becomes more critical to ensure that the sand does not freeze. Electric blankets or pads can safely heat the sand overnight without risk of freezing or exceeding a sand temperature of 100 °F (37.8 °C). Some insulating blankets may provide proper protection from both weathering and loss of heat from the sand.

Another common method to heat the sand is to place heated pipes beneath the sand pile, to place the sand around a smokestack where a slow-burning fire can be built, or to place the sand around a heated horizontal metal culvert, as shown in Photo 3. Any safe heating device that can thaw ice without scorching the sand is recommended.

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.

Photo 2
Heating a Sand Pile with an Electric Blanket

Photo 3
Sand Pile Warmed by Heated Pipe

Enclosures (Newly Constructed Masonry)

Contractors have used several different methods to provide heat and protection for newly constructed masonry, including complete and partial enclosures. Some also use these enclosures during masonry installation. 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.

Photo 4
Scaffold Enclosures

Photo 5
Space Heater in Enclosure

When complete enclosures of the work area are provided, space heaters are recommended to keep the masonry heated during the curing period, as shown in Photo 5. Cold weather provisions require circulation of warm air on both sides of the masonry wall within the enclosure. Forced air heaters, such as torpedo heaters or gas salamanders, can be used during construction as a source of heat within the enclosures. When using heaters within the enclosure, special precautions against fire and noxious fumes should be taken to protect the workers and the masonry.

OTHER COLD WEATHER CONSIDERATIONS

Admixtures

In general, admixtures are not recommended for use in mortar, although they may be suitable or appropriate in some cases. Indiscriminate use of admixtures can adversely affect the performance of the completed masonry. Therefore, all admixtures must be evaluated to verify that they will not result in any detrimental effects such as corrosion, efflorescence or reduced strength. The use of cold weather admixtures is not a substitute for compliance with the other cold weather construction provisions.

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.

Calcium chloride, while highly effective as an accelerator and 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 the TMS Code. The incidence of efflorescence may also increase if the accelerator contains excessive salts.

Other compounds that are used as accelerators are calcium nitrite and calcium nitrate. These inorganic non-chloride compounds require higher dosages by weight and are more expensive than calcium chloride but will not corrode metals or contribute to efflorescence. For this reason, non-chloride compounds are recommended if an accelerator is approved for use and performance is demonstrated to meet project requirements.

The use of accelerators alone is not recommended, because they do not address all concerns related to cold weather construction. Masonry constructed using accelerators in mortar or grout must still be protected from freezing.

Antifreeze. Do not use antifreeze compounds. These admixtures are made with alcohols or combinations of salts that are intended to reduce the freezing point of a substance. Most commercial mortar “antifreeze” admixtures do not lower the freezing point of mortar or grout but are actually accelerators. If antifreeze compounds are used in the quantities required to be effective, the result is usually a significant reduction in mortar compressive strength and bond strength.

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 groundwater.
- Units with higher IRA (up to 40 g/min/30 sq in. [40 g/min/194 cm²]) may be used to resist mortar freezing. However, units with IRA in excess of 30 g/min/30 sq in. (30 g/min/194 cm²) should be wetted, but not saturated, with heated water just prior to laying. Water used for wetting should be above 70 °F (21.1 °C) when units are above 32 °F (0 °C). If units are 32 °F (0 °C) or below, then the water temperature should be above 120 °F (48.9 °C).

If walls are properly covered when work is halted, then ice or snow removal should not be necessary. However, in the event that the covering is displaced, the top course of the masonry 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, then replace the defective parts before continuing with new work.

CLEANING

Air temperature, temperature of the masonry and wind conditions will impact the ability to perform cleaning procedures, as well as affect the drying time and reaction rate of different cleaning solutions. When implementing cleaning procedures during periods of hot or cold weather, additional precautions may be necessary to avoid damaging the brickwork.

Hot Weather. Before applying a cleaning solution to the wall, the area to be cleaned must be thoroughly saturated with water. Water may need to be reapplied to the wall more often during higher temperatures to keep it from drying before cleaning solutions are applied and rinsed. If cleaning solutions are allowed to dry on the brickwork, damage or staining of the masonry can result. Rapid drying can also be avoided by working in small, shaded areas of the wall when possible.

Cold Weather. Masonry should not be cleaned during freezing weather or when freezing weather is expected. Because many cleaning methods require the wall to be saturated with water, there is an increased risk of the water freezing on the surface or within the wall and damaging the masonry. To avoid harming the masonry or increasing the risk of efflorescence, it is recommended that cleaning methods involving water should be used only if the ambient temperature will be 40 °F (4.4 °C) or above and will remain so until the brickwork is dry.

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 the recommendations in this *Technical Note*. Table 1 summarizes practices required by building codes for cold and hot weather construction.

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