Materials in Cold Weather

Make sure they're a match for the weather

by Scott Schuttner

During the summer, house building in Fairbanks, Alaska, presents no more than the usual number of obstacles to builders. But once summer's over, temperatures begin to fall toward zero and below, and they can stay that way until after Easter. In these parts, builders who plan to keep their income flowing year around like I do need to adjust their work habits to do it. And that goes for other northern climes as well. If you read my article in the last issue ("Out in the Cold," *FHB* #50, pp. 60-63), you have a pretty good idea of how to outfit yourself and winterize your tools in order to build in cold weather. In this article, I'll talk about how materials react to the cold.

Concrete and masonry—The foundation is where the project usually begins, and that's where you can run into the most trouble if you don't know how to handle the cold. Concrete is extremely sensitive to cold weather. The standard rule of thumb says that concrete should not be placed without special precautions in temperatures uniformly colder than 40° F, or 32° F if the temperature is rising and is expected to exceed 40°. Concrete must be kept above freezing until it attains a compressive strength of 500 PSI or it will lose up to 50% of its strength when fully cured. This takes about two days for Type III cement and three days for Type I cement.

The concrete most commonly used in cold weather is called "high-early-strength." It can be obtained by using Type III cement instead of the usual Type I cement, by adding accelerators to the mix or by increasing the proportion of portland cement in the mix (or any combination of the three). Builders most commonly use Type III cement around here, which yields the equivalent of the 28-day strength of the standard Type I cement in about a week. Type III cement also gives off more heat than Type I while it's curing, which helps to protect the concrete from freezing. In Fairbanks, Type III cement costs about the same as Type I cement.

Accelerators are chemical admixtures that speed up the curing process. Calcium chloride was at one time commonly used as an accelerator but is no longer allowed in many places because it can cause chemical reactions that damage the reinforcing steel. Calcium chloride can also cause shrinkage cracks and scaling of the concrete. If you use it, never use more than 2% of the weight of the portland cement. Other admixtures, such as Pozzutec 20 (Master Builders, 23700 Chagrin Blvd., Cleveland, Ohio 44122) accelerate curing while lowering the freezing point of concrete to about 20°. This makes it invaluable in the spring and fall, but in climates as cold as ours you can seldom rely on admixtures alone in the winter.

You can also attain high-early-strength by adding an additional 100 lb. to 200 lb. of cement per cubic yard of concrete. This will increase the heat of hydration, too, and help prevent concrete from freezing while it cures. In Fairbanks, we use air-entraining compounds as well. They cause minute air bubbles to form in the concrete to protect it from the freeze/thaw cycle. Although they add to the long-term durability of the concrete, they don't protect the concrete during curing.

The concrete mix should be between 60° F and 80° F at delivery time. If you're mixing your own concrete, the temperature can be adjusted by using warm water in the mix. If the aggregate is very cold, however, don't try to compensate by using extra-hot water because this can cause the concrete to flash set, leaving chunks of hardened concrete in the mix. It's better to warm the aggregate as well as the water. Water can be heated in an open barrel with a large propane torch, known as a weed burner, playing on the side. Aggregate can be warmed by piling it over culverts or pipes and lighting a fire inside or blowing warm air through with a space heater. Some concrete plants will heat the aggregate and water for you. In Fairbanks, they'll heat the aggregate for $10 per yd. of concrete and the water for $5 per yd. of concrete. Once they're warm, combine the water and aggregates in the mixer to even out the temperature of the mix, then add the cement, but don't let the temperature of the mix exceed 90° F. Try to maintain the same temperature for consecutive batches so the slump remains consistent. Regardless of the temperature of the concrete, don't pour it over frozen rebar or frozen ground. To avoid this, you may need to erect temporary structures and heat the site before the concrete pour (more on that later).

The American Concrete Institute (P. O. Box 19150, Redford Station, Detroit, Mich. 48219) has volumes written on this subject, and the National Research Council of Canada offers a handy book on cold-weather concreting (Publication Sales and Distribution, National Research Council of Canada, Division of Building Research, Montreal Road, Ottawa, Canada K1A 0R6). Local building codes and architect's specifications usually list standards for concrete work in cold weather. The Fairbanks concrete plant has made it a point to remain up-to-date on new techniques for pouring concrete in freezing temperatures; your plant might be able to offer advice which accounts for local conditions and material availability.

For masonry work, avoid using accelerators in the mortar because they'll substantially weaken the set. Bricks and blocks should be dry and warmed to above 20° F and ideally to above 32° F. Mortar ingredients should be heated to produce mortar temperatures above 40° F. Blocks and bricks can be warmed with a space heater in a tunnel or tent made from polyethylene sheeting. Fin-

Enclosures can be made of polyethylene sheeting and inflated with heaters and blowers to cover everything from slabs to entire houses.

Photo: Courtesy Cold Regions Research Lab ished masonry walls should be covered and heated to above-freezing temperatures for at least 24 hours.

Temporary structures—Often it's too cold for the above measures alone to protect concrete from freezing. An insulating blanket of straw, polypropylene or canvas over the concrete can be a big help. Around here, we get plenty of mileage out of 6-mil polyethylene sheeting and space heaters. Poly can be draped over a variety of simple structures built out of 1x and 2x lumber, and space heaters can be placed to blow hot air inside. The structures range from simple box tunnels over perimeter footings to large arch-rib buildings with laminated 1x ribs that span an entire slab.

To avoid the need for supporting structures, enclosures can also be made of reinforced polyethylene and then inflated with space heaters and blowers (photo facing page). These poly enclosures require surprisingly little air to keep them up, but can consume a lot of Btus. In some places, trailers are available for rent that contain a large-volume fan coupled with a heater and fuel tank. You can also use a fan designed for pre-inflating hot-air balloons to inflate these poly structures.

Large commercially built air structures are also available. These structures, which are usually used for permanent installations such as ice rinks and tennis courts, are inflated with large fans and can cost about $8 per sq. ft. Some are big enough to contain an entire house (see this issue's back cover). Check auctions and surplus sales to find them at a reduced price.

Once a building is partially complete, polyethylene sheets can be suspended from the fascia or eaves to help retain heat inside the building. Also, poly and 2x2s can be assembled into modular panels and then erected around particular parts of the building. These are easily moved as the need arises.

Space heaters—Here are a few tips about space heaters (photo below). Any heater that burns fossil fuels produces carbon dioxide, which reacts with fresh concrete to form a weak surface layer of calcium carbonate. This layer is soft and chalky, and spalls (flakes) easily. The problem can be avoided by covering the surface of the concrete with poly or by brushing or spraying on a coating, such as Horncure 30 (A. C. Horn, 12116 Conway Rd., Beltsville, Md. 20705), which is made specifically to seal the concrete and prevent it from drying out during the cure period. Another option is to use vented space heaters, at least for the first 24 hours. They allow the products of combustion to be exhausted outside of the enclosure. Avoid blowing a space heater directly onto fresh masonry or concrete. This creates hot spots which can lead to premature drying of the concrete and cause spelling. Finally, don't use unvented space heaters inside enclosures where people are working. They produce carbon monoxide and other hazardous exhaust fumes.

Lumber, poly, caulks, adhesives—Lumber doesn't present much of a problem in cold weather. Sawing frozen lumber requires slightly more power than sawing thawed lumber, but frozen wood cuts more cleanly. A carbide-tipped sawblade works well. The biggest problem with frozen lumber is that of drawing a decent cut line on it. Pencils don't work on ice. Your best bet is to scratch the cut line with a hard carpenter's pencil or a scratch awl. Better yet, keep the lumber covered so that snow and ice don't stick to it. Frozen lumber is less resistant to impact damage, so handle it a little more carefully to avoid breakage.

Photo by author

Portable space heaters and fans are a big help in cold weather. From left to right is a 500,000 Btu vented heater, a 320,000 Btu unvented heater, a 100,000 Btu unvented heater and a 30-in. hot-air balloon fan for inflating temporary polyethylene air structures. Vented space heaters are the best choice for curing concrete and for heating enclosures with people inside, while unvented heaters are great for warming up building materials and tools.

Cold polyethylene gets brittle and can tear easily. If you're installing a poly vapor retarder, warm up the room first and provide some slack when you staple the poly up. Otherwise, when it gets cold it might shrink and tear. Protect the poly from wind loading.

Other materials particularly affected by the cold are caulks and construction adhesives. A friend of mine always warms his caulking tubes at home overnight and brings them to the job packed in an ice chest along with some extra heat storage (nails work nicely). This keeps the tubes warm enough to flow for almost the whole day.

Water-based caulks and adhesives can't be used in cold weather or they'll freeze and deteriorate, so I use silicone caulk. It can be applied at temperatures as low as -35° F provided the surfaces are clean, dry and frost-free. And once it's cured, it remains flexible down to -65° F. Polyurethane foam sealants don't work below 35° F. Construction adhesives that meet the APA specification AFG-01 (look on the label) will work on either frozen or wet lumber, but there can't be ice or puddled water on the surface. Keep the tubes warmed to room temperature until you're ready to use them.

Paint, too, should be kept warm. Oil-based paints will not dry properly and latex paints will freeze quickly when applied to frozen surfaces.

The plastic insulation on the nonmetallic sheathed cable (type NM) typically used for residential wiring is brittle when it's cold and can crack. Wiring should be done when the temperature is above freezing to avoid hidden damage inside the cable. Leave some slack in the wire to allow for shrinkage at colder temperatures. Underground service wires should have a loop at both ends to prevent shorts caused by the contraction of the cable.

Moisture condensation problems—The exhaust from temporary heating equipment such as space heaters can cause moisture condensation in a building's roof and walls. Insulation traps this moisture, which then freezes. Also, frozen framing lumber holds its moisture. When the permanent furnace in a house is finally fired up, all this ice thaws out, causing damage to both the inside and outside of a house.

The use of vented temporary heating can help minimize these problems. A mobile-home type forced-air furnace connected to a barrel of oil outside works well and is easily transportable. Woodstoves also work well and can be fueled with scraps of lumber. Unvented space heaters aren't a good idea. Aside from the obvious health and safety hazards of using them indoors, they produce a pound of moisture per pound of fuel. Although inexpensive, they are suitable only for specific applications, such as warming up materials or tools. Unvented propane space heaters are purported to be safe, but they also produce too much moisture to be used indoors. □

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