Pouring Concrete Slabs

Tips on ordering, placing, screeding, floating and finishing

by Carl Hagstrom

Using a screed rail. **Two workers use a magnesium straightedge, or screed rail, to level freshly placed concrete. The ends of the rail glide over previously leveled concrete strips, called wet screeds. A third worker rakes the concrete behind the screed rail to adjust for high and low spots.**

Liquid stone. It's an image you might think describes placing concrete, and to some extent, it does. But there's more to it than backing up the ready-mix truck, opening the spigot and letting the concrete flow out until the forms are full.

The applications of concrete are almost limitless, but here I'll focus on residential slabs. About half of the new homes currently built in the United States start with full-basement foundations, and virtually all of these basements have concrete floors. For the most part, these floors consist of 4 in. of concrete placed over 4 in. or more of crushed stone. Concrete floors in garages are similar, except they are sometimes reinforced with wire mesh or steel. But whether it's a basement or a garage slab, the way you place the concrete is the same.

Ordering concrete—Concrete is sold by the cubic yard, and calculating the amount you need is simple: length times width times depth (in feet) divided by 27 equals cubic yards. Most concrete trucks max out at 9 yd., and if your floor will require more than nine (the average floor uses about 19 yd.), tell your supplier to allow about an hour to an hour and a half per truckload so that all the trucks don't arrive at once.

But a word of caution. Running out of concrete is like running out of champagne at a wedding: If you can't get more real soon, you're headed for trouble. Don't be stingy with your concrete estimate. You're a lot better off with half a yard left over than a quarter yard short.

Once you've told your concrete supplier how much concrete, you'll have to tell them what kind. Concrete is made up of four basic ingredients: cement, sand, stone and water. Depending on the proportions of the ingredients, the strength can vary considerably. Compressive strength, measured in pounds per square inch (psi), is the method used to evaluate the performance of a given mix. Generally speaking, the higher the cement content, the higher the compressive strength. Most residential concrete has a compressive strength between 2,000 psi and 3,500 psi.

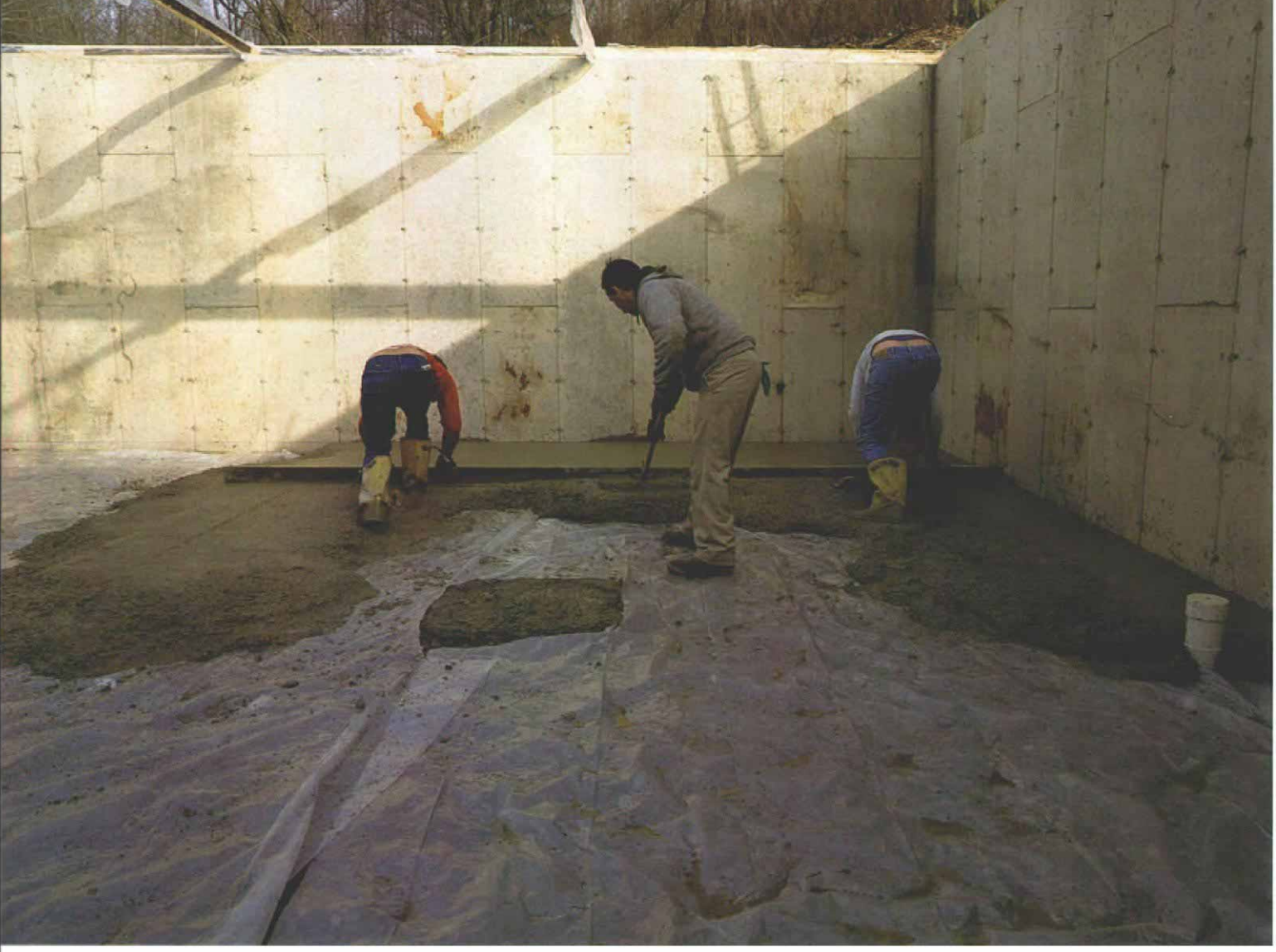
You'll also need to specify the slump, or the wetness, of the mix. A slump of 4 to 5 is about right for slabs, whereas a slump of about 2 to 3 is normal for piers, which don't need to be worked, so the concrete can be stiffer.

Be prepared—Take a few moments and survey the situation. Do you have a grade-level door, or will you need to chute the concrete through a basement window? Will the ready-mix truck be able to get next to the house, and if not, will the manpower be available to transport the concrete in wheelbarrows? Pushing one wheelbarrow full of concrete uphill is possible for some, but making 30 trips uphill is a job for the John Henry type. It never hurts to have more help than you might need because concrete is always a rugged day's work.

A little rain the night before can turn a dry approach into a muddy nightmare. I call my supplier several days in advance and say that I'm shooting for next Thursday, for example, but that

First mud. **With the vapor barrier in place and the chalklines snapped, the first load of concrete is dumped in the far corner of the foundation. The mason dumps the concrete away from the wall so that he won't cover the chalkline.**

Establishing a perimeter screed. **A magnesium hand float is used to push the concrete up to the chalkline. This strip of wet concrete, placed along the foundation walls, is a perimeter screed.**



Raker's role. **As the screed rail levels concrete between the perimeter screed (right) and the center screed (left), the raker pulls away excess concrete or fills low spots. A rebar spike set at finish-floor height and subsequently driven below the concrete's surface establishes the center screed's level.**

I'll call first thing Thursday to confirm. If conditions are terrible, I reschedule.

Remember, concrete waits for no one. From the minute it leaves the plant, it has a finite time before it sets up, and just about any builder can come up with a horror story describing a pour that got away.

Placing the slab—Arrive early on the day of the pour and use a water level or a transit to snap chalklines on the foundation wall at finish-floor height (usually 4 in. higher than the stone). The lines help you level the concrete along the walls.

You should also lay out the vapor barrier at this time. Six-mil polyethylene works well, but if you're concerned about punctures from traffic during the pour, a puncture-resistant, cross-laminated product is available, called Tu-Tuf (Sto-Cote Products, Inc., P. O. Box 310, Richmond, Ill. 60071;815-675-2358).

If you elect to use wire-mesh reinforcement, this is also the time to lay it out. Wire mesh doesn't prevent cracking, but it will help keep hairline cracks tight, even as the temperature varies. Typically, a basement slab isn't subjected to wide temperature swings. Therefore, a basement slab placed over a properly prepared stone base doesn't require wire mesh. Garage slabs, on the other hand, typically experience harsher weather conditions, and wire mesh may be used as temperature reinforcement. But wire mesh won't be effective unless it's placed midway in the thickness of the slab, so be sure to use wire high chairs, which hold the reinforcement up off the stone during the pour.

The ready-mix truck arrives, and the driver asks, "How wet do you want it, Mac?" Drivers routinely ask about adding water to soften the mix. When a mix is too stiff, it's physically difficult to work and presents problems when it's time to float and finish the slab. To get a smooth, hard, dense finish on top of the slab, the mix has to be workable. As mentioned earlier, however, the wetness was determined when you specified the slump of the mix. And as any structural engineer will tell you, when you add water to concrete, you lower the final strength. The issue of water content in concrete is critical; many concrete companies require that you "sign off" on the delivery slip when requesting additional water so that they have a record of your compromising the rated strength of the mix.

If the first few wheelbarrows of concrete are difficult to work, have the driver add water to it—but in small amounts. You can always soften the mix by adding water, but you can never dry it if it becomes too wet.

Leveling with wet screeds—There are many ways to place a basement slab. If you've never placed one, ask some masons about the techniques they use. If you have placed a few slabs, don't be afraid to try a different method; you may discover a system that you're more comfortable with. But whatever approach you take, follow a logical progression: Don't trap yourself in a corner. I prefer to use wet screeds as guides to level the slab (photo p. 46).

Wet screeds are wet strips of concrete that are leveled off at finish-floor height and used to guide a straightedge, or screed rail, as you level the slab. If you've ever watched a sidewalk being placed, you've seen concrete placed between two wood forms, a screed rail placed on top of those forms and sawed back and forth to strike the wet concrete down to the level of the forms. Wet screeds guide the screed rail in places where there are no wood forms, such as against an existing concrete wall or in the middle of a slab.

Where you start with your wet screeds depends on the layout of the slab. In a typical rectangular

Operating a bull float. **After the concrete is screeded, a bull float pushes stones down and brings up the fines—sand and cement—that make a smooth, finished surface. To use a bull float, lower its handle as you push it away, and lift the handle as you pull it back.**

basement with the walls already in place, a wet screed is placed around the perimeter of the foundation, and a second wet screed is placed down the center of the foundation (photo facing page), parallel to the longer dimension of the foundation. On a bigger slab you might need more wet screeds; the determining factor is the length of the screed rail you'll be using.

Placing the wet screeds around the perimeter of the foundation is simple. Use the chalkline you snapped at finish-floor height as a guide to level the concrete at the wall (bottom photo, p. 47). As the concrete is placed, either from a wheelbarrow or directly from the chute, use a magnesium hand float to push and level the concrete to the line. Be sure you don't cover up your chalkline as you place the concrete. Dump it near the wall and bring it up to the line with the float (top photo, p. 47).

Establishing the level of the center screed requires that you drive pins about 8 ft. apart at the level of the finish floor; 16-in. lengths of ½-in. rebar work well. Try to set these pins immediately before the pour, using a transit or a Stringline, and cover them with upturned buckets so that no one trips on the pins. Place and level a pad of concrete around each pin, then fill in the area between the pads with concrete and use a screed rail, guided by the pads, to level the area between them. As you complete each portion of this center screed, drive the pins a few inches below the surface with a hammer and fill the resulting holes with a little concrete.

Raking and striking—To fill in the areas between screeds, place and rake the concrete as close as possible to finish level before striking with a screed rail. Placing too much material makes it difficult to pull the excess concrete with the screed rail as you strike off, and the weight of the excess concrete can distort a wooden screed rail. If you starve the area between the screeds, you'll constantly be backtracking through freshly placed concrete, filling in low spots and rescreeding.

Cement shoes. **Kneeboards—pieces of plywood with strips of wood on one edge—allow you to move around on fresh concrete without sinking in because the boards distribute weight over a large surface area. Concrete finishing is done from kneeboards while the concrete is in a plastic state, meaning it's neither liquid nor solid.**

Using a screed rail, strike off the concrete with the perimeter screed and the center screed as guides. Your path of escape will determine the placement and the size of your screeds, but generally speaking, you progress in about 10-ft. or 12-ft. sections of slab.

The person raking the concrete can make or break the pour. As the wheelbarrows are dumped, the raker should nudge the concrete to the plane of the finish floor, eyeing the placed concrete like a golfer lining up a putt, and noting any mounds or valleys that will create problems as the screed rail works across. As the concrete is struck off, an alert rake person will pull away any excess concrete accumulating ahead of the screed rail (photo facing page) and push concrete into any low spots.

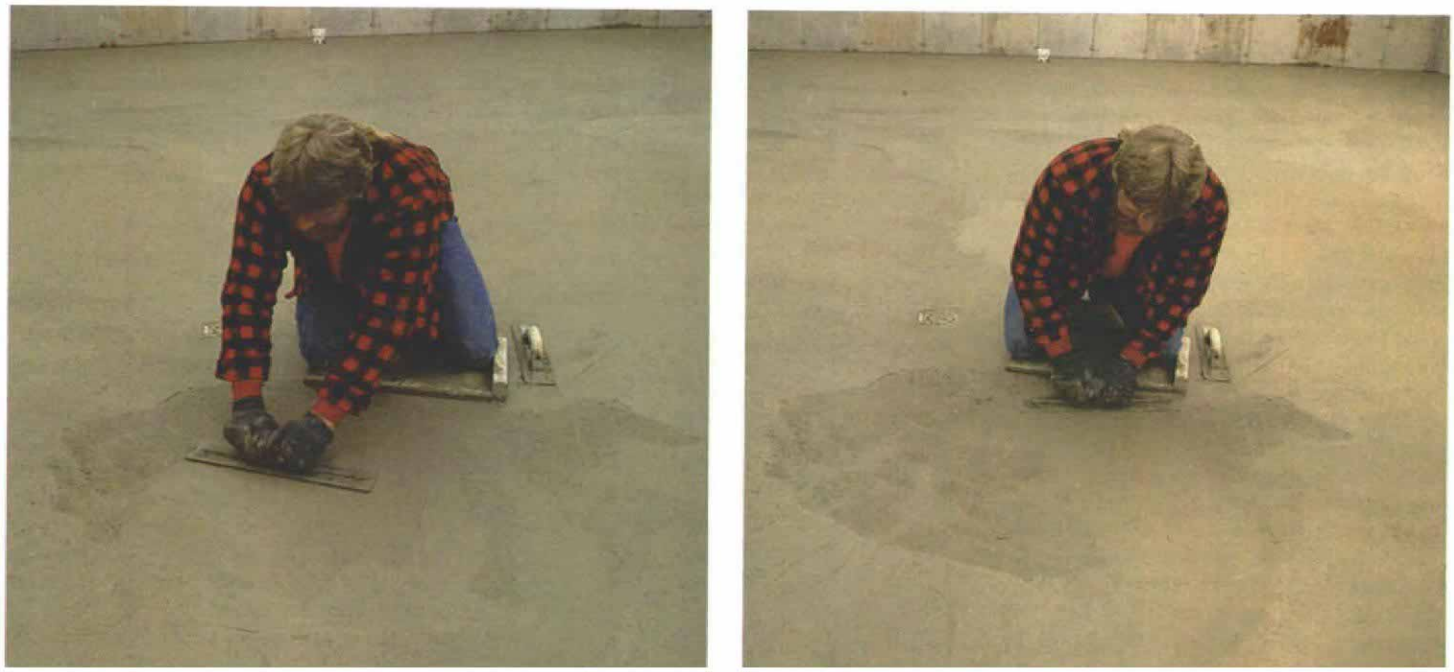
At this stage of the pour, with five or more people working, teamwork is the name of the game. Establish each person's role well ahead of the pour, and do your best to stick to the plan.

Striking off the concrete with the screed rail is the last step in placing the concrete and the first step in finishing it. A good, straight 2x4 will work well, but magnesium screed rails, available in various lengths, will perform better. No matter which you choose, working a straightedge back and forth is a lot like running a two-man saw. The work is done on the pull stroke, and you have to be aware of your partner's progress. Wear rubber boots because, standing alongside the wet screeds, you'll often be wading through concrete. (For anyone tempted by the prospect of a barefoot frolic in concrete, be warned that concrete is caustic and will corrode your skin.)

As you saw the screed rail back and forth, let it float on top of the wet screeds, keeping an eye open for low spots and stopping when excess concrete dams up ahead of the screed rail so that the raker can pull off the excess.

Bull floating—As the pour progresses, it's necessary to smooth the surface of the leveled concrete with a magnesium bull float (top photo, this page). When you bull float is determined by

Start with a mag; finish with steel. **After bull floating, use a magnesium float (left) to smooth out bumps and fill in low spots. The resulting finish will be coarse. Later, use a steel trowel (right) to get a smooth, dense finish that won't crumble when it's swept.**



Two hands! Two hands! **As the concrete sets up, working it with a steel trowel may require the strength of two hands. The back of the trowel is angled up as you push it away (left), and the front of the trowel is angled up as you pull it toward you (right).**

the length of the tool's handle and how comfortable you are operating the tool. For example, a bull float with an 18-ft. handle will easily float a 10-ft. or 12-ft. section of a slab. Bull floating levels the ridges created by the screed rail, but more importantly, it brings cement and sand to the surface of the slab and pushes stones lower.

Water is the lightest ingredient in concrete and quickly finds its way to the surface as you jostle the mix around with a bull float. As the water rises to the surface, it also brings some cement and sand with it. These are the fines (sometimes called fat or cream) that provide a stone-free medium for troweling to a smooth finish.

Although its size is intimidating, a bull float works about the same as a hand trowel. The trick is to keep the leading edge of the bull float inclined above the surface of the slab by lowering the bull float's handle as you push it away and raising the handle as you pull it back. Some masons jiggle the handle as they move it out and back to jostle more fines to the surface. The ease of final troweling depends on how well the slab has been bull floated.

Hurry up and wait—Once the slab is placed and bull floated, it's time to sit and wait. The first stage will be the evaporation of the bleed water, water that rises to the surface as the slab sets up. Depending on the weather conditions and the consistency of the mix, this time can vary from one hour on a hot, dry day to 10 hours on a cool, damp day (see sidebar on the facing page).

But keep in mind that when concrete starts to set, it waits for no one. There is a small window of opportunity in which you can work the slab, and if you happen to be out for coffee when the concrete starts to set up, you'll learn an expensive lesson. Unless you're a veteran finisher, don't ever leave the pour; you may return to a problem whose only solution is a jackhammer.

Floating from kneeboards—Once the bleed water has evaporated, work the slab. Some slabs (in crawlspaces, for example) are acceptable with just a coarse, bull-floated finish. But these finishes tend to dust over time; that is, concrete particles come loose from the coarse slab surface whenever it's swept. Additional finishing compacts the surface so that the slab won't dust.

You may have seen professionals using a power trowel to float and finish larger slabs. A power trowel works like a lawn mower without wheels. It rides on rotating blades that smooth the sur-

face of the concrete. (For more on power troweling, see p. 52) If you're inexperienced, however, or if the slab is small, you're better off finishing it by hand. And even professionals still use hand floats and trowels at the edges of the slab and around projections because a power trowel will only finish to within a few inches of these spots.

Hand finishing is commonly done from kneeboards, which are like snow shoes for the still-wet slab (bottom photo, p. 49). They let you move around on the slab without sinking. To make a simple pair of kneeboards, cut two pieces of ¾-in. plywood 2 ft. square, and tack a 2x2 strip at one edge of each piece.

It's difficult to describe just when the slab is ready for hand floating, but it may help to think of the slab as drying from the bottom up. If you set a kneeboard on the slab, and it sinks ¾ in. when you step on it, you're too early; if it fails to leave a mark, you're too late.

As soon as you can easily smooth over the tracks the kneeboards leave behind, the slab is ready for the first hand floating.

Test the concrete at the area where the pour started because it tends to be ready first. If any areas of the slab are in direct sunlight, you can bet they'll be ready long before the shaded areas are. At any rate, your first pass will be with a magnesium hand float (top left photo, facing page).

Like a bull float, a magnesium hand float works the fines to the surface, and you fill in any low spots or knock down any high spots during this pass. The goal when using the magnesium float is to level the concrete, preparing a surface that is ready for smoothing with the steel trowel. You can generally work the entire slab with the magnesium float before it's time to trowel with steel.

The difference between a magnesium float and a steel trowel is easy to recognize on the slab. You can work the slab all day long with magnesium, but you'll never get beyond a level, grainy surface. But when the slab is ready, and you lay a steel trowel to it, the results are impressive.

Hit the slab with steel—Keeping the image in your mind of the slab drying from the bottom up, picture the top ⅛ in. of the concrete, which is all cement, sand and water. While this top section is in a plastic state—neither liquid nor solid—the steel trowel will smooth this layer and compact it into a dense, hard finish. Now the preparatory work pays off; if the concrete was placed and leveled accurately, the final finish goes quickly.

Obtaining an exceptionally smooth finish is a practiced technique that takes years to develop. The steeper the angle of the trowel to the slab, the more trowel marks will occur. If you hold the trowel at an extremely slight angle, you're liable to catch the slab and tear out the surface.

Your troweling technique will be dictated by how loose or tight the surface of the slab is. When the surface is wet, you can hold your trowel fairly flat, but as the fines tighten up, you'll have to increase both the angle and pressure of your trowel. As the slab dries you might have to use both hands on the trowel to muscle some fines to the surface (bottom photos, facing page). Once the fines have emerged, switch back to one hand and polish the area with your trowel (top right photo, facing page). If you've waited too long, and you're losing the slab, sprinkle water on its surface to buy a little more finishing time. After that, there isn't enough angle, pressure or water anywhere on earth to bring a lost slab back to life. If it's important that the final finish be first rate, consider hiring a professional. Remember, you get only one try.

Curing the finished slab—While it's true that you can walk on the floor the day after it's placed, concrete actually hardens very slowly. The initial set represents about a quarter of the total strength; it takes about a month for concrete to cure fully. The goal during this period is to have the concrete cure as slowly as possible.

Keeping the slab soaked with water for four or five days will keep it from drying too quickly, but continual hosing down involves a lot of time and effort. Slabs can require a soaking every half hour in the heat of summer. A masonry sealer applied the day after the pour will keep the slab from drying too quickly and protect the floor from stains that might otherwise wick into the slab.

When you consider that the material cost of a basement slab is less than $1 per sq. ft., it's difficult to imagine a more economical finished floor system. But when you consider the cost of removing and replacing an improperly finished concrete floor, the importance of knowing how to handle two or three truckloads of concrete becomes apparent. □

Carl Hagstrom manages Hagstrom Contracting, a design/build company in Montrose, Pa. Photos by Rich Ziegner.

Tips for pouring in the weather

Temperamental is a literal description of concrete Temperature, along with humidity, influences the pour more than any other factor

Hot-weather pours—When it's hot, and the humidity is low, every minute is important. If you spend time fussing around, when the last wheelbarrow of concrete is finally off the truck, the first section of floor you placed will probably be hard enough to walk on.

Here are some strategies that help in hot weather

Even if a polyethylene vapor barrier is not required, use one. It blocks the moisture from dropping through the subgravel.

Have lots of help available. The sooner you get the truck unloaded and the concrete leveled, the better your chances will be of getting a good finish.

Have two finishers working the slab: one with a magnesium float, and another following behind with a steel trowel

Although it compromises compressive strength, consider using a wetter mix to buy a little more working tune.

If more than one truckload is needed, coordinate the arrival times carefully. If a fresh truckload of concrete has to sit and wait an hour while you finish unloading the first truck, you may find that concrete from the second truckload will set up before you're ready for it.

Areas that receive direct sunlight set up much quicker than shaded areas.

Start wetting down the slab as soon as the final finish has set. Few things will weaken concrete as much as a "flash" set, where the concrete dries too quickly.

Cool-weather pours—When the temperature is cool, concrete initially reacts in slow motion. After the slab is placed, and the bleed water slowly evaporates, you'll wait hours for the slab to tighten up enough to start hand troweling. When it's finally ready to be troweled, you'd better be there because that window of opportunity for finishing doesn't stay open much longer on a cool day than it does on a warm day.

Here are a few cool-weather tips:

Don't wet the mix any more than necessary.

If a polyethylene vapor barrier isn't required, don't use one. Any moisture that drains out of the slab will speed the set.

Pour as early as possible to avoid finishing the slab after dark.

Cold-weather pours—When the temperature is cold, a whole new set of rules comes into play. Concrete cannot be allowed to freeze. That tender, finely finished surface you just troweled on the slab will turn to mush if it's allowed to freeze. Fortunately, the chemical reaction that takes place when concrete hardens generates heat.

Here are some strategies that help in a cold weather pour:

Ask your concrete supplier about using warm mixing water to prevent problems during transit on days when, the temperature is well below freezing.

Having the supplier add calcium to the mix accelerates the initial set of the concrete, and the concrete achieves the strength to resist freeze/thaw stress faster. The amount of calcium is measured as a percentage of the cement content and ranges from ½% to 2%. Talk to a veteran concrete finisher before deciding when and how much calcium to add to the mix. Too much calcium produces the same problems as hot, dry weather. It's important to note that calcium is corrosive to steel and should never be used in steel-reinforced concrete.

Always be sure that all components of the subbase are frost free.

Provide supplemental heat to keep the building above freezing.

Cover the slab with polyethylene and then spread an insulating layer of straw or hay at least 4 in thick on top, or use an insulating tarp

The best strategy: Pour when cold temperatures are not an issue. —*C H.*