Pouring Successful Slabs

by Peter Schober

Careful preparation and curing are essential to quality concrete slabs

Concrete is the most unforgiving material builders use. Once it has cured, mistakes are "set in stone" and are extremely difficult and costly to repair. But like any other part of the building process, with planning and coordination, you can ensure a quality product and minimize callbacks.

Design

A well-designed slab is sized for its intended use: The more demanding the use, the stronger the slab needs to be. Typical residential slabs for foot traffic, storage, and vehicle parking are 4 inches thick, but large, heavy vehicles — like loaded pickups, oil delivery trucks, and trash haulers — require a 5- or 6-inch slab. Parts of the slab may be thickened to support heavier loads, such as bearing walls or fireplaces (see Figure 1). For most residential loads, I recommend a 3,000 psi mix. This will give the concrete sufficient strength and workability at a reasonable cost.

Subgrade Preparation

Unlike the structural slabs used in multistory buildings, a slab-on-grade is not designed to support loads on its own or to carry loads from one support to another. It must be held up by a subgrade of coarse granular material that is well-drained and properly compacted.

Drainage. Before laying and compacting any fill, you should divert pockets of standing water away from the slab area. Wet areas will not compact well and will cause heaving and cracking in exterior or garage slabs susceptible to freezing. In extremely wet areas or where it is likely water will be running under the slab, use drain pipe embedded in clean stone and wrapped in filter fabric to capture the water and carry it safely out from under the slab.

Fill. Granular fill, such as gravel or a mixture of sand and gravel, works best under a slab because it compacts well. The fill should be completely unfrozen and free of organic material, like sod, leaves, and wood scraps. Otherwise, the melted ice and decomposed organic material will leave voids and increase the likelihood of settling.

Compaction. The best thing you can do to protect against settling is to compact the fill with a small, portable plate compactor, which you can rent by the hour or day (Figure 2). Spread the fill in layers no thicker than 6 to 8 inches, and compact each layer uniformly. If the layers are too thick or if you miss a spot with the compactor, the slab will settle.

All fill material should be reasonably free of moisture, but if it's too dry, you can pound on it all day and it won't compact much. In this case, spray it sparingly with water, which lubricates the grains and helps them slide closer together. But don't saturate the fill. This causes the grains to "float," and makes them virtually impossible to compact. The trick is to use just enough water to dampen the fill without puddling.

Typically, a residential slab subgrade should be compacted to at least 95% of maximum density. With careful attention to the compaction process, you can achieve these results without the expense of testing. But if you want to be sure, you can hire an engineering technician or testing service for about $300 to perform a compaction test. There are two methods, both of which measure

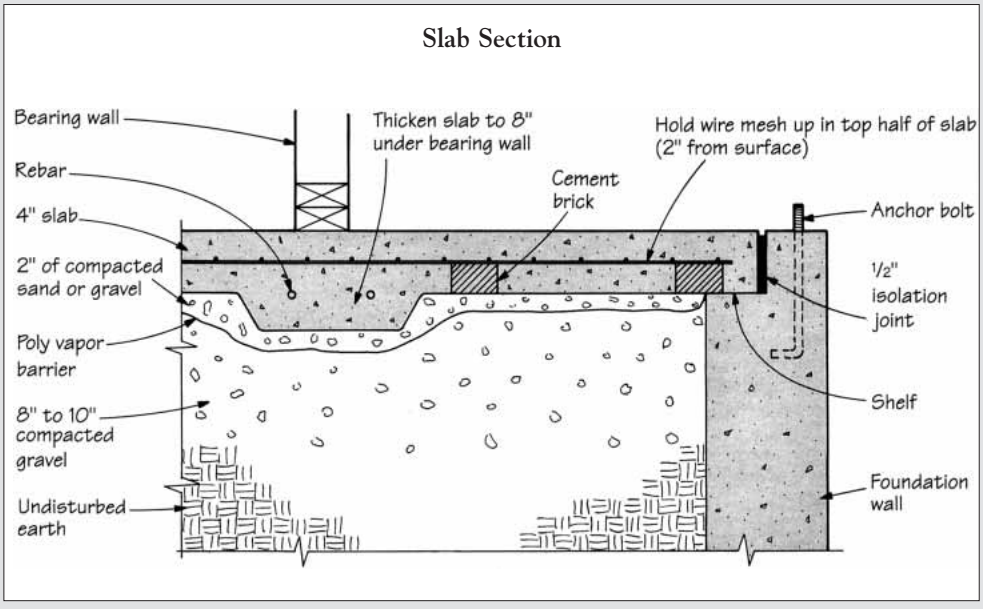
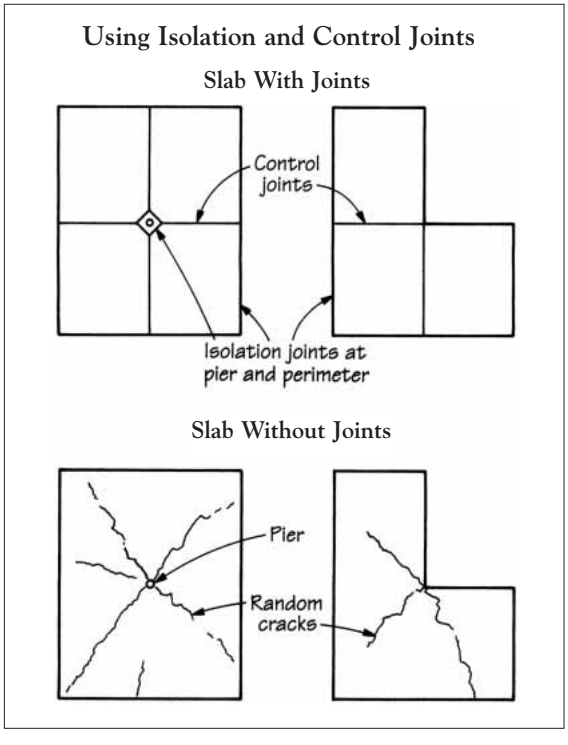


Figure 1. *Thicken a slab to 8 inches under a bearing wall, and lay two #4 (1/2- inch) reinforcing bars lengthwise for additional support. Under a fireplace, thicken the slab to 12 inches and use #5 (5/8-inch) reinforcing bars 12 inches on-center each way. A shelf in the foundation will not hold up a slab-on-grade and is not a substitute for good compaction of the subgrade. Wire mesh does not provide support either. Its sole purpose is to keep cracks from opening, which works only if it is placed 2 inches from the top of the slab.*

actual compaction against the maximum possible for the particular fill material you are using. A cone test is accurate, but it takes longer than a nuclear gauge test, which is less reliable but gives immediate results.

Vapor barrier. A good vapor barrier will cut down on moisture penetrating the slab. While any impermeable plastic membrane will do, high-density polyethylene, such as *Cross-Tuff* (Manufactured Plastics and Distribution, 2162 Market St., Denver, CO 80205; 303/296-3516), *Dura Tuff* (Yunker Industries, Plastics Division, 200 Sheridan Springs Rd., Lake Geneva, WI 53147; 800/236-3328), or *Tu-Tuff* (Sto-Cote Products, Drawer 310, Richmond, IL 60071; 800/435-2621, 815/675-2358 in Ill.) will hold up better during construction. Fold or tape the joints and carefully place and compact at least two inches of granular fill on top, as shown in Figure 1. This helps the slab cure without curling (more about curling later) and protects the vapor barrier during construction.

Figure 2. *For good compaction, run a plate compactor uniformly over granular fill. Each fill layer should be no thicker than 6 to 8 inches. If the fill is too dry, spray it with water, but avoid puddling.*



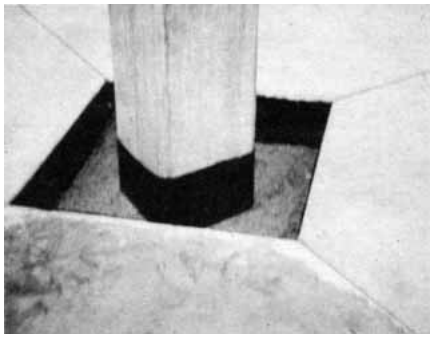


Figure 3. *Control joints force cracks to follow the path of the joint. Without them, random cracks will ruin the appearance and sometimes the usefulness of the slab (left). Use isolation joints around pipes, piers, or drains that penetrate the slab (above).*

Forming

Choose straight, smooth lumber to form edges that will show, and don't be stingy with stakes and braces, especially at overhead doors or places where the foundation wall drops. You don't want to fool with bulging edge forms after you've started to place the concrete.

If you have a floor drain, cover the drain pipes completely with fill so they won't be dislodged by the weight of the concrete or from being stepped on. And don't forget to cover the floor drain itself with poly or tape to keep the concrete out. Otherwise, you may get a very nasty phone call the first time the owner tries to use it. Finally, if you have an iron or copper pipe that penetrates the slab, wrap it with tape or closed-cell foam insulation to protect it from coming into contact with the concrete, which can be corrosive.

Joints

Concrete has very little flexibility and will almost always crack. Short of very expensive reinforcing (a mat of rebar) or post-tensioning procedures, jointing is the best way to control the inevitable. If possible, joints should divide the slab into squares, because concrete will eventually break itself into ragged approximately-square areas anyway (Figure 3).

Isolation joints. The two most important joints for residential slabs are isolation joints and control joints. Building or masonry supply companies sell 1/2-inch-thick isolation joint material that is precut to the thickness of your slab. When installed against the concrete foundation at the perimeter of the slab, as shown in Figure 1, the joint material prevents the slab from bonding to the walls. It also allows the slab to expand without cracking during temperature fluctuations.

Control joints. A control joint forces the slab to crack exactly where you want it to, rather than randomly. In wet concrete, you can make a control joint by forcing a plastic strip, such as *Zip-Strip* (Superior Featherweight, 1325 Bixby Dr., City of Industry, CA 91745; 800/423-1802), into the surface, or you can use a hand trowel known as a "jointer" to make a joint as the concrete sets (Figure 4, next page). In concrete that has hardened, you can cut a control joint into the slab using a diamond-tip saw blade. This is easiest to do within 12 to 24 hours of placement. But unless you own the blade and a concrete saw, it can get expensive.

Reinforcing

For most residential slabs, reinforcing is simply not necessary because the compacted subgrade provides structural support. Unfortunately, many builders believe that welded wire mesh or plastic fibers, like Fibermesh (Fibermesh Co., 4019 Industry Dr., Chattanooga, TN 37416; 615/892-7243), help support the slab, so they don't give enough attention to the all-important step of subgrade drainage and compaction. This is a costly mistake. Wire mesh or plastic fibers can help reduce the size and number of cracks in a slab, but neither of them can hold up a slab that has no other support.

If you are looking for a little insurance and a higher level of quality, both products are inexpensive when compared to the overall cost of a slab, and will give good results if used properly.

To be effective, wire mesh should be positioned in the top 2 inches of the slab, as shown in Figure 1. Unfortunately, this is easier said than done. Flat sheets of wire mesh work better than pieces cut from a roll, but they are 15% more expensive, and the 5x10 and 8x20 sizes are difficult to transport. In any case, you should use concrete bricks broken in half to support mesh. Space them 36 inches apart in a grid pattern so you'll be able to find them once they're covered with concrete. As you place the concrete, stand on these supports while you hook the mesh and pull it up into the slab.

Plastic fibers are easier to use. When they are thoroughly mixed into a relatively dry (low slump) concrete mix, they work as well as or better than wire mesh to prevent cracks from opening. The one drawback is that the fibers may poke through the surface of the slab, giving it a fuzzy appearance. Although recent improvements in fiber technology have reduced the problem, there is really no way to prevent it. Many slab masons solve the problem by singeing exposed fibers with a weed burner after the slab has cured.

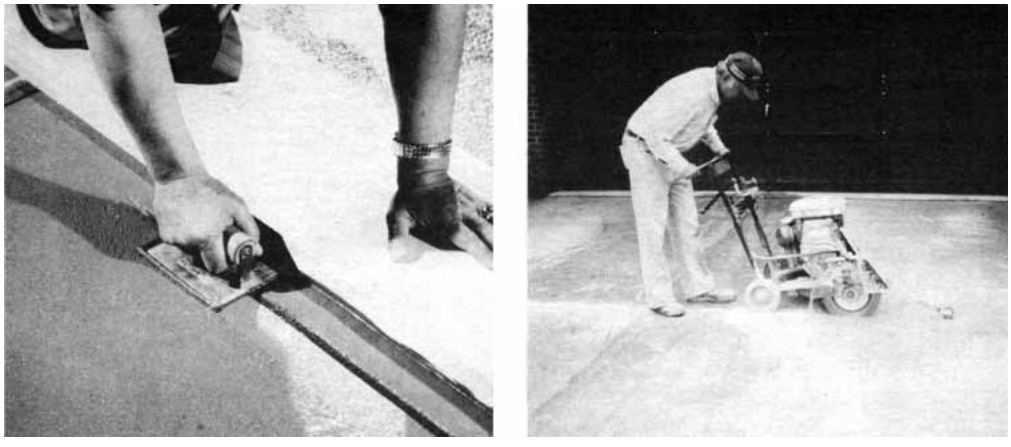


Figure 4. *Control joints can be made in wet concrete with a jointing trowel (left) or by forcing a preformed joint material into the surface. In concrete that has already set, you can cut control joints with a concrete saw (right). All control joints should penetrate into the slab at least one quarter of its total thickness.*

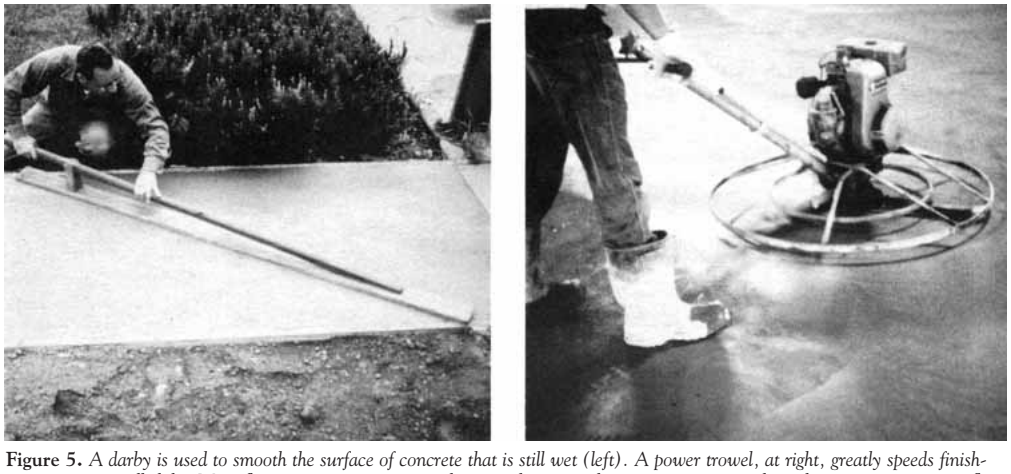


Figure 5. *A darby is used to smooth the surface of concrete that is still wet (left). A power trowel, at right, greatly speeds finishing, even on small slabs. Most floor masons carry a spare because there is nothing more nerve-wracking than trying to repair a floor machine while you watch the slab set.*

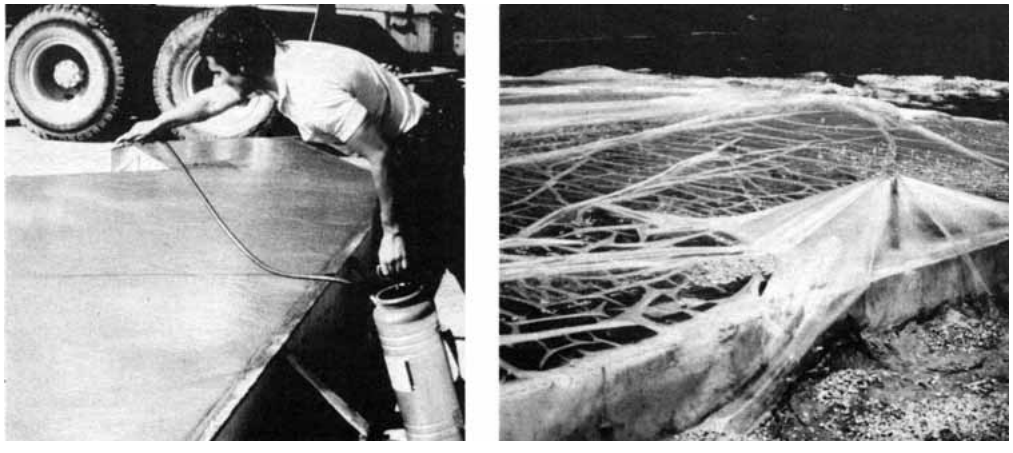


Figure 6. *To keep a slab from drying too fast, cure for at least seven days by coating it with a curing compound (left) or covering it with poly sheeting to help hold in the moisture (right). You may need to sprinkle a curing slab with water to keep the temperature below 70°F. In cold climates, heat the slab indirectly to keep it above 40°F.*

Ready-Mix

Be sure to talk to your local ready-mix producer about your project's requirements. Remember to give good directions to the site, and to discuss delivery schedules and site access. Check for overhead power or phone lines that may be in the way, and remove low-hanging tree branches so they won't get caught on the truck's hydraulic hoses.

Loaded concrete trucks are very heavy and can easily become mired in soft soils. If they get stuck, you will have to pay to have them pulled out. The same is true if you let the truck get too close to the edge of an open excavation. The weight may cause the embankment to collapse sooner than you think.

If you need to cancel a delivery, notify your supplier as far in advance as possible. If they can't reroute your order and have to unload the concrete back at the plant, you may end up paying for part or all of the concrete anyway.

Placing and Finishing

Wet concrete weighs two tons per cubic yard, and moving it around is no easy task under the best of circumstances. But if you are ill-prepared for the job, you will live to regret it. Be sure you have all the tools and equipment you need lined up before you order your concrete because you won't have time to gather them once it's been delivered. To get the concrete from the mixer to the slab, you may need a couple of wheelbarrows. You can make extra chutes by curling up a piece of corrugated steel roofing inside a 2x4 frame or by lining a plywood chute with poly.

Have as many people on hand as possible to help distribute and level the concrete, and let gravity do most of the work. You'll need straightedges and screeds (Figure 5), and possibly a concrete hoe — a wide blade on a long handle, also called a "Texas placer." Don't use steel garden rakes, because they separate the aggregate from the mortar. You'll also need a square-end shovel to spade the concrete along the forms to eliminate voids and honeycomb. Always clean the concrete off your tools and equipment as soon as possible. If you wait too long, you will have a nasty job the next time you want to use them. And if you return rented equipment dirty, you will be charged for cleaning.

Resist the temptation to wet the concrete mix to make it flow better. Too much water substantially weakens the concrete and reduces

Checking the Slump

A slump test measures the consistency of concrete. The wetter the concrete is, the more it "slumps." Concrete producers can provide you with a special mold called a "slump cone" so you can perform a slump test on site when the concrete is delivered, following the three steps shown in the illustration.

The entire slump test should take no more than a minute or two. After that, it may no longer be accurate and you should start over. A slump of 5 inches (plus or minus 1/2 inch) is about right for residential slabs. Any less means the mix is too dry, and will set up too fast. A larger slump means there's too much water in the mix. This will substantially reduce the strength and durability of the concrete. In this case, unless you can use the high-slump concrete elsewhere on the site, you should reject the load and order another.

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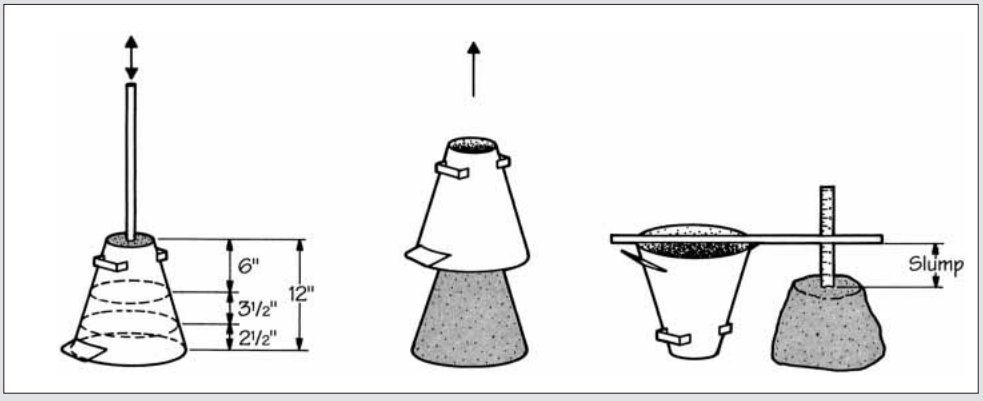

Step 1. *Place the slump cone on a flat surface and fill it with mixed concrete in three layers of approximately equal volume. To avoid trapping air, stroke each layer about 25 times with a piece of rebar.*

Step 2. *Strike off the top and remove the cone slowly — take five or ten seconds. Use even pressure on the cone handles so as not to jar or tilt the cone in the process.*

Step 3. *Stand the empty cone next to the mound of concrete and balance a straight piece of rebar or lumber across the top so it extends over the concrete. The distance between the straightedge and the top of the mound of concrete is the slump.*

the durability of the slab, especially the surface. Use a 4- to 5-inch slump, which you can easily measure on site (see "Checking the Slump," above).

Finishing a concrete slab is a skill developed over a period of years. If it's new to you, I suggest subcontracting it to an experienced professional. In any case, keep these simple rules in mind:

- place the concrete at a slump of about 5 inches
- use the longest straightedge you can to strike off the concrete
- wait until the water sheen is gone from the surface before working on the slab with a power trowel
- begin the curing process as soon as finishing is complete

Curing

Concrete should be cured during the initial seven-day setting period. This means keeping it wet and at a temperature between 40°F and 70°F. You can keep the slab wet with sprinklers or hoses, or you can trap the concrete's own moisture by covering it with polyethylene (Figure 6). Poly may cause some surface discoloration, but it will usually even out over time. You can also coat the slab with water-based sprays or curing compounds, like *Clear Seal EM-180* (A. C. Horn, 12116 Conway Rd., Beltsville, MD 20705; 800/654-0402), which are safe and relatively inexpensive.

Any of these methods will work in the 40°F to 70°F temperature range. But as the temperature rises, you may need to use a combination of methods — a poly cover, for example, with periodic wetting of the slab to keep the temperature down. At the other extreme, when temperatures fall below 40°F, you will need to keep the slab warm. Always heat concrete indirectly because the carbon monoxide from any open-flame heater, regardless of the fuel, can cause damage to the slab surface.

Careful curing also minimizes curling — an upward warping of the slab. Curling usually occurs at the edges when the top of the slab dries faster than the bottom. A vapor barrier under the slab allows the bottom surface to dry more slowly than it would otherwise, and curing the top surface equalizes the drying rate. After all the work you have done, it makes no sense to risk ruining the slab for lack of one week's good curing.

You can usually walk on a slab within 24 hours of finishing, but the edges of "green" concrete will chip easily. Avoid dragging heavy objects, like table saws or furnaces, over the slab until it has cured for several days. And never drive a vehicle onto a slab until it has cured for at least seven days — 28 days for unusually heavy vehicles.

Care and Use

If the slab is to be tiled or carpeted, you won't need to do anything except give it a good final cleanup. Scrape any lumps of stray concrete from the surface, and make sure joints are clean and open so they will function properly.

If the slab will be the final wearing surface, how you care for it depends on where it's located and how it's used. A basement slab needs only an occasional sweeping or vacuuming. Garage or driveway slabs exposed to deicing salts melting off vehicles should be coated with a sealer, such as *Kur-N-Seal* (Sonneborn Building Products, 7711 Computer Ave., Minneapolis, MN 55435; 800/433-9517), or an anti-spalling compound, such as *Super Anspall* (A. H. Harris, P.O. Box 2, New Britain, CT 06050; 203/225-7671). Coat the concrete annually before the weather turns cold. With coverage ranging from 200 to 400 square feet per gallon, you can adequately safeguard a typical garage slab from surface deterioration for less than $50 a year. ■

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Play It Safe

Concrete is hygroscopic (absorptive). It will dry your skin quickly and can cause cracking and peeling if allowed to stay in contact with your skin for too long. Over a period of hours, this condition can become aggravated and resemble a second- or third-degree burn. To protect yourself, wear boots, long pants, long-sleeved shirts, and gloves, and always wash concrete off your skin as soon as possible. Using lotions and creams before and after handling concrete can also help to reduce the effects. Avoid getting concrete splattered into your eyes. Wear glasses or goggles as a precaution, but if you do get splashed in the eyes, rinse them thoroughly *immediately*.

Any time you work with heavy equipment, such as concrete mixer trucks, you should be alert. Have someone direct the truck while it's on your job site to avoid hitting anything or anyone. And be careful around the chutes on the mixer: The hinges are dangerous pinch points.

Heaters, compactors, and power trowels are heavy, have sharp edges, and get hot, and you can easily pull a muscle, cut yourself, or get a nasty burn. This is another reason to get everything ready ahead of time. You're less likely to get injured if you're not rushing around trying to find a tool or shoring up a bulging form.

With gas-powered equipment, watch out for carbon monoxide buildup in contained areas, especially basements. You should also exercise caution when curing or sealing a slab with chemicals. Use water-based products if possible, but as with any chemical, always read the label and follow the directions on the container.

— *P. S.*