

CONCRETE



Mixing Your Own Concrete

Save time and money with a small mixer and some elbow grease

BY JOHN CARROLL

Recently, I mixed and poured a yard of concrete for the footing of a small addition with the help of a friend, who made it a point to remind me that there were big, clunky trucks that will bring concrete to you all mixed and ready to go. Of course, I was well aware of that fact, but as I pointed out to him, those big, clunky trucks cost close to a quarter of a million dollars apiece, and the people who invest in them are not all that interested in selling their concrete a yard at a time.

Most ready-mix concrete companies don't want their expensive trucks tied up on what they consider tiny pours. Usually, they won't make the trip for less than a yard, and to make money on these so-called "short loads" (one to seven yards), they apply a minimum load

charge of around \$100. In addition, many concrete companies have time limits of seven to 10 minutes per yard for unloading the concrete.

The extra charges for the concrete are not as bad as they may seem. For example, on a two-yard pour, who wouldn't pay an extra \$100 to avoid mixing up four tons of concrete? The time limits are another matter. Unless the truck can pull up very close to the pour, it can be difficult to unload a yard of concrete—which weighs 4,000 pounds—in less than 10 minutes.

You can line up extra help to unload the concrete, but lining up good help for a backbreaking job like that isn't always easy, and it can be expensive if the truck doesn't show up on time. Like any supplier of building materials, ready-mix concrete companies face numerous

Photos by Matthew Carroll Navey

MIXING YOUR OWN CONCRETE



Mixing concrete from scratch involves the combination of portland cement, sand, coarse aggregate (crushed and graded stone), and water. The industry standard uses a 1-2-3 formula with one part portland cement, two parts sand, and three parts aggregate for a 4,500-psi mix **(1)**. Adding 50% more portland cement increases the strength to more than 5,000 psi **(2)**.



Bagged premixed concrete has many advantages and is convenient. The 80-pound bags can be arduous to handle all at once, so the author cuts the bags in half. First, he places the bag over a pipe and slits the top paper **(3)**. Lifting the pipe splits the contents in half **(4)** and then tears through the rest of the bag, leaving two 40-pound bags **(5)**.

variables that make it difficult to stay on schedule. And the customer who buys hundreds of yards per month takes precedence over guys like me, who buy only five or six yards every two months. Unfortunately, when the truck is late, I still have to pay my help for the time they're on the job.

In my world of remodeling and custom masonry work, most pours are inaccessible to a concrete truck. Some pours are also several feet above the ground. The good news is that the majority of my pours are fairly small and I can mix the concrete myself. With my concrete mixer, I can mix up about a half yard per hour, so I don't think twice about mixing my own concrete for up to one-and-a-half yards.

WORKING STEADILY

While mixing concrete on site is physically demanding, the time pressures are considerably more relaxed compared with those of a

pour using ready-mixed concrete. For the footing pour mentioned above, I started by putting a plastic sheet on the ground at the edge of the property. While I dug the footing, I had 41 bags of concrete—at 80 pounds apiece—delivered and stacked neatly on the plastic. At the end of the day, I carefully covered the concrete with a tarp to protect the bags from getting wet.

The next day, I set up my mixer near the concrete stack, and, with everything already set up, I was able to start mixing and pouring just minutes after the inspector approved the footing. With no time constraints, there was no urgency to move the concrete from the truck and into the forms. Instead, my sole employee and I mixed and placed the concrete over the course of a couple of hours in a calm and controlled fashion.

Had we gone the ready-mix route, I would have needed to schedule the delivery after the inspection, and delivery might have been a

day or two later. I also would have needed to round up another worker to help unload the concrete in the time allowed, and the three of us might have had to wait an hour or two for the truck to arrive. If it happened to rain between the inspector's approval and the arrival of the truck, I would have had to pump the water out of the footing, remove the rebar, and scoop up the wet muck at the bottom of the footing before the pour. So while those big, clunky trucks do offer the initial convenience of bringing ready-to-pour concrete to you, they can sometimes bring some big, clunky problems as well.

MATERIALS FOR MIXING ON SITE

Basic concrete consists of four ingredients: portland cement, sand, coarse aggregate (usually crushed and graded stone), and water. There are two ways to assemble materials for making concrete on site. The traditional way is to buy the stone, sand, and portland cement separately, measure them on site, and mix them with water. The second way is to buy premixed dry concrete by the bag and add water. Both methods work well.

Mixing concrete is actually as easy as 1-2-3. In the industry, there is an oft-quoted 1-2-3 formula for mixing concrete, where one part portland cement is combined with two parts sand and three parts stone (1). In his article "As Simple as 1-2-3" (*Concrete Construction*, Jun/10), Allen Face reports that the 1-2-3 formula delivers concrete with a compressive strength of 4,500 pounds per square inch (psi)—fine for standard residential work, which typically calls for concrete in the range of 2,500 to 3,000 psi.

If I need stronger concrete, I increase the proportion of portland cement. On a recent project, the client requested that I beef up the mixture to produce high-strength concrete that exceeded 5,000 psi. I achieved this number by mixing the materials in a 1.5:2:3 ratio (2).

CONCRETE BY THE BAG

For most of my pours, I buy concrete premixed in 80-pound bags, rather than mixing the materials from scratch. The cost for both approaches is roughly the same, but premixed bags have three advantages. First, the bags take up less space (there is often no place for me to put piles of sand and stone on my client's property). Second, with bagged concrete, I can buy the exact amount that I need. (I typically buy a few extra bags to make sure I don't end up short, then return any unused bags after the pour). Third, mixing concrete by the bag is easier and faster than making it from scratch. And when I'm finished with the concrete work, I don't have to deal with leftover materials.

The big-box stores in my area sell bagged concrete that is rated at 4,000 psi, but local suppliers also offer high-strength concrete in bags rated at 5,000 psi. They also offer concrete with additives to make the concrete cure more quickly and with fibers in the mix to increase crack resistance.

ESTIMATING MATERIALS

Sand, gravel, and concrete are usually sold by the cubic yard, which can be confusing because just about everything else in the building industry is measured in feet and inches or just straight



Mechanical mixers are a great way to mix small batches of concrete (6). The author pours water into the drum up to the inner ring (7) and then adds premixed concrete (8).



Choose concrete with a 4-inch slump for flatwork (9). Use a stiffer mix of 2 to 3 inches for deeper work such as this footing (10), then consolidate the mix with a vibrator (11).

inches. In lieu of a calculator or jobsite computer, I usually resort to basic math, which to me is far simpler than trying to use any of those gadgets.

Basic geometry teaches us that to determine volume, multiply the length times the width times the thickness. The confusion begins when you have to convert from feet and inches to yards.

As an example for calculating amounts, let's take a U-shaped concrete footing for an addition that will be 12 feet long and 10 feet wide. The footing is specified to be 16 inches wide and 8 inches thick. After accounting for the corner overlaps, the total length of the footing is 30 feet 8 inches (368 inches). So, now we just need to calculate the volume and convert those numbers into cubic yards.

For me, the simplest approach is to measure the length in straight inches, then multiply the result by the width and the depth. The math looks like this: $368 \times 16 \times 8 = 47,104$. Then I divide 47,104 (the total number of cubic inches in the footing) by 46,656 (the number of cubic inches in a cubic yard), which gives me the volume of the footing in cubic yards. These calculations indicate that the exact amount of concrete needed would be 1.01 cubic yards. By the way, you don't need to carry the 46,656 dimension around in your head; any time you need to use it, just multiply $36 \times 36 \times 36$.

When estimating materials for the 1-2-3 method, I don't figure in the volume of the portland cement. For the most part, the cement fills in the spaces between the grains of sand and the stones. So applying the formula to this footing, I'd need a bare minimum of a half yard (two parts) of sand and three-quarters of a yard (three parts) of stone. To estimate the amount of portland cement needed, I use the figure of six 94-pound bags per yard. Because I've established that I'll need approximately one yard total, I know that I'll need six bags of portland cement.

When estimating the number of 80-pound bags of premixed concrete needed, I divide the number of cubic inches needed—in this case 47,104—by 1,150 to determine the number of 80-pound bags needed. The result is 41 bags. So where did I come up with the number 1,150? According to manufacturers, each 80-pound bag produces $\frac{2}{3}$ cubic foot of concrete. A cubic foot (12x12x12 inches) is equal to 1,728 cubic inches. Multiplying that number by .667, or $\frac{2}{3}$, yields 1,152 inches, which I rounded down to 1,150.

MEASURING THE DRY INGREDIENTS

When mixing 1-2-3 concrete, many masons count shovel loads of each ingredient to make up the recipe. But because I consider a shovelful to be an inaccurate measure and because I find it easy to lose count, I prefer to fill six buckets of equal size with the ingredients. To make a batch of 4,500-psi concrete, I fill one bucket with portland cement, two buckets with sand and three buckets with stone (see photo 1). If I want stronger concrete, I increase the amount of portland by 50%.

If I'm using premixed concrete, following a recipe isn't necessary. I can load my mixer with three 80-pound bags, which produces about two-thirds of a wheelbarrow worth of concrete. To save my back, I don't try to empty a full bag into the machine in one shot. Instead, I cut the bags in half and dump them 40 pounds at a time.

To cut a full bag in half, I place it over a length of pipe and slit the bag down the middle (3). Lifting up the pipe lifts the bag and breaks through the underside of the bag (4), leaving two half bags ready to dump into the mixer (5).

MIXING THE CONCRETE

There's no escaping the fact that mixing and placing concrete is heavy work. For this reason, I always try to set up the job and use techniques that minimize the grunt force required. With all the masonry work I do, one key to saving my back is the aforementioned mechanical concrete mixer (6). If you find that you're mixing concrete on site every couple of weeks or even every couple of months, a mechanical mixer can pay for itself quickly with the work that it saves. Mixers can be gas-powered or electric, and they vary in their capacity or volume. Mine is a 115-volt electric mixer. New professional-grade mixers can cost up to \$3,000, and new light-duty mixers can cost about the same as a miter saw. With a little shopping, you may be able to find a less expensive, used mixer.

I begin by setting up my mixer on concrete blocks 8 inches high. That height lets me dump the concrete easily into the wheelbarrow. Next, I set up a hose with a pistol-grip nozzle that allows me to control the water flow with one hand. The nozzle can also be hooked on the side of the mixer, so I don't have to bend down to pick the hose up off the ground every time I need it.

Whether I'm mixing concrete from scratch (using the 1-2-3 formula or a slight variation of it) or from premixed bags, I always start with the water. Inside the drum of my mixer, there is a raised section in the center that forms a ring. I've found that filling the drum with water up to the bottom edge of this ring is a good starting point for one load (7).

It's important to realize that water is in the mix to cause a chemical reaction called "hydration," which in turn creates the hardened concrete. The amount of water needed to achieve hydration is surprisingly small—the dry ingredients have to be thoroughly moistened but they don't need to be saturated with water. Excessive water substantially weakens concrete (see sidebar, page 50), so as I mix the concrete, I try to add just enough water to make the mixture workable.

After putting water in the drum of the mixer, I add the dry ingredients. If I'm using the 1-2-3 method, I put the stone in first, followed by the sand. These abrasive materials help clean the inside of the mixer drum. After these ingredients are thoroughly blended, I add a little more water, which turns the mix into a fairly thick, wet slurry. Then I add the portland cement and monitor the batch as the mixer churns, adding a little water at a time until the mixture has the consistency, or slump, I'm looking for.

If I'm using premixed concrete, I also start with the water filled to the ring. Then I add the dry ingredients a half-bag at a time (8). As with 1-2-3 concrete, I add small quantities of water as the ingredients mix until the mixture has the slump I want.

The term "slump" refers to the fluidity or consistency of the concrete mix. The higher the number, the more fluid the mix is. For flatwork, I aim for a slump of 4 inches. At this slump, the concrete is thick but plastic enough to spread and cut even with the form



For wheelbarrow mixing, measure water more precisely (12). Mix all the water with half the dry mix (13), then add the second half of the dry mix for the proper consistency (14).



For mixing concrete in a wheelbarrow, a conventional hoe doesn't work well, because its square corners don't fit into the corners of the tub (15). A mortar hoe has rounded corners and holes in the blade for easier and more thorough mixing (16).

with a straightedge screed (9). On deeper pours, I use a slump of 2 or 3 inches, which is much stiffer (10). After placing this stiffer mix, I use a vibrator that consolidates the mix and brings the finer particles in the mix to the surface (11).

KEEPING THE MIXER CLEAN

After mixing each batch of concrete and dumping it into my wheelbarrow, I leave the drum turning and again add water up to the ring inside the drum. The water washes off the inside surface of the drum as well as the paddles as it turns. The mixer continues to turn while I wheel the concrete over to the site of the pour. In the meantime, the water thoroughly cleans and rinses the inside of the drum.

When I mix the next batch of concrete, the cleaning water in the drum provides the initial water for that batch. The mixer stays running throughout the pour, and at the end of the day, I just give the drum a final rinse and dump that small amount of water.

THINGS TO KNOW WHEN MIXING YOUR OWN CONCRETE

It takes eight to 10 wheelbarrow loads (¾ full) to move a cubic yard of concrete. A contractor's wheelbarrow loaded with concrete weighs more than 400 pounds.

Adding one gallon of water to a yard of concrete:

- Increases the slump about 1 inch
- Decreases the compressive strength 200 to 330 psi
- Increases the amount of shrinkage up to 10%

Cost comparison of a single yard of concrete in the author's area:

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|---|-------------------------|
| • Ready-mix concrete delivered by truck | \$285 (w/min. load fee) |
| • Bagged concrete mixed on site (add \$80 for delivery) | \$140 |
| • 1-2-3 concrete mixed on site (add \$80 for delivery) | \$170 |

Helpful hints: Always wear eye protection when mixing concrete. Avoid standing in front of the drum looking directly at the concrete as it churns. The drum can spit out gobs of wet cement as it turns, so always stand to one side while mixing.

MIXING CONCRETE IN A WHEELBARROW

It's not always worth the time and effort to tow my mixer to the site and set it up. On very small pours, it's often easier to mix the concrete by hand in a wheelbarrow. Mixing by hand is hard work, but there are a couple of things that make the job easier and also help produce high-quality concrete.

The first thing I do is to measure the water more carefully than I do with the mixer. For an 80-pound bag of concrete, manufacturers recommend using three-and-three-quarters quarts of water per bag (12). But I've found that this ratio makes very stiff, zero-slump concrete, which can be difficult to place and finish. Instead, I use four quarts (a full gallon), which makes very good concrete that is easy to work with.

To mix the concrete, I cut a bag in half as before and dump a half-bag in a wheelbarrow. I add the entire gallon of water and mix the dry concrete into it, creating a soupy and fluid mix (13). Then I add the second half-bag to the soupy mixture and mix it thoroughly with my hoe (14). The result is an excellent low-slump concrete. If I need to increase the slump, I can add water sparingly. But I'm careful not to overdo it; too much water weakens the concrete.

The second thing I do is to mix the concrete with a hoe called a "short-handled mortar hoe," which has rounded corners. A regular hoe has trouble getting into the corners of the wheelbarrow, where dry or unmixed concrete tends to accumulate (15). Because of its rounded corners, the mortar-hoe blade fits much better (16). The holes in the hoe let some of the mix pass through for less resistance as you stir the mix, and the short handle makes it much easier to handle the hoe while mixing concrete at wheelbarrow height.

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