Small-Job Concrete

Site-mixed mud can be batched as accurately as ready-mix, given a strong back and a few guidelines

by Bob Syvanen

Most batch plants charge extra for less than a cubic yard or two of concrete. The service you're likely to get on a small order is pretty minimal, so it often makes sense to mix on site. You can do this by hand in a trough or wheelbarrow, or you can rent a mechanical concrete mixer. You'll be using the same ingredients as the batch plant; if you measure and mix carefully, the quality of the concrete should be at least as good. For folks beyond the range of ready-mix trucks, this is the only way.

Ingredients—Clean water is a must for concrete. Sea water is okay if the concrete won't be reinforced with steel. The pour will attain high early strength, but will not be as strong in the long run. Increase the cement content and reduce the water to recover some of the strength lost to the salt.

Cement should be bought by the 94-lb. bag and kept dry. In most cases, Type I is what you need. For resistance to freeze-thaw cycles in northern climates, buy air-entrained cement, which requires using a portable power mixer, since the air-entraining agent needs vigorous mechanical agitation to be effective.

Large aggregate and sand can be purchased by the cubic yard from quarries, building-supply yards and batch plants. Large aggregate can range from ½ in. to 1½ in. It should be clean, hard, durable gravel or crushed stone such as granite or hard limestone. Most sandstone isn't usable. Crushed stone should be square, triangular or rectangular in shape, Flat, elongated pieces shouldn't be used, Sand, the fine aggregate, should be a mix of coarse and fine grains up to ¼ in.

When ordering cement and aggregates, keep in mind that the amount of concrete you get from mixing the ingredients is not nearly as much as the sum of the volume of those materials. This is because the sand in the mix fills in the voids between the gravel or stone, and the cement nestles in between the particles of sand. A rule of thumb that's sometimes used is to figure the amount of your mix to be slightly greater than the amount of coarse aggregate you're using. The chart below will get you a little closer, so you don't end up short on the last batch of your pour.

Unless you are pouring just a few cubic feet of concrete, which can be done using dry-packaged pre-mix, have the aggregates and cement delivered. These materials are extremely heavy, and your good old pickup truck can easily get overloaded with a half-yard of wet sand. Most suppliers will deliver with a dump truck that can spot the materials almost anyplace. As near as possible to where you'll be mixing and pouring is best. Lay plastic sheeting, 6 mil or heavier, on the ground for each kind of aggregate. Plywood is even better because it is a harder surface for scooping against with a shovel, but don't plan on using the plywood for anything very important afterward. You can also use old plywood to separate the sand and coarse aggregate piles vertically, so that they can be placed close together without mingling. Stack bags of cement close together, and up off the ground so they don't turn to stone. Cover them with waterproof plastic whether or not it looks like rain. Don't use cement that is so hard it won't crumble in your hand.

Cement (bag)	+ Sand (cu ft)	+ Gravel (cu ft)	= Concrete (cu ft)
1	+ 15	+ 3	35
1	+ 2	+ 3	39
1	+ 2	+ 4	45
1	+ 25	+ 5	54
1	+ 3	+ 5	58

It's okay to scavenge aggregates for your concrete as long as you test them to be sure that they are clean and free of fine dust, loam, clay and vegetable matter. The beach is a good place to find clean sand, and old quarries and stream beds often have acceptable gravels. Aggregates taken from tidal areas contain larger quantities of salt, and should be washed with fresh water before being used in concrete. You can test both sand and gravel for dirt or loam by placing them in a glass jar filled with water. Put on the lid, shake the jar, and then wait for the water to clear. If silt covers the gravel or sand, it needs washing.

There are two tests for vegetable matter. For gravel, add a teaspoon of household lye to a cup of water in a glass jar, add the gravel and shake well. If the water turns dark brown, the gravel needs washing. This can be done with a good hosing. Sand is tested by putting it in a clear glass jar with a 3% solution of caustic soda, which can be made by dissolving 1 oz. of sodium hydroxide in a quart of water. If the solution in the jar remains colorless, the sand is in good shape. A straw color is still okay, but anything that resembles brown means finding another source for sand.

Sand shouldn't be rejected because it's holding a lot of water, but you need to know how wet it is in order to adjust the water content of your mix. Although damp sand feels a little wet, it won't leave much moisture on

your hands, and won't form a ball when squeezed in your fist. It contains about ¼ gal. of water per cu. ft. Wet sand will form a ball, but still won't leave your hands very wet. Most sand falls into this category. It contains about ½ gal. of water in each cu. ft. Very wet sand is obviously dripping wet and holds about ¾ gal. of water per cu. ft.

The mix—The strength and durability of the concrete that comes out of your wheelbarrow or mixer depends on the proportion of the cement to the aggregates, and on the proportion of water to cement. Instruction manuals and construction textbooks often show concrete mixes as a ratio of cement, sand and gravel by volume, such as 1-2-4. The first number always represents the cement content, the second is the small aggregate (sand), and the third is the large aggregate (gravel or rock). The more cement used, the stronger the mix. A rich mix, 1-1½-3, is used for roadbeds and waterproof structures. The 1-2-4 mix is used for industrial floors, roofs and columns. A medium mix (1-2½-5) is used for foundations, walls and piers. A lean mix such as a 1-3-6 is used in less demanding applications.

Volume formulas like the ones above give the proportions of dry ingredients but leave the water content up to you. Start with a trial batch, and use the least water you can to get a workable mix. Add a little at a time, and keep track of how much you used.

I favor mix formulas that specify the water/cement ratio, which is called a paste. A 5-gal. paste contains five gallons of water for every bag of cement. This includes the water contained in the sand. The lower the water figure in relation to the cement, the stronger and more durable the concrete. Sidewalks, driveways and floors require a 5-gal. paste for durability. A 6-gal. paste is good for moderate wear and weathering such as foundations and walls. Where there is no wear, weather exposure or water pressure to deal with, a 7-gal. paste will do. Footings are typically poured with 7-gal. paste concrete.

Listed in the chart above are the formulas I use for 5-gal., 6-gal. and 7-gal. pastes, including volume amounts of aggregates for each mix. Each mix differs from the others not only in the ratio of water to cement, but also in the amount and size of aggregates. These adjustments are compromises between economy, strength, durability, workability and slump (stiffness of the mixture). The engineered mixes batch plants use for ready-mix concrete make the same kind of adjustments. The first formula for each mix lists the ingredients used with a single, 1-cu. ft. bag of cement. The second formula gives the correct amount of each material for mixing one cubic yard of concrete, which is useful for figuring and ordering cement and aggregates.

The amounts of water, cement and aggregates in these formulas are given by volume—gallons and cubic feet. There are other formulas that give proportions by weight, but I don't like them as well because ultimately you are trying to fill up a given space—the forms—with concrete. The formulas above also assume wet sand, with its ½ gal. of water per cu. ft. If you use damp sand, increase the amount of water you add by a quart per cu. ft. of sand. Decrease the water content by a quart for very wet sand. These proportions will yield a fairly stiff mix, depending on the size and shape of your aggregate. But you may need to make adjustments, so mix up a small trial batch first. If the concrete is too soupy, you can correct it by adding aggregates. Don't play with the cement or water content. Instead, add 2½ parts sand with 3 parts gravel in small amounts until the mud stiffens up. For the next batch, be sure to deduct the moisture carried by the extra sand from the total water to be added to the mix. If the test batch is too stiff, use slightly less sand and gravel in the next batch.

Five-gallon paste

1 bag cement, 4½ gal water 1 cu ft sand, 1¾ cu ft gravel (⅜ in maximum)

for 1 cu yd of mix 10 bags cement 10 cu ft sand, 17 cu ft gravel

Six-gallon paste

1 bag cement, 5 gal water, 2¼ cu ft sand 3 cu ft gravel (¾ in maximum),

for 1 cu yd of mix 6¼ bags cement, 14 cu ft sand, 19 cu ft gravel

Seven-gallon paste

1 bag cement, 5½ gal water, 2¾ cu ft sand, 4 cu ft gravel (1½-in maximum),

for 1 cu yd of mix 5 bags cement 14 cu ft sand, 20 cu ft gravel

Accurate measure—The care that you take in proportioning the mix has everything to do with the quality of your concrete. If you are following a formula for mixing that is given by weight, you will need a bathroom scale for careful weighing. For measuring volume in cubic feet, make a 12-in. by 12-in. by 12-in. frame with no handles or bottom. Place it on a flat surface, fill it level, and lift. Cement is easy to deal with because it comes in 1-cu. ft. bags. You can also make a level mark on the side of your wheelbarrow to indicate the 1 or 2-cu. ft. level. In the case of a ratio mix like 1-2-4, use any convenient measure—a shovel, bucket or box—but don't let your mind wander when you're counting. For water, mark a large bucket for half-gallons and gallons.

Mixing by hand—A lot of concrete has been mixed by hand, but it is a long, backbreaking job worth avoiding for anything more than a few cubic feet of mud. You can mix in a deep (4 or 5-cu. ft.) wheelbarrow or buy a steel or plastic mortar box (about $70) that holds 6 to 9 cu. ft., or you can make your own mixing tray. A large, shallow plywood box lined with metal so that water won't leak away works pretty well. A flat platform works even better because there are no corners for the shovel or hoe to hang up on. However, mixing must be done carefully to avoid losing water on this flat surface.

First, load the tray with a measured amount of sand. Spread the correct amount of cement evenly over the sand and mix them together with long push and pull strokes with a hoe or shovel. Work the large aggregate into this mix with the same method. Make a depression in the center of the mix and slowly add the water. Pull the mix toward the water until the dry material is saturated, and then turn the mud over until it reaches a workable smoothness. Use this method even if you are mixing in a wheelbarrow or box. A mortar hoe is useful if your aggregate is no bigger than ¾ in. It looks like a large steel garden hoe with two holes in the blade, and costs about $15 to $20. A square-point shovel turned over so that the back of it faces away from you works too.

Mixing by machine—Machine mixing is easier than hand mixing, but it's still a lot of hard work. Electric or gasoline-powered mixers with a capacity of ½ cu. ft. to 6 cu. ft. can be rented by the day or week. Electric mixers are the least trouble. If your job site doesn't have power, then rent a gasoline-powered model. If you are going to use a mixer for more than two weeks and you do lots of small jobs involving concrete, consider buying one.

Set up the mixer right next to your sand and gravel, and run a water hose there. If you have chosen a shady spot, both you and your concrete will set less quickly. Load the drum of the mixer with all of the large aggregate and about half of the water in the formula. Start up the mixer and add the sand and cement slowly, along with the remainder of the water. Let the mixer run for about three minutes or until the concrete has become uniformly grey. When you are finished mixing for the day, add a couple of shovels of large aggregate and some water and turn the machine on one more time to scour the inside. Emptying the drum and a final rinse with a hard jet of water will leave the mixer clean.

Cold-weather concrete—Most engineers do not want you to pour concrete at air temperatures lower than 40°F. A lot of good loads have been poured when it's colder than this, but it's a bit of extra work. Both the aggregate and the water can be heated to keep the concrete warm while it's being mixed and poured, but don't heat the cement. If you heat just the water, bring it to a boil in a 55-gal. drum or other container and pour it on the aggregates to warm them. If you are heating the aggregates also, keep the temperature of the water below 175°F, or the cement will flash-set when mixed, and you won't be able to get a finish on the concrete. Aggregates can be heated on a tray of heavy sheet metal. Build a makeshift firebox out of large stones or concrete block underneath the tray, and heat the aggregates separately. Take them off the fire when they are hot to the touch. □

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