Concrete

Understanding the characteristics of this material can take some of the anxious moments out of your pour and ensure a finished product of high quality

by Trey Loy

Concrete is a remarkable material that can be cast into almost any shape. It will sustain and transmit tremendous loads, and once hardened, it is practically indestructible. Yet few builders feel as affectionate about concrete as did Slim Gaillard and Lee Ricks in their scat tune from the 1940s.

Cement mixer, put-ti, put-ti,
Cement mixer, put-ti, put-ti,
Puddle-o-votty, puddle-o-goody,
Puddle-o-scooty, puddle-o-vett.
Who wants a bucket of cement?

Cement mixers have been largely replaced by huge batch plants that measure out hundreds of cubic yards of ready-mix a day to waiting transit mixers. The leisurely pace of pouring concrete is also a thing of the past. The distant rumblings of an approaching concrete truck can strike fear into the heart of a carpenter still bracing the forms. At nearly two tons a cubic yard, concrete has to be poured immediately, with no time to ponder problems or locate tools. For many people, a pour is considered successful when forms don't break; and a sigh of relief can be heard when a slab is smooth and unblemished by cracks the next day.

Contrary to its reputation, concrete reacts predictably, and the builder can regulate many of the variables that affect its working properties while plastic, and its strength when hardened. Some practical knowledge of the kinds of cements and aggregates and the correct proportions of each, admixtures, slump, and the effects of weather during pouring and curing can make the difference between feeling confident about a pour, and feeling you are constantly dodging disaster.

Concrete is a mixture of water, portland cement, and fine and coarse aggregates. The active ingredients are water and cement. They combine in a chemical reaction called hydration. Although concrete that is beginning to set appears to be drying out, or dehydrating, about half the water is actually incorporated in the hydration process and becomes a permanent part of the bonding paste. This is why concrete needs to be kept moist during the first few days of curing. In fact, concrete will harden quite effectively under water.

The advent of ready-mix has brought a change to the quality, quantity and pace of concrete pours. The physical properties of concrete in its plastic and hardened states are well understood by researchers, engineers and batch-plant operators, but this information seldom trickles down to the builder who is actually working with the material. Knowing how mixes are designed, and the different kinds of cements, aggregates and admixtures that are used to alter the concrete can give the builder the ability to predict how it is going to react and why. For more on hand and machine-mixing concrete on site, see pp.34-35.

Aggregates—The major function of aggregates is to make concrete more economical. While the cement paste binds the aggregates together in a solid mass, the aggregates keep the concrete from shrinking and cracking as hydration and evaporation take place during setting and hardening. Neat, or pure, cement is not nearly as strong as concrete correctly proportioned with aggregate.

Fine aggregate can be either sand or rock screenings. Fine-aggregate particles range in size from very fine sand to ¼ in. Coarse aggregate is either gravel or crushed stone ¼ in. to 1½ in. in diameter. The aggregate mix should be proportioned so that the smaller particles fill in the voids between the larger ones. For thick foundations and footings, gravel or rock with a diameter of 1½ inches is used. For ordinary walls, the largest pieces should be not more than one-fifth the thickness of the finished wall section. And for slabs, the maximum thickness of the rock aggregate should not be more than one-third that of the slab.

The amounts and sizes of the sand and gravel are also adjusted for the strength and workability of the mix. The plasticity of concrete in its wet state, as well as its ultimate density, depend in part on the aggregates meshing. How well the mud moves down the chute, how easily it fills the forms, and how well it finishes are measures of its workability.

Cement—An English stonemason, Joseph Aspdin, patented the process for manufacturing portland cement in 1824. He used this name because it produced a hardened concrete with a color that reminded him of the natural grey stone on the Isle of Portland. Portland cement was first produced in North America in 1872. Interestingly, the use of steel reinforcing bar was introduced a .few years later, around 1880. And the first patent for prestressed concrete using steel-wire rope was issued in 1888.

Today, portland cement is produced in huge rotary kilns at temperatures of nearly

2,700°F. At this temperature, lime, silica, alumina and iron oxides, which are derived from limestone, oyster shells, marl, shale, iron ore and clay, undergo a kind of molecular reformation called calcination. After cooling, the resulting greenish-black clinkers are pulverized with small amounts of gypsum to control the set time of the cement.

The American Society for Testing and Materials (ASTM) recognizes five types of portland cement. Each is intended for a specific purpose, although they all achieve about the same strength after curing for three months.

Type I. This is the most common type of general-purpose cement, and is used when a specific type isn't called out. Most residential construction uses Type I.

Type II. A moderately sulfate-resistant cement, it is sometimes specified for walkways where de-icing chemicals will be heavily used. It sets more slowly than Type I, an advantage during the summer, when getting a finish on concrete can be a real race. Also, because it generates less heat during curing than Type I, it is better suited for mass pours, where heat radiating from hundreds of yards of curing concrete can cause problems.

Type III. This type is called high-early-strength cement because it achieves most of its strength within the first week of curing. This is useful if the concrete has to be put under full load within a few weeks of pouring, or if forms have to be stripped early. It is not widely stocked by concrete companies, but adding an extra bag of Type I or Type II cement per cubic yard of concrete and mixing at high speeds will produce similar results.

Type IV. A slow-curing variety that generates very little heat by hydration, it is used exclusively in mass concrete, such as dams.

Type V. This cement will withstand severe sulfate action that occurs in heavily alkaline soil or groundwater. Concrete can deteriorate because of physical and chemical reactions between sulfates and compounds formed by hydrated portland cement. Type V gains strength much more slowly than Type I.

The Canadian Standards Association (CSA) has three categories—normal, high-early-strength, and sulfate-resisting. These correspond to ASTM Types I, III, and V.

There are a number of ways that these cement types can be altered to meet special conditions. Portland cement is normally grey. White portland cement, light in color because it's made with a minimum of iron and magnesium oxides, can be tinted by adding pigments or used as is. Blast-furnace slag and pozzolan are two materials that are ground up and blended with portland cement to bring down its cost. When pozzolan is added to Type I it is designated IP; for slag, the abbreviation is IS. Another application of portland cement is

Jitterbugging a slab settles the large aggregate just below the surface to allow a smooth, troweled finish. Most problems in residential concrete are surface faults—crazing, dusting, scaling, honeycombing and shrinkage cracking—rather than strength failures.

lightweight concrete, which uses artificial aggregates and gas-forming admixtures to make it lighter. Types I, II, and III are available with air-entrainers (discussed under admixtures) interground, and designated with an A after the type number.

Portland cement is usually packaged in paper bags. Each bag weighs 94 lb. and contains 1 cu. ft. of cement. A common unit of measure in the past was the barrel, which contained the equivalent of four bags.

The cement content of a mix has a lot to do with its strength. One method of ordering ready-mix concrete is to specify how much cement should be used for each cubic yard of concrete. Producers of ready-mix prefer that you give cement content by weight (such as 470 lb. per cu. yd.), but ordering a certain number of bags, or sacks, of cement per cubic yard (such as a five-bag mix) is still very common. A four-bag mix is the minimum for most residential uses; five-bag is better. You should ask for six-bag or seven-bag if you use smaller aggregate or if you want greater strength, waterproofing and durability.

Water—For mixing concrete, it's best to use water that is fit to drink. It should not contain any oil, alkali or acid. In hydration, the water and cement in concrete combine chemically to form a paste that binds the aggregates together. It can be thought of as a glue.

The more water added to a given amount of cement, the weaker the concrete will ultimately be. This relationship of water and cement is known to concrete engineers as Abrams' law, or the water/cement ratio (W/C). It is a central factor in the design of the mix. The W/C ratio needs to be adjusted for a large number of variables, including the quantity of water that the aggregates are carrying, and the ambient temperature and humidity at the time of the pour.

The strength of concrete decreases as the W/C ratio increases, as seen in the chart above. The first column expresses the ratio in weight (pounds of water divided by pounds of cement). The second column gives the same ratio in gallons of water per bag of cement.

W/C (weight)	Gallons per bag	Approx. 28-day strength (psi)
.45	5.0	5,000
.49	5.5	4,500
.53	6.0	4,000
.57	6.5	3,500
.62	7.0	3,000

Strength and quality—The strength of a given sample of concrete is measured by how much compression-loading a test cylinder of concrete 6 in. in diameter by 12 in. high can take before fracturing. The testing is done in a laboratory using a hydraulic piston hooked up to a meter that measures pounds per square inch (psi). Compression-strength figures for concrete refer to tests conducted after 28 days of curing unless otherwise noted. These figures indicate how well a batch of concrete will stand up to vertical and lateral loading. It is also a measure of durability and watertightness. Most engineers require that any load-bearing concrete achieve a minimum 28-day strength of 2,500 psi.

Although most concrete is batched to exact engineering standards at the plant, a lot can happen to affect its quality before, during and after the pour. How much water is added to the concrete after it's initially mixed is a good example of this.

Some drivers will ask if you want the mix stiff or sloppy, and then judge how much water to add, according to the slope (if any) involved in the pour, the angle of the chute from the truck to the forms, the depth of the forms, the amount of rebar, how long the pour is taking, and the weather (hot, dry days call for more water). A thin, watery mix is easier to handle, but much of the water added to the concrete at the job site may not have been figured in the mix design, and the resulting concrete will be less durable and much more subject to cracking.

Slump—To regulate the amount of water in ready-mix, specify slump. If you are working from a set of engineered plans, this may already be listed in the specs. Slump is a measure of the consistency of concrete—the higher the slump, the wetter the mixture. Slump is measured with a 12-in. high truncated metal cone with a base diameter of 8 in. and a top diameter of 4 in. The cone is filled with concrete right off the truck and rodded with a tamping rod. Then the cone is lifted free, inverted and placed beside the sagging pile of concrete for comparison. The distance the concrete subsides from the top of the cone, measured to the quarter inch, is the slump.

Roadways, industrial floors and any concrete that is consolidated with mechanical vibration requires a 1-in. to 3-in. slump. Most foundations, slabs and walls consolidated by hand methods such as spading can have a slump between 4 in. and 6 in. On most residential pours, taking the time for a slump test isn't feasible. I usually just eyeball the mix. A good 3-in.to 4-in. slump mix will stand in a pile. A 5-in. to 6-in. slump sags into a blob, and a 7-in. to 8-in. slump just flattens out.

Many problems in residential concrete are the result of high slump. Unlike public projects such as bridges and highways, where compressive strength is essential, residential pours seldom suffer failures under a load. Instead, it is surface faults—honeycombing, crazing, dusting, surface cracking and scaling—that cause the problems.

One serious failure of concrete associated with high slump is segregation, which is a re-separation of concrete back into sand and gravel. Bleeding is another kind of separation that can be serious if it occurs on a large scale. Bleeding is the emergence of water on the surface of newly poured concrete. This occurs when the large aggregate settles within the mass, displacing the water in the mix. Heavy bleeding greatly dilutes the cement particles on the surface of the concrete, making it susceptible to abrasion. When this bleed water is troweled into the surface of a slab during finishing, it can result in crazing lines, shallow parallel fissures called plastic shrinkage cracking, a powdery dusting on the surface, and even scaling, which is the flaking of the finished concrete. If you keep slump low, and finish and cure the resulting concrete with care, you can avoid these problems.

The mix—Although all concrete consists of the same basic ingredients, how they are proportioned can make a huge difference in strength and workability. Because of all the variables involved, there are hundreds of possible combinations that will produce concrete with a wide variety of characteristics. As explained on p. 33, it's very important to mention the conditions and requirements of a pour when ordering concrete, so that a mix can be designed or chosen from standard designs that will give you the kind of concrete you need.

The design of a mix is complex because of the interrelationships of the materials. For example, if the size of coarse aggregate is limited in order to pour a thin slab, this will affect the amount of cement needed to reach the necessary compressive strength. The amount of cement used in turn affects the amount of water to be added, as well as the

Concrete is one of the few residential building materials that have no forgiveness, and any pour will have its frantic moments. But good forming, careful planning, ordering the right mix, and knowing how the mud will react can keep the panic to a minimum.

Mechanical vibrators should be used with caution, and low-slump concrete. Prolonged vibrating can cause the concrete to segregate, bringing the fines—cement and water—to the top, leaving the heavier aggregates below. This can lead to surface failures on a slab.

Photo: Bob Syvanen

size and proportion of fine aggregate. The mix will also have to be adjusted for slump, workability, admixtures and the weather.

Admixtures—There are four kinds of admixtures that can give concrete specific qualities. The first, called air-entraining agents, are known to most builders who work in areas with hard freezes. This admixture is a material that stabilizes bubbles formed by air incorporated in the concrete during the mixing process. The bubbles create tiny voids that act as expansion chambers or shock absorbers, which allow the concrete to withstand freeze-thaw cycles. The amount of air in the mix is a variable of mix design. It is typically 5% to 7% by volume.

Although these air bubbles make the mix slightly weaker, they also have beneficial effects. Air-entrainers increase the workability of the mud (so less water can be used for a given slump), make the mud more resistant to salts, and produce a more durable concrete.

A set-retarder may be added to ready-mix to prolong its setting time by 30% to 60%. If you need extra working time on hot days, tell the dispatcher when you order, and the plant engineer will determine the exact amount according to the weather and the mix.

Concrete companies are also likely to add a water-reducing agent, sometimes called a plasticizer, which may allow as much as a 15% reduction in water content for a given slump. Water-reducing agents can help minimize problems relating to an excess of water, such as segregation, plastic shrinkage cracking, crazing and dusting. It can also increase the concrete's strength and its bond to steel reinforcing rod.

Probably the best-known admixture is calcium chloride. This chemical is an accelerator, used to get an early set in freezing weather. Ideally, concrete should be poured when it's at least 50°F, with the mud maintained in the forms at 70°F. But pours in cold weather are often necessary, and quite common. If concrete freezes while it's setting or during the first few days of curing, it won't gain much strength and problems will develop. Pop-out, scaling and cracking occur when water in the concrete freezes and expands nearly 9% of its liquid volume.

Contrary to myth, accelerators aren't effective as antifreeze. Concrete, even with calcium chloride added, can freeze. Like any accelerator, it will only decrease the setting time. This allows the builder to pour, finish and insulate the concrete before the onset of freezing temperatures. Calcium chloride should be used sparingly and not just for convenience when better scheduling would solve the problem. It attacks aluminum conduit, lowers the resistance of the concrete to sulfates, increases shrinkage, and generally weakens the mix. If you need to use it to beat the weather, limit it to 2% by weight of cement. An effective alternative is to add an extra bag of cement to each cubic yard of concrete.

Working concrete—If you pour a lot of concrete, buy a pair of rubber boots. Leather work boots will rot off your feet after a few dunkings in concrete. The only way I've found to restore the flexibility of the leather is to remove all of the concrete and soak the boots in motor oil for a day—crude but effective.

Gloves are another must. The cement contains lime, an alkali that dries out skin and leaves it cracked and sore. Thick rubber gloves offer good protection, but they are awkward to wear. Lately I've been wearing doctor's disposable examination gloves. They cost less than $10 for fifty pairs, and fit like another layer of skin.

It's a good idea to keep a bottle of vinegar with your concrete finishing tools. Vinegar contains acetic acid, which neutralizes the lime. Wash your hands in it when you quit for the day, and don't rinse it off immediately. You'll smell like a salad bar, but your hands won't be any the worse for wear the next day.

There are several general procedures that should be followed to end up with strong concrete that looks good after the forms are stripped. Concrete should be poured in horizontal layers of 6 in. to 12 in., depending on the stiffness of the mix. Start in the corners of the forms and work toward the middle. Concrete should not be dumped into separate piles and then leveled and worked together. Pouring it near its final place will save your back and keep the mud from separating.

If you are ordering ready-mix concrete,

Photo: Ross Lowell

check the approaches that the transit mixer can make, and calculate how many chute sections you will need. Most trucks carry 10 ft. of chute. You can usually arrange with the dispatcher to have the driver bring another 10 ft. If this doesn't do it, you will have to hire a pumper, build a chute, or truck the wet mud around the site in wheelbarrows. These alternatives are listed in order of preference. Although everybody has had to use a wheelbarrow to complete a pour on occasion, it is slow, risky work.

Most concrete companies will allow between 30 minutes and an hour to empty a full truck (about 8 cu. yd.), before they charge overtime. Money isn't the only issue. Time is also a critical factor. Depending on the air temperature, the mix can agitate in the drum of the truck for up to an hour after batching. After that, more water has to be added, which will weaken the mix. Under average conditions, concrete that is left in a truck for longer than 90 minutes is considered unusable.

Pumpers should be considered for a job where ready-mix is used and some part of the pour is inaccessible by ordinary means. Hillsides, high walls, muddy ground where a fully loaded truck could become stuck, and sites with dense trees or landscaping are all good candidates. In addition to the huge pump trucks with articulating booms or snorkels used for big commercial jobs, there are smaller portable pumping machines and trucks that are suitable for residential jobs. In most areas, they can be hired with an operator for $100 to $200 for an average pour.

Using a pumper can cut down the number of people needed to make the pour, and still give better results. Small pumpers use a 3-in. or 4-in. diameter hose. This requires using pea gravel as large aggregate and adding an extra bag of cement for each yard. This mix is rich and easy to work. If you need to build a chute for the site, use at least ¾-in. plywood and lots of bracing. Pitch it at about a 5-in-12.

Once the mud is in the forms, it needs to be tamped or vibrated to eliminate voids around rebar or against the form faces. Spading the sides of the form just after the mix is placed will minimize honeycombing and sand streaking, and keep aggregates from showing on the surface of a poured wall. You can buy special spading tools—thin, flat pieces of metal mounted on long handles—but 1x4s or long pieces of rebar work fine. Another good technique to eliminate honeycombing is to rap the forms sharply with your hammer, moving up and down the forms. This brings the cement paste out to the surface of the wall to cover the aggregate.

The best tool for settling the concrete into forms is a vibrator, a portable motor with a long, flexible, waterproof shaft. You can rent one for less than $20 a day. Use a vibrator as you are pouring on each level, particularly at the face of walls, corners and around rebar. Plunge the shaft into the mud every few feet along the length of the form, and let it vibrate for 5 to 15 seconds. Prolonged vibrating is not good because it can cause segregation. In fact, a vibrator shouldn't be used on any mix that can be placed and consolidated readily by hand tools.

With a slab, it is common practice to tamp the wet concrete with a Jitterbug —a tubular-steel frame with a mesh bottom and waist-high handles—to settle the aggregate below the surface (photo, previous page). This aids in floating and finish troweling, and brings excess water to the surface to evaporate.

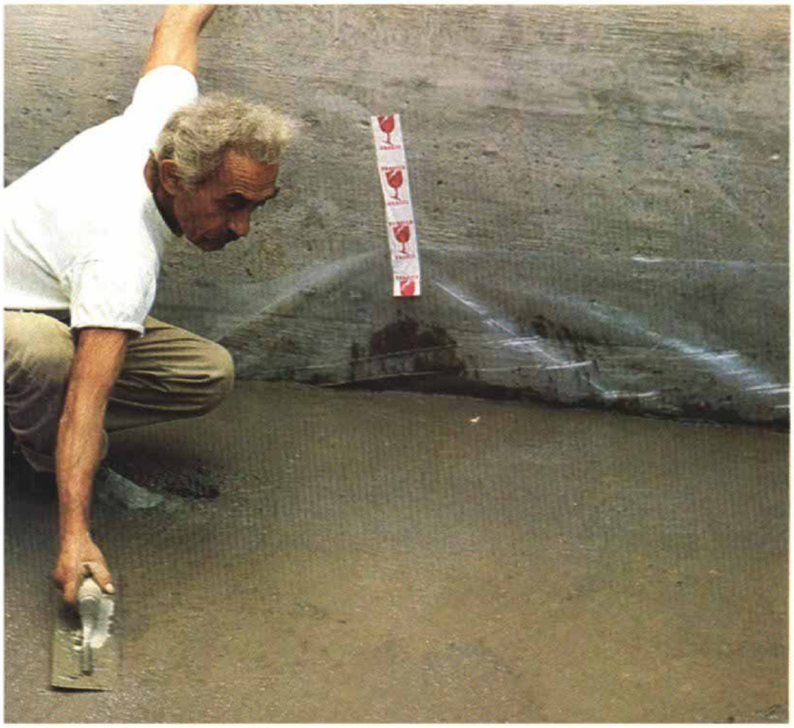
Curing—Proper curing is essential in achieving high-strength concrete and durable surfaces. As long as it is kept moist and warm—above 80% relative humidity and 70°F is ideal—concrete will harden indefinitely at a diminishing rate, as shown in the chart below. If the humidity drops below 80%, the surface of the concrete begins to lose moisture more rapidly than the interior of the pour. This causes the surface to shrink, and results in a soft, dusty skin that is less resistant to abrasion. Surface hairline fissures (crazing) are sure signs that concrete dried out too much during its initial curing. Plastic shrinkage cracks, which seldom have any structural significance but mar the appearance of a finished slab, are also caused by allowing the surface of the concrete to dry out. To get the best cure, the surfaces of the concrete should be kept moist for at least three days. After seven days it will have attained about 60% of its eventual 28-day strength.

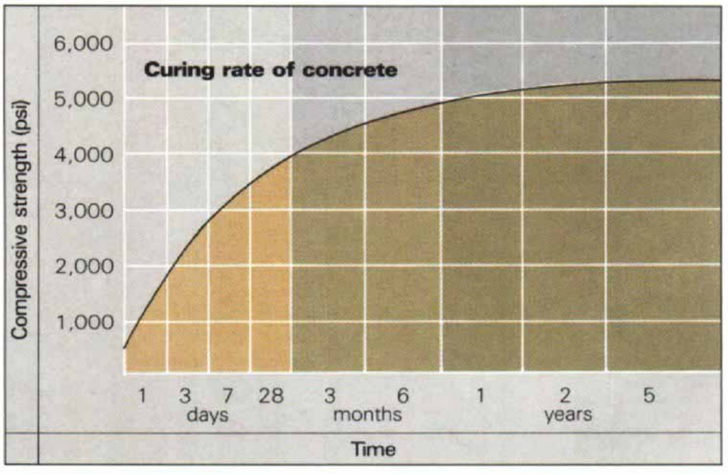
Concrete can be kept wet by spraying it lightly with water several times a day; or, in the case of a slab, by maintaining a pond of water on the finished surface. How much moisture it will need depends upon air temperature and humidity. It's impossible to keep concrete too wet during curing. Spreading burlap or straw on the surface and soaking it with water will help hold moisture, as will covering the surface with plastic sheeting.

Membrane curing compounds, which can be sprayed on the surface, are also available. Clear compounds are preferred for surfaces that will be exposed. Black curing compounds have an asphaltic base and are used when staining isn't important. The black compounds will also hold in heat as the concrete cures. White compounds are effective in hot weather to reflect heat from the sun.

In cold weather, concrete slabs should be protected against freezing with straw covered with plastic sheeting or insulating blankets. If temperatures are in the 40°s, maintain this insulation for at least 48 hours. Insulated forms used for columns and walls should remain in place for at least a week. If temperatures are lower, keep the covering on even longer. Since hydration is an exothermic reaction, the primary concern should be holding this heat in. Only if the air temperature drops below 0°F should you supply heat. □

Trey Loy is a designer and builder who lives in Little River, Calif. He spent five years pouring concrete professionally.





Curing. **Concrete acquires most of its strength in the first month after the pour. This graph plots the approximate compressive strength of a six-bag mix using five gallons of water per bag over time, assuming the concrete is maintained at about 70 °F.**

Photo: Ross Lowell

Figuring and ordering ready-mix concrete

Gulping is the initial reflex for most builders, seasoned or not, when the dispatcher asks the inevitable question, "How many yards you want?" Like it or not, you've got to give an exact figure in cubic yards, no matter how complicated or irregular the pour is. Ordering too much means the driver of the transit mixer will need a place on your job site to dump the excess, which, like the mud inside your forms, will cost you nearly $50 a cubic yard. Ordering too little is even worse. Unless the plant can send another truck with a short load right away (this costs extra), you'll have to cap off your forms, add a keyway, and create a construction joint in a pour that was designed to be monolithic.

The way to prevent these problems is to figure your needs precisely, and then cheat the moment of truth as much as you can. If you have to reserve the concrete several days ahead, give the dispatcher a figure 15% higher than what you think you'll need, and tell him you'll call in the exact number of yards an hour or so before the pour. This way you'll be calculating trench depths and form widths as they exist. If you are figuring a big job, put off estimating the final load until after you have finished pouring from the fully loaded trucks. You won't have a lot of time in which to make that final calculation in order to send it back with the last driver or call it in to the dispatcher, but you will have cut down your margin of error by dealing with only the few yards that remain rather than with the whole job.

On the day of the pour, leave yourself enough time for careful figuring and double-checking. Last-minute concrete panic has a long tradition, but punching the keys on a pocket calculator while you are trying to get the building inspector to sign off the formwork will make for miscalculations every time. Have a helper figure independently how much concrete you'll need, and then compare notes. This should pick up careless errors in math, and the easily made mistake of forgetting to figure in some portion of the pour.

Calculating volume—The only accurate way to calculate most residential concrete jobs is to get down in the trenches and take measurements. Write down the width, depth and length of each trench or form. Having to remove a large root from a footing trench and undersupervising an overeager backhoe operator are just two reasons why the actual measurements may differ from the numbers on your blueprints enough to make a real difference.

Particularly with slabs and trenches, the depth figure can be a compromise based on measurements taken at many points and tempered by the kind of intuition that comes with experience. The same can be true of trench width, depending on the soil.

Once you've noted the measurements for each wall, footing or slab, group them into separate categories, one for each configuration or cross section If the depth of a footing trench changes, figure this portion of the footing as a separate category, even if the width remains the same. When a configuration has more than four sides, such as a T footing, break it down into separate rectangles, trapezoids or triangles. Keep all this information on a clipboard. I number the categories, draw a small section of each one and fill in the dimensions so I don't get confused. List the different lengths for each cross section below the appropriate drawing, and note its location on a plan drawing of the pour. This really helps later in the pour when you have to calculate the last load in a hurry. You can now add the lengths of all the footings and walls in each category to get the total lineal feet for each configuration.

Concrete is ordered by the cubic yard. Unfortunately, the width and depth of footings, walls and slabs are often in inches, and length is in feet and inches. Calculate each cross section—width x depth—in inches if the increments are small, or in feet and decimal feet if the numbers get too big. Just don't mix the two. To convert your square-inch answers to square feet, divide by 144. List the total area of each cross section on your clipboard. Use a pocket calculator to grind out these numbers.

To get the total concrete needed in each category, multiply the cross-section figure, now in square feet, by the total of all the lengths in the category, which is already in feet. The product will be in cubic feet. Adding all of the totals for the categories together, and dividing by 27—the number of cubic feet in a cubic yard—will yield a total in cubic yards.

You can order concrete in fractional yards, but remember to round off high, not low, to get to the nearest large fraction. I usually order a few extra cubic feet to protect against being short, in addition to the standard 5% allowance for spillage It's a good idea to have pier holes for decks or retaining-wall footings dug to use any excess concrete.

Placing your order—If there is more than one batch plant near the job site, ask around to see which one other builders like. Since price per yard is usually similar, their impressions will be based on phone contact with the dispatcher, and on pouring with the drivers. These opinions are useful, because the cooperation and expertise of the people in these two positions will determine how easy and successful your pour will be.

Give the dispatcher the day and time you want to see the first concrete truck, and how many yards you'll need. Then describe the mix you want, in enough detail so that the proper concrete will get sent to your job site. There are two established methods-performance and prescription.

When you order with a performance specification, you give the dispatcher a compressive strength in psi, and it's up to the batch plant to supply concrete that will test to that minimum figure in 28 days. Prescription ordering, on the other hand, puts the responsibility on you. It also lets you determine some of the variables in the mix design You may want to duplicate a mix that worked well for you in the past, or to satisfy a restriction unique to this pour, such as a maximum aggregate size that the pumper can handle.

A minimum prescription tells the dispatcher how many pounds or bags of cement to use with every cubic yard of concrete. When you specify only the cement content, the batch plant will determine all the other variables.

If you are knowledgeable, or if there are engineering specifications on your plans you need to satisfy, carry prescription ordering a step further by specifying slump, maximum size of the coarse aggregate, or the percent of air-entrainment. If not, you should mention any special characteristics of the site or of the pour that will affect batching or delivery. If weather is a problem, ask about admixtures. If you are pouring grade beams on a steep slope, talk about slump. If you are going to use a pump, tell the dispatcher which company, confirm the time of the pour, and have the aggregate and mix adjusted.

Whatever way you order, make sure you get a batch ticket from the driver for each load you receive. This is more than just an invoice that lists the number of yards of concrete. It should also tell you the cement and water content of the mix, the size and amount of aggregates, the amount of air-entrainment, the percentage or weight of admixtures, and the slump.

Maybe most important, give the dispatcher clear directions to your job site and a telephone number where the driver or the batch-plant dispatcher can reach you or someone who can get in touch with you. It's surprisingly easy to lose a truck that weighs 27 tons, but it's more than difficult—and expensive—to deal with its load after it's sat in there a few hours.

—Paul Spring