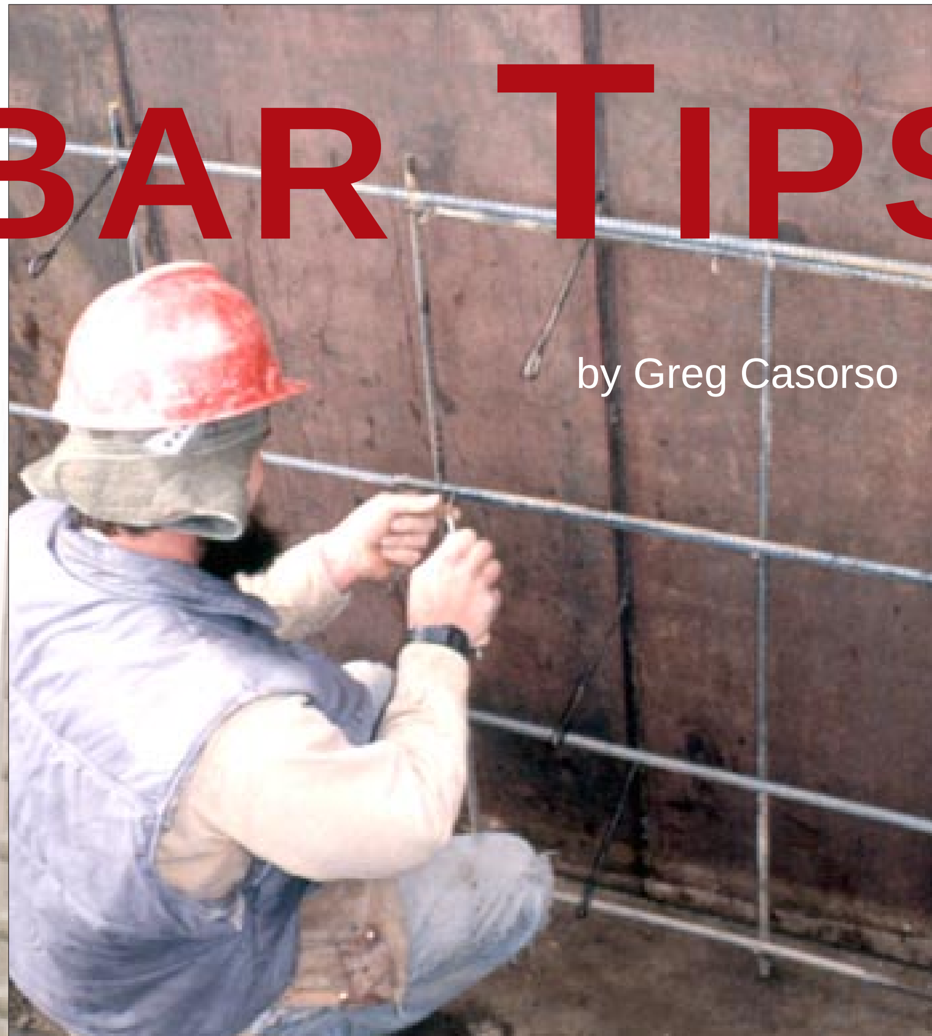
REBAR TIPS



by Greg Casorso

Reinforcing steel enables concrete to resist bending forces — but you have to place it and tie it correctly

The steel reinforcing that we all know as "rebar" is a critical component of quality concrete construction. By enabling concrete to resist bending forces, rebar allows concrete to be used for overhead spans like freeway overpasses or multilevel parking garages. In residential use, rebar enables slender concrete foundation walls to resist horizontal soil pressures, and gives piers, grade beams, and slabs the strength to support the weight of a home.

Anyone who's had to break out a concrete structure knows that a slab or wall poured without steel is much easier to demolish than one with even a few pieces of rebar. It's no coincidence that bomb shelters and missile silos are made of steel-reinforced concrete. It is steel reinforcing that makes concrete such a valuable and versatile building material.

Rebar Specs

Engineers design strength into a concrete structure by specifying a certain size and grade of rebar, placed in specific ways. Rebar specs are usually detailed on the blueprints.

Sizes. Rebar comes in a range of diameters, numbered 3 through 11. The numbers denote the diameter of the bar in 1/8-inch increments. Thus, #3 bar is 3/8 inch in diameter, #4 bar is 4/8 (or 1/2) inch, #5 bar is 5/8 inch, and so on. The size most commonly used in residential construction is #4, though #5 and #6 bar are used often in hillside construction (see "Hillside Foundations," 3/93). Rebar larger than #6 will sometimes be found in large retaining walls or in large-diameter deep piers, but in residential work these larger bars are rare. Patio slabs, garage floors, walkways, pool decks, steps, and simple landings are often made with #3 bar. The 3/8-inch size is also used in stirrups or cage ties, which also contain an assembly of larger bars (see Figure 1, next page).

Grades. Besides a variety of bar diameters, rebar is graded in two

Figure 1. *For deep concrete piers, the author uses steel cages made from #3 rebar spirals with #5 rebar in the middle. The cage shown here will help support the brick chimney in a foundation underpinning job.*

primary grade classifications, commonly known as grade 40 and grade 60. Grade 40 is more malleable and easier to bend. Grade 60 is stiffer and does not bend as easily. Generally, grade 40 is found in #3 and #4 bar, and grade 60 in #5 and larger.

Lengths. When you're ordering rebar, you should be aware that it's manufactured in standard lengths. Depending on the mill, it's usually available in 20-foot, 30-foot, and 60-foot lengths, with 20-foot the most common. So if you order prebent rebar in an odd length, the supplier has to cut some off. The remnants get collected and recycled, but you pay for them anyway. To cut your own costs, try to work in lengths that divide evenly into 20, 30, or 60 feet.

Proper Use of Reinforcing Bar

To get the full benefit of steel in a concrete structure, the rebar must be handled and installed properly. As with any other material, the correct techniques become a habit with experience.

Handling. Specs usually call for rebar to be clean and free from rust. In practice, the thin film of rust you often see on rebar isn't a problem. If the material sits on the job site for four to six weeks or so, it will still be fine. We don't even cover it on the site. Occasionally, however, sandblasting is required to clean the rust off rebar that has been exposed for too long. Rebar that is old and has rusted extensively should not be used.

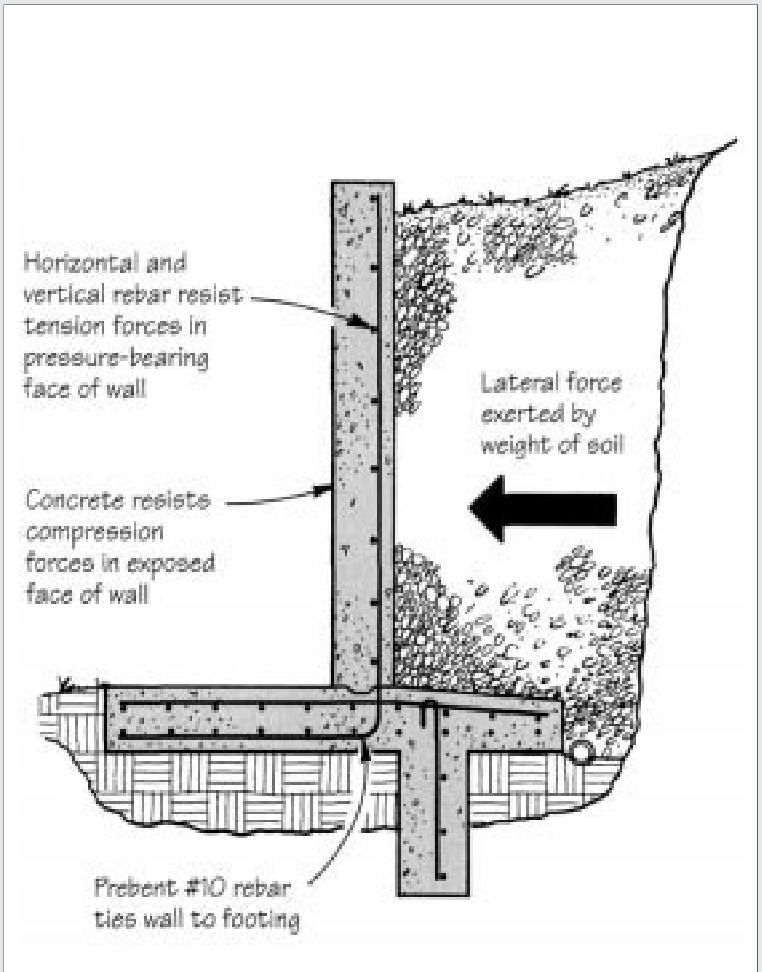
Keeping the rebar clean is a more common problem. Mud and dirt on the steel will prevent the concrete from bonding to it and reduce its effectiveness. Rebar can easily get muddy as it's dragged around a job site. We take care to keep the mud off it.

Cutting. To cut #5 or larger rebar, you really need an oxygen acetylene cutting torch (Figure 2), which you can buy at welding supply stores (a torch also makes cutting smaller sizes easier). The torch costs about $350, and then you have to rent bottles of oxygen and acetylene. Oxyacetylene torches are dangerous — anyone who's handling one should be trained to use it properly.

Rebar sizes #4 and smaller can be both cut and bent with a cutter/bender

Figure 2. *The author uses an oxyacetylene torch to cut large-diameter rebar (left), while #3 and #4 can be cut and bent with a combination cutting and bending tool (right).*

How Rebar Works in a Retaining Wall



The compressive strength of concrete and the tensile strength of steel work together to resist lateral soil pressures in this retaining wall.

Concrete has tremendous compressive strength — anywhere from 3,500 psi to 6,000 psi. But it has almost no tensile strength — tension forces can easily pull it apart. Steel rebar, on the other hand, is very strong in tension.

When a sideways load is applied to a concrete retaining wall, tension develops on the pressure-bearing side and compression on the side away from the load. Concrete readily resists the compression, while the steel carries the tension and prevents the structure from breaking and toppling.

The retaining wall drawn here is from a job my company did recently. The engineer called for #6 bar to be placed vertically on 6-inch centers, 3 inches from the pressure-bearing face of the wall, tied to horizontal courses of #5 rebar every 16 inches on-center to the top of the wall. Prebent #10 bar provided the crucial link between the wall and the spread footing below.

In this case, steel rebar not only provides the necessary tensile strength for the pressure-bearing vertical face of the wall, but it also provides vital tensile strength at the joint between the wall and the spread footing. Without the continuous steel running from footing to wall, that joint would fail, causing failure of the entire structure.

Retaining walls should be designed by experienced design professionals. Each case is different, and there is no "cookbook solution" that works for all walls. Also, different engineers will find different ways to solve the same problem. The concrete contractor must place the steel where the engineer says to (industry standards allow a 1/4-inch tolerance for error). If you put the steel in the wrong place, you've entered lawsuit country.

— G.C.

tool. The tool is readily available at most concrete supply stores, also for about $350.

Bending. We bend #3 and #4 bar on site with the bending tool, but the larger sizes are practically impossible to work on site. I always order the larger sizes bent by the supplier and delivered to the site ready for installation. Never bend rebar by heating it with a torch — this makes the steel brittle and easy to break, defeating its structural purpose of resisting flex.

Placing. Rebar has to be buried at least 3 inches deep in the concrete unless otherwise specified. Good concrete cover is essential — otherwise water will get to the rebar, rust the steel, and eventually cause failure. To hold rebar off the ground or away from the forms, we use concrete spacer blocks called "dobies" (Figure 3). Dobies come in many sizes: 1 inch, 2 inch, 3 inch, and larger. Three-inch dobies are the most common, because 3-inch concrete coverage is the industry standard.

Tying. Rebar should be tied together with tie wire at every intersection (Figure 4, next page). The wire is wrapped around the bars and twisted just like the tie wrap on a loaf of bread. The rebar should be held in place firmly and securely by the tie wire — on larger walls we tie the rebar so securely that we can actually climb up the bars.

Tie wire comes in rolls, or in bundles of precut lengths. We like to

Figure 3. *Concrete "dobies" are used to hold rebar off the ground or away from forms, ensuring adequate concrete coverage and preventing rust.*

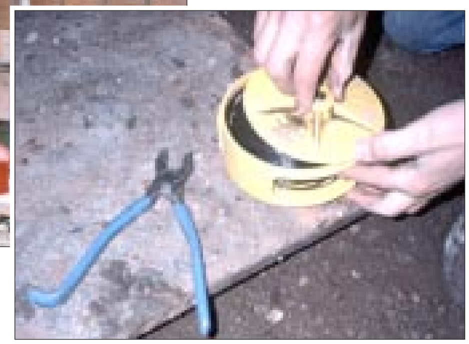


Figure 4. *The author ties the rebar at every intersection. Precut wire can be bought in bundles and twisted with a special swiveling tool (top right), but the author's crew prefers to use a pair of spring-loaded linesman's pliers and a roll of wire on a spool (right).*

use the roll-type that comes on a special spool that can be worn on a work belt. The spool conveniently dispenses the tie wire as needed without tangles. We tie the wire with special spring-loaded linesman's pliers that gently open by themselves, making it easy to grasp, wrap, twist, and cut.

Installers who work with precut bundles of looped wire use a special tool that twists the wire up with a few snaps of the wrist. I've found that this is an efficient method if you have acres of slab to tie, where there are a lot of intersections that are easy to get at. But the reel-and-pliers method is more versatile for smaller jobs because it's good for working in tight spaces.

Splicing. Be sure to splice the rebar as specified by the engineer. For example, if you are using #4 bar and the engineer calls for splices of 28 bar diameters, then you know that you need at least a 14-inch overlap when two bars are spliced together. The overlap should be tied with wire in at least two places.

The pour. When you place the concrete, make sure that it fills in completely around the rebar and bonds to the steel tightly. You should spray release agents on the forms before placing the rebar, but don't get any release agent on the rebar, or the concrete won't bond to the steel as well.

Use a mechanical vibrator to work the concrete in and around the rebar. Pay special attention to corners, where there is often lots of rebar. The vibrator works air out of the concrete and allows a better concrete-to-rebar bond. But don't rest the vibrator head on the rebar. That causes the rebar to pulsate and reduces the bond between the concrete and the rebar.

Figure 5. *The exposed ends of rebar can cause fatal accidents. OSHA regulations call for rebar ends to be covered with high-visibility protective caps.*

Safety. Exposed rebar ends are very dangerous. There is a very real risk of falling on the sharp steel. A man was killed recently in my area when he tripped and fell from a grade beam form. He didn't fall from a height — he just tripped and fell down, and a piece of rebar punctured his heart.

OSHA now requires that all rebar ends be covered with high-visibility plastic safety caps (Figure 5). This is one rule that I strongly support. It is worth making the effort to train people to put those caps on, and to be aware of the risk. We take the caps off when the concrete gets poured, and caps come off by accident, too. At any given time, there are probably some exposed ends around. I just try to stay continuously vigilant, and make sure my workers remember to put the caps on and keep them on. ■

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