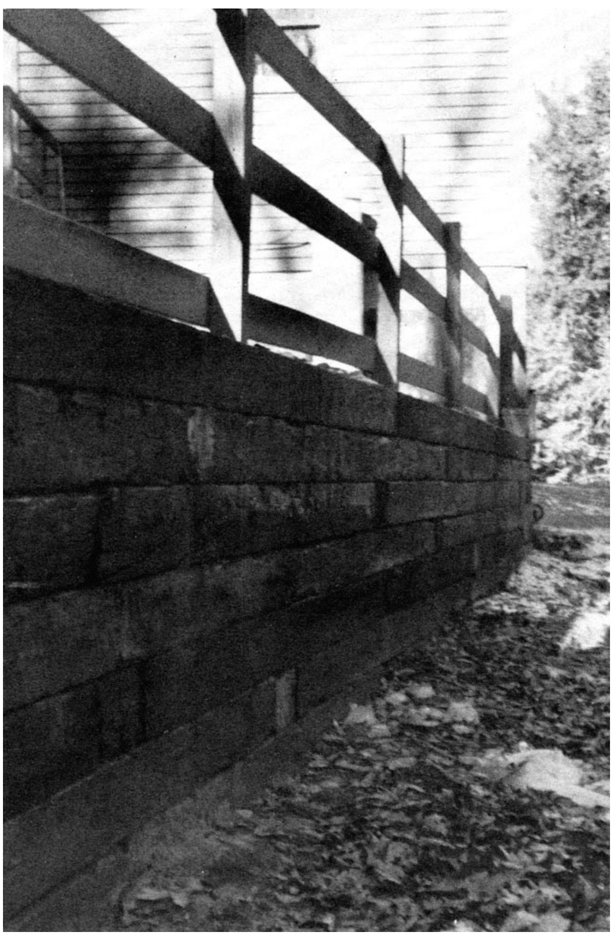
TIMBER

Retaining Walls That Last

For durable walls, tie them back into the hillside and provide good drainage

by Gary Tasker

Although a lot of contractors think poured concrete at the mention of retaining walls, I prefer wood. Whether you use new pressure-treated lumber or old railroad ties, timber walls are usually less expensive than concrete, simpler to build, blend well with other landscaping, and will last 25 years if constructed properly.



Building low timber retaining walls is neither as hard nor as easy as many people think. It's true that you can't just spike a bunch of timbers together and expect them to stay in place. But you also don't need to go to the same measures for a 4-foot wall as the highway department does to retain 30 vertical feet of hillside.

For the smaller walls I build as a landscape contractor, a simple tieback system works well. This relies on T-shaped timber ties that go back into the bank 3 feet or so. I run these on every course at intervals of 16 feet and stagger them between courses.

Design Decisions

You have three main concerns when inspecting a site for a timber retaining wall. First is the height and length of area you're going to have to retain. Second, you need to consider potential water problems and how you're going to provide drainage. Third, you have to look at whether the soil will support the wall at the base or require a footing.

Height. Most of the timber walls I build are 4 feet or less in height. I have gone above 5 feet a few times, but at this point you're dealing with the kind of loads that call for more knowledge about the soil and some precise calculations from an engineer. As you get into taller walls, the forces you are counteracting — the horizontal thrust of the hill and the tendency of the wall to overturn — increase at a much greater rate. (For a more technical discussion of the physics of soil retention see "Low Retaining Walls," *3/88).*

One of the ways I keep my walls low on steep sites is *terracing*: stepping back at least a couple of feet from the previous wall and building another. This not only solves some of the structural problems of a tall wall, but two 30-inch walls look a lot better to the eye than a massive 5-foot surface.

And if I am forced to build a single, tall wall, I *batter* it — build it so it leans back at a slight angle into the hill by stepping each higher course

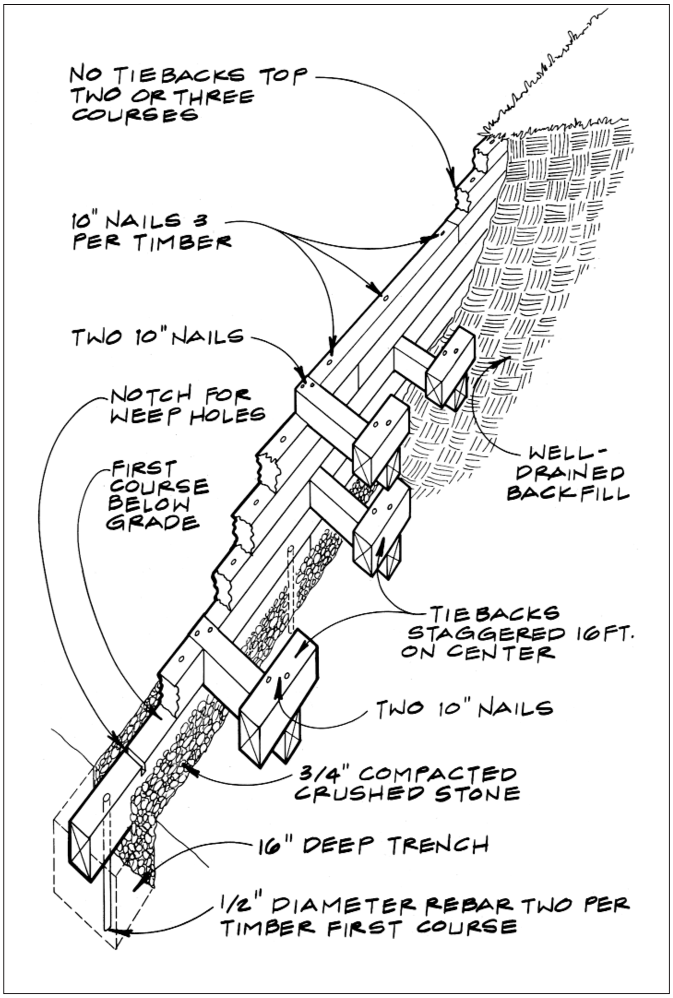


Figure 1. *Installing the first row of timbers below grade gives the wall extra stability. Two-foot sections of rebar, driven through the bottom course into the ground, can also help anchor the base. T-shaped timber tiebacks every 16 feet on each course help stabilize the slope. In heavy soils, the author backfills with sand or crushed stone. With new, surfaced timbers that fit snugly together, weep holes or perforated drain pipe are needed to relieve hydrostatic pressure.*

back by 1/2 inch. This gives some of the same structural and aesthetic advantages as terracing.

Drainage. The greatest threat to a retaining wall is moisture buildup in the soil behind it. The hydrostatic pressure produced by dammed up water can slowly bulldoze a wall of any construction. And anywhere the ground freezes, you're also asking for problems with frost heaving as ice lenses form from this moisture.

There are three common ways to help solve the problem: Contour the grade *above the wall* so surface water doesn't percolate into the soil; provide drainage *behind* the wall with granular backfill and possibly a subdrain; and allow the water to pass *through* it by providing weep holes.

I try to slope the finished grade of the soil held back by the wall to one side or the other so rainwater runs off, but I also make sure the grade falls away from the outside of the wall at its base.

It's also a good idea to backfill behind the wall with sand or 3/4-inch crushed stone. (To avoid problems with frost heaving, you'll want to make sure this material isn't silty.) Although I sometimes skip this step if I'm only going up a few feet, it's essential on higher walls, in areas where the water table is high, or if you're dealing with a clay soil that doesn't drain well and expands when it gets wet.

Weep holes provide a safety valve so hydrostatic pressure can't build up behind the wall. You don't need to worry about providing weep holes with railroad ties, since their uneven contours allow water to seep right through the wall. With new, surfaced timbers you can drill small holes between rows or cut half-inch slits into the top of every other tie (see Figure 1).

Larger amounts of water should be diverted using crushed stone and 4-inch perforated PVC pipe. If the soil is very silty, you should use filter cloth around this subdrain and drape it up the cut of the bank.

Footings. What they say about a house only being as strong as its foundation also applies to retaining walls. If the soil at the base of the wall is dry and undisturbed, you may be able to bury your first course in it and go up from there. But if I have any doubts, I dig a foot-wide trench about 16 inches deep and fill it within 4 inches of the top with 3/4-inch crushed rock. This base should be well compacted with a vibrating compactor before the first timber is laid.

Fit To Be Tied

There are a couple of choices in retaining wall timbers: railroad ties and new pressure-treated lumber. But within these categories you have to be careful that you're getting something that will survive ground contact for more than a few years. Just because it's the right color and sitting in a lumberyard or landscape supply doesn't mean it's been properly treated. Look for the grade stamp that certifies the preservatives used and the retentions achieved.

Railroad ties. These 8-foot heavily creosoted timbers make great retaining walls. Where I live, they're typically oak 6x8s. Their dark, rustic appearance goes well with most landscaping, and despite their previous use in a railroad bed, they're good for another 20 to 25 years.

However, you will need to check them thoroughly. Spikes, nails, and track hardware should be removed. And you'll have to discard, cut up, and trim ends on some of the ties because of rotting endgrain, deep checks, and serious crooks. This cutting typically leaves me with the 2-and 3-foot pieces I need for my tiebacks.

The creosote left on the ties is usually minimal, and isn't likely to harm the soil or plantings. However, you should take care when working around any treated timber. Always wear gloves, a long-sleeved shirt, long pants, and a mask to protect yourself.

There is another variety of tie in my area that is treated with creosote, but I wouldn't recommend it. These are typically pine or poplar 6x6s that are dipped in creosote. They typically don't last more than six or seven years, and because most of the creosote is on the surface, they're highly toxic to plants and to anyone using them.

Pressure-treated. In new timbers, the preservative treatments are either pentachlorophenol or one of the water-borne (inorganic arsenical) salts.

"Penta" is typically used in a light petroleum solvent on timbers. This should be at a rate of .5 pounds per square foot for ground contact. These timbers have the reputation for lasting the longest in my area, but the solvent is somewhat oily and can stain if someone sits on the wall. And there are also more restrictions on penta than the water-borne salts in terms of human, animal, and food contact.

In my area, penta ties are usually made of hemlock, and are easier to work with than the used oak ties because they're straighter and more uniform in size. This produces a straighter, tighter wall. The timbers are also much lighter in weight than the oak, and available in a variety of dimensions and lengths, which gives you a lot more flexibility in design.

The water-borne salts — CCA (chromated copper arsenate) and ACZA (ammoniacal copper zinc arsenate) — can usually be identified by their green color. A retention of .4 pounds per square foot is sufficient for ground contact. ACZA is typically reserved for douglas fir; while CCA is used on southern yellow pine, hem-fir (western hemlock and "true" firs), most eastern and western pines, and the poplar stock they use around here. These ties are typically 6x6s, and come in various lengths up to 8 feet.

Building the Wall

You can excavate the site either by hand or by backhoe. Keep the trench at least a couple of feet out from the bank if possible, or plan to excavate enough to leave room to lay in (rather than cut in) the tiebacks behind the wall.

If you can arrange to bring the machinery in, consider a small Bobcat-type loader with a backhoe attachment. Its quick turning radius and ability to transform itself into a loader or a forklift that will move the ties around can really save some time and money as well as a few backs.

First course. Whether you've trenched 16 inches deep for gravel or just gone down 4 to 6 inches for the first course, use a builders level or transit to level the compacted base material in preparation for the first course. Spend some extra time here to make sure it's perfect — how level and how even your subsequent courses are depends on this first one.

I actually set the first course with a string and line level, using a 4-foot level for a quick check. Once the timbers are set, I fill in around them and compact. Installing the first row below grade offers some extra stability to the wall, and allows you to hide steps in the grade.

Toenailing the base row together is usually sufficient to hold it in place, but for a little extra security you might want to drill two 5/8-inch holes per tie and drive 2-foot pieces of 1/2-inch rebar through the tie and into the prepared gravel base below. I don't worry about drilling completely through the ties. I just get as far as I can with a spade or twist-drill bit from the top, and then drive the rebar pin through with an eight-pound sledge hammer.

Tiebacks. I usually start the tiebacks on the first or second course and space them every 16 feet — typically two timber lengths. I use 3-footers starting flush with the face of the wall and going back toward the bank. I typically make up the tiebacks by nailing 2-foot "heads" onto the three-foot "tails" of the Ts before I begin assembling the wall. Once each is in place, I backfill around it and carefully compact.

After the first course is secured, the remaining courses go much faster. You'll want to start the second course with a 4-foot timber, the third row with an 8-foot section, and so on, throwing in a tieback every 16 feet. This way the butt joints between timbers and the tiebacks are staggered along the wall for the greatest strength.

If your retaining wall has a return — a 90° exterior corner — you'll want to run tiebacks into this intersection from the hillside by bisecting the angle (45° to the face of the wall). You can run these long to the outside and then trim them in place with a chainsaw along the two faces of the wall.

Making cuts. All cuts should be made with a lightweight chain saw. Keep the chain sharp; it's impossible to make a clean, straight cut with a dull chain. You'll also need some extras when working with railroad ties because they're laced with sand and dirt.

However, you should try to keep your cuts to a minimum. The penetration of preservative during the pressure-treating process varies a lot according to species, and cutting will expose untreated areas. When you do have to make cuts, apply a copper naphthenate solution (with at least 2% copper) to the cut ends. Dipping or soaking is far more effective than brushing. Not surprisingly, end grain will soak up a good deal of the preservative, while flat grain takes very little.

You don't need to worry about providing weep holes with railroad ties, since their uneven contours allow water to seep right through the wall

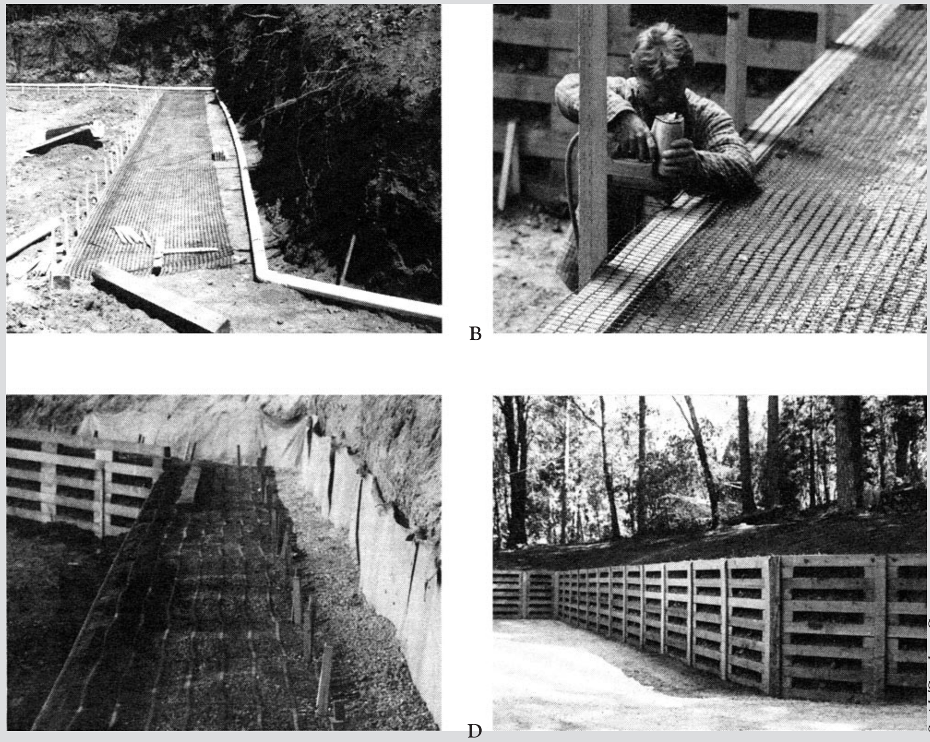
Stacking and nailing. Each timber should be nailed through the top using at least 8-inch-long nails (I use 10-inchers if the wall is over 3 feet high). Hot-dipped galvanized are the longest lasting, although they're a lot harder to drive and bend more than uncoated steel "brights." Three nails per timber is usually sufficient. Predrilling isn't necessary if you use a sledge hammer. Staggering the nail pattern will help keep the tie from splitting.

The 2-foot head of each T is held on with two vertically driven nails, and the tail of the "T" is also spiked into the previous course with two nails.

Finishing off. Stop the tiebacks about two or three courses from the top depending on the finished grade. You may also want to step the ends down to give the wall a softer, less imposing look. And don't forget to grade the soil on top for drainage. In instances where the grade is well above the finished height of the wall, the slope can be brought gradually to wall level and graded for side drainage. Finally, your wall will be complete when it's landscaped as part of a complete picture. ■

Gary Tasker is the owner of Tasker Landscaping in Concord, N.H., and has been building timber retaining walls for nearly 15 years.

Wood Walls With A Hi-Tech Twist



A B C D

Smith/Crockett Co.

The Timberloc system relies on plastic "geogrid" to stabilize the slope. The first timber course (a) is stapled to a 4-foot-wide roll of geogrid material with pneumatically driven stainless-steel staples (b). Next, the geogrid is pretensioned with stakes (c) and is ready for a lift of backfill. The completed 6-foot wall (d) will have plantings in the open sections on the wall's face.

When engineering contractors Smith/Crockett Company were asked to correct a ten-year-old grading and drainage problem on a residence in California's hilly "gold country" last year, they found themselves looking at the usual alternatives: poured concrete, masonry units, and wood crib walls. (These are complete rectangles or "bins" of bolted timbers with all but one face buried in the hillside.) Budget was a factor, but at a little over 6 feet in height with a 2:1 slope behind it, the retaining walls would be taking quite a load.

New Direction

Initially, they settled on 4x5-foot pressure-treated wood cribs because the timbers were the best looking choice for this site, and because they are more durable than concrete or masonry in resisting freeze-thaw cycles. But just before starting construction they got curious about some of the new geotextile fabrics. Geotextiles are synthetic fabrics that can be used to separate backfill materials, promote drainage, or in the case of large weave *geogrids*, reinforce steep slopes (for more on geotextiles, see "Geotextiles and Geocomposites," 3/89).

Their calculations showed that they could retain the same slope as the crib wall by building a timber-faced wall that used a high-strength, polymer geogrid on every other course to reinforce the backfill, stabilizing the hillside.

The idea saved the client about 30% on costs, and reduced the lumber used by nearly 60%. It also gave birth to a product. Smith/Crockett now engineers and builds *Timberloc* walls for other contractors and developers with the experience they've gained. In addition to the obvious savings, they point out the flexibility of this type of construction — it will handle from 4-foot to 40-foot high walls. A recent project used a "finger joint" configuration to create a curved wall with a 22½-foot radius that also carries the weight of traffic.

Geogrid Construction

Although the design conditions of each project determine the actual specs of grid spacing, grid strength, etc., the walls themselves are quite simple to build. Typically a footing isn't necessary, just undisturbed soil. After the first pressure-treated 6x6 timber is set in place, the BX-1200 geogrid is rolled out. It runs to the front edge of the timber and is fastened along the top with pneumatically-driven stainless steel staples. Then it's pulled back toward the hillside (about 4 feet in the case of a 6 foot wall that's retaining a 2:1 slope) and anchored in tension with wood stakes.

Then 12-inch spacer blocks are toenailed on top of the first timber course on 5-foot centers and another full timber course is nailed to the blocks. Once these 12 inches have been backfilled and compacted, another layer of geogrid is rolled out and fastened.

The geogrid is left off the top course and the last two courses are nailed together with 11-inch timber spikes. Pressure-treated 2x6 uprights, fastened with stainless steel nails, are used to contain and hide splices.

Whether a drainage system is necessary with this type of construction depends on soil and groundwater conditions, and even on the kind of backfill used. On the original project, local soil was mixed with the crushed rock aggregate to allow plantings to root in the wall face. This required a drainage system near the rear of the backfilled area. However, when free-draining aggregate is used, the open courses of the wall will typically allow water to weep out. ■

— Paul Spring