

The Structural Stone Wall

Save your mortar for pointing,
bed your stones in concrete, and
remember that there's no substitute for gravity

by Stephen Kennedy

Adams County, in south-central Pennsylvania, has hundreds of stone buildings, most of them built before the days of portland cement. I got started in stonemasonry by pointing up some of these old beauties, and I've always been impressed with the soundness of their stonework. After nearly two centuries, these buildings are still young. The masons who built them couldn't rely on their crude lime mortar to hold stones together. Instead, they used a far stronger glue—gravity. The stonemasonry I do today follows this old-fashioned philosophy, but fortunately I'm able to take advantage of some new materials that weren't available 150 years ago—concrete and pointing mortar.

The trademark of my stonework is spotless pointing. A good pointing job keeps water from getting inside the wall and also provides a consistent background that can really show off the variety of textures, colors and shapes in a rock wall (photos, facing page).

High-quality pointing mortar isn't cheap, but I don't use a lot of it. The jointwork extends only an inch or two into the wall. The rest—the part you can't see—is just stone and concrete. There

are a number of advantages to using concrete instead of mortar to lay up a stone wall. The most obvious is cost: mortar mix is a lot more expensive than concrete, and you'd need quite a few more bags to complete a comparably sized wall. This is because the gravel (technically known as *coarse aggregate*) acts as a filler in the mix, making it go twice as far without sacrificing strength. The large stones still rely on gravity to hold their position in the wall, and the concrete ensures that there will be enough space between stones for me to point later.

With a 5-gal. bucket as a measuring unit, I make and mix the concrete on site. Two buckets of sand, three buckets of gravel, $\frac{3}{8}$ bucket of portland cement and about $\frac{1}{2}$ bucket of water (depending on the moisture content of the sand) yields a large wheelbarrow load of concrete. I mix everything together at once except the gravel, which gets added last. The final bucket of gravel really dries up the mix, and then it's ready to use.

Concrete also gives me greater flexibility in laying up the wall than mortar would. Without the added gravel to hold adjacent stones apart, mortar tends to squish out between joints. With a stiff mix of concrete, I can keep the mix well away from the exposed face of the wall. This leaves room in the joints for my pointing mortar and cuts down the risk of messing up the faces of the stones with squeeze-out. The concrete won't compress with added weight even if it hasn't set, and this allows me to work vertically without worrying about the joints collapsing. Regular mortar mix can't stand up to much compression before it sets, so you have to work horizontally, which isn't always convenient.

The search for stones—To build a structural stone wall you need plenty of stones—about 30 tons for a 2-ft. thick wall 10 ft. high and 10 ft. long. Finding the rocks and getting them to the site is at least half the work. Both your back and your pickup truck will probably suffer for it, too. Fortunately, this is stone country. Mortarless

With the help of fellow mason Paul Qually, the author built the walls of this small house (facing page) in 1977 using locally gathered stone. The best stones for building structural walls have at least two sides that are roughly parallel. Large, square-edged stones that span the full thickness of the wall were saved to build corners that look and work like rough, massive finger joints (facing page, bottom left).

stone walls hastily piled up by earlier generations of farmers crisscross the landscape, so few house sites are bereft of material. This isn't usually enough, though, so I end up looking on mountaintops and through dry washes and stretches of woods for the many elusive "ideal" stones that almost every job demands. I sometimes take out permits to get rocks out of state forests. In fact, when I'm in the middle of a job it's hard for me to drive down the road without scanning the countryside for rocks.

I hardly ever cut or dress my stones because this takes lots of extra time and because it alters the rock's naturally weathered surface. If I find a nice stone that's covered with lichen, I'll often leave the lichen exposed in the finished wall.

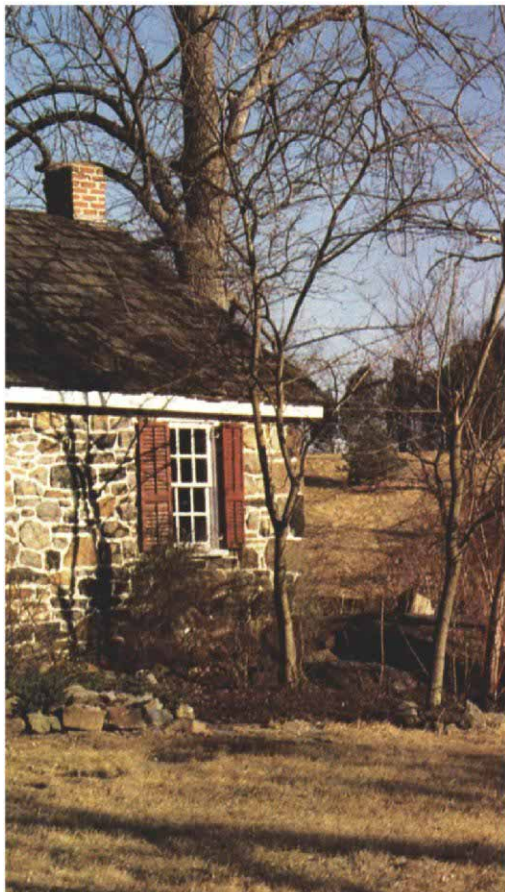
I look for stones that are shaped like large boxes, books, bricks and milk cartons. These and other cubic forms are far easier to stack than bowling balls, footballs, turtles and sausages. On every job I always have a few unusual stones that I want to fit into the wall somehow, but the heart of the wall should be made up of parallel-sided rocks.

Wall construction—The size and construction of the footing, or footer, for a stone wall depends a lot on wall dimensions and local soil conditions. I've dismantled old walls 2 ft. thick that had no footing to speak of. I prefer to foot a stone wall with a stone base, rather than use rebar and poured concrete. This is another method used by early stonemasons, and it's stood the test of time well.

I usually start by digging a trench about 3 ft. wide and 3 ft. deep, and fill it with large rock rubble up to just below grade level. Then I pour a broad concrete cap about 3 in. or 4 in. thick. This is where the visible stonework begins (drawing, p. 67).

Keeping a stone wall plumb is always a challenge. Inevitably, some stones will protrude beyond the plumb line while others will fall slightly short of it. If the average between the proud and shy stones is close to plumb, the wall should be plumb (and look plumb) overall.

I use a plumb bob whenever I can, but sometimes there's no place to hang the bob. An alternative to the plumb line that works well for me is a 6-ft. level upended in a bucket of sand. I often use two or more of these guide sticks, positioning them as close as possible to the work in progress. I usually align the levels with the chalklines on the footer that describe the average wall width I'm aiming for. Eyeballing my



stonework off these verticals is fairly easy, and they're easy to reposition.

The stones for the first course sit in a bed of concrete laid directly on the footer (drawing, facing page). Their exposed faces should fit together with a fairly even space around them. Angular stones should be positioned so the faces slope in, toward the center of the wall. This sometimes creates depressions inside the wall, which I fill with concrete or small rocks. I often have to test-fit a rock, looking under it or lifting it up to see how solid a "print" it makes on its rock and concrete base; then I adjust with more or less concrete and reposition the rock.

I hold the concrete back from the face of the

wall, so that there's room between rocks for pointing. The real structural bearing starts an inch or more back from the wall face.

Vertical joints should be staggered. And it's important to use large stones here and there that span the full thickness of the wall. Large stones are essential structural and visual elements, especially at corners.

I avoid standing narrow rocks on edge in a wall. This often sacrifices the look of a really big stone, or even hides an attractive rock face. But anti-gravity stunts don't hold up over time, even if you glue a shaky stone in place with mortar. The challenge in my kind of work is to create a nice-looking wall that will last for generations.

Pointing—Before I start pointing up the joints between rocks, I hose down the wall thoroughly. This removes loose grit and dust that would prevent the pointing mortar from adhering strongly. Once the wall has dried so that it's damp rather than wet, I can start pointing. I usually buy the best cement and the cleanest, finest sand I can find. This sounds extravagant, but it isn't, because a little pointing mortar goes a long way in my walls—the pointed joint is only one or two inches thick. I use either black or white pointing mortar. For a really white mix, you have to use white sand. A grey mix can be darkened by adding black pigment. On a Trombe wall that I built recently, the north wall face is



The heart of the wall. The ingredients are stones and a very dry, stiff mix of concrete. The stones are gravity fit with overlapping joints. Concrete and small stones are used to fill the voids between larger stones. As the wall is built, the concrete is kept back at least an inch from the face of the wall. This leaves enough space between stones for a thin, strong mix of pointing mortar.



Pointing. A rich, buttery mix of pointing mortar made with fine sand sits well on the trowel and is easy to work. At left, Kennedy uses a pointing trowel to work the mortar into joints between stones. When the mortar starts to dry, he goes over it with a stiff, dry brush, right, smoothing the joint tight against the stones and brushing away small splatters and crumbs. Pointing mortar should be kept damp to prolong its curing time.

pointed with white mortar, while the south-facing joints (photo center right) are black for better solar absorption.

I always use a rich pointing mix: 2 parts fine sand, 1 part cement. This keeps the mortar buttery and generally easy to work; it won't slide off your trowel or out of the joint as easily as a 4-to-1 mix will.

You've also got to keep the mix as dry as possible. I add just enough water to get the mortar past the crumbly stage. This way, I can pack the joint well without having the mortar run down the face of the wall. I load a triangular mason's trowel with a fist-sized blob of mortar, flatten it and then pack it into the joint with any one of several thin pointing trowels (photo facing page, bottom left). The wider the pointing trowel, the better it will hold mortar, but for thinner joints you need skinnier trowels.

The more pointing you do, the less you'll tend to lose mortar off your trowel. A few drips are inevitable, though, and if these land on exposed rock faces, just leave them be. If you can resist the urge to clean up these splatters immediately, you'll avoid staining the face of the wall. Let the misplaced mortar stand until it's very dry, but not hard; then scrape it off with a trowel or stiff-bristled brush. It should fall off like dust.

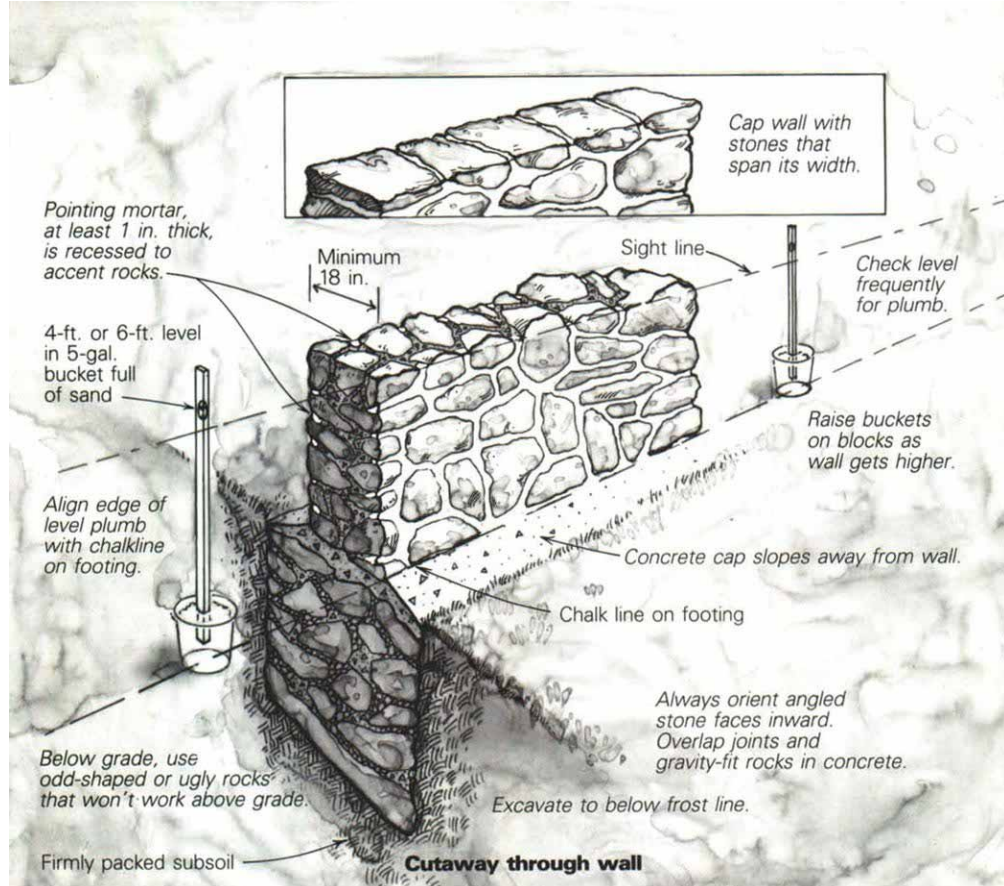
Every so often there's an especially large or broad joint that looks out of place among its narrower neighbors. When this happens, I pack pointing mortar into the space and then push a small face stone into the mud. This fills in the space nicely and eliminates unsightly fat joints in the finished wall. Whenever I insert such non-structural stones, though, I make sure that, they penetrate the full depth of the pointing mortar. Otherwise, they're liable to fall out sometime in the future.

Another way to fill fat joints is with small ornaments. Not all clients like this kind of thing, but a sculptor I built for recently supplied me with quite a nice variety of inserts, including a brass horse, a steel toy truck (photo bottom right) and a small, cast-bronze Mickey Mouse.

Once the mortar is worked into the joint, I don't fuss with its rough texture for about an hour or so. This gives the mud time to harden up slightly. I then scrape it back and smooth it with a pointing trowel. After troweling the mud smooth, I go over each joint with a small (2-in.), dry paintbrush (photo facing page, bottom right). This really tightens the joint against the edges of the stones, and it removes any remaining grit from the mortar.

The next day after pointing, when the mortar is very firm, I give the wall a thorough hosing down. This helps the mortar to cure better by prolonging its drying time. With hose in hand, you can also go over the wall and wire-brush away any stray mortar globs that might have escaped your scrutiny earlier. The second day after pointing, I wet the wall again, this time setting the nozzle to its hardest spray. This is the last chance to brush off excess mortar without having to resort to muriatic acid or sandblasting. Once the pointing mix has cured, what's on the rock will pretty much stay there. □

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Keeping the wall plumb and strong. Instead of a conventional concrete footing, the author frequently fills a trench with a rubble of rock, gravel and concrete. The trench should be excavated twice as wide as the wall to a packed base below the frost line. The rubble footing is topped with a concrete cap 4 in. to 6 in. thick that slopes slightly away from the wall. Stones should be gravity fit with overlapping joints. Some stones will have to protrude slightly beyond the intended width of the wall, while others will set just shy of it. If plumb lines can't be set conveniently, you can work off sightlines established by two or more levels upended in buckets of sand. The levels should be positioned at opposite ends of the wall, vertically aligned with the layout line chalked on the footing.



Skill, patience and a varied selection of shapes and sizes make it possible to accomplish intricate stone joinery without cutting any stones to size. Kennedy built the wall shown above in his own house and pointed the joints with dark mortar. Several stones have a natural lichen mantle that Kennedy decided not to disturb. At left, a toy steel pickup truck is used to fill a large joint that would otherwise stand out badly in the finished wall. Small, non-structural stones can also be used in this way, but they must be pressed firmly in the pointing mortar before it sets.