Preserving a Stone Retaining Wall

BY GERRET WIKOFF

The middle third of a leaning, unreinforced stone retaining wall collapsed during excavation by the homeowner **(1)**.

At the street-adjacent curved section of wall, a steel anchor post was driven into undisturbed soil **(2)**. A come-along attached to the steel anchor and a 4-by wall brace pulled the wall back to plumb. Workers reset the 2x4 angled bracing after plumbing up the wall **(3)**.

Last spring, a returning client asked me about repairing a leaning retaining wall for a large planter in his driveway. (The year before, I had repaired the porch on his late 1920s Storybook-style bungalow home in Los Angeles; see "Repairing a Bungalow Balcony," Feb/21). I suggested if he were to dig the soil out from behind the stone wall, we could add rebar, push it plumb, pump in some concrete to bond it together, and Bob's your uncle. Possessing a shovel and the gumption to use it, the homeowner started excavating behind the wall. A few days into the project, the middle section collapsed; he thought that the clay soil must have been holding it in place, but I suspected otherwise **(1)**.

I investigated the collapsed section and found that it was an unreinforced wall with no rebar connecting the stone to its concrete footing and that the site's expansive clay soil had managed to push the stone wall beyond the edge of its footing. Over the years, the clay soil would get saturated, push the wall a little, and then contract, with the remaining gap eventually filling in; the cycle had repeated itself to the point that the wall had nearly sheared off its footing, particularly in the area where it collapsed.

Complicating any repair efforts, the circa-1920s stone wall had been rebuilt in the 1970s using Portland cement mortar, which was stronger than the stone it held together (the stone broke when we tried to chip the mortar off). The original wall would have been built using lime mortar, which is relatively soft and would have been easy to break apart from the stone. As a result, we needed to reassemble the wall with large, salvaged pieces while I tried to get my hands on similar stone for infill.

I didn't want to attempt to move the wall back onto the footing with a Bobcat and risk further collapse while repairing the wall, so my plan was to rebuild the collapsed portion, then bond the driveway wall in situ to a new, poured-concrete retaining wall, doing an end run around its precarious balancing act.

Caught between codes. The client's house is located in one of Los Angeles' several HPOZs (Historical Preservation Overlay Zones), which in this case translated to "keep the wall as close to original as possible." Working in these zones typically involves submitting plans to the local HPOZ committee for review, then several back-and-forth submissions until the committee's satisfied you are maintaining the integrity of the original structure.

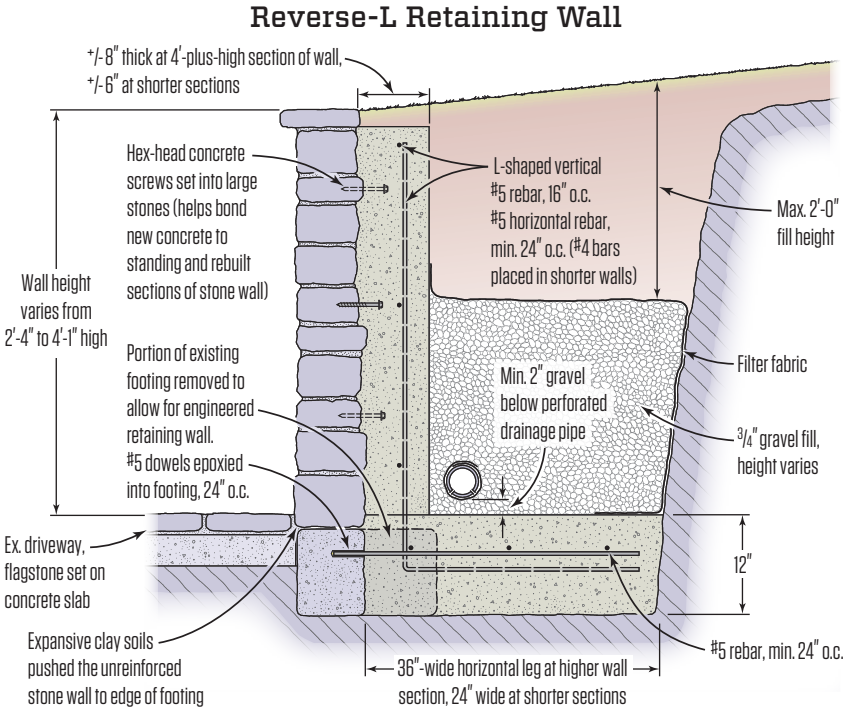
To avoid this potentially long, drawn-out process,

Photos by Gerret Wikoff; illustration by Tim Healey

exacerbated by the pandemic, I proposed to the planning official that we replace the fallen-down portion with salvaged original stones as much as possible, which she approved. But, because a portion of the wall exceeded the Los Angeles Department of Building and Safety's maximum height of 4 feet, the wall required engineering and would need to be approved by the city's building department as well.

The design. The driveway wall was a curved "J" shape and was roughly 30 lineal feet long. Its height varied from 2 feet 4 inches high along the curved section adjacent to the city sidewalk to roughly 4 feet 1 inch high where it butted into the home by the garage doors. The middle third of the wall had partially collapsed while the rest of the wall (the curved, shorter wall at one end and the 4-foot-plus-high section at the other end) remained standing.

Going forward, the only practical way to install a new, poured-concrete retaining wall without tearing up the homeowner's



After the interior side of the standing wall sections were pressure-washed **(4)**, the rebar was placed and the footing was poured using 3,000-psi pea-gravel concrete **(5)**. Horizontal wall rebar was installed, and perforated drainage piping was dry-fit **(6)**. Hex-head concrete screws set into the stones help bond the new concrete to the stone **(7)**.

The collapsed portion of the wall was rebuilt using salvaged and new stone **(8)**. Sheets of 1/4-inch-thick Masonite, 2x4 horizontal blocks, and sandbags were used as wall forms on the shorter curved wall sections **(9)**.

driveway was with a "reverse L" retaining wall. Where I work, the typical retaining wall has the L pointing away from the hill it is retaining. But, with a reverse L, the L shape points toward the hill and its success depends on the weight of the soil pressing down on the horizontal leg of the L to keep the wall from overturning. Therefore, the higher the vertical leg is, the wider the horizontal leg has to be.

Using SketchUp (and its companion program LayOut), I drew up a set of rough plans and had an engineer size the concrete retaining wall and rebar, then tweaked my drawings to conform to the engineering calculations and submitted them to the city. Corrections ensued, due mainly to the evolution in code since the wall was originally constructed; for example, the building department wanted a guardrail on any portions of the retaining wall higher than 30 inches. Here, we had to point out that the job was in the HPOZ, and those corrections were not in compliance with HPOZ regulations (HPOZ officials have a lot of power in maintaining portions of a home visible from the street so they look original, and HPOZ regulations can trump local and state building codes).

RESTORING THE WALL

Permit in hand, my crew and I started in earnest. The first step was to brace the unreinforced stone wall. This was done by making screwed-together 2x4 angled bracing and bolting it down with large Titan concrete screws to the sidewalk and driveway on the outside of the shorter curved wall. We then braced the wall to the interior side with horizontal 2x4s to keep the wall from falling inward. With excavation complete on the short wall, we drove a steel anchor fabricated by a welder into undisturbed soil **(2)**. We used a come-along attached to the steel anchor and a 4-by wall brace to pull the wall back to plumb, then reset the 2x4 angled bracing **(3)**. Because the short wall was broken into two large sections, we forced the second one into position after moving the first.

Given the greater mass of the upper 4-foot-high wall, we braced the wall with 4-by lumber taller than the wall, then sledge-hammered two steel anchors into the soil. Next, we hooked up three come-alongs with chain wrapped around the top of the 4-by wall braces and pulled the wall gradually back to plumb. We then braced the inside of the wall against the soil embankment to keep it locked in place. The next step was to rent a pressure washer and clean the interior side of the standing wall sections of soil and debris **(4)**.

The placement of the rebar was our next priority. In general terms, we used #4 bars (which were easier to bend) horizontally on the shorter curved section and #5 bars on the taller section by the house. We increased the thickness of the concrete wall from 6 inches to 8 inches and widened the horizontal leg of our reverse L from 24 inches wide to 36 inches wide as the wall approached the higher 4-foot section (see illustration, page 25).

The walls were poured without any blow-outs **(10)**. The author's crew finished off the top of the wall, working around the irregularly shaped capstone **(11)**. The completed retaining wall **(12)**.

Because of the wall's wavy shape and the space constraints for formwork, we installed the reverse-L retaining wall in two pours. At the horizontal leg or footing, we epoxied #4 dowels into the existing footing, then ran #4 bars the length of the footing (switching to #5 bar in the straighter, higher section). Using a rebar bender, we bent #5 bars into L-shapes and tie-wired them together.

After obtaining the approval from the inspector, we poured the footing using 3,000-psi pea-gravel concrete **(5)**. I prefer this stronger mix to the standard 2,500-psi concrete minimum prescribed by the city because the additional cost is minimal compared with the benefit. But, since we were essentially rebuilding a retaining wall for a large planter with proper drainage, the additional cost of using an even stronger "big rock" concrete mix with an accompanying larger pump wasn't justified.

With the footing in place, we placed the horizontal rebar and dry-fit the drainage piping **(6)**. The hillside face of the stone was irregular and the new concrete would lock into this toothy surface fairly well. But to improve the bond, we drilled holes into the larger stones and set hex-head concrete screws **(7)** with a battery-powered impact driver.

The next step was to rebuild the fallen-down portion of the wall. I was able to buy a few hundred pounds of similar stones, and we mortared the wall back together with Spec Mix mortar, trying to match the original style as much as possible **(8)**.

Next, we worked on the wall forms. Due to the pandemic, plywood had tripled in cost, so I wanted a cost-effective alternative. This idea, Mickey Mouse as it was, worked surprisingly well: We placed 2x4 vertical ribs approximately 2 feet on-center and braced them with sandbags at the bottom and with 2x4 horizontal blocks to the side of the excavation **(9)**. This was to hold 1/4-inch Masonite in place around the curves. In the 4-foot-tall section, we placed 7/16-inch OSB and braced the forms similarly. We poured the walls without any blow-outs **(10)**, and our crew finished off the top of the wall, working around the irregularly shaped capstone **(11)**.

Finishing up, we installed the drainage piping in a sock, buried it in gravel, wrapped filter fabric, and backfilled. Then we loaded the rest of the soil into a dumpster and hauled it off. With the job complete **(12)**, the Los Angeles city building inspector signed off on it.

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