

REPAIRING A Stone Foundation

by David Rippe

In the early 1900s, the town of Marble, Colo., produced some of the country's finest pure white marble. Its stone went into the Lincoln Memorial, the Tomb of the Unknown Soldier, and other well-known landmarks. But by the Second

World War, the town was in decline, and after a series of floods and landslides destroyed its original business district, it became a virtual ghost town.

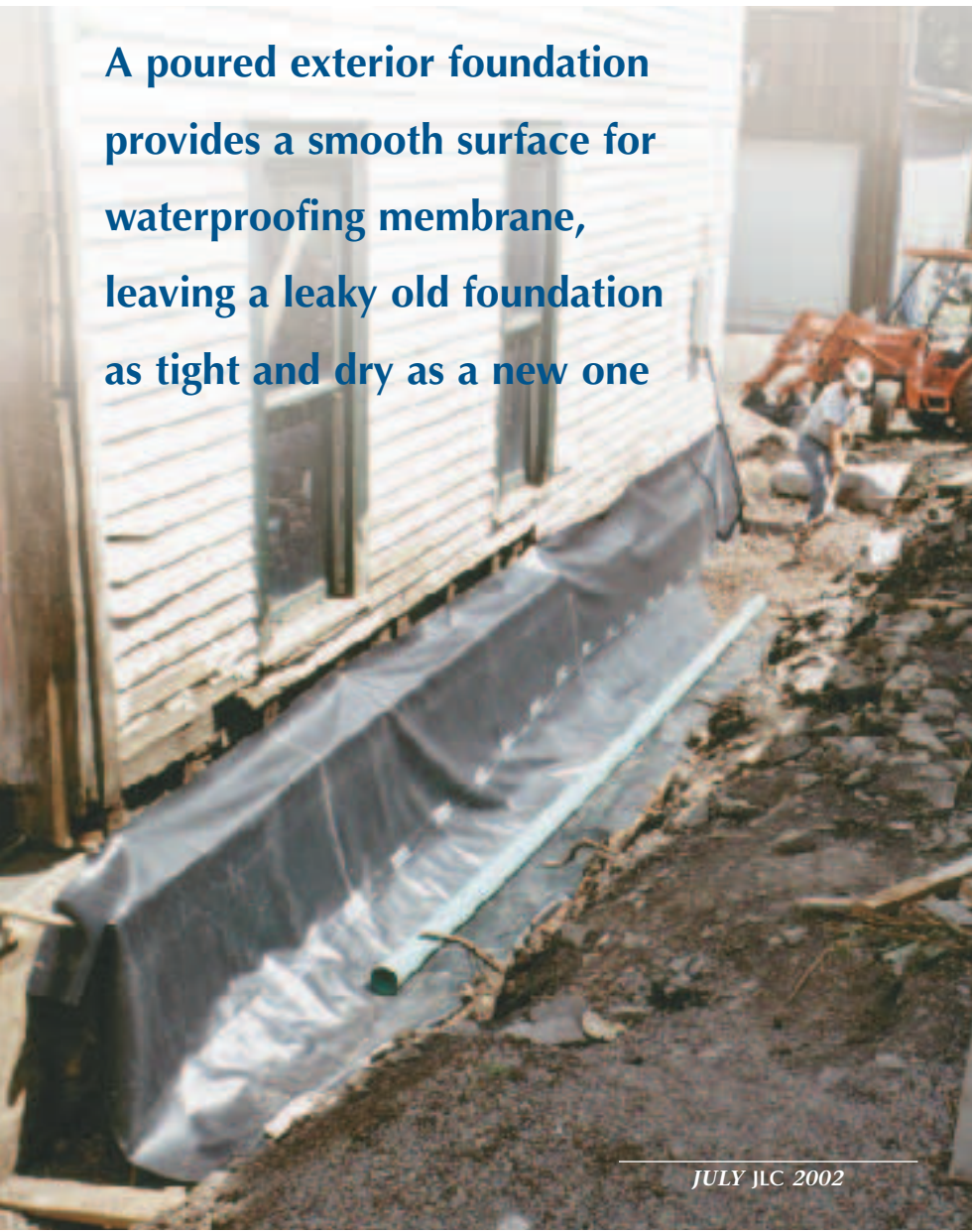
Eventually, Marble revived as an adventurous vacation destination, and, with the help of some grant money from the Colorado Historical Society, the local historical society decided to restore the only surviving commercial structure in town, a small bank. My company, R-3 Construction, which does a lot of historical restoration work, agreed to take on the job.

The Building and the Site

The 20-by-30-foot bank building featured an unusual sort of wooden construction: The exterior walls were made from 4x6 timbers stacked and spiked together in log cabin fashion, probably because skilled carpenters were in short supply, while squared timbers, sawn locally for use in the marble quarries, were cheap and readily available. The balloon-framed interior walls and floor framing were supported by a ledge in the rubble stemwall foundation.

The 2-foot-thick stone foundation seemed to be in reasonably good shape, but because it was built into the slope, the exterior grade in back was much higher than the level of the original floor. As a result, the original floor joists were completely rotted out, as was the flooring itself. Fortunately, the structural stacked-timber wall was in excellent shape. There are no termites at this 8,000-foot altitude, and the local humidity averages around 20% during

A poured exterior foundation provides a smooth surface for waterproofing membrane, leaving a leaky old foundation as tight and dry as a new one



the few months of the year when things aren't frozen. Although water flows everywhere during spring runoff, things tend to dry quickly, which keeps wood rot to a minimum.

Rubble trouble. A few years earlier, we'd restored a nearby historic school building with a rubble foundation much like the one at the bank. In that case, we'd simply excavated around the foundation walls and added a waterproof EPDM liner and drainage system. Our original plan was to approach this job the same way. But once we began excavating, we found that the bank foundation was in worse condition than we'd thought.

Unlike the school foundation, which was smooth on the outside, the below-grade portion of this one had a lot of uneven and protruding stones that would quickly puncture a liner (see Figure 1). The low-quality concrete was deteriorated and crumbling, and although the foundation was supporting the building adequately, we knew we'd have to stabilize it and provide a smooth backing for the liner before we could proceed. After some thought, we worked out a plan to form and pour an external reinforcing wall directly against the existing walls. Regular concrete subs wouldn't touch the job ("You want to do what, now?"), so we decided to go ahead and do it ourselves.

Excavation and Cleanup

The first step was to rip out the remains of the old floor joists and cut away the rotten part of the old wall studs in preparation for a floor slab that would eventually be covered by sleepers and hardwood flooring. The rot was limited to the portion of the studs that extended below the original floor, so once the commercial flatwork sub was finished with the slab — which came to the same height as the old wood floor — we just slipped in a new green-lumber plate at the base of the balloon-framed finish wall. The flatwork sub also formed and poured a new foundation for a



Figure 1. The existing rubble foundation was sitting on well-drained soil and supported the building adequately, but it was far too rough to accept the waterproofing membrane needed to deflect heavy spring runoff.



Figure 2. Wall forms were made from 2x4s and full sheets of $\frac{3}{4}$ -inch plywood. Before they were secured to the wall in preparation for the concrete pour, the forms were leaned back against the side of the trench to help keep dirt out of the excavation while the existing walls were being cleaned.

shed that had originally extended off the back of the building, which we would be replacing. Most of the timbers in the exterior wall were sound, but we cut out and replaced a few rotten sections near the back, where the grade was highest.

Backhoe archaeology. We dug the perimeter trench with the backhoe attachment on our Kubota tractor. Only 6 feet wide, it's ideal for working in close quarters. An archaeologist sent by the state wanted to examine the excavated material for artifacts, so we worked slowly, raking carefully through the soil with the bucket before removing each scoop of material. We'd hoped to turn up

some hidden gold, but we didn't find much besides a few whiskey bottles and a silver-capped vial that still held some sweet-smelling perfume.

Cleaning the stone. To reduce the risk of damaging the wall by hitting large irregular stones, we also made a point of keeping the bucket at least 8 inches away from it. The base of the wall barely extended to the local 40-inch frost line, so we were also careful not to undermine it by going too deep. On the plus side, this meant we didn't have to worry about shoring up the soil face of the excavation. After completing the main trench, we peeled away the last of the dirt from the stone by hand.

Site-Built Forms

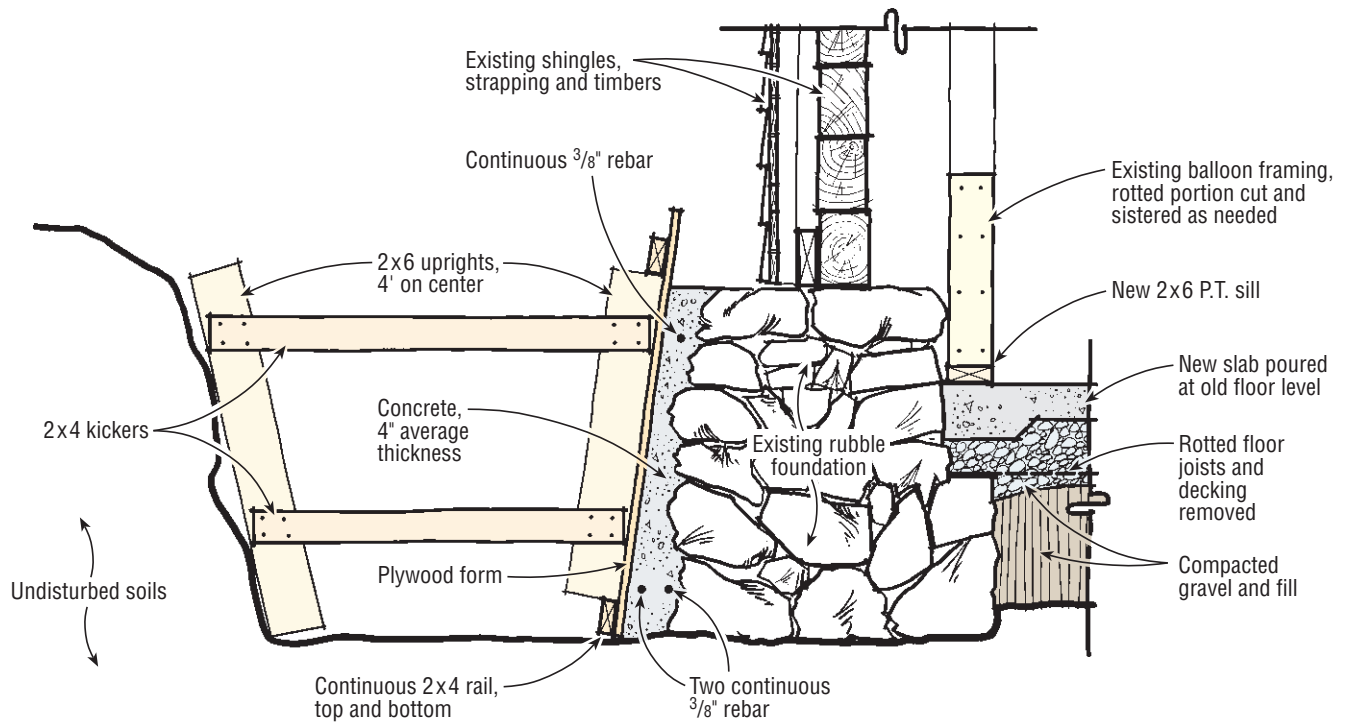


Figure 3. Horizontal kickers secured the plywood forms to uprights pushed against the face of the excavation. The existing rubble wall acted as the inner face of the form.

Once we'd exposed the irregular rubble surface, we cleaned the remaining dirt from the cracks and crevices with pointing tools before blowing them out with compressed air. This involved striking a balance between removing as much dirt and badly deteriorated masonry as possible without compromising the integrity of the wall itself; it was one of the most time-consuming parts of the entire job. It took us a full day to excavate and clean each of the 30-foot side walls. We decided not to reinforce the back wall, which was in much better condition to begin with and would be enclosed by the poured shed foundation. The front foundation wall had been replaced years earlier, so

from here on, we had only the side walls to worry about.

Site-Built Forms

After digging and carefully leveling the bottoms of the trenches, we'd prepared some simple forms by placing full sheets of plywood end to end and connecting them with 16-foot 2x4s scabbed together where they butted. These were temporarily left leaning back against the bank, where they helped prevent soil from spilling into the trench while we gave the stones their final cleaning (Figure 2, previous page).

When the walls were completely clean, we leaned the plywood in

toward the stone to form a slightly tapered wall. We shot for an average wall thickness of about 4 inches, but because the existing foundation wall was so uneven, the forms practically touched the stone in some areas and stood nearly a foot away from it in others. Once we had the plywood in position, we secured it with horizontal 2x4 kickers running between 2x6 uprights screwed to the plywood and other uprights pushed up against the bank on about 4-foot centers (Figure 3). The top edges of the forms were 6 or 8 inches above the level of where the finished pour would be, but there was enough space between the form and the rubble wall for us to reach inside



Figure 4. The new poured wall locked the rubble in place and provided a smooth surface for a waterproofing membrane. A smooth layer of roadbed material in the bottom of the trench helps protect the membrane from punctures.

and snap a chalk line marking the level of the finished pour.

Rebar and bulkheads. For crack control, we placed two strands of $\frac{3}{8}$ -inch rebar at the base of the wall and a single strand at the top. The top of the wall stepped down in several places, and there we formed bulkheads by scribing tapered blocks of 2x8 to fit tightly against the stone and screwing it vertically to the inside of the forms. We used the same method to fit the full-length bulkheads at the ends of the forms. Some dirt packed along the bottom edge of the forms kept the concrete from leaking out.

Pouring the Concrete

We were confident that the thick stone walls could take the pressure of the concrete. They weren't very high to begin with, and the new interior slab would prevent their bases from sliding inward. In contrast to the poor condition of the exterior concrete — which had spent nearly a century underground — the unweathered inner face was in decent shape. In a few areas, where there were cracks or suspicious voids, we did some preliminary patching of the wall from the outside using Sakrete and stones.

Conveyor and pea stone aggregate. Still, we approached the actual pour cautiously. We didn't want to use a pump, because we needed only about



Figure 5. The 40-mil EPDM membrane extends to the top edge of the new shed foundation but overlaps the reinforcing wall, which lies outside the footprint of the building.

$1\frac{1}{2}$ yards of concrete for each side, but we also needed to control the flow carefully to avoid overfilling the forms. Instead, we used a conveyor with a 36-foot reach, which was both cheaper and more accurate than pumping would have been.

We specified a 3,000-psi fiber-mesh concrete with pea gravel aggregate in place of the usual $\frac{1}{2}$ - or $\frac{3}{4}$ -inch stone. That helped the mix flow into the many small voids in the old wall,

which we encouraged by carefully vibrating the concrete throughout the three or four lifts it took to fill the forms. We also tapped the outside of the form with a hammer throughout the pour to encourage the “gravy” to rise to the surface, leaving a nice smooth wall without honeycombing. After placing the final lift, we troweled the top surface to slope away from the building and rounded the outside edge to prevent it from dam-

aging the liner. Twenty-four hours later, we stripped the forms.

Waterproofing, Drainage, and Backfill

Because spring snowmelt exposes the repaired foundation to very heavy runoff, we waterproofed it with a 40-mil EPDM membrane made by Carlisle (800/527-7092, www.carlisle-ccw.com). To prevent the membrane from being damaged by sharp stones, we started by lining the trenches with a smooth layer of what's locally called roadbed material — a mixture of dirt, sand, and fine gravel — sloped gently to the front for drainage (Figure 4, previous page).

After rolling out the 6-foot-wide material, we tacked it temporarily to the siding at the top before cutting, fitting, and cementing it where it joined the poured addition at the back (Figure 5, previous page). Finally, we put down crushed stone, drainage pipe, and filter cloth, topped by dirt from the site.

Flashing. Backfill tends to pull waterproofing membrane down slightly as it settles, so I waited two months before I cut and cemented the flap that covers the top of the new reinforcing wall (Figure 6). I'd originally hoped to cap the foundation with blocks of cut sandstone known locally as farmer stone. In the end, though, the budget couldn't be stretched that far, so we finished up with a cap of 24-gauge galvanized flashing, which was later tucked under the siding.

Even so, this was a very cost-effective project. The total cost of the foundation repair — including forming and pouring the new section of wall in back and pouring the slab —



Figure 6. The topmost edge of the membrane was left loose for two months to allow the backfill to settle (right). After being cut and fitted over stepped sections of the foundation, it was covered by galvanized flashing that was later tucked beneath the siding (below).



came to about \$4,800. That's a fraction of what it would have cost to jack up the building and pour a new foundation from scratch. The rebuilt foundation is every bit as solid and watertight as a new one would have been, while preserving the historic original. 

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