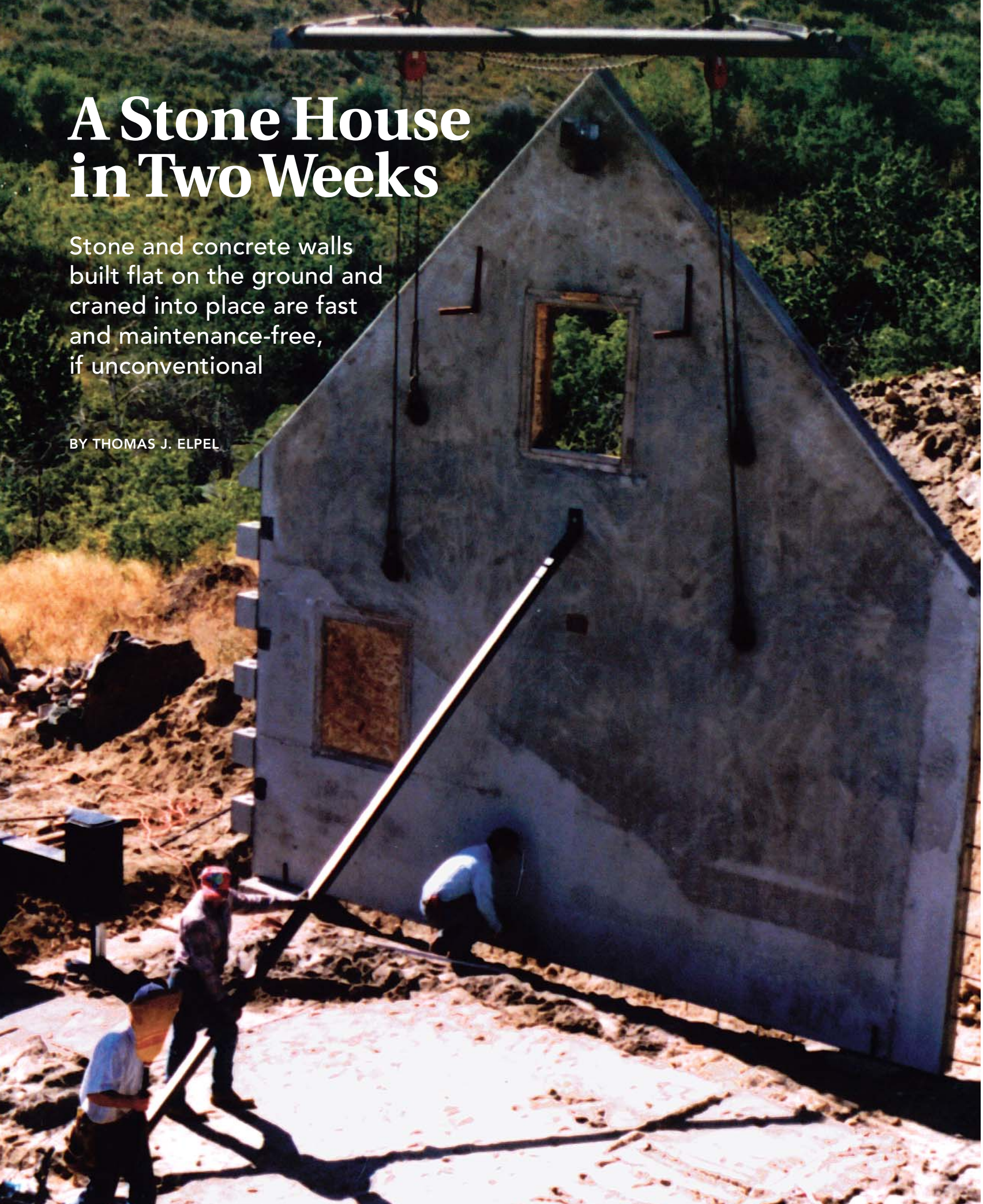


A Stone House in Two Weeks

Stone and concrete walls built flat on the ground and craned into place are fast and maintenance-free, if unconventional

BY THOMAS J. ELPEL

Stonemasonry is the stuff of castles and cathedrals and of houses that have been around for centuries, or will be. Because he'd spent years fixing up old wooden houses, my brother Nick was building a new house in Montana with stone walls. However, he thought there had to be a faster, easier way than laying them up one stone at a time. So he decided to experiment with hybrid walls of stone and concrete. In a nutshell, Nick laid the facing stones of his walls flat on the ground and poured a concrete slab over them; the slab also filled the spaces between the stones to lock them in place (photo top right). Once the concrete set, the assembly was raised into position with a crane (photo facing page). This method is called tilt-up construction, and it's common in commercial projects.

Walls are formed much like a slab

Because the ground is essentially the bottom of the formwork and any irregularity there would show in the finished walls, Nick leveled the area so that it was almost perfectly flat. He then formed the walls with 2x8s, much as if he were forming for a concrete slab (drawing right). Once raised, these walls would have to match up precisely at the corners, so he took extra care leveling the forms and bracing them straight (photo bottom right).

One of the challenges to tilt-up construction is bonding the wall panels to each other at the corners so that they look and function as a single unit. Nick achieved this end in three ways. Steel plates pressed into wet concrete were welded together as soon as the walls were raised. The true bond in Nick's walls, however, comes from interlocking quoins, a concrete version of a woodworker's box joint.

The quoins were formed with 1 in. of clearance between them to provide a little maneuvering room during the lift. This space was filled with mortar once the walls were permanently in place. Oriented strand board was used for the forms to give the quoins a random texture.

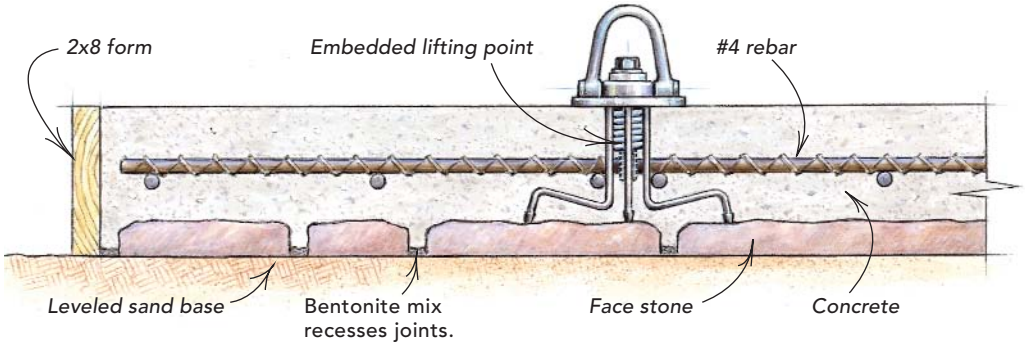
Tying together the corners are 1¼-in. dia. #10 rebar pins grouted into 3-in. dia. holes cast into the concrete (top photo, p. 78). These holes were formed with carefully placed foam cores (Big Sky Insulations; www.bsiinc.com; 800-766-3626), which were drilled out with a spade bit once the forms were stripped.

Clay and sand keep stones clean

Nick used flat fieldstone collected from the local hills. Each stone was placed carefully in

STONE WALLS BUILT FLAT ON THE GROUND

The author's brother needed about two weeks to lay the wall stones on sand leveled in forms and to pour reinforced concrete slabs over them. Once they cured, embedded lifting points (drawing below) were hooked to a crane, and the walls went up. To keep the walls stable, they initially were placed only on concrete pads at the corners, and the footings were poured later.



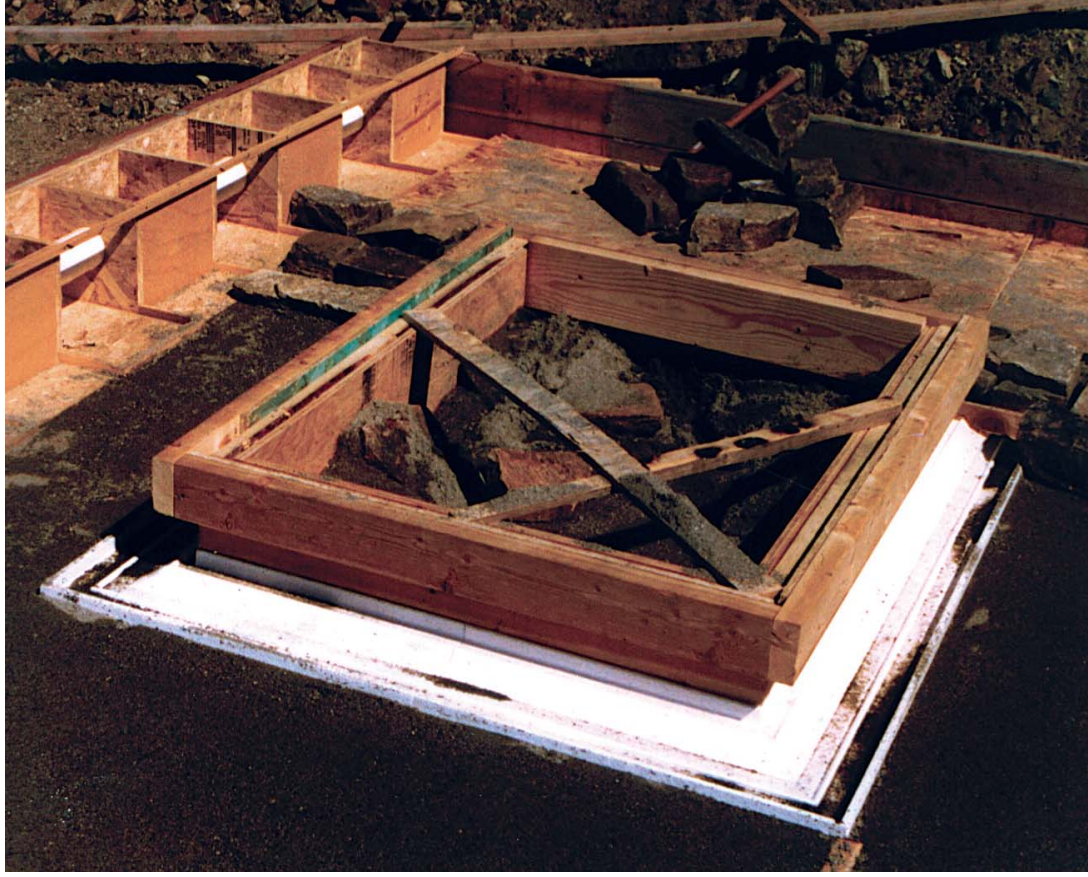
Please, oh please fit together. *Formed to leave 1 in. of wiggle space, the quoins joined up fine on crane day. The wiggle space later was packed solid with mortar.*

Drawing: Don Monnes

the forms, leaving space for mortar joints all around. Although faster than traditional stonemasonry, the process required time to sort through the puzzle pieces to find just the right stones.

To recess the mortar joints and to keep the stone faces clean, Nick sprinkled a mix of 4 parts masonry sand to 1 part bentonite clay powder about ½ in. deep between the rocks. After spreading the sand/bentonite mix, he swept the back of the rocks clean with an air hose and misted everything with a garden hose to dampen the bentonite. Bentonite swells when damp, making a waterproof barrier that mostly prevents the cement slurry from leaking through the joints and staining the rock faces.

Window and door openings also must be included in the formwork. Nick combined wooden frames with foam trim, custom-molded in the negative of the desired pattern (also from Big Sky Insulation), to form these openings (photo right). When the walls were poured, the foam shaped the permanent concrete window trim (inset photo, facing page). The foam was removed in bits and pieces after the walls were lifted and left a beady texture in the concrete. Some type of form-release agent on the foam might have been helpful.



Forming windows and quoins. *Lumber and foam form the window openings, while oriented strand board forms (background, top photo) add texture to the quoins' surface. Foam rod in the quoin forms creates a void for #10 rebar that pins together the corners.*

Steel makes it possible

At 7¾ in. thick, Nick's tilt-up walls are thinner than conventional masonry walls, and they had to be able to handle the stresses of being lifted from horizontal to vertical. Concrete and rebar hold this type of wall together as it is lifted and set in place. Nick used ½-in. rebar spaced 1 ft. apart throughout the walls, supported so that it would end up in the middle of the concrete for maximum strength. Additional, thicker rebar reinforces the areas around windows and doors.

After placing the rebar, Nick embedded the crane's pickup points, or coil inserts (Dayton/Richmond Concrete Accessories; www.daytonrichmond.com; 800-745-3700), as well as inserts for attaching temporary bracing. Dayton/Richmond's *Tilt-Up Construction Handbook* guided the work. Dayton/Richmond also can provide tilt-up consultation services. Because of the unusual stresses involved with tilt-up construction, some help with the engineering is a good idea. Another source for information is the Tilt-Up Concrete Association (www.tilt-up.org).

Pouring the concrete for these walls was like pouring a slab. Nick used six-sack cement for optimal strength, filled the forms and screeded the top. He also vibrated the concrete to be sure voids between the rocks were filled. The concrete had to cure for at least one week before being lifted; it was covered with plastic to ensure the hydration needed for the concrete to reach its design strength.

Nick built the forms, set stones and poured the concrete for four wall panels of the house in about two weeks, working mostly solo. Because Nick's place is built into a hill, he tilted up only three sides of the house. The back wall was formed conventionally and poured later. Rebar from the tilt-up panels extends into the poured-concrete walls.

Footings come later

Bonding the walls to the footing is a challenge in tilt-up construction. A variation in either means that the wall won't sit completely on the footing. Nick's solution to this problem was to pour 2-ft. square concrete pads at the corners to support the walls as they were raised, then later to pour the footings under the raised walls. Rebar protruded out of the concrete pads and the wall panels to bond into the future footings.

It's good when a plan comes together. *A day's crane work raised and fit together the walls. The ridge pole braces the gable ends, and anchor bolts cast into the wall tops are for tying in the roof framing (photo above). The concrete window trim (inset photo) won't ever rot. Rot or fire shouldn't be a problem anywhere outside this masonry house: Even the soffits are stuccoed (bottom photo).*

When pouring the pads, Nick also poured a dead-man anchor in the center of the house, a 30-in. sq. by 2-ft. deep concrete pad. The anchor provided a place to bolt the temporary wall braces.

Raising the walls, or How long has that house been there?

Lifting the walls is clearly the most exciting aspect of building a tilt-up house, both for the builder and for spectators. People may drive by for weeks not knowing what you are up to, but suddenly, massive stone walls are standing as if they've always been there. Lifting the walls is also the most hazardous aspect of the work, so safety was the top priority. The rule of thumb was to avoid passing beneath the raised panel. Any failure in our system for raising the panels could flatten a person like a pancake.

After the cables were bolted to the wall, the lift was mostly crane work with Nick standing at the edge of the panel, guiding it to the layout marks he'd made on the footing pads. Once the panel was on the footing pads, a pry bar could lever it in any direction, as long as the crane was lifting most of the weight.

When the first panel was exactly where it belonged, it was locked in place with braces bolted to anchors in the wall and to the dead-man concrete pad in middle of the floor. Subsequent panels were set in place and welded together at the plates embedded in the concrete. As soon as both gable walls were up, Nick bolted a ridge pole across the house to tie the peaks together (photo above). Next, he inserted the rebar pins at the corners, poured the cores full of concrete grout and filled the corner joints with mortar. Then it was time to go back to pour the footings.

When the panels were raised, their faces appeared messy. The sand and bentonite mixture adheres well, and Nick had to scrape it out of every nook and cranny with a screwdriver. A pressure washer may have been more effective.

The remainder of the house was completed more conventionally. Frame walls to accommodate insulation and utilities were built inside the stone, and the roof was built like any other gable roof. □

Thomas J. Elpel is the author of *Living Homes: Integrated Design & Construction* (HOPS Press, 2001). You can go to www.hollowtop.com for additional information. Photos by the author, except where noted.

continued

Bottom photo this page: J. K. Lawrence

Reader Response

Do you know where the stress is in a concrete wall?

In the December/January issue, your article "A Stone House in Two Weeks" (*FHB* #152, pp. 76-79) might have missed the target when it stated that ½-in. rebar was placed "in the middle of the concrete (wall) for maximum strength." The middle of the wall should be the location of minimum bending stresses.

Plain concrete should be strong enough to resist any compressive forces that might be applied. The reinforcing steel might be needed to resist bending forces. However, any bending stresses would approach zero at the center, or neutral axis, of the concrete with maximum stress occurring at each face of the wall.

—*Alva Hill Rutledge, P. E., Madison, MS*