RAISING THE CEILINGS IN A Whole-House Remodel

Thanks to a good plan, a sizable crew, and a bunch of 20-ton screw jacks, the walls of this house grew taller

by David Morgan

We were three months into a whole-house makeover, installing new windows, doors, exterior trim, roofing, and siding, when the homeowner, a tall man, asked if there was any way we could improve on the low, 7-foot-6-inch ceiling height throughout the house. My first reaction: No way. But the more I thought about it, the more feasible it seemed. We were already installing all-new interior window and exterior door trim, which meant that all the rooms required header adjustments, plaster patching and painting, and so on. The kitchen and baths also were being updated, with new cabinets, fixtures, and finishes. All the carpeting was going to be replaced and the wood floors sanded and refinished. Most of the work involved was already factored into the budget.

It occurred to me that if ever a house was a candidate for increased ceiling height, it was this one, a two-story, 3,800-square-foot garrison colonial. Cutting and extending the hvac ducts seemed simple enough, as did the plumbing — just cut the pipes and solder on extensions. The real issue would be with the wiring, which I knew in many cases crossed over the ceiling between walls above and below. With no code-approved method of splicing wires available, it was obvious that the entire house would have to be rewired.

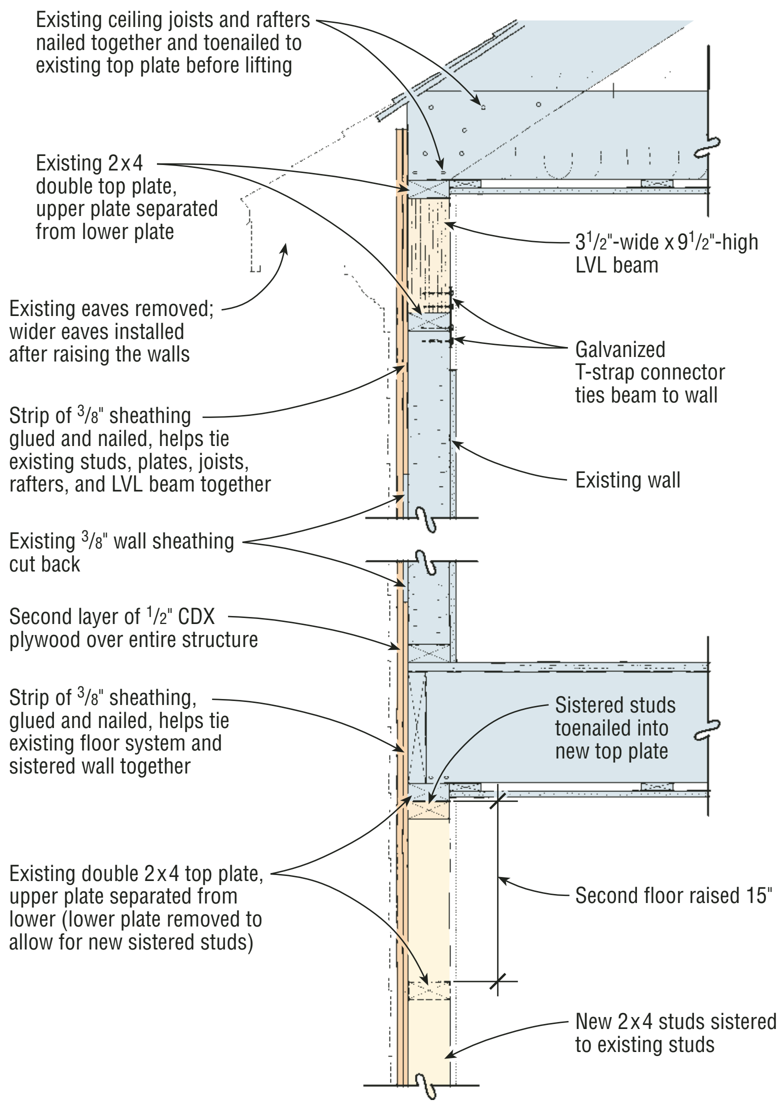

Before

I sought advice from several building movers on lifting the structure, then developed a revised plan and cost for the project that my client accepted. He and his wife had already intended to move out at some point in the original process, but this new plan


After

meant the move would have to happen as soon as possible. We leased two large steel storage containers and placed them on the property to temporarily house the furniture and salvaged fixtures, and within three weeks began to prep the house for the first stage of the vertical stretch — lifting the main roof.

Jacking Up the Ceiling



Preparing to Lift

Raising the ceiling joists and rafters above the second floor of the main part of the house would be simpler than other parts of the process and therefore seemed like a good place to start. There was less weight to consider, assuming a standard dead load of 15 pounds per square foot, and not so great a change in elevation — 9 1/2 inches vs. the 15-inch increase we'd determined for the first-floor ceilings. I chose this specific height increase for two reasons: It was proportionate to the smaller upstairs bedrooms, and it could be accomplished simply, by inserting a 3 1/2-by-9 1/2-inch engineered beam along the entire top plate of the house. Not only would that give us a uniform height, but the LVL (laminated veneer lumber) beam would also help to straighten the tops of the walls, which weren't all that straight to start.

We began by removing a 12-inch-high strip of plaster at the top of all the second-floor walls (see Figure 1, on this page and continued on page 3). We then drove a flat bar between the two 2x4 top plates and cut the nails with a recip saw. This left the ceiling joists, rafters, and top-plate assembly intact, saving time and maintaining structural integrity.

Other prep work included cutting back the framing around the existing large central chimney, which served three fireplaces below. We removed the lead flashing and the original headers, which were embedded in mortar, framed tight to the bricks in the days before codes required chimney clearances. We reframed a new code-compliant opening for the chimney, allowing a minimum 2-inch clearance between the masonry and the headed-off rafters. We planned to lift the roof from underneath the ceiling joists, working from inside the second floor. The 2x8 joists were solidly hand-nailed to the rafters and toenailed to the top plate. They were also strapped with 1x3s on 16-inch centers, a typical framing detail in our region, and still covered with plaster board, making rollovers during lifting highly unlikely. To make sure they'd lift intact with the roof, we reinforced the gable-end walls with diagonal cross-bracing down from the ridge to the wall plates. We set up three rows of 4x10 Douglas fir lifting beams under the ceiling joists — at the front of the house, at midspan parallel to the bearing wall, and at the rear. That way, the roof and joists would remain supported during lifting, similar to the way they were supported in the original structure.

A major concern was making sure that the roof would stay square, plumb, and aligned over the top plates during lifting. If it was not carefully restrained, we could have trouble placing the raised section back where it belonged. We solved the problem by through-bolting 2x4s vertically to the tops of the exterior walls around the entire perimeter of the house (Figure 2, next page). We notched the overhanging

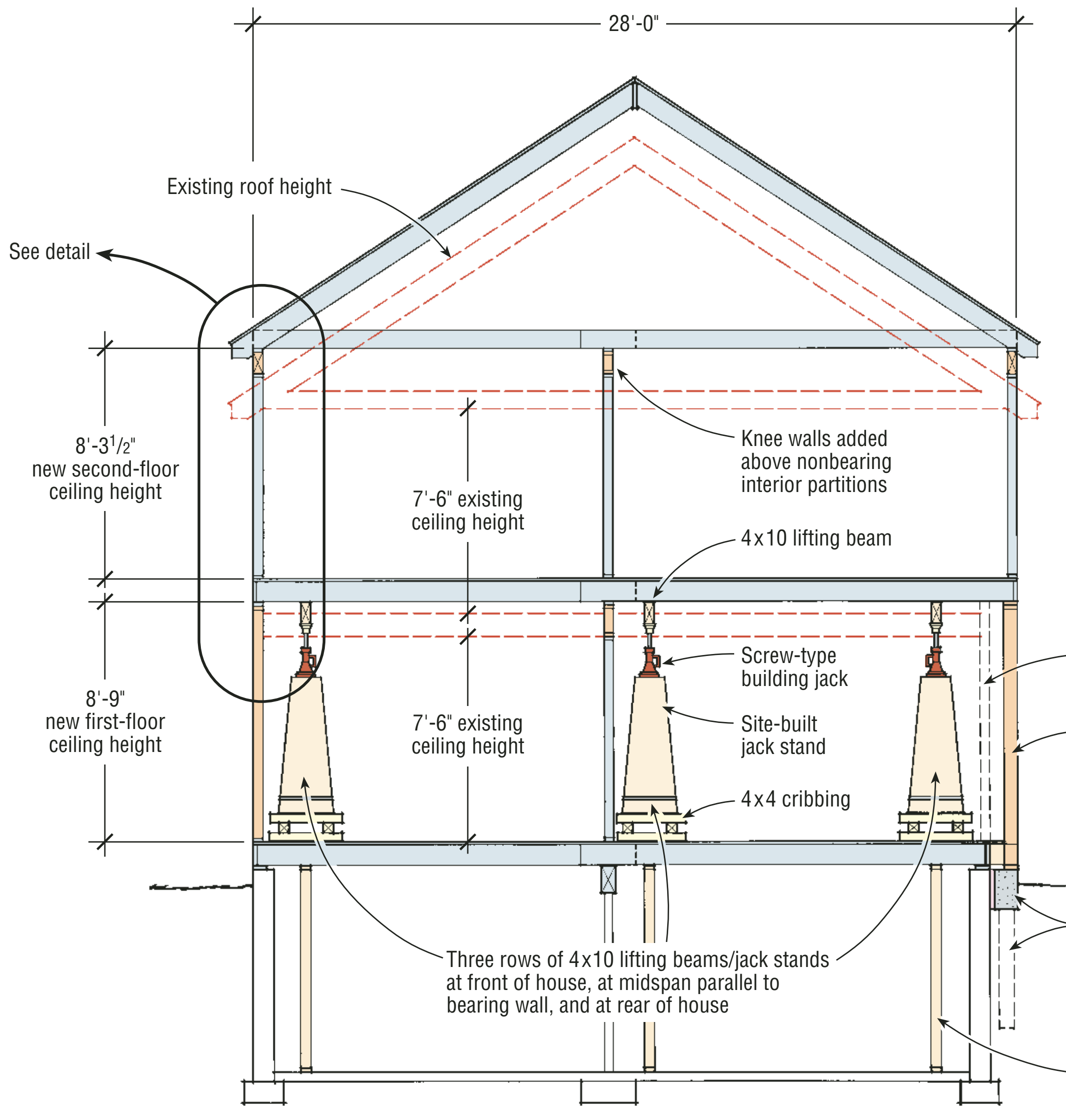


Figure 1. The original 1970s-era structure had low, 7-foot-6-inch ceiling heights and a garrison-style overhanging front elevation. The author split the house along the first- and second-story wall top plates, then raised the ceilings to increase headroom and improve proportion in the interior spaces. The second-floor overhang was converted to a flush bearing wall standing on a new grade-beam foundation.

Figure 2. To maintain the original alignment and prevent the roof structure from shifting during lifting, the author's crew bolted 2x4 vertical struts to the tops of the walls around the house's perimeter.

roof sheathing directly above to provide slots for the 2x4s, so that they'd trap the roof above the walls and keep it from twisting in the wind or wracking out of alignment during the jacking.

The second-floor footprint measured only about 45 by 28 feet, so we were able to handle this part of the work using my own crew, which, including me, numbered seven guys. We had two dozen 20-ton screw jacks on hand for the lift. I bought most of the jacks for this job, thinking they'd be a lot safer than bottle-type hydraulic jacks that could leak fluid and fail in the middle of the lift. I got them for about $129 each from Toolhauz in Needham, Mass., a great independent tool store. The jacks provided a maximum lift of 10 inches, just right for this stage.

The lifting beams consisted of three 16-foot 4x10s each, overlapped at the ends and supported on approximately 7-foot centers by the jacks. This spacing was close to the standard for column spacing under a main floor girt, which is typically calculated for a 40-psf dead load. We'd be lifting less than half that weight.

One of the early issues we had to decide was how to safely extend the reach of the screw jacks to the ceiling joists. My first thought was to place the jacks on the floor and use fir 4x4s or two 2x4s nailed together to prop under the 4x10 lift beams. But that presented a serious problem of stability — it would be easy for a post to kick out suddenly under a load, posing an unacceptable risk. We decided instead to build a quantity of structural pyramidal jack stands whose height could be supplemented as needed by stacking 4x4 cribbing under them. Some stands could serve as dead men, while others served as jack stations (Figure 3).

Figure 3. Site-built pyramidal jacking stands safely extended the screw jacks' reach to just below the lifting beams.

Pyramid stands. We made the stands by cutting 5-foot-long 2x8s at the requisite angle to taper from a 2-foot-square base at the bottom to a 1-foot-square top platform. We wrapped the sides, top, and bottom with $^5/_8$-inch plywood and screwed it with $1^5/_8$-inch galvanized deck screws. As a final precaution, we wrapped a band of perforated, galvanized-steel strapping around the base about 8 inches up from the bottom and screwed through it into the studs with $2^1/_2$-inch galvanized deck screws. In the unlikely event one or more studs failed under load, we figured the band would help keep the base from spreading.

To carry the lifting loads through to the basement floor, we built temporary stud walls on the first floor and in the basement below each jack stand, perpendicular to the floor joists.

Don't blow it. When lifting something as big as a house, you want to keep the wind in mind — the potential for the building to act like a sail could introduce big problems. In researching the job, I spoke with several professional home movers, all of whom emphasized the importance of avoiding

Figure 4. Working in small increments, the seven-man crew slowly raised the roof structure by 9 1/2 inches, allowing the nominal 4x10 engineered LVL plates to be inserted into position on top of the wall.

wind on jacking day. Because it was midsummer, we didn't have to wait long for a windless day. In breezy fall or spring weather, the wait factor could have become a more serious scheduling consideration.

Raising the Plates

With the LVL beams cut and ready for placement, we proceeded with the lift. The screw jacks allowed us to raise the roof in small, controlled increments. We started with three rotations of each screw — about 5/16 inch — across the front, then performed the same step at the middle and at the back. We repeated this sequence until we were able to set the beams on the lower top plate (Figure 4).

Toenailing to the top and bottom of the beam provided a quick and accurate means of aligning the plates, leaving them straighter than they had been originally.

To consolidate the new and the existing framing, we cut back the plywood exterior sheathing about 15 inches down from its top edge and inlaid new, 2-foot-wide sheathing with glue and nails, tying together the existing studs, lower top plate, and LVLs. On the inside, we used 66T T-strap galvanized connecting plates (Simpson Strong-Tie, 800/999-5099, www.strongtie.com) to tie the bottom of the beams to the tops of the walls, which would help prevent the beam from rolling under lateral wind loading or during a seismic event (Figure 5). The connecting plates caught the LVL beam along its bottom edge on 16-inch centers and were nailed into both the wall plate and the studs.

The second lift. Once we had the roof reattached, all the connectors installed, and the exterior plywood replaced, we moved our beams and jacks downstairs. To supplement my own crew of seven, we hired two more framing crews, Brendon Lynch Carpentry and Martel Construction. On the day of the second jacking, we had a total of 14 carpenters on the job.

We would be lifting the entire second floor — walls, roof, and all — a total of 15 inches. We settled on this height because the existing stair risers were a comfortable $7^1/2$ inches each. We decided that one riser wasn't enough and three would be disproportionate to the house. With a 15-inch rise, the new first-floor ceiling height would become about 8 feet 9 inches. Because the stair was more or less centrally located in the house, we had room on the first-floor level to elongate the flight by two treads. The stairwell remained unaltered, but we determined that it was best to build an entirely new staircase rather than supplement the existing one (Figure 6).

Due to the greater load we'd be lifting this time — I allowed for a dead load of 15 psf, multiplied by the second floor and the roof square footage combined, for a total of about 19 tons — and the increased height of the lift, we took some additional preparatory steps and precautions.

First, instead of using 2x4 retainers to prevent the building from moving out of alignment as it rose, we fabricated 7-foot lengths of 4-inch steel angle for that purpose (Figure 7, next page). We drilled holes for $^1/2$-inch through-bolts to pass through the wall, where they would be captured in the same way that sidewall staging brackets are mounted, with the capture

Figure 5. T-straps tie the LVL beam to the original plate at 16-inch intervals, helping to prevent the beam from rolling outward under lateral loads.

Figure 6. Though the staircase would be rebuilt, the original stair helped determine the distance that the first-floor ceilings were raised: two riser heights, or 15 inches.

Figure 7. To prevent the upper story from being displaced when it was lifted, the author installed 4-inch steel angles to restrain it (above). At the over-hanging front elevation (left), the crew cut L-shaped slots for the angles to pass through the second-story floor (below).

blocks spanning pairs of wall studs on the interior side. Instead of costly 10-inch or 12-inch carriage bolts, we bought much more economical 1/2-inch threaded rod and cut it to the lengths we needed.

As yet another precaution, we tied the middle front and middle rear of the building's second-floor joists to the first-floor joists with heavy chains in two places. This backup system would help hold the top and bottom portions of the house together if a sudden wind came up (Figure 8, next page).

New Front Wall

Part of the original remodel design included the elimination of the 1-foot overhang of the second floor at the front of the house. In effect, we were changing the house from a garrison colonial to a more traditional center-entrance colonial. This change actually

Figure 8. As a precaution against sudden strong gusts of wind, the crew tied the front and back of the house to the first story with a pair of heavy chains.

Figure 9. A new grade-beam concrete foundation, poured directly along the existing basement wall, and new wall framing provided direct support to eliminate the overhang of the second-story eaves wall.

simplified the task of raising the first-floor ceiling, because we could precut and build a new, full-height wall to support the joists along the front wall. Elsewhere, at the middle and rear bearing partitions, we'd have to tackle more elaborate, piecemeal framing measures. Stacking short cripple studs or a solid beam on the existing plate would create a potential "hinge" in the wall framing that could buckle during a wind or seismic event, so we chose to sister longer studs alongside the existing ones, instead.

At the front of the house, we poured a new foundation alongside the old one, filling the gap between the old and new walls with 2-inch rigid foam insulation to save on concrete, which we had to place by hand in wheelbarrows in order to protect the existing landscaping (Figure 9).

To further cut down on concrete, we formed the foundation as an 18-inch-high grade beam on top of concrete piers placed every 4 to 5 feet. We reinforced the piers vertically with rerod bent at right angles to join the horizontal rerod we placed in the grade beam.

With the second floor raised, we were able to put the new front wall in place quickly and focus on the rest of the house (Figure 10, next page).

To secure the rear wall and middle bearing partition, we worked piecemeal. We sistered the existing studs with longer ones cut to the new height and toenailed them to a new, double top plate. Above the interior, nonbearing partitions, we simply added small knee walls to extend the tops.

Since the increased height of the first-floor lift exceeded the 10-inch reach of the screw jacks, we purchased

Figure 10. While the front wall went up quickly to support the building at its new height (left), the center and rear partitions had to be revised one stud at a time, by cutting and sistering in full-length studs under a new top plate. Nonbearing interior partitions were elevated with short cripple-wall sections (below).

Figure 11. The screw jacks were limited to a 10-inch lifting range, so the jacking stands had to be supplemented with 4x4 cribbing placed in crosswise layers under the base.

a quantity of 16-foot 4x4s and cut them into 4-foot lengths. We used these as cribbing underneath the pyramid jacking stands. This provided a stable, strong method that could be quickly placed as needed (Figure 11).

To set the cribbing, we used a screw jack on a nearby pyramid to temporarily transfer the load. A pair of crossed 4x4s added 7 inches to the jack-stand height, slightly more than needed to finish the job.

Stitching It All Back Together

The original wall sheathing was in good condition, but it was only $3/8$ inch thick, once a basic sheathing standard. After patching the new gaps with same-thickness material, we ran a new, secondary layer of $1/2$-inch CDX plywood over the entire structure. This allowed us to bridge the existing and new framing with a unifying skin. In all, the structural revisions, including labor and materials, added about $120,000 to the cost of the original contract.

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