by Keith Fitzpatrick

A New Interior in an Antique Building

New I-joist floors solved serious structural problems in this traditional timber-frame home

When I was invited to bid on the complete renovation of a 150-year-old house, I knew the project would pose some major challenges. While the interior needed all-new plumbing, electric, and hvac systems, the real trick would be executing the architect's design: to create a contemporary interior with an open floor plan inside the traditional exterior. Nothing was plumb, level, or square in the old structure, which would make layout and alignment of the aesthetic elements very difficult. In a traditional interior, you can scribe the trim and fudge reveals to hide the defects; in this case, there would be very little trim to work with. The framing would have to be dead on.

Structural Issues

Originally built in the mid-1800s as a boarding school for girls, the house had been converted some 50 or so years later into a private residence (**see Figure 1, page 2**). When my clients purchased the building a couple of years ago, it was in the midst of an extensive but incomplete renovation. Like many old houses, this one had serious structural problems.

The timber-frame building had three oak bents with 8-by-8-inch vertical posts, 8-by-12-inch horizontal beams, and 3¾-by-3¾-inch studs roughly 16 inches on-center in the exterior walls. The floor framing was a mixed bag, especially the first-floor deck, which had a hodgepodge of 2x8 and

2x10 joists feeding into various girders that had been propped up over the years with wood posts. Also, the tops of the walls had bowed out from the weight of the roof and were as much as 2½ inches out of plumb over 9 feet in some areas.

The structural engineer's remedial plan included the addition of several LVLs to reinforce the original beams, new posts in the exterior walls to carry the new point loads, a new center bearing wall in the basement to support bearing walls above, and five 1-inch-diameter steel rods with turnbuckles to tie the building together and prevent the walls from spreading further.

As we demolished the interior finishes and exposed the existing framing, we found that in some places the outside walls had spread so much that the floor joist tenons had slipped out of their mortises. In the second-floor framing, we discovered a 44-foot-long 8x12 oak beam

Figure 1. While the exterior of the 150-year-old timber-frame building was in reasonable condition (above left), the interior was well-worn and already in the midst of renovation when the project began (above and left).

Figure 2. One of the first orders of business was to provide a center bearing wall in the basement. After cutting through the thin slab, the author's crew dug a trench the length of the basement for a new reinforced concrete footing (above). To accommodate the bearing walls for a stairway, the 12-inch-deep by 24-inch-wide footing widens to 5 feet at one end of the basement (right).

Figure 3. The floor framing was removed in sections and interior bracing installed to stabilize the walls; tall posts supported the floor system above (A). Because the original oak sill was rotting (B), the crew placed a new 2x4 pressure-treated sill on the inner portion of the wide foundation, then set a double-LVL rim joist on top to catch the ends of the new I-joists (C). This approach allowed reframing of the floors to proceed in sections (D).

spanning the building from front to back. As part of the last renovation, the ceiling in this area had been furred down flat with metal framing and drywalled, so the engineer didn't know about the beam — which had a 6-inch sag in the center.

Given these serious problems, I wondered whether all the new structural shoring would mesh with the new contemporary interior design, or whether it might be better to remove all the existing floor framing and install new I-joist floor framing throughout. This would give us level, flat floors to work from and make the rest of the finish work much easier, and would also eliminate the five 1-inch steel rods from the design. As long as the cost wasn't prohibitive, the engineer liked my idea, so I met with the homeowners and walked them through both scenarios. The new engineered floor systems would add $6,000 to our $11,000 estimate for the originally proposed structural work — a cost they decided they were willing to live with.

New Floor System

In the basement, the center bearing would include both 4-inch Lally columns and a framed bearing wall. Rather than create individual piers for the columns, we poured a 24-inch-wide by 12-inch-deep reinforced trench footing down the center of the basement (**Figure 2, page 2**). There was no easy access to the basement, so we dug the trench by hand. Luckily, the old basement floor was no more than a thin coating of cement over the dirt, so we could easily cut it up with a demo saw and a diamond blade. Other than hitting some large rocks, digging the footing was easier than expected. We moved the soil directly into a dumpster outside with a rented conveyer belt, and then, after placing the rebar, we placed the concrete using a chute through the basement windows.

Demolition. First, we demolished all of the nonbearing walls. Next we removed as much of the flooring and subflooring as we safely could, to get as much weight as possible off the framing and expose any potentially dangerous conditions. We started on the first floor and worked our way up (**Figure 3**). We removed the

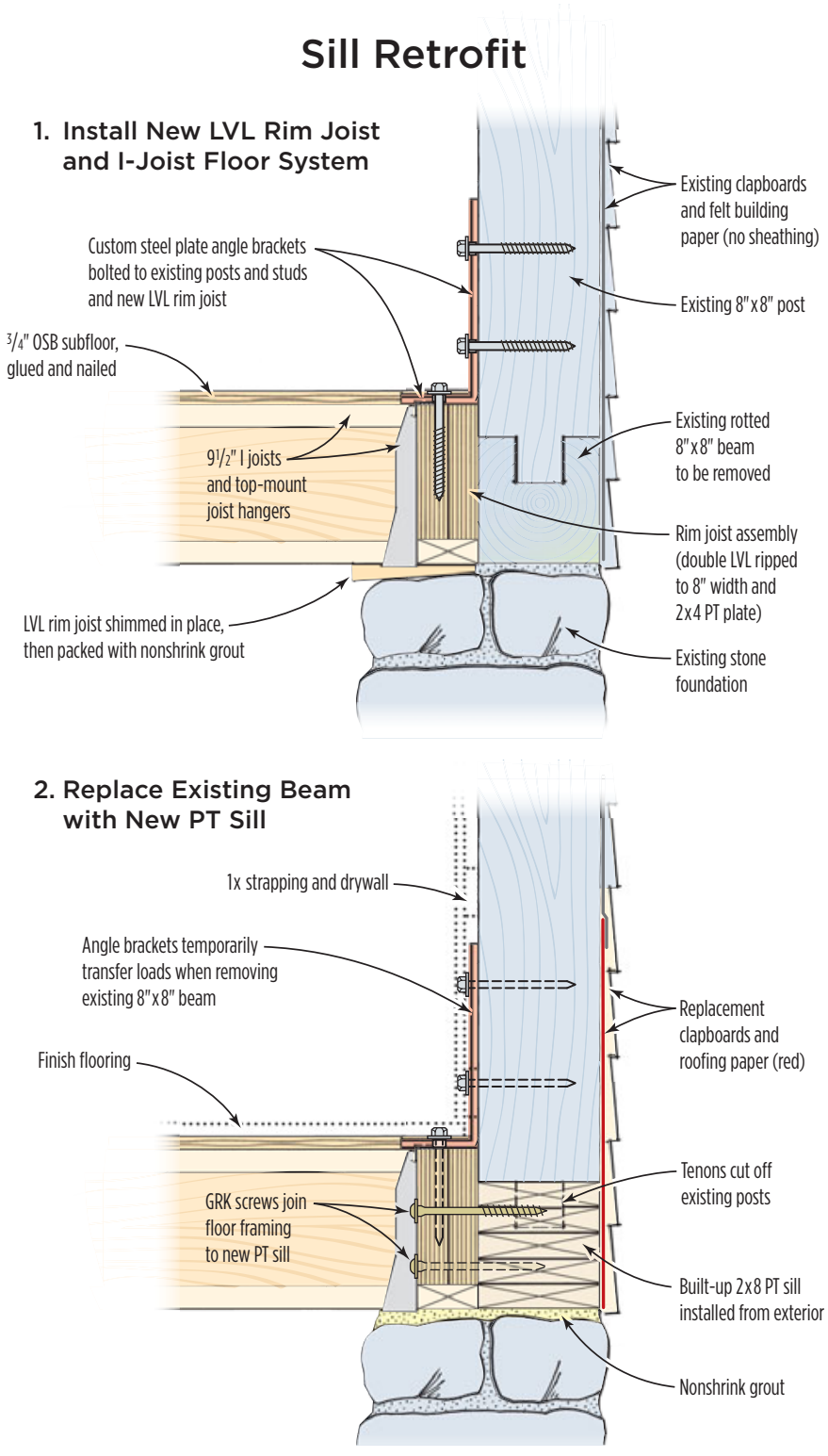

Figure 4. To transfer exterior wall point loads to the new rim joist, the author used custom-fabricated steel angle brackets, lagged into the original timber posts and studs (top). Working from outside, the crew replaced the original rotted timber sills with a built-up pressure-treated sill (above).

floor framing in thirds, starting at the front of the building and working toward the back.

To support the second-floor framing while we tackled the bearing walls, we posted down to the basement floor through holes cut in the flooring. My little 16-inch Husqvarna chain saw got a workout — we went through a half-dozen chains, but it was a lot faster than using a reciprocating saw.

As we removed each floor section, we replaced it with new framing before moving on to the next. Thanks to the trench footing and center bearing walls, the longest joist span was only 14 feet 2 inches, so we used 9 1/2-inch 230 series I-joists from Weyerhaeuser for the first-floor framing. On the second and third floors, we used 11 7/8-inch-deep I-joists so that we could cover existing 10- and 11-inch-deep beams without interrupting the ceiling plane.

LVL rim joists. Our initial plan was to hang the I-joists from LVL rim joists bolted to the 8x8 oak sill beams around the perimeter. But on discovering that many of the sills were rotting and would have to be replaced, we decided instead to hang the joists from a doubled LVL beam attached to a 2x4 PT plate sitting on top of the foundation wall inside the rotten sills. This way we could continue replacing the floor framing and replace the existing sill later, working from outside. We leveled the LVL band-joist assemblies with a laser, temporarily shimmed them in, then packed nonshrink grout in the voids.

The sills along the covered porches were still in good shape, so there we bolted a single 9 1/2-inch LVL to the existing oak beams using 3/8-inch-by-7 1/4-inch GRK lag screws placed 24 inches on-center in a staggered pattern. Not only are GRK lag screws stronger than conventional lags,

Figure 5. Diagonal braces prevented the exterior walls from spreading as the floors were reframed, a section at a time (above). Meanwhile, carpenters removed the bottom clapboard courses and replaced the rotted sills (above right). After the exterior walls were insulated with closed-cell foam, the author strapped them with 1X2s, shimming or notching as needed to remove the worst irregularities (right).

but they install much faster because they don't need to be predrilled and can be driven with a corded drill driver.

We needed to transfer vertical post loads from the old sill beam to our new double-LVL rim joist. So we had a local shop fabricate custom angle brackets from 1/2-inch steel plate. The horizontal flanges of the plates bear on top of the doubled LVL rim joist, while the vertical legs are bolted to the timbers with 1/2-inch lag bolts (**Figure 4, page 4**).

I-joists. Once the new LVL rims were in place, we set the first third of the center girder on top of Lally columns, installed Simpson ITS 9.5/2.37 top-mount joist hangers, and started hanging the joists. These hangers are a little tricky because both sides of the joist must come down evenly to get the teeth on the bottom of the hanger to grab the bottom flange of the joist correctly. And once the joist is in place, it can be very difficult to remove if there are problems with the layout.

Bracing. After gluing and nailing down the 3/4-inch OSB subfloor on the first section of the floor, we nailed diagonal bracing down from the outside walls to the new first-floor deck and started working on the next section.

Once we'd completed the first-floor deck and securely braced the walls, we felt it was safe to remove and reframe the second floor, again working in sections. Here we were able to simply bolt the LVLs to the beam at the top of the first-floor walls. The 11 7/8-inch-wide LVLs were almost an inch taller than the existing beams, which were only slightly out of level, so we were able to install the new rim joists perfectly level while still covering the entire beam.

Sill Replacement

After completing the new interior framing, we tackled the existing sill replacement from the outside (**Figure 5**). The building had no sheathing, so to expose the sills, we only had to strip the bottom five courses of clapboards and cut the heavy building paper. We removed the oak sill in 12-foot sections, replacing it with a built-up sill made from five layers of pressure-treated 2x8s.

The studs had been mortised into the

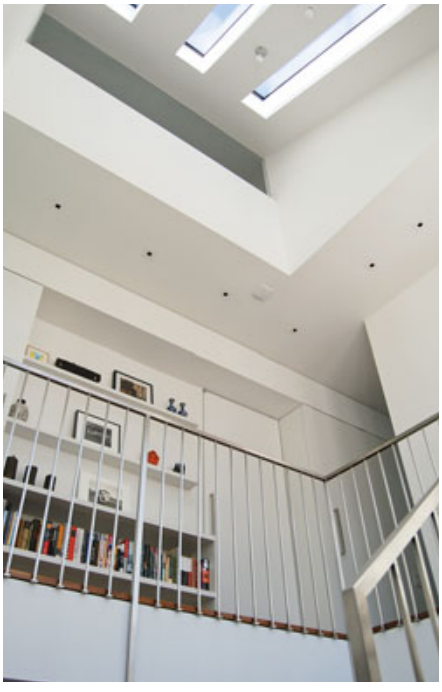

Figure 6. A bay of tall windows on one side is the only clue from outside that the vintage home has a stylish contemporary interior.

top of the old sill, so we had to cut the tenons off before installing the new sill. We toenailed the bottom of the studs into the sill, and where the sections of our new sill joined we lapped the top layer over the section before it. After packing voids between the new sill and the top of the foundation wall with nonshrink grout, we stapled up 30-pound roofing paper and re-sided. Finally, we drove GRK screws through the LVLs into the new sill beam from the inside to join the floor framing to the new PT sill.

The new floors were stiff and level, and the new interior wall framing followed suit. This made the finish work much easier, since there are no dropped headers in the ceilings and very little scribing was needed. While packaged in a traditional-looking exterior, the resulting interior space has an open and modern look that would have been hard to achieve if we had tried to make do with the original floor framing (**Figure 6**).

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