Deep Structural Retrofit

Rotted framing called for a complete rework of the load path

BY JAKE LEWANDOWSKI

Our company, which specializes in structural repairs, was recently called to an expensive residence outside of Chicago. A number of contractors had been to this house to bid on replacing a large wrap-around deck, but they had concerns; extensive rot of the ledger board signaled deeper structural problems that exceeded their expertise. Our inspection revealed numerous places where poor flashing had led to extensive water intrusion problems. The worst was at the base of large banks of windows on the A-frame-style wing that the deck wrapped around. Water running off the large expanses of glass had leaked for years through the base of the window walls, jeopardizing not just the deck ledger but the entire floor-system supports, which served to tie together the A-frame rafters. The house was on a hill and exposed, resulting in significant lateral wind loads on the steep roof, so a rotting floor system put this entire A-frame at risk of collapse.

The original structure appeared to be built with clad, heavy timber rafters that continued past the roof overhang and tied into a clad, horizontal timber beam, which completed a triangle. After we removed the cladding from the rafters, though, we discovered they were constructed from two roughly 3-by-14-inch boards sandwiching a 1/2-inch steel flitch plate welded to a flitch plate in the horizontal member. The floor system sat above this horizontal beam. This design may have worked while the wood framing was sound, but

Photos by Jake Lewandowski

This photo **(1)** shows the deck wrapping the A-frame-style wing of the house during the initial investigation by the author's company. Excavation in preparation for drilling helical piers was done by hand to carefully work around utilities **(2, 3, 4,)**. A lumber extension attached to a rafter revealed that a waste line was in the exact location where a pier needed to be drilled **(5)**.

once the wood rotted out, the integrity of the bolted assembly was severely compromised. Rather than try to reproduce this triangular load path, we worked with our engineer on a repair that redefined the load path: By driving helical piers at the same angle as the slope of the roof, the thrust of the rafters would be supported in-line with the rafters. We also supported the floor system with laminated veneer lumber (LVL) beams and completely reframed the supporting walls to create a robust structure with redundant support paths.

Given the tenuous condition of the existing structure and the possibility of the roof spreading as we unraveled the load path, we had to thoroughly shore up the home during the repair. This involved shoring under the entire A-frame floor, as well as erecting shoring towers on the right and left flanks of the A-frame where the main house roof extended over the deck. We also installed a temporary LVL beam across the face of the windows at the base of the triangular gable end.

Like many jobs on existing homes, our repair work touched a lot of the building systems. As seen in the photos above, several of the initial excavations for the helical piers had cable and electric lines crossing them, and one had a waste line that was directly in the path of the helical pier. A section of this pipe had to be removed to set the pier and then replaced once the pier was installed.

The photos that follow show the crucial steps we took to complete the repair and reframe the enclosure. Our work will be followed by several contractors: One will remove all the windows and the remainder of the existing cladding and replace them with a modern WRB, new flashing, new insulated glass units, and new cladding; and a deck builder will rebuild the wrap-around deck.

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After protecting the floor below the A-frame wing, subcontractors from the window company removed the lower windows **(6)**, and shoring was erected to support the floor during demolition **(7)**. Additional shoring was erected to the left and right of the A-frame gable end to support the roof extending over the deck (shown in photo **10** below).

A worker stripped the trim off the face of the gable end to expose bolts holding an existing flitch plate that was spliced into the end of an outermost rafter **(8)**. The author used a plywood template to position a Forstner bit while drilling countersunk holes for larger bolts **(9)**. All the bolts holding the flitch beam were replaced and additional bolts added, per the engineer's specifications. Photo **10**, below, shows the temporary LVL beam installed to prevent the roof from spreading during the repair work.

Two-by lumber extensions (nailed in an "L" shape to keep them straight and stiff) projected the line of the rafters to guide the installation of the helical piers, which were drilled at the same angle as the pitch of the roof **(10, 11, 12)**. A total of four helical piers were drilled, two on each side of the A-frame gable.

These end caps **(13)** were fabricated for the ends of the helical piers. The author's crew were then able to connect steel columns that spliced onto the existing flitch plates at the rafter ends. Each end cap was field welded **(14)** to the end of a helical pier, once the pier had been firmly driven into place.

A strong field weld requires clean surfaces free from rust and paint, so a worker grinds the surface of an existing flitch plate **(15)** in preparation for welding on the HSS diagonal columns. Note the slots fabricated at one end of the columns **(16)**. These allow the column to slip onto the flitch plate; the column will then be cut to length and welded to the cap.

Here **(20)**, the bottom end of the diagonal column has been cut to length and welded to the end cap on the pier. At top, it is being welded to the flitch steel at the end of a rafter. After the diagonal columns were firmly in place, the bottom ends of the columns and the end caps were coated with a rust-inhibiting paint **(21)**.


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After removing the rotted ledger and grinding off the corroded bolts, the author made the first cut **(22)** to sever the connection between the flitch plate spliced into the rafters and the plate sandwiched between the ledger and the rim joist. The flitch plates running along the bottom of the gable end were cut and removed in sections **(23, 24)**.

As the crew stripped away the layers, they discovered how deteriorated the rim joist was. Shoring was added to support the temporary LVL spanning the gable end, and a new LVL beam supporting a new rim joist was installed **(25, 26)**.


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To support the new floor beam, the concrete slab had to be repaired and a new framing sill installed **(27)**. New joist hangers were installed to support the floor joists **(28)**, along with new PSL columns to support the new beam **(29)**.


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The author planed 2x10 stock **(30)** to pack out the space between the new rim joist and the face of the new beam. (One piece of this planed material can be seen installed on the left-hand side of photo **31**.) It was much quicker and neater to plane down this material than it would have been to cut back all the floor joists to reposition the rim joist in relation to the windows.


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A new LVL was installed to support the windows on the right and left of the gable end **(32)**. Once the deteriorated, let-in columns supporting this part of the floor system were removed, the foundation had to be repaired with non-shrink grout **(33)**, and new, built-up PSL columns installed **(34)**.


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A view of the new LVL beams and PSL columns on an outside corner **(35)**. The complete structure **(36)**; all that remained were short walls between the columns to support new windows, and Zip System sheathing to protect the new framing **(37)**.