# Securing Rainscreen Siding

## Test results show how to install clapboards and strapping over exterior foam

by Zeno Martin, P.E.

As houses get tighter and energy codes stricter, it has become increasingly common for builders to apply one or more layers of rigid foam to the outside of wood-framed shells, then install horizontal siding over vertical strapping. The method adds R-value to the walls, cuts thermal conduction through the framing, and when done carefully, creates a flashed drainage space for any water that makes it through the cladding layer. The technique's been covered in several *JLC* articles over the past few years; after reading "Building a High-Performance Shell" (5/10), my colleagues and I decided to test the strength of the connection between the strapping and the framing — especially given the fact that the fastener is being driven through several inches of foam, which acts essentially the same as an air gap.

### Test Procedure

Using our hydraulic testing equipment, we set up an experiment to measure the real performance of the type of assembly seen in the *JLC* article. Our test specimens consisted of a No. 2 Douglas fir 2x6 stud, 7/16-inch OSB attached to the stud with three 10d nails (.148-inch diameter), two layers of 2-inch foil-faced polyisocyanurate foam insulation glued to each other and to the OSB with construction adhesive, and 1x3 No. 2 hem-fir strapping secured through the foam with two 7-inch-long FastenMaster HeadLok screws spaced 16 inches on-center. We predrilled the screw holes to avoid splitting the strapping, and aligned the foam and strapping layers so that we could observe the displacement as the hydraulic ram pushed down on top of the strapping.

We loaded each sample assembly to determine its maximum load-carrying capacity, and used a dial indicator at the base of the strapping to measure displacement while capturing the progress with a digital video camera. Matching the data from the computer-controlled hydraulic ram and the real-time video log, we were able to accurately determine the "yield" point of the fasteners — the load at which the steel develops a permanent bend. As the table below shows, the yield loads are much smaller than the maximum loads at failure.

Displacement of the strapping against the dial indicator was typically greater than 2 inches at the maximum load capacity. The displacement at the yield point, however, was quite small — a few hundredths of an inch.

## Analyzing the Results

Next, we compared our test results against "predicted," or calculated, results based on formulas found in *Technical Report 12 (TR12)* from the American Forest & Paper Association, which is used to design wood structural connections that rely on steel fasteners. Our average tested yield value per fastener was 46 pounds. Calculations using *TR12* methods, which allowed us to account for the 4-inch

**Test Results**

| Sample | Yield load (lb.) | Max. load (lb.) |
|---|---|---|
| 1 | 95 | -- |
| 2 | 66 | 1,106 |
| 3 | 71 | 2,086 |
| 4 | 91 | 1,182 |
| 5 | 106 | 1,576 |
| 6 | 91 | 1,222 |
| 7 | 111 | 1,364 |
| 8 | 131 | 1,636 |
| 9 | 76 | 1,566 |
| 10 | 106 | 2,060 |
| 11 | 76 | 1,222 |
| Sample average | 93 | 1,502 |
| Avg. per fastener | 46 | 751 |

The test assembly was a sturdy shop-built frame securely attached to the concrete floor with metal hold-downs and concrete anchors (top left). A hydraulic ram secured to a cross-member provided the measured force. The wall-assembly samples were clamped in place to resist movement as the piston bore down on top of the strapping; a dial indicator on the floor (far left) measured the strapping's displacement as a video camera (visible in top photo) recorded the movement of the dial. The testers then used the real-time data to calculate the yield point of the tested fasteners (chart, left). The average per fastener is half the sample average because each assembly had two fasteners.

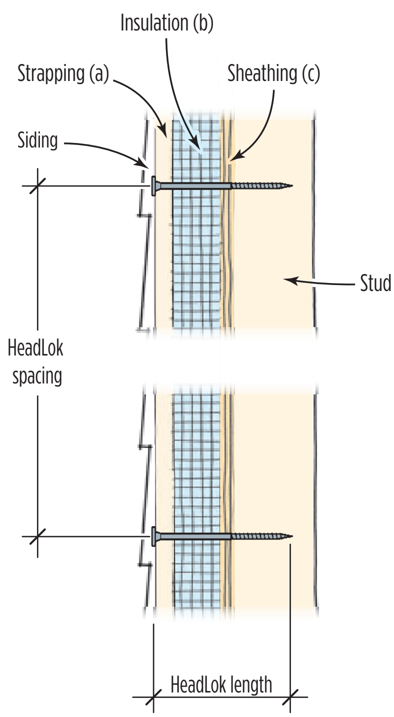
This sample is in position to be tested, with the head of the screw just proud of the strapping surface (left). As the force is applied, well beyond the yield point, the strapping begins to pull through as the screw rotates slightly (center). At maximum load, the head has pulled halfway through the strapping (right).


The strapping in this sample (far left) has crushed the foam, which offers little resistance. Note that the tops of the two layers of foam were flush at the start. In another test (near left), the wood has split and the fastener rotated at maximum load.

FastenMaster uses a high-strength steel for its fasteners, evidenced by the near perfect condition of many of the screws in the test (far left). On a few occasions when the strapping did not split or pull through, the screw showed only a slight bend (near left).

## Fastener Schedule for Attaching Strapping Over Exterior Foam Insulation for Wood, Vinyl, and Fiber-Cement Siding[1]

| Strapping[2] thickness (a), inches | 0.75 | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Insulation thickness (b), inches | 2 | | | | 4 | | | |
| Sheathing thickness (c), inches | 0.375 to 0.625 | | | | 0.375 to 0.625 | | | |
| HeadLok length, inches | 6 | | | | 7 | | | |
| Siding type | Wood/vinyl[3] | | Fiber cement[4] | | Wood/vinyl[3] | | Fiber cement[4] | |
| Stud spacing, inches o.c. | 16 | 24 | 16 | 24 | 16 | 24 | 16 | 24 |
| Calculated HeadLok spacing, inches[5] | 86 | 62 | 48 | 33 | 50 | 35 | 28 | 19 |




### Footnotes

1. Gravity loads only; wind and seismic not considered.
2. Strapping assumed to have specific gravity of 0.36. Denser lumber species would be permitted.
3. Wood/vinyl siding plus strapping assumed to weigh 1.5 psf.
4. Fiber-cement board plus strapping assumed to weigh 3.0 psf.
5. Calculations based on *TR12* (AF&PA), assuming SPF studs (specific gravity 0.42), and additional safety factors applied as noted in article. Denser lumber would be permitted.

"air" gap, gave a predicted yield of 53 pounds. (We also ran the numbers, per *TR12,* for a connection with no insulation gap at all, and the yield rose by a factor of six, to 321 pounds.)

Since the calculated value was reasonably close to our tested values, we used *TR12* to create the HeadLok schedule above. We applied the *TR12* safety factor of 2.2 for design values, the load duration adjustments for dead load, and an additional safety factor of 2. We added the extra safety factor for several reasons. One, we wanted to account for possible installation variables, given that carpenters are having to blindly screw through several inches of material in order to hit the studs. Not every screw will be dead center. Second, we wanted to account for creep — the tendency for installed materials to deform slowly over time. And finally we wanted to err on the side of caution, especially given that FastenMaster, the maker of HeadLok screws, has published a much more conservative schedule (see *Technical Evaluation Report 1009-01* at fastenmaster.com).

When using the schedule, keep in mind that it does not address seismic or wind loads — only the gravity loads from the weight of the assembly itself.

*__Zeno Martin,__ P.E., S.E., is a senior associate with Wiss, Janney, Elstner Associates in Seattle, Wash.*