

Strengthening Residential Roof Assemblies: Liquid Adhesive Field Trial



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Submitted by:



Newport Partners LLC.

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Introduction

Home owners, insurance industry groups, and the federal, state, and local governments are all evaluating methods to increase a home's ability to withstand hurricane forces winds and reduce property damage/loss. This case study is part of a two-part series on field trials which gathered information on the process of roofing a new home using liquid adhesives and adhesive tape (in additional to traditional nailing) to fortify the roof assembly. Information on the application process, constructability issues, impacts on other building systems, and stakeholder perceptions were gathered by documenting the construction process and conducting pre- and post-interviews with each construction crew.

The field trials and case study development were supported by the Adhesive and Sealant Council and the U.S. Department of Housing and Urban Development's Partnership for Advancing Technology in Housing (PATH) program. The Adhesive and Sealant Council is a trade association representing manufacturers and suppliers in the adhesive and sealant industry. The PATH program is a public-private partnership of leading-edge home builders, manufacturers, researchers, professional groups, and federal agencies concerned with housing. By working together, PATH partners improve the quality and affordability of today's new and existing homes, and help to create the next generation of housing for America's families.

This particular case study focuses on the application of liquid adhesives to a new residential roof assembly. The field observations were conducted by Newport Partners LLC, a research firm specializing in construction technologies, codes, and market research.

Special thanks go to Wise Choice Construction and Chad Garner, for allowing us to document their work, and Bostik Inc, for supplying the construction adhesive.

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Liquid Adhesive Field Trial

Newport Partners conducted two field trials in which roofers used liquid adhesives on the framing-to-sheathing connections of a new residential roof system. One project was on a new single-family detached home under construction, and the other was on an addition to a single-family home. The objective of these trials was to document constructability issues and gather insights from the roofing contractors when applying adhesives on roof assemblies. This report summarizes the findings from both field trials.

Overview

New Construction

The new house under construction was a fairly large (~3,200 sf) single-family structure with a multi-plane roof line (Picture 1). While its size and roof line complexity are beyond average houses, many new houses built in the U.S. would have similar characteristics.



Picture 1: New construction home.

The new home used 19/32" plywood roof sheathing panels, which were lifted up to the roof in small batches with a "Sky Genie". Once the panels were lifted up to the roof, they were manually transferred to a storage point on the roof framing or put directly into place.

This new home was constructed on Maryland's Eastern Shore.

Addition

This was an 18x24 addition to an existing home. The roof line was shed style, with two smaller sloping sides. This addition is similar to the types of additions commonly added to U.S. homes (Figures 2 and 3).



Picture 2: A picture from inside the addition.



Picture 3: A picture from the side of the addition.



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The addition used 7/16" OSB roof sheathing panels. A stack of panels was lifted to the roof level using an all-terrain Bobcat with a forklift attachment. The crew worked directly from this stack, including cutting/sawing sheathing panels on the elevated stack.

The observed addition was constructed on a home located in southern Maryland's Chesapeake Bay region.

Liquid Adhesive

The liquid adhesives used on the new home field trial were purchased directly from a home improvement retailer. Two of the three adhesive products were AFG-01 certified (Picture 4). This product certification was desired based on prior research performed by Clemson University. The research found that AFG-01 certified adhesives were effective in significantly increasing the uplift resistance of roof sheathing when applied as a retrofit measure.

The liquid adhesive used on the addition was supplied by an adhesive manufacturer, Bostik. Bostik's HDCA polyurethane adhesive is AFG-01 certified, as well as ASTM D3498, ASTM C557, and HUD UM-60A compliant. HDCA adhesive is capable of bonding to wet, frozen, or treated lumber (Picture 5).



Picture 4: Adhesives used on the new home.



Picture 5: Adhesive used on addition.

It should be noted that the scope of this field trial did not include any uplift strength testing or any other structural or performance testing.



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Construction Sequence

The following discussion on the construction sequence treats the new construction and addition projects separately. Although there were similarities in the crews' construction sequence, there were subtle differences that should be recognized.

New Construction

Once the sheathing panels were lifted to the roof line, measured, cut to fit (for non-full sheets), and pre-positioned in the right place, the roofers would lay a bead of adhesive on the top chord of the roof truss where the sheet would be placed (Picture 6). For the first sheets of roof sheathing installed on the house, the preliminary steps of lifting panels, measuring, cutting, and positioning took considerable amounts of time. Once the bead was laid, the panel would be placed onto the roof framing, adjusted to the exact position, and then nailed in place with a pneumatic nail gun.



Picture 6: Applying the adhesive, with sheathing panel waiting in place.

This roof sheathing project was not going to be completed in a single day; therefore, the crew avoided caulking areas that were not going to be immediately sheathed. The crew was worried that the adhesive would cure and need to be scrapped off before applying the adjacent sheathing panels when they returned to work.

Similarly, the new home construction crew was concerned that if they applied the construction adhesive too early, the adhesive would harden before they could get the sheathing panel down. Although this situation did not occur, the crew exercised restraint when applying the adhesive, applying the adhesive only one sheet ahead of laying the OSB decking.

Addition

On the home addition project, the crew applied the construction adhesive a few moments before the sheathing panel was applied. While one crew member was cutting the sheathing panel, another crew member applied the adhesive.



Picture 7: Applying the adhesive while the sheathing panel is being cut.

Traditionally, the crew would set a sheathing panel on the roof framing members and slide the panel into the H-clips ("H"-shaped clips which provide a gap for expansion between adjacent deck panels). During this field trial, the roofing crew needed to insert the sheathing panel into the H-clips as they lowered the panel into place; occasionally the crew would tap the sheathing panel with a hammer to help push the panel into the H-clip (Picture 8). The crew used this placement method to limit the need to shift the panel once it was set on the framing members, due to a concern about



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the ability to easily slide the sheathing panels on top of the adhesive. However, the crew was able to move and slide the panels on the framing members, as necessary.



Picture 8: H-Clip on roof sheathing.

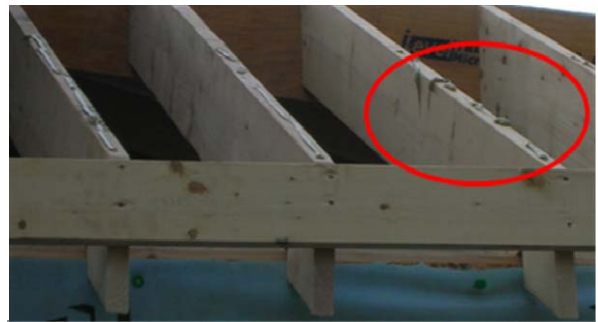
Once the panel was in place the crew members temporarily secured the panel using hand-driven nails. After an entire section of the roof was complete, a crew member would use a pneumatic nail gun to permanently attach the sheathing to the framing member.

Overall the necessary tools and supplies were fairly easy to manage, although one roofer did drop his hammer while handling the caulk gun. Occasionally, a crew member would hang the caulk gun on a rafter or sheathing panel, instead of setting it on the roof sheathing.

Observations

The liquid adhesive field trial produced a series of insights provided through observation and interviews with the roofing installers. The companion document to this field trial, *Strengthening Residential Roof Assemblies: Adhesive Tape Field Trial* has additional insights that could be of interest.

- Applying liquid adhesives on roof assemblies does not present any major difficulties in terms of constructability. It took roughly 1 to 2 minutes per sheet to lay the bead of construction adhesive. Once a few sheets were laid and footing on the roof becomes easier, subsequent sheets were easier to install.



Picture 9: Adhesive not applied evenly on rafters.



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- The bead of construction adhesive was not always evenly applied on the framing member. There were gaps in coverage due to the nozzle getting clogged or the crew member moving the caulk gun too fast (Picture 9).



Picture 10: Adhesive pushed to edge of framing member.

- Roofing crews were particularly conscious of not scrapping off the adhesive by excessively sliding the sheathing panels on the framing members. The adhesive was pushed to the edges on a few framing members (Picture 10).
- It was slightly more difficult to shift the panel into its exact position when the liquid adhesive was applied to the framing member, but not impossible. Roofers typically set the panel on the framing member and slide the panel into place, usually the panel would slide between $\frac{1}{2}$ " to 1" to get into the correct position. With the adhesive in place, the crew needed to insert the sheathing panel into the H-clip while lowering the sheathing panel because they wanted to limit panel movement once it was on the framing member.
- Inserting the sheathing panel into the H-clip while setting the sheathing panel was not difficult, but did require the roofing crews to alter their normal construction process.
- Once the adhesive is applied to rafters or trusses, the roofing crews could not walk on these members until they were covered with sheathing. In some cases this made movement on the roof somewhat awkward.
- For big jobs, contractor-size liquid adhesive tubes (29 ounces) are recommended over the smaller home owner sized tubes (10.1 ounces).
- The plywood or OSB roof sheathing panels definitely need to be nailed down immediately to the truss/rafter, even when adhesive is applied, because the use of mechanical fasteners helps set the sheathing into the adhesive. Further, most sheathing panels had some warp and would not sit flat to the framing without the use of nails.
- A pre-applied peel-away product could facilitate installation. Another idea is pre-applied adhesive micro-capsules which are located on the top surface of the truss. When roof sheathing was fastened down on the truss the capsules would rupture and release the adhesive, creating a bond between the sheathing and truss.
- Nail "misses" occur pretty frequently, which offers credibility to the value of a back-up attachment assembly (Picture 11).



Picture 11: Highlighted missed nails.



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- Installers generally recognize the adhesive as providing a stronger roof assembly.

Conclusion

The application of liquid adhesives onto new roof assemblies to supplement traditional fasteners is not difficult. The observed framing crews easily inserted the application of the construction adhesive into their construction sequence. Since this was the first time either crew applied adhesives on a new roof assembly a few application errors were observed. As roofing crews become experienced in applying adhesives on roof assemblies, application errors should be reduced.

These preliminary demonstrations indicate that the application of adhesives may not present major difficulties in terms of constructability. However builders, and to some extent homeowners, need to see clear value to the dual strategy of adhesives supplementing metal fasteners, since applying the adhesive will be viewed as an additional step.

The potential value gained from using adhesives on roof assemblies can be shown in multiple ways:

- Adhesives add strength to roof assemblies which is especially important in high wind zones
- Adhesives provide a margin of error for nails which are the wrong type, not spaced correctly, or miss the framing member
- Adhesives are a simple and inexpensive tool to significantly increase the uplift resistance of a residential roof system, in much the same way that adhesives are used in other parts of a home such as floor systems.

Additional research which can help to further characterize the benefits of using liquid adhesives would include:

- Uplift strength testing of sample assemblies using liquid adhesives plus nails
- Establishing minimum standards for the use of liquid adhesives in roof assemblies
- Long-term uplift testing of nails-only and nails plus liquid adhesive assemblies in a simulated attic environment.

These research needs are discussed further in the final summary report for this project, title "Research Overview and Gap Analysis."