EVALUATING THE ADEQUACY OF SIDING ATTACHMENT

By John C. Wylie, REWC, PE;
and Derek A. Hodgin, RBEC, PE; CDT, CCCA

INTRODUCTION

There are six sides to a building that engineers, architects, and consultants must consider during the design phase of a project. A key element is the design and installation of the exterior wall cladding on four of those six sides. Over the years, the construction industry has been introduced to several types of exterior claddings. Cementitious horizontal lap siding (also known as fiber cement board siding) is one of the most popular choices for higher-end single-family and multifamily wood-framed residential buildings.

There has been an increase in the installation of fiber cement board siding in coastal environments, where wind pressures are typically higher. Criticisms of the installation of the fiber cement siding attachment have become common in the context of construction litigation, with some expert witnesses opining that complete removal and replacement of the siding is required when not installed in...
accordance with manufacturers' installation instructions.¹

In addition to relying on the applicable building codes, accepted industry standards, and manufacturer literature, expert witnesses should utilize engineering judgment and experience to formulate opinions. Expert witnesses should evaluate, analyze, and suggest reasonable repairs based on the as-built attachment conditions of the fiber cement board siding for each case, and avoid generalizations that replacement is required if manufacturers' installation instructions are not followed exactly. Over the past several years, leading industry groups and manufacturers have provided supplemental information that has allowed expert witnesses to further analyze and formulate reasonable repairs that may not require removal and replacement of the siding system.

This article is intended to provide a basic understanding of siding attachment
Fasteners are hidden by the course above.

Nails are driven through the sheathing into the studs.

Exposed fasteners are driven through the face of the boards.

Drive fasteners only where planks overlap.

issues that are frequently discussed during construction litigation cases involving fiber cement board siding.

ATTACHMENT TERMINOLOGY

Horizontal lapped fiber cement board siding can be attached to the exterior walls of a building by blind nailing (i.e., concealed fasteners) or face nailing (i.e., exposed fasteners). As shown in Figures 1 and 2, blind nailing is when the head of a fastener is driven through the bottom course of siding and covered by the adjacent course above, whereas face nailing is when the same fastener is driven through the top and bottom course of siding where the planks overlap.

BUILDING CODE REQUIREMENTS

In its simplest form, the intent of the building code is to provide the design professional and/or general contractor with the minimum requirements to which a building is to be constructed. The residential and commercial building codes include a combination of prescriptive and performance-based requirements. Similar to the instructions in a cookbook, prescriptive code requirements specifically state how a building should be constructed; whereas, similar to a passing grade on a test, performance code requirements provide a minimum level of building performance. For example, the residential building code may provide the specific prescriptive requirement that the fiber cement board siding shall be attached using 6d common nails that penetrate each wall stud a minimum of one inch.

Conversely, the commercial building code states that the fiber cement board siding attachment needs to resist a wind pressure resulting from a code-prescribed wind speed.

Since its introduction in the 2003 International Residential Code (IRC), prescriptive requirements for fiber cement board siding attachment have been provided for different nail-base substrates that include wood structural panel sheathing and wall framing (i.e., oriented strand board [OSB] or plywood). Subsequent editions of the IRC have included changes to the attachment requirements of the fiber cement board siding—such as minimum fastener size and head diameters, reduction in the number of fasteners, and fastener compliance with ASTM F1667, Standard Specification for Driven Fasteners: Nails, Spikes and Staples. Table 1 provides a summary of IRC fiber cement board attachment requirements that are provided within Chapter 7 of the referenced building codes.

As shown in Table 1, the IRC provides a prescriptive method for fiber cement board attachment that includes minimum type, size, and location of the fasteners when not located in a high-wind region. However, due to significant wind events that have impacted the coastlines over recent years, additional research has been performed. This research has resulted in changes in how wind pressures are determined—particularly in high-wind environments (i.e., hurricane coastlines), where the prescriptive requirements for fiber cement board attachment may not be reflected. It should be noted that the referenced building codes provide commentary discussing the determination of wall covering attachment (e.g., fiber cement board) when the wind pressures exceed a certain limit, which is typically for buildings located in high-wind environments.

MANUFACTURER LITERATURE/CODE EVALUATION REPORTS

Manufacturers have their products evaluated by certified testing agencies in order to verify compliance with the applicable building codes. The resulting code evaluation reports are based on typical installation instructions provided by the manufacturer that include acceptable nailable substrates, types of fasteners, dimensional tolerances, and condition of the installed fasteners. This type of information is closely scrutinized when evaluating the adequacy of the fiber cement board attachment during construction litigation. Unlike the building codes that provide minimum requirements, the manufacturers’ literature and associated code evaluation reports may include best practices and alternative attachment details. For example, some manufacturers provide supplemental documents that include information regarding the use of blind and face-nailing combinations for the purposes of repair.

INDUSTRY STANDARDS

Mother Nature has recently produced extreme weather conditions that have tested fiber cement board siding attachment conditions. These events have provided manufacturers and industry groups with performance data that are used to develop state-of-the-art construction practices.

Industry groups and publishers—such as the Journal of Light Construction (JLC),
<table>
<thead>
<tr>
<th>Building Code</th>
<th>Table Number</th>
<th>Fastener into Structural Panel Sheathing and Wood Stud</th>
<th>Spacing of Fasteners</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003 IRC⁴</td>
<td>R703.4</td>
<td>Requirement: 6d corrosion-resistant nail</td>
<td>Face Nailing: 2 nails at each stud</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Footnote: Minimum 0.102-in. smooth shank, 0.225-in. round head</td>
<td>Concealed Nailing: One 11-gauge 1½-in.-long galvanized roofing nail (0.371-in. head diameter, 0.120 shank) or 6d galvanized box nail at each stud</td>
</tr>
<tr>
<td>2006 IRC⁵</td>
<td>R703.4</td>
<td>Requirement: 6d corrosion-resistant nail</td>
<td>Face Nailing: One 6d common nail through the overlapping planks at each end</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Footnote: Fasteners shall comply with nominal dimensions in ASTM 1667.</td>
<td>Concealed Nailing: One 11-gauge, 1½-in.-long galvanized roofing nail through the top edge of each plank at each end</td>
</tr>
<tr>
<td>2009 IRC⁶</td>
<td>R703.4</td>
<td>Requirement: 6d corrosion-resistant nail</td>
<td>Face Nailing: One 6d common nail through the overlapping planks at each end</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Concealed Nailing: One 11-gauge, 1½-in.-long galvanized roofing nail through the top edge of each plank at each end in accordance with the manufacturer's installation instructions</td>
</tr>
<tr>
<td>2012 IRC⁶</td>
<td>R703.4</td>
<td>Requirement: 6d corrosion-resistant nail</td>
<td></td>
</tr>
<tr>
<td>2015 IRC⁷</td>
<td>R703.3(1)</td>
<td>Requirement: 6d common nail</td>
<td></td>
</tr>
<tr>
<td>2018 IRC⁸</td>
<td>R703.3(1)</td>
<td>Requirement: 6d common nail</td>
<td></td>
</tr>
</tbody>
</table>

Table 1: Summary of prescriptive building code requirements.

the Federal Emergency Management Agency (FEMA), and APA—The Engineered Wood Association (APA)—have produced best practices guidelines regarding fiber cement board siding attachment. Though the information supplied by these groups may or may not be included in the building codes and/or manufacturers' literature, the best practice guides provide supplemental information that can be used by expert witnesses to evaluate an existing installation or to formulate repair specifications.

**JLC Industry Standard**

Though JLC continually provides information regarding the newest trends and best practices in construction, the *JLC Field Guide to Residential Construction: A Manual of Best Practice*⁶ (JLC Guide) has not been updated since it was first published. However, the best practices outlined in the JLC Guide are considered to be applicable today. For example, the JLC Guide provides recommendations regarding the location of fasteners, types of fasteners for face- and blind-nailing applications, and dimensions for fastener locations.

**FEMA Industry Standards**

FEMA has published several documents describing best practices for building enclosures subjected to extreme environmental events such as tornados, earthquakes, and hurricanes. Of these documents, FEMA P-499, *Home Builder's Guide to Coastal Construction*,⁷ and FEMA P-424, *Design Guide for Improving School Safety in Earthquakes, Floods, and High Winds*,⁸ provide best practices for the installation of fiber cement board siding. For instance, FEMA P-499 recommends that stainless steel fasteners be used to attach the fiber cement board siding to the structure within 3000 feet of the coastline. The salt-laden air in a coastal environment can accelerate deterioration and corrosion of coated fasteners in the absence of routine maintenance.

**APA Industry Standard**

APA is recognized in the industry for standards related to engineered structural
# TABLE 1

**Fastener Substitution Schedule for Nail-Base Sheathing**

<table>
<thead>
<tr>
<th>Fastener Diameter</th>
<th>Fastener Type</th>
<th>3/8</th>
<th>7/16</th>
<th>15/32</th>
<th>1/2</th>
<th>19/32</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use same diameter for all types of fastener as the smooth-shank nail diameter recommended by siding manufacturer</td>
<td>Smooth- or screw-shank nails</td>
<td>4:1</td>
<td>3:1</td>
<td>3:1</td>
<td>3:1</td>
<td>3:1</td>
</tr>
<tr>
<td>Use 3 additional fasteners per specified fastener spacing</td>
<td>3:1</td>
<td>3:1</td>
<td>3:1</td>
<td>3:1</td>
<td>3:1</td>
<td>3:1</td>
</tr>
<tr>
<td>Ring-shank nails&lt;sup&gt;(a)&lt;/sup&gt;</td>
<td>1:1</td>
<td>1:1</td>
<td>1:1</td>
<td>1:1</td>
<td>1:1</td>
<td>1:1</td>
</tr>
<tr>
<td>Wood screws&lt;sup&gt;(b)&lt;/sup&gt;</td>
<td>1:1</td>
<td>1:1</td>
<td>1:1</td>
<td>1:1</td>
<td>1:1</td>
<td>1:1</td>
</tr>
</tbody>
</table>

**Notes:**
(a) The table above is based on the siding manufacturer's installation recommendations for 1.25-inch penetration into spruce-pine-fir lumber framing by smooth-shank nails.
(b) The table above is based on the use of a siding product with a weight of not more than 3 psf.
(c) Additional nails may be required if the siding manufacturer’s installation recommendations are based on framing lumber with a specific gravity (SG) greater than 0.42.
(d) Use same number of fasteners and fastener spacing recommended by the siding manufacturer for fastening to studs.

---

**Figure 3**

wood products, including exterior wood structural panels used for wall sheathing (e.g., OSB and plywood). Since wood structural panels are considered to be a suitable nail base for fiber cement board siding, APA recently published a document regarding the attachment of fiber cement board siding. APA Q250, *Nail-Base Sheathing for Siding and Trim Attachment*,<sup>(4)</sup> provides information that references the installation of supplemental fasteners for smooth-shank, ring-shank, and wood screws when these fasteners are not directly installed into studs (Figure 3).

Based on the table provided in APA Q250, supplemental fastening into the nail base only (i.e., OSB and plywood) of the fiber cement board siding is allowed if the original fastener is not directly installed into a stud. For example, two additional fasteners are required if a stud is missed for a smooth-shank fastener into 1/4-in. sheathing.

### TYPICAL SIDING ATTACHMENT ALLEGATIONS

The previously referenced paper by the authors<sup>(1)</sup> outlined typical allegations asserted by plaintiff experts regarding fiber cement board attachment: improper fastener type and inadequate fastener spacing.

- **Inadequate edge distance**
- **Fasteners not installed into framing**
- **Overdriven/underdriven fasteners**
- **Inadequate end distance**

Several expert witnesses consistently opine that the above-referenced conditions constitute a construction deficiency based on the fact that they may deviate from a combination of the applicable building codes, accepted industry standards, and that manufacturers' installation instructions. However, it is the opinion of the authors that while these conditions may deviate from written instructions, they do not always represent a construction defect that requires removal and replacement of the siding system. It is important for the expert witnesses to perform research and evaluate the as-built conditions by collecting fastener data and determining the need for a repair.

As an example, an expert witness may allege that a significant percentage of the fasteners were not installed directly into the studs, but into the exterior sheathing only. This condition could result in damage or localized blow-off of the siding during a code-prescribed wind event. It could be the opinion of the expert witness that this condition would constitute a construction deficiency, due to not being installed in accordance with the manufacturer's installation instructions (which is considered a technical violation of the applicable building code since the code requires that the manufacturer's instructions be followed). However, manufacturers may allow alternative fastening (e.g., the use of blind and face nailing), in addition to industry standard organizations providing alternative fastener schedules (e.g., APA Q250) that allow the fiber cement board siding to be repaired in lieu of complete removal and replacement.

Another example that an expert witness may allege is the use of improper fasteners. Manufacturers will provide minimum head diameter and shank diameter for several different types of fasteners. However, an expert witness may allege that a particular fastener—in this instance a ring-shank nail—would not be considered an appropriate fastener because it is not specifically referenced within the manufacturer's literature. A preliminary engineering analysis of the withdrawal resistance of a ring-shank nail versus a smooth-shank nail will show that the ring shank has considerably more withdrawal resistance, especially when comparing both types installed into exterior sheathing. It is clearly unreasonable to suggest that using a nail that provides improved performance represents a defect that requires repair.

### ANALYSIS AND EVALUATION

In order to support one’s position in construction litigation, sufficient data collection and sample size relative to that issue...
are considered to be important. With regard to fiber cement board attachment, the data collection provides the information that will be used to determine the adequacy of the as-built siding attachment conditions. As an expert witness, the following variables are considered to be important in the evaluation of the fiber cement board attachment:

- Fastener type (i.e., length, shank diameter, head diameter, shank type)
- Horizontal fastener spacing
- Vertical fastener spacing
- Siding width and overlap (i.e., exposure)
- Fastener end and edge distance
- Overdriven and underdriven fasteners
- Statistical count of fasteners into stud framing
- Substrate type and thickness
- Species of wood framing

In order to adequately evaluate the as-built conditions of the fiber cement board siding attachment to determine compliance with the applicable building code, it may be necessary for the expert witness to perform a preliminary engineering analysis. Specifically, comparison of the withdrawal resistance of the fasteners with the code-prescribed design wind pressures using the variables collected will provide the information required to determine the adequacy of the fasteners.

Design wind pressures are calculated using information provided in the applicable building codes or by using code-referenced industry standards, such as the American Society of Civil Engineer’s (ASCE’s) and the Structural Engineering Institute’s (SEI’s) Minimum Design Loads for Buildings and Other Structures (ASCE/SEI 7). The fastener withdrawal resistance is determined by code-referenced industry standards, such as the American Wood Council’s (AWC’s) National Design Specification for Wood Construction. When the design wind pressures and withdrawal resistance of the siding fasteners are established, the expert witness can evaluate and determine whether the as-built conditions of the fiber cement board attachment are adequate (i.e., meet or exceed building code requirements).

**RECOMMENDED REPAIRS**

There are a variety of conditions (i.e., environmental, construction, etc.) that can determine the type of repair that may be required. Based on the research and engineering analysis, an expert witness may typically opine on one or more of the following repair options that include, but may not be limited to:

- Complete removal and replacement
- Localized removal and replacement
- Installation of supplemental fasteners
- No repair

The determination of each type of recommended repair is based on the area of inadequate attachment. For example, supplemental fasteners may only be necessary at the top floor corners due to the existing fasteners not being able to properly resist the increased wind pressures at this location. It should be noted that, depending on the result of the engineering analysis, an expert witness may assert that repairs are unnecessary when a deviation from the manufacturer's installation instructions may exist.

**CONCLUSIONS**

Based on the number of variables that can affect the adequacy of the fiber cement board siding attachment to resist a code-prescribed wind event, it is not reasonable to assert that the installation is immediately defective due to a deviation from the published manufacturer’s literature. It is important for every expert witness to perform a thorough evaluation of the as-built conditions to determine the appropriate repair or if a repair is even necessary.

**REFERENCES**

3. ASTM F1667.

---

**John C. Wylie**

With Construction Science and Engineering Inc., has over ten years of experience as an engineering intern and consultant—primarily in the areas of deficient construction, structural analysis, and collapse/damage investigations. He is responsible for the inspection and structural analysis of a wide variety of building enclosure and framing systems, including roof, wall, and guardrail systems that have been subjected to damage caused by hurricanes, floods, tornadoes, hail, wind, ice, and fire.

**Derek A. Hodgin**

Of Construction Science and Engineering in Westminster, SC, has over 25 years of experience as an engineering consultant. He is responsible for facility condition inspections, failure analyses, damage assessments, and forensic engineering investigations of all types of structures. A large part of his projects included analysis of deficient construction cases including roofs, exterior walls, windows, doors, structural framing, civil site work, and building code review.