# Buckling of Wood-Based Panel Siding

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The expansion or shrinkage of wood due to changing moisture conditions occasionally results in buckling of wood-based panel siding. Such buckling may occur between studs as in Figure 1 or between nails along the studs as in Figure 2. Shrinkage of green framing members, such as studs, plates and header joists, can also generate substantial internal compression stresses in siding panels, occasionally leading to buckling horizontally across the panel as shown in Figure 3. Although structural properties are unaffected, the waviness can be aesthetically displeasing and lead to complaints. By carefully following good construction practices and recommended siding installation procedures, builders can significantly reduce the potential for siding buckling.

APA Standard PRP-108 includes criteria for buckling performance of APA Rated Siding when tested under a carefully controlled laboratory moisture cycle that simulates exterior exposure. However, it should be recognized that because of normal construction tolerances and practices, an absolutely flat wall surface is not a realistic expectation.

## Buckling Due to Moisture Absorption

The moisture content of all wood-based products changes to reach equilibrium with its surroundings. The moisture content of wood products increases when exposed to rain and decreases during subsequent drying. When not exposed to direct wetting, the moisture content of wood-based siding changes while seeking equilibrium with the relative humidity of the surrounding air. This results in swelling or shrinking of the wood. For solid wood, this expansion is 20 to 40 times as great across the grain as along the grain. APA Rated Siding has good dimensional stability because the tendency of individual veneers, strands or wood particles to swell or shrink crosswise is greatly restricted by other adjacent veneers, strands or wood particles. Some APA Rated Siding products also incorporate features designed to reduce moisture absorption, such as overlays, edge sealers or pre-priming.

The tendency of expansion to cause buckling is related to mechanical and physical properties of the siding and to application techniques. An important mechanical property is siding stiffness relative to the length of the span. For a given stud spacing, a thicker siding has greater resistance to buckling when it expands than a thinner siding. Important physical properties of the siding include the natural variability of the wood constituents, moisture absorption rate (some wood species or surface features absorb moisture faster than others), and the overall balance of the wood grain direction in the siding. Some of these inherent siding characteristics are generally

FIGURE 1

**BUCKLING BETWEEN STUDS**

FIGURE 2

**BUCKLING BETWEEN NAILS**

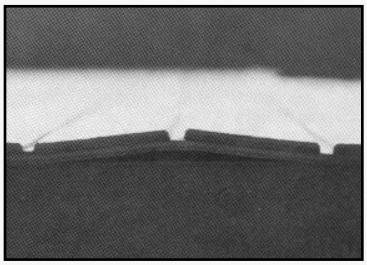

FIGURE 3

**BUCKLING ACROSS PANEL, CAUSED BY SHRINKAGE OF FRAMING MEMBERS**

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impractical to control. Since little can be done to prevent high moisture conditions in exposed siding, builders can minimize their effects by using good construction practice.

### Construction Features that Reduce Buckling

It is important that the proper siding is specified for the stud spacing used in fabricating the wall. This can be determined by observing the APA trademark, where the Span Rating shows whether the siding can be fastened to studs spaced 16 inches or 24 inches on center. APA Rated Siding panels bearing the designation "16 oc" may be used on studs 24 inches on center only when applied with its strength axis (long panel dimension) or face grain across the studs, or when applied over nailable panel or lumber sheathing. When applied horizontally direct to studs or over non-structural sheathing, the horizontal joints (or shiplap edges) of the siding panels must be nailed to blocking between studs.

Although protection from direct weather exposure prior to installation is desirable, siding allowed to equalize with the ambient relative humidity before installation has less tendency to buckle, since some natural expansion of the wood will already have taken place. It is especially important that end and edge joints be properly spaced during siding installation. No matter what steps are taken, wood-based siding will expand or shrink slightly with changes in its moisture content. Because wood-based siding is dry when manufactured, it typically picks up moisture after installation. If expansion is prevented by tightly butted joints, resulting internal compression stress in the siding could lead to buckling.

Spacing should be 1/8 inch at all siding edges unless otherwise recommended by the manufacturer. The APA Rated Siding specifications include provisions to allow manufacturers, at their option, to cut back siding as much as 1/8 inch so that trimming or adjusting stud locations will not be necessary in the field. Some builders fashion a spacer tool, or a spacing block which can be temporarily placed in the groove at the shiplap edge of grooved siding panels, to assure proper spacing. As an alternative, a 4d galvanized finish nail or casing nail can be driven into the stud at two or three locations along the preceding panel edge to act as a spacer. The nail head should be driven flush with the surface of the panel or shiplap edge.

Improper nailing is often the cause of reported buckling problems. Close attention should be paid to proper nail size and spacing and, of course, to assure that fasteners do not miss the studs. For ordinary siding applications, a nail spacing of 6 inches on center at all panel edges and 12 inches on center at intermediate studs has been found sufficient to hold panels flat under most conditions, while not providing excessive constraint to expansion. Other nail spacings may be required for engineered construction such as shear walls. Builders sometimes space nails much farther apart than recommended or inadvertently forget to complete the nailing. In some cases, the fasteners miss the studs altogether; special care is needed to locate framing when nailing siding over nonstructural sheathing, which hides the framing locations.

The sequence of panel nailing can also be a factor in maintaining a uniformly flat appearance of the finished wall. The following sequence avoids building an internal compression stress into panel siding. First, position the siding panel, maintaining recommended edge spacing, and lightly tack at each corner. Install the first row of nails next to the preceding panel from top to bottom. Remove remaining tacking nails. Then nail the row at the first intermediate stud. Continue by nailing at the second intermediate stud, and finally, at the edge opposite the preceding panel. Complete the installation by fastening to the top and bottom plates.

Gluing siding panels to framing is not recommended because the adhesive bond prevents the panel from expanding when subjected to moisture, thereby increasing the risk of panel buckling.

Finishing the siding with stain or paint promptly after installation will help it shed water, and thus slow down expansion. See *APA Builder Tips "Finishing APA Rated Siding"* (APA Form Q350) for staining and painting recommendations. A vapor retarder is recommended on the "warm" side of the wall to prevent a build-up of moisture in the wall cavity from within the building. (Note that some authorities recommend omission of vapor retarders in hot humid climates to prevent condensation on the interior side of the wall during the summer, particularly if the building is cooled by air conditioning.) For maximum effectiveness of integral vapor-retarder facings on insulation batts, the flanges should be stapled to the nailing edge of studs. This avoids gaps which can occur when flanges are stapled to the sides of the studs, which allow moisture to move into the wall cavity. A continuous 4-mil polyethylene vapor retarder would provide a more positive "seal." All penetrations should be thoroughly and carefully sealed to prevent moisture-laden air from moving into the wall cavity, which could condense on the siding with the possibility of producing buckling.

### Buckling Induced by Other Factors

In some reported instances of buckling, the primary cause is a construction feature not related to the siding itself. In some cases, compressive stresses sufficient to cause buckling are actually induced into the siding.

Siding buckling is occasionally associated with expansive soils which occur in some regions of the U.S. If portions of a building settle unequally, high compression stresses could be developed in the siding as it attempts to bridge differential settlement. This could result in compression buckling across the width of the siding.

In multistory building construction, siding panel buckling may occur as a result of shrinkage of wall and floor framing. The total shrinkage of the studs, plates and floor framing members, as they dry or season, may be as much as 1/2 inch per floor. If the panel ends are not spaced to accommodate shrinkage, compression forces can be developed on the panels and may lead to compression buckling. In this case, buckling generally occurs across the full width of the panel, rather than between studs. Buckling of this type can be minimized by using dry lumber framing or engineered structural composite lumber such as *APA EWS* "Rim Board"™ with wood I-joists for floor framing.

Trimming panels after installation is a convenient method of spacing the horizontal butt joints at panel ends to accommodate lumber shrinkage in studs, plates and floor framing. The ends of the siding panels are simply trimmed off after installation using a power saw to provide 1/2-inch panel end spacing. A chalk line, or a straight wood batten temporarily nailed to the wall to serve as a fence guide for the saw, can be used to establish a reference for trimming the panels. The depth of the cut is adjusted so that the saw blade does not cut into the Z-flashing along the horizontal joint. The resulting joint is quite satisfactory from an appearance standpoint. If desired, the Z-flashing can be hidden behind an accent band board.

In other cases, wavy or uneven appearance may result from installing panels over framing surfaces that are not in a flat plane. A "wavy" wall surface can result when siding is applied over wall studs which contain a crook (or warp), or over sill, floor and wall framing joints which are not flush. Crook affects the flatness of the wall – it's the deviation edgewise from the straight line from end to end of a stud. Up to 1/4-inch crook is permitted by the lumber standards for 8-foot long, 2x4 studs. The flatness of the wall can be improved by using straight studs, or at least by "sighting" along the studs beforehand and placing them with the crook (or crown) oriented in the same direction along the wall. Be sure that all framing joints are flush before application of panel siding.

### Correction of Siding Buckling

If buckling has occurred, assure first that waviness is not actually caused by poor alignment or warping of studs, or by framing that is not flush. A 4- or 8-foot straightedge can be used to ascertain the flatness of the framing surface.

If siding buckling has occurred, correction in a completed wall is difficult. In some cases it may be necessary to remove and replace panels. No technique has yet been identified as 100% effective in correcting buckling once it has occurred. However, several techniques have met with some success:

1) Flat, unbroken wall surfaces tend to highlight any surface unevenness. If siding panels have buckled between studs, it might be "masked" effectively by nailing battens over the studs and/or trim pieces around the perimeter of the wall. The battens break up the side lighting so that it is difficult to detect surface unevenness. It is an especially practical fix with ungrooved siding.

Saw-kerfing shiplap panel edges cannot be accomplished without destroying the weather-tight joint at this location; it would also affect the siding appearance, since one edge of the shiplap joint would be sawn off. This would necessitate installing battens over the panel siding joints, anyway. Furthermore, if panels are nailed through the shiplap edge, the nails would have to be removed before sawing the edges to prevent damage to the saw blades.

2) Additional nailing of the siding might be attempted to flatten the siding. Galvanized box nails are recommended for maximum holding power and corrosion resistance.

3) If the wall is not yet finished on the inside, nailing the siding to blocking installed between studs may correct a buckling problem. Blocking can be installed at locations where buckling is objectionable. Blocking should be snug and tightly nailed to the studs. The siding nails should force the panel into acceptable flatness over the studs and blocking.

We have field representatives in many major U.S. cities and in Canada who can help answer questions involving APA trademarked products. For additional assistance in specifying engineered wood products, contact us:


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