Shear Wall Basics

Details for sheathing walls in seismic and high wind zones

BY TIM UHLER

When we construct a building, we "typically intend it to stay where we build it." This is a quote from an APA-The Engineered Wood Association webinar on shear walls and load paths that speaks to an issue we have become increasingly aware of in this country—building for resilience. Whether we are designing for hurricanes, tornadoes, or earthquakes, one of the most basic structural elements that helps resist the forces a building sees during such events is the shear wall.

WHY SHEAR WALLS?

A shear wall (called a "braced wall" in the prescriptive world of the International Codes) is a building element that will resist the racking forces caused by high winds or earthquakes. When we stand an unbraced wall, it is easy to push it parallel to the top and bottom plates and cause the wall to collapse. Shear walls are designed to resist the lateral loading caused by wind pressure or ground movement in an earthquake and transfer those loads to the foundation. Imagine a perfect square that isn't designed to meet lateral loads: It deforms to the shape of a parallelogram until it collapses.

Here in the United States, the most common method for constructing shear walls involves attaching structural sheathing to framed walls. The APA (apawood.org) has published guidelines to meet the requirements in the code, calling for "continuously

Photos by Tim Uhler; Illustration: Tim Healey

The panel stamp on structural OSB and plywood reveals key details. These are the ones you need to understand for shear walls:
Panel grade: For walls, look for a "Rated Sheathing" designation.
Span rating: This is tied to the "strength axis" and is relevant to roof and floor decking, not walls.
Exposure rating: Sometimes called the "bond classification" in reference to the adhesive used to bond plies, "Exposure 1" indicates that panels will withstand normal construction delays without affecting the panel's structural properties.
DOC product standard: U.S. building codes require structural panels to comply with either PS 1 or PS product standards. PS 1 applies to structural plywood; PS 2 to OSB.
Strength axis: This refers to the panel when used on floors and roofs; it is not relevant to lateral loads.

sheathing with OSB or plywood." There are basically three elements to the shear wall—the framing, the fasteners, and the "method of resisting lateral forces," which is structural plywood or OSB "Rated Sheathing."

The rigidity of the sheathing directly contributes to the strength of the shear wall, but only if it is attached properly. When we construct shear walls, we must use the right sheathing—defined in terms of thickness and rating—and the right nail size and nail spacing. In this article, I will look at each of these in detail.

STRUCTURAL PANELS

We build in seismic country and therefore we typically build from engineered plans that include a shear panel schedule. This table lists the shear panel thickness—usually listed as 15/32-inch CDX (plywood) or 7/16-inch "APA Rated Sheathing" (OSB). The schedule also calls out the attachment of sheathing to framing as well as the attachment of the wall to the foundation and roof.

To make sure we have the right sheathing for the application, framers should know how to read a panel stamp. Besides the manufacturer's name and brand, this panel marking will include a number of lines (shown above) that are critical to its performance as a shear wall.

Panels used for walls and roofs will be marked "Rated Sheathing" or "Structural 1." Struct 1, as it's sometimes called, is a subcategory that is sometimes required for shear walls but not always.

"Sized for Spacing" (listed under the span rating) means the panels are undersized slightly to allow for a 1/8-inch gap between them when they are installed. This gap allows the panels to expand without buckling when they get wet.

The Department of Commerce (DOC) product standard (indicated under the mill number on the panel stamp) also deserves attention because U.S. building codes require structural panels to meet either

One advantage to OSB is the availability of lengths over 8 feet. Here **(2)**, 4x10 sheets vastly simplify the shear wall on side walls. The author balloon frames gable-end walls and installs 4-by fire blocking for easy nailing of the tight edge nailing required for the shear panel **(3)**.

the PS 1 or PS 2 standard. PS 1 applies to plywood; PS 2 to "wood-based structural-use panels," including OSB. (You may see this listed as PS 1-19 or PS 2-18; the last two numbers identify the year the standard was adopted.) In addition to compliance with the nailing schedule, this will probably be what an inspector will look for first on shear walls.

Panel lengths. One advantage with OSB is the availability of lengths longer than 8 feet. Panels are commonly available in 9- and 10-foot lengths, with some manufacturers offering 9 feet 1 1/8 inches and 10 feet 1 1/8 inches. Norbord even offers sheathing in lengths up to 12 feet 1 1/8 inches.

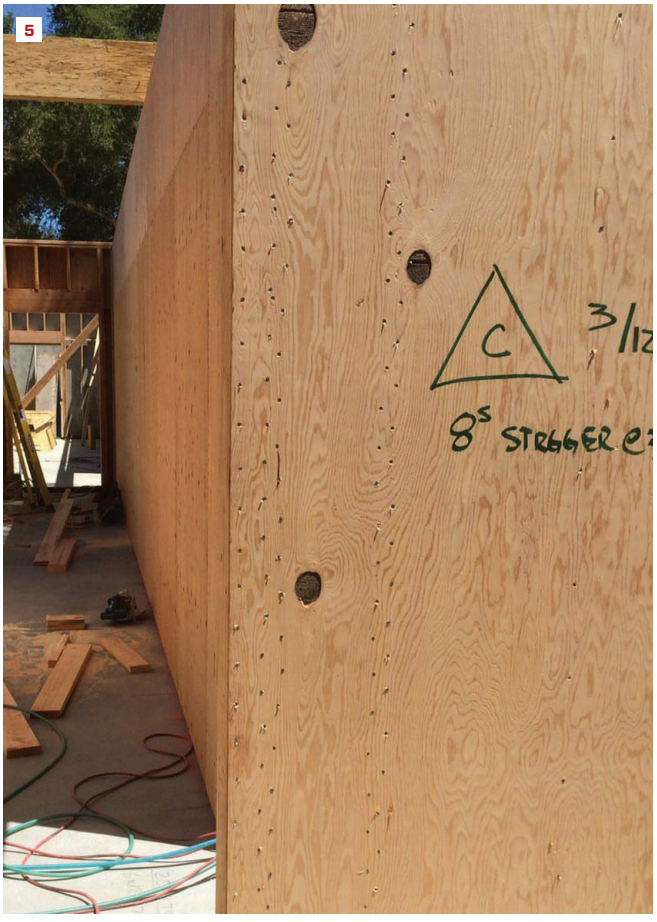
For us, the primary advantage of longer sheathing panels is a big reduction in labor. Longer panels mean less blocking in the walls and a lot less edge nailing. And when the engineer has designed for combined shear and uplift requirements, longer panels that span the rim joist between floors can eliminate metal straps or other uplift connectors.

Horizontal vs. vertical installation. The panel labeling includes a "strength axis," which is often misunderstood. It typically runs parallel to the length of the panel, and in floor and roof installations, this axis must be perpendicular to framing for the span ratings to apply. This is used only for floors and roofs, not for lateral loading. Here in the West, panels are typically installed vertically to save labor and (because less blocking is required) to increase the thermal resistance of the wall.

All panel edges must be blocked with nominal 2-inch or wider framing. We typically install blocking at wall-to-ceiling or wall-to-floor intersections. This panel-edge blocking also acts as fire blocking.

FASTENERS

Proper fastener size is crucial for the shear wall to perform as designed. The actual nail size called out might not be what the box of fasteners says. Sometimes the box will say 8d nails, but the nails aren't the right diameter. For example, an 8d common nail is 2 1/2 inches (length) x .131 inch (diameter), whereas an 8d box nail is 2 1/2 inches (length) x .113 inch (diameter). When I order nails for wall sheathing, I



Tight edge nailing that matches the plans' shear wall schedule and a 1/8-inch gap are details that a building inspector will look for first **(4)**. The nailing schedule can vary from wall to wall, so some framers mark up panels so it's clear to the crew exactly what the nailing should be. Here **(5)**, 3/12 refers to edge and boundary nailing every 3 inches and nailing in the field every 12 inches along studs.

don't order them by penny weight; instead, I order by the length and diameter.

FASTENING

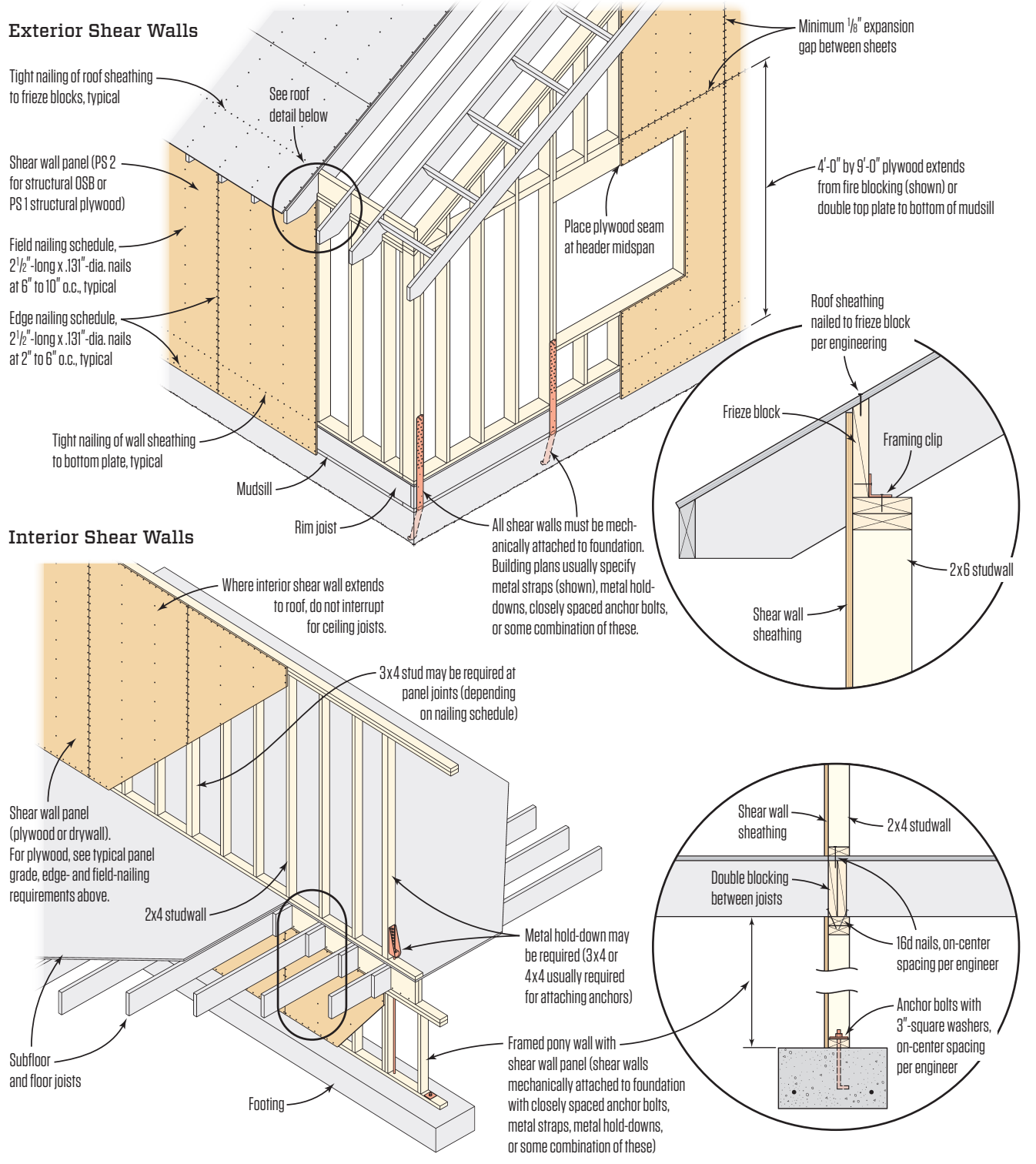
For a panel to be fastened correctly, it must be nailed off at the correct spacing and the nails set properly. The shear wall schedule provided by the designer or engineer typically includes nail size and spacing. It will specify both edge nailing and field nailing. For example "6/12" means nails are spaced every 6 inches on-center along edges and boundaries (edges of windows and doors) and every 12 inches along intermediate studs. It's not uncommon to see 3/12 and even 2/12 on shear walls, and the schedule can vary throughout the building, so some framers will label the walls on site so it's clear exactly how each wall should be nailed off, as shown above.

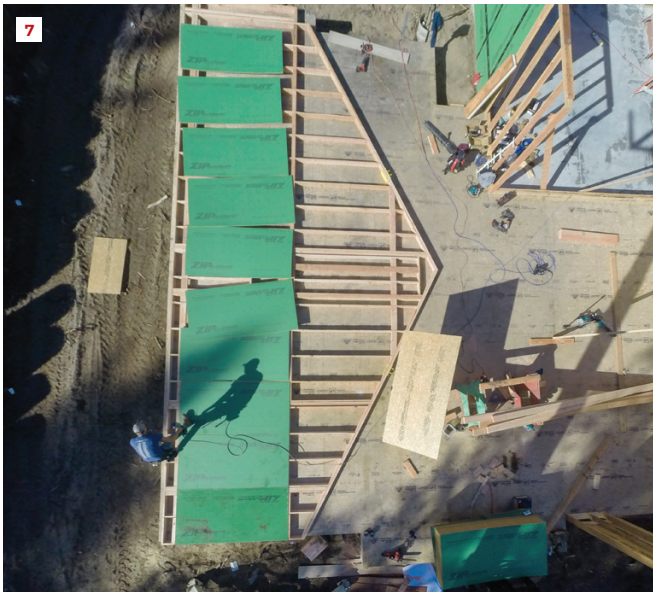
Typical nailing should be positioned 3/8 inch from panel edges and the head of the nail should be flush with the panel. It is a fact of life that not every nail will be perfectly set. In my experience, the number of overdriven fasteners can be greatly reduced by adjusting the depth of drive on the gun conservatively. I'd rather drive a few proud nails than fail a nailing inspection with too many overdriven nails.

I've found that there always seems to be one gun that does better than others at the same pressure. We designate that gun for sheathing.

If you have some overdriven nails, though, don't panic. According to an APA technical brief, there is no appreciable reduction in shear capacity if less than 20% of the fasteners around the perimeter of panels are overdriven by no more than 1/8 inch . Sometimes, the panel will swell somewhat, giving the appearance of overdriven

Typical Shear Wall Details





For the required connection of a shear wall to the roof structure, the author uses a Quik Stick to drive structural screws through the top plate into rafters **(6)**. He typically installs shear panels on the deck before standing walls **(7)**, sheathing over window and door openings and routing them out afterward **(8)**.

fasteners, but we find that most inspectors can tell the difference.

Metal connectors. All shear walls must be mechanically attached to the foundation. The plans usually specify metal straps, hold-downs, closely spaced anchor bolts, or some combination.

At the top of the wall, metal "hurricane" clips or structural screws are typically called for to connect the shear wall to the roof structure. Structural screws install twice as fast as a hurricane clips with a tool like Simpson Strong-Tie's Quik Stik (see "Racing Through Rafter Connections," May/19).

INSTALLATION TIPS

The actual installation is simple. As often as possible, we sheathe our walls before standing them up (a square wall on a level floor will be plumb when it is in place). We always place panels on the center of studs and leave a 1/8-inch gap. While you can use a 16d common nail to create this space, we do it by eye because it's faster. As mentioned earlier, the panel should say "sized for spacing."

As you tack panels in place, make sure they lie flat. Any warping or tension in the panel can cause buckling later. The standard on my crew is to sheathe over windows and doors and rout out the openings. This is fast and clean.

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