Structural Insulated Panels (SIPs)

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Scope

Construct exterior walls with structural insulated panels (SIPs) to provide an air-tight wall with consistent insulation and very little thermal bridging.

- Design and construct SIP walls according to manufacturer’s specifications.
- Seal all seams between SIPs following manufacturer's specifications.

See the Compliance Tab for related codes and standards requirements, and criteria to meet national programs such as DOE’s Zero Energy Ready Home program, ENERGY STAR Certified Homes, and Indoor airPLUS.
SIPs consist of two layers of plywood or OSB that “sandwich” an inner core of insulating rigid foam. SIP walls meet or exceed typical dimensional lumber construction structural properties. Because less framing is needed with SIP panels, there is also less thermal bridging than in a stick-built wall. Studies have found that framing comprises 25% of a stick-built wall and 14% of an advanced framed wall but only 8.7% of a SIP wall (CEC 2001; Carpenter and Schumacher 2003).

SIP panel walls are less susceptible to air leakage and convection and resultant potential condensation problems than stick-built walls (see Figure 1).

The following general guidance is provided when installing SIP panels. Also follow the specific manufacturer’s instructions for the SIP product be installed.

How to Install SIP Panels

When installing SIPs the ten most important considerations are the following (Christian 2011).

1. Start with detailed plans.
   Meet with all subcontractors and key personnel before construction to review the plans and discuss sequencing. Either train yourself on SIP installation or have trained personnel involved in the project at as early a stage as possible. Know the location of structural point loads. Continuously check the accuracy of shop drawings to ensure the installation matches the intent of the plans. In general, the entire exterior wall needs to be supported all the way to the foundation. Plan for a single ridge beam if possible for simplicity of installation. The ridge beam generally has several intermittent load points that transfer the design load to the ground. Understanding where these load points are located is important to maintain not only the needed structural support within the conditioned space but also to maintain chase ways for HVAC, plumbing, and electrical distribution. Make sure that the window and door rough openings are correctly placed in precut panels. Avoid designs that call for ganged or mulled windows because they are heavy, awkward to handle, and harder to install. They also require more solid wood headers in the SIP panels, resulting in potential thermal bridging. Make sure that the HVAC chases are specified and maintained as construction proceeds. Make sure the electrical plan is complete and reflected in the panel cut drawings sent to you for your approval prior to panel fabrication. Keep all plumbing out of exterior walls and keep the electrical in exterior walls to the bare minimum. Run all vertical chases into floor spaces by routing from exterior to interior walls and then up or down. An excellent book to read before constructing your first SIP house is Building with Structural Insulated Panels by Michael Morley (Morley 2000).

2. Protect the panels prior to Installation.
   Avoid damaged panels. Ideally have the foundation assembly completed just before the arrival of the panels. Coordinate with the SIP manufacturer to determine who will unload and stack the panels when they arrive at the work site, it is generally the contractor’s responsibility to unload the truck. To protect the panels and minimize handling, stack the panels high, dry, and flat and in the order they will be needed as when assembly begins. Manufacturers ship groups of panels that will be erected together. Panels should be stacked off the ground on 4 X 4 timbers no more than 6 ft. apart and covered with a tarp (Figure 2). Avoid locating the stacks above standing water and wet soils. Place a ground cover down first to avoid soil moisture driving conditions transporting ground moisture up into the panels and causing edge swelling. Reusable tarps are easily held in place by wedging scraps of wood into the recessed cut-outs for the splines at the ends of the panels. Make sure the panels lay flat while stored on site.
3. **Ensure the foundation is plumb, level, and square.**

There is less tolerance for foundations that are not level in SIP construction than in stick frame. Double-check to make sure you have the right dimensions for the footer, foundation wall, and floor on the design drawings, and measure for confirmation of plumb, level, and square of the footer, foundation wall, and floor during construction. The concrete subcontractor needs to understand that a SIP foundation must be closer to plumb, level, and square than the typical residential construction industry accepted standard.
Figure 4 shows the recommended foundation/floor/SIP wall detail. The outside facing of the SIP must have continuous structural support for the full length of the bottom edge. It should sit on, not hang over the edge of the top plate. Install a termite shield and capillary break between the sill plate and foundation wall; this can be aluminum flashing that covers the top of the foundation from the inside to outside wall surfaces.

4. Assemble the Walls and Roof.
For assembling the exterior walls there are two general approaches: 1) assemble 4x8-foot SIP panels manually or 2) assemble 10x24-foot panels with rough openings precut that are lifted in place with a crane or fork lift with a high boom pole (See Figures 5 and 6). Larger wall panels have fewer seams, which reduces both thermal bridging and the risk of air leakage.
For assembling the roof, use a boom truck and crane with proper rigging to lift the ridge beam and SIP ceiling panels. For quickest assembly, use a single ridge beam and have it available on site to lift in place as soon as the walls are up, plumbed, leveled, and squared. Lift the ridge beam in place with the boom truck and a rigger’s sling made up of double-choker hitches. Have the roof panels and crews in place so that once the crane arrives and the beam is placed, the roof panel placement can commence immediately, so that rigging time and costs are minimized.

Figure 5 - Walls are being assembled at this SIP house.

Figure 6 - A crane is used to install the SIP fireplace chimney chase.

5. **Connect the panels together.**

The SIP package will have with it a detailed set of plans and instructions with corresponding panel numbers marked on both the plans and on the panels themselves. The shipment will also include connecting splines and caulking to connect the panels to each other. The three most common splines are shown in Figures 7, 8, and 9. The structural spline (a solid 2x) should only be used when the load cannot be carried by the panels alone. The surface splines almost completely eliminate thermal bridging. Some splines can be installed by the SIP manufacturer in one of the panels in the factory, which saves site assembly time.
Figure 9 - A structural spline made of a solid 2x is used where needed to meet structural load requirements at SIP panel seams.

Apply caulk to the seams before assembly following the SIP manufacturer's instructions and using their caulk, if provided. Make sure seams are continuous (see Figure 10). Consider using a power caulk. The wall/floor, wall/wall, and wall/roof seams can each require as many as six beads of caulk, and the roof ridge can require up to 8 beads of caulk. In a 1200-square-foot house this can total over 5,000 lineal feet of caulk (more than 17 football fields).