APA

Structural Insulated Panels

PRODUCT GUIDE

Structural Insulated Panel Association




Wood: The Natural Choice

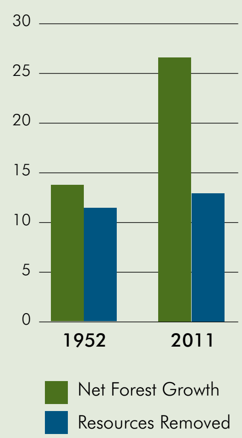
Engineered wood products are among the most beautiful and environmentally friendly building materials. In manufacture, they are produced efficiently from a renewable resource. In construction, the fact that engineered wood products are available in a wide variety of sizes and dimensions means there is less jobsite waste and lower disposal costs. In completed buildings, engineered wood products are carbon storehouses that deliver decades of strong, dependable structural performance. Plus, wood's natural properties, combined with highly efficient wood-frame construction systems, make it a top choice in energy conservation.

A few facts about wood:

We're growing more wood every day. For the past 100 years, the amount of forestland in the United States has remained stable at a level of about 751 million acres.[1] Forests and wooded lands cover over 40 percent of North America's land mass.[2] Net growth of forests has exceeded net removal since 1952[3]; in 2011, net forest growth was measured at double the amount of resources removed.[4] American landowners plant more than two-and-a-half billion new trees every year.[5] In addition, millions of trees seed naturally.

U.S. Forest Growth and All Forest Product Removals

Billions of cubic feet/year



Source: USDA—Forest Service

Manufacturing wood is energy efficient. Over 50 percent of the energy consumed in manufacturing wood products comes from bioenergy such as tree bark, sawdust, and other harvesting by-products.[6] Very little of the energy used to manufacture engineered wood comes from fossil fuels. Plus, modern methods allow manufacturers to get more out of each log, ensuring that very little of the forest resource is wasted.

Life Cycle Assessment measures the long-term green value of wood. Studies by CORRIM (Consortium for Research on Renewable Industrial Materials) give scientific validation to the strength of wood as a green building product. In examining building products' life cycles—from extraction of the raw material to demolition of the building at the end of its long lifespan—CORRIM found that wood had a more positive impact on the environment than steel or concrete in terms of embodied energy, global warming potential, air emissions, water emissions and solid waste production. For the complete details of the report, visit www.CORRIM.org.

Wood adds environmental value throughout the life of a structure. When the goal is energy-efficient construction, wood's low thermal conductivity makes it a superior material. As an insulator, wood is six times more efficient than an equivalent thickness of brick, 105 times more efficient than concrete, and 400 times more efficient than steel.[7]

Good news for a healthy planet. For every ton of wood grown, a young forest produces 1.07 tons of oxygen and absorbs 1.47 tons of carbon dioxide.

Wood is the natural choice for the environment, for design, and for strong, resilient construction.

1. United States Department of Agriculture, U.S. Forest Service, FS-979, June 2011; 2. FAO, UN-ECE (1996) North American Timber Trends Study. ECE/TIM/SP/9. Geneva; Smith et al. (1994), Forest Statistics of the United States, 1992. Gen. Tech. Rep. NC-168; 3. United States Department of Agriculture, U.S. Forest Service; FS-801 Revised September 2009; 4. U.S. Department of Agriculture, U.S. Forest Service, August 2014; 5. Forest Landowners Association, 2011; 6. U.S. Environmental Protection Agency, March 2007; 7. Produced for the Commonwealth of Australia by the Institute for Sustainable Futures, University of Technology, Sydney, 2010.

Building for the Future

Advanced emerging building materials, such as structural insulated panels (SIPs), are engineered to provide more durable and energy-efficient residential and commercial buildings. Using SIPs to create a high-performance building envelope is the first step to producing a sustainable building that is strong, energy-efficient, and cost effective.

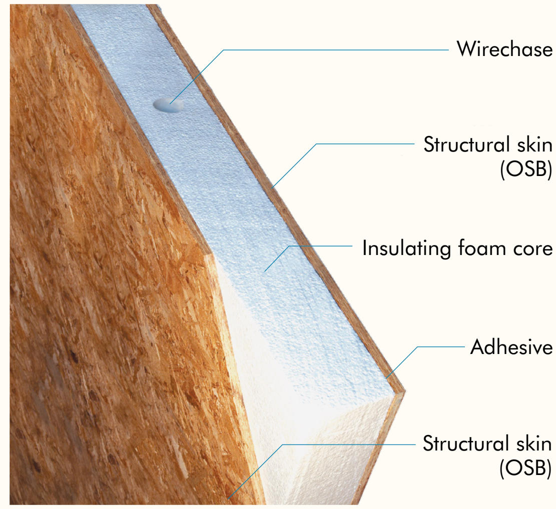
WHAT ARE SIPS?

Structural insulated panels are highly insulated structural building panels used in exterior walls, roofs, and floors for residential and light commercial construction. The panels are made by sandwiching a core of rigid foam insulation between two skins of structural sheathing, usually oriented strand board (OSB).

The foam core of the panel is typically composed of expanded polystyrene (EPS), polyurethane, extruded polystyrene (XPS) or polyisocyanurate. Where required by the manufacturing process, structural adhesive is used to adhere the foam cores to the skins of the panel in a lamination process. Once laminated, solid panels are cut for doors, windows, and switches in the manufacturing plant (or on site) to meet the design specifications and then shipped to the site for a quick and easy installation.

FIGURE 1

SIPS PANEL DETAILS



The SIP fabrication process usually begins with a computer aided design (CAD) drawing of the building. Panel manufacturers convert the CAD electronic drawings into shop drawings that are either digitally transferred to computer numerically controlled (CNC) automated cutting machines or used to measure and cut panels by hand. "Chases" or channels for electrical wiring are cut or formed into the foam core, and the foam edges are recessed to accept connection splines for joining to adjacent panels. Fabricating SIPs under factory-controlled conditions achieves tolerances far more precise than wood framing where problematic moisture and irregular dimensional issues are common. Common sizes range from standard 4 x 8 feet up to jumbo 8 x 24 feet. SIP thicknesses range from 4-1/2 to 12-1/4 inches, providing a range of R-values that economically comply with insulation and strength requirements across different climate and seismic zones.

Structural insulated panels satisfy single and multifamily residential as well as light commercial structural requirements. SIPs are most commonly used in walls and roofs, but they can also be used in floors and foundations.

WHY SIPS?

The SIP building system saves builders time, money, and labor while producing high-performance, sustainable, and resilient buildings that economically meet or surpass the newest energy codes, green rating systems, and continuous insulation requirements. SIP structures offer occupants superior comfort and indoor environmental quality (IEQ). Thermal stability with consistent temperatures throughout multistory structures, no drafts from air leakage, and enhanced acoustic performance all contribute to SIPs' high performance.

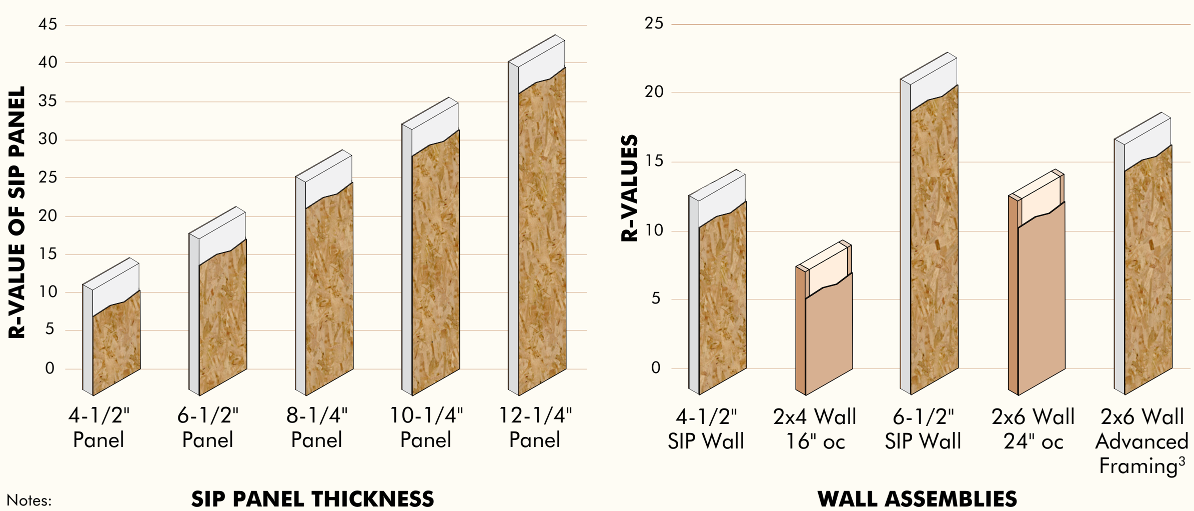
SIPS SAVE ENERGY

Energy efficiency and environmental responsibility are two hallmarks of a sustainable building. Buildings that use less energy and generate less carbon dioxide emissions have a smaller impact on the environment.

The insulating core of a structural insulated panel provides continuous insulation. SIPs enable structures to be assembled with minimal framing. The percentage of area in a wall assembly composed of sawn lumber is classified as a wall's "framing factor." The framing factor contributes to thermal bridging. The more framing, the higher the framing factor, and the more energy is lost due to thermal bridging. A typical stick-framed home averages a framing factor ranging from 15 to 25 percent, while a SIP home averages a framing factor of only 3 percent. When the whole-wall R-value is measured, SIP walls outperform stick-framed walls because studs placed 16 or 24 inches on center cause thermal bridging and result in energy loss. Additionally, fiberglass and other insulating materials are subject to gaps, voids, or compression, leading to further thermal performance degradation.

FIGURE 2

SIP (WITH EPS FOAM CORES) PANEL R-VALUES **WHOLE-WALL R-VALUES**



Notes:

1. The first graph shows different ranges of SIP panel thickness's R-Values.
2. Calculated whole-wall R-values from Oak Ridge National Laboratory, *Whole Wall Rating/Label for Structural Insulated Panels: Steady-State Thermal Analysis*, 1999.
3. See APA *Advanced Framing Construction Guide*, Form M400 for whole-wall R-values using advanced framing.

When working with panels as large as 8 x 24 feet, there are significantly fewer joints that require sealing. SIPs establish a whole-house air barrier simply and effectively. Studies at the U.S. Department of Energy's (DOE) Oak Ridge National Laboratory (ORNL) show a SIP room to have 90 percent less leakage than its stick-framed counterpart.[a]

Building air leakage is measured with a blower door test. Using specially designed fans to pressurize the structure, Home Energy Rating System (HERS) technicians measure the lower amount of home air leakage and use this information to properly size HVAC equipment and apply for ENERGY STAR®, Passive House (PHIUS+ 2015), and/or U.S. DOE Zero Energy Ready Home qualifications. SIP research homes built by ORNL have infiltration rates as low as 0.03 natural air changes per hour (ACHnat) or approximately 0.9 ACH at 50 Pascals of pressure differential (ACH50). Similarly sized stick-framed homes in the same subdivision averaged blower door test results ranging from 6–7.5 ACH50 (almost 700 percent more leakage).[b]

Commercial buildings also benefit from SIPs. The renowned Rocky Mountain Institute, a nonprofit organization focused on worldwide clean energy solutions, selected SIPs for its 2016 Innovation Center. Located high in the mountains of Basalt, Colorado, this 15,610-square-foot "beyond net-zero" building is certified LEED Platinum and is the largest PHIUS+ Source Net Zero Certified structure in the world, with an air leakage rate of 0.36 ACH50 (97 percent less leakage than typical commercial buildings). With an energy use intensity of 15.9 kBtu/ft^2/year, the building is on track to deliver two times more energy than it uses. The modest 10.8 percent premium to achieve net-zero is paid back in less than four years with the help of SIPs.

When combined with other high-performance systems, SIP homes typically reduce annual energy use by 50 percent or more. SIPs are instrumental in creating many zero-energy buildings that produce as much energy as they consume using solar panels and a high-performance SIP building envelope.

In 2002, ORNL teamed up with the Structural Insulated Panel Association (SIPA) and the DOE to create five innovative net-zero energy buildings. These high-performance homes featured structural insulated panel walls and roofs, rooftop solar photovoltaic systems, and other energy-efficient technologies, helping them approach DOE's goal of net-zero energy use.

The small, affordable single-family homes were built in Habitat for Humanity's Harmony Heights subdivision in Lenoir, Tennessee. ORNL performed extensive testing on the performance of these homes and monitored energy usage for the first year of habitation. The airtightness and insulating properties of the SIP building envelope helped cut the annual heating and cooling cost for the first zero-energy home to $0.45 a day. By using SIPs in conjunction with other energy-efficient and economic features, builders are able to offer net-zero energy homes to North American homebuyers.

2011 studies by the DOE and ORNL Zero Energy Building Residence Alliance (ZEBRA) compared energy performance of four side-by-side, equally sized, three-bedroom, two-bath, single-story unoccupied homes over a period of two years as shown in Table 1. The homes were programmed to operate lights, water heating, and HVAC identically over the two years. The SIP home with a HERS rating of 46 and air leakage of 1.25 (ACH50) performed best compared to the other three systems: the 2x6 at 24 inches on center stud wall with spray foam and fiberglass batt, a 2x4 double stud wall system with fiberglass and phase change materials, and a 2x4 at 16 inches on center with exterior foam sheathing. The SIP home saved over 50 percent energy compared to the IECC 2006 baseline with 4.66 kWh/ft^2/year.[c]

a. Christian, Jeff and T.W. Petrie, *Heating and Blower Door Tests of the Rooms for the SIPA/Reiker Project*. ORNL. 2002.

b. *Energy Savings from Small Near-Zero-Energy Houses*, ORNL, 2002.

c. *ZEBRA Field Study and Energy-Plus Benchmarks for Energy Saver Homes Having Different Envelopes*. ORNL. 2011.

TABLE 1

NEAR-ZERO ENERGY HOUSES

House	Sq. Ft.	% Energy Savings	Annual Utility Costs
SIPA ZEH1	1060	51.0%	$343
SIPA ZEH2	1060	57.0%	$484
SIPA ZEH3	1060	57.5%	$413
SIPA ZEH4	1200	62.5%	$275
SIPA ZEH5	1232	69.5%	$242

SIPS SAVE THE ENVIRONMENT

With rising concerns over global climate change, designers and builders are focusing on reducing the environmental impact of homes and commercial buildings. SIPs help achieve this mission by saving energy and valuable natural resources and by providing a healthy indoor environment for building occupants. Builders using SIPs often find it easier and more cost effective to meet the qualification standards under many green building rating systems, such as the Leadership in Energy and Environmental Design (LEED), Green Globes, and National Association of Home Builders' National Green Building Standard, ICC-700.

SIPs are both energy-efficient and an efficient use of resources, making them an ideal choice for a high-performance building. The OSB used in SIP skins is made from rapidly renewable trees that are harvested from sustainably managed forests.

The insulating core used in SIPs is a lightweight structural foam composed of 98 percent air, and requires a relatively small amount of raw material to produce. Both EPS and polyurethane-based foam insulations are made using non-chlorofluorocarbon (CFC) blowing agents that do not threaten the earth's ozone layer.

SIPs are often cut using optimization software that minimizes the amount of waste. EPS waste generated in the SIP manufacturing and fabricating process is recycled into other EPS products. Jobsite framing and roofing waste is almost completely eliminated using SIPs, saving the need for expensive landfill fees.

By using less energy than most buildings, SIPs cut down on carbon dioxide emissions. According to the EPA, when the emissions generated during energy production are included, the average home emits 22,000 lbs. of carbon dioxide annually, roughly twice as much as the average car. Homes built with SIPs and other high-performance systems can reduce a home's carbon dioxide emissions by as much as 50 percent.

SIPs are inert and stable. An airtight SIP building envelope allows for fresh air to be provided in controlled amounts, filtered to remove allergens and conditioned, amounting to healthy indoor air quality. SIPs are uniformly insulated, without the voids, cold spots, or thermal bypasses of conventional insulation that can cause condensation leading to potentially hazardous mold growth.

SIPS SAVE TIME AND LABOR

Prefabricated SIPs can save builders a significant amount of onsite labor. SIPs are ready to install when they arrive at the jobsite, eliminating the need to perform the individual operations of framing, sheathing, and insulating stick-framed walls. Window openings may be precut in the panels, and depending on the size, a separate header may not need to be installed. Working with jumbo panels means entire walls and roof sections can be put up quickly.

Since SIPs are an entirely engineered product, they are inherently flat, straight, and true. With SIPs, there is no need to spend time culling studs or straightening stick-framed walls. Siding, interior finishes, and trim will go up faster because SIPs provide a uniform nailing surface. Interior framing can be done after SIPs are set, meaning a house can be dried-in quickly. Vertical and horizontal wall electrical chase runs, plug outlets, and switch boxes can be precut at the factory. An RSMeans study[d] shows building with SIPs saves 55 percent on labor. Quicker dry-in time leads to a more stable structure with fewer problems involving drywall cracks, nail pops, and subfloor movement.

SIPS SAVE MONEY

In addition to trimming time off the build cycle of a structure, SIPs can be installed with less skilled labor than traditional stick framing. Early completion translates to lower loan cost overhead, no nail pops from wet wood, uneven lumber causing out-of-square walls, and additional opportunity for profit by building more homes in the same amount of time. Jobsite waste-disposal costs will be reduced because SIPs are primarily fabricated offsite.

The energy efficiency and tightness of a SIP structure allow smaller HVAC equipment to be used, duct runs to be minimized, and wintertime heating costs during the construction process and ongoing operation to be lowered. Builders who build energy-efficient homes may qualify for federal or state tax credits while also meeting continuous insulation requirements mandated by the International Energy Conservation Code (IECC).

d. BASF Corporation, *Time & Motion Study,* RSMeans, 2006.

DESIGN ADVANTAGES

SIPs offer several inherent advantages due to their engineered fabrication and structural abilities. SIPs are an integrated system. The manufacturing process is fully integrated with the CAD design process. This introduces the flexibility and accuracy of CAD design into the actual construction of the home. The entire building process from design to finished construction takes less time and is closer to the design specifications with a SIP structure.

Building with an engineered product means that SIP components will always be straight, true, and cut with close tolerances. Designers can use complexity to their advantage with CAD/CAM fabrication technology. CNC cutting machines are capable of cutting just about any shape and size of panel, taking complex measuring and mathematics out of onsite construction. Complex roofs, rounded roofs, dormers, and rounded or arched windows are only a few examples of design elements easily achieved with SIPs

SIPs can dramatically simplify the construction process. Jumbo 8x24-foot panels with large spanning capabilities can close space with fewer structural members than traditional stick framing. Transverse and racking load tests confirm the strength and transverse load resistance of SIPs, meaning that fewer additional supports will be needed to add stability in high seismic or wind areas. SIPs satisfy code requirements for continuous insulation and eliminate the complication of additional external insulating sheathing.

SIP roofs connecting to SIP walls create a continuous thermal envelope eliminating the need for an attic. This not only saves resources and keeps air duct work inside the thermal envelope, but allows for a large, open sensation with vaulted ceilings which can make small rooms feel more spacious. Complex features such as dormers can be built easily with SIPs and installed rapidly in one piece.

APPLICATIONS

Custom Homes

For the custom-home market, SIPs offer a cutting-edge product that can deliver a variety of custom designed elements. In any design, SIPs create a solid and energy-efficient structure with trim and interior finishes that match the accurate, engineered construction of the exterior panels.

Timber Frames

SIPs owe a portion of their emerging popularity to the renewed interest in timber framing. SIPs are a perfect fit to provide exceptional insulation for the large spans and voluminous interior spaces of timber-framed structures.

Affordable Housing

SIPs make housing affordable for low-income residents. Low-income families spend an average of 19.5 percent of household income on home energy costs[e]. When SIPs are used in single unit or multifamily low-income housing, this number can be drastically reduced. SIPs also cater to volunteer housing programs, such as Habitat for Humanity, because less skilled labor is needed to erect a SIP building than a conventional stick-framed home.

e. Phillips, Judith. *Housing Strategies for Mississippi.* John C. Stennis Institute of Government, Mississippi State University. 2006.

Nonresidential, Industrial and Commercial

SIPs are frequently used in light commercial construction. Crews working with 8x24-foot jumbo panels can close in a large building very quickly. SIPs are commonly used in conjunction with engineered wood products such as structural glued laminated timber (glulam) and structural composite lumber (SCL) because they can cover large spans without additional structural support. SIPs are also a widely used choice for schools wishing to cut energy costs and create a healthy indoor environment for students. The SIP *Engineering Design Guide* from SIPA (available at www.sips.org) provides industry-recommended design guidelines applicable to virtually any SIP application.

DESIGN AND CONSTRUCTION CONSIDERATIONS

Building with SIPs involves several unique design and construction considerations.

Foundations

Working with SIPs requires attention to foundation tolerances. Although SIPs can be modified onsite to fit an out-of-square or non-level foundation, this process is laborious and can affect the air sealing capabilities of the panels. Make sure the foundation contractor is aware of the tolerance required when building with SIPs.

Window and Door Openings

When drywall is applied to SIPs, the total wall thickness may be slightly different than a stick-framed wall because SIPs have wood structural panels on both sides. Window and door openings need to be sized accordingly.

Site Conditions and Material Handling

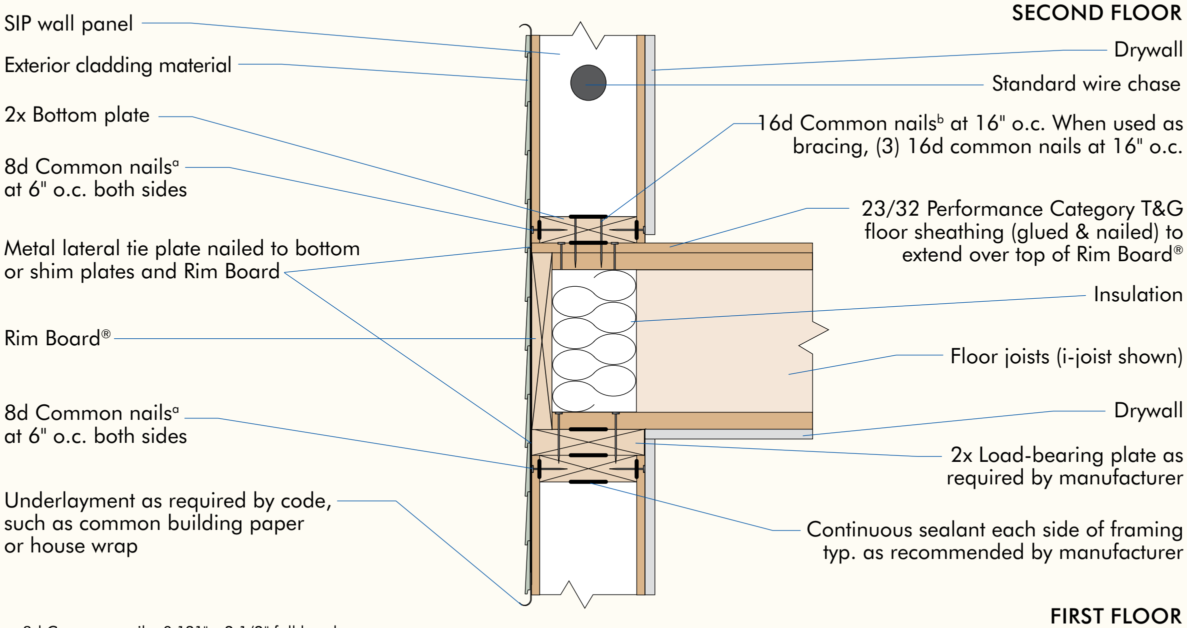
Although 4x8-foot panels can often be unloaded and set by hand, jumbo 8x24-foot panels weigh up to 700 pounds and require the use of equipment to unload and install. To set jumbo wall and roof panels, an extending boom fork lift, boom truck, or crane is used. Site conditions need to be taken into consideration when dealing with large equipment. High-wind conditions present the need for careful rigging to set large roof panels.

Floor Systems

Builders have two options for floor systems when constructing a home with SIPs. In a hanging floor system, high-efficiency SIPs are used in place of Rim Boards, and floor joists are attached using metal hangers. In a platform floor design, builders use traditional floor construction design, and a Rim Board to connect wall panels to the foundation. Insulated SIP Rim Boards are available from many SIP manufacturers.

FIGURE 3

SECOND FLOOR CONNECTION DETAILS – RIM BOARD®

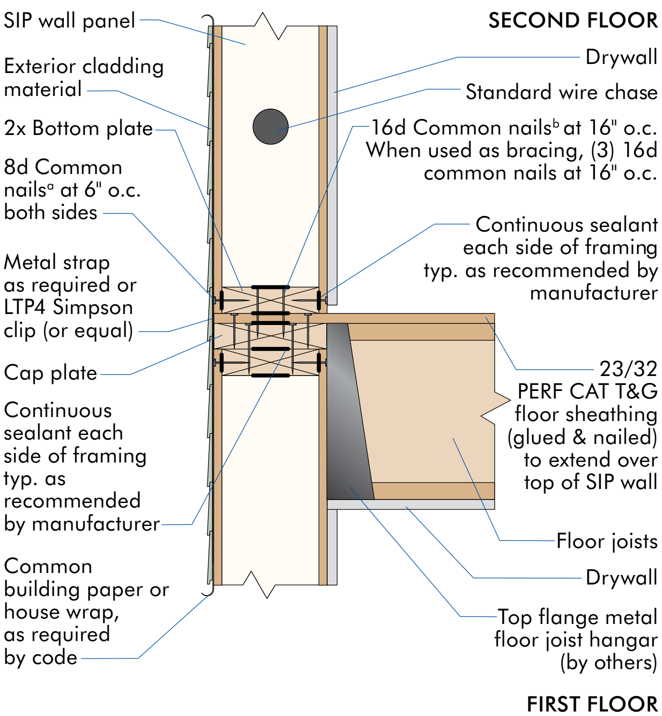


a. 8d Common nail – 0.131" x 2 1/2" full head
b. 16d Common nail – 0162" x 3 1/2" full head

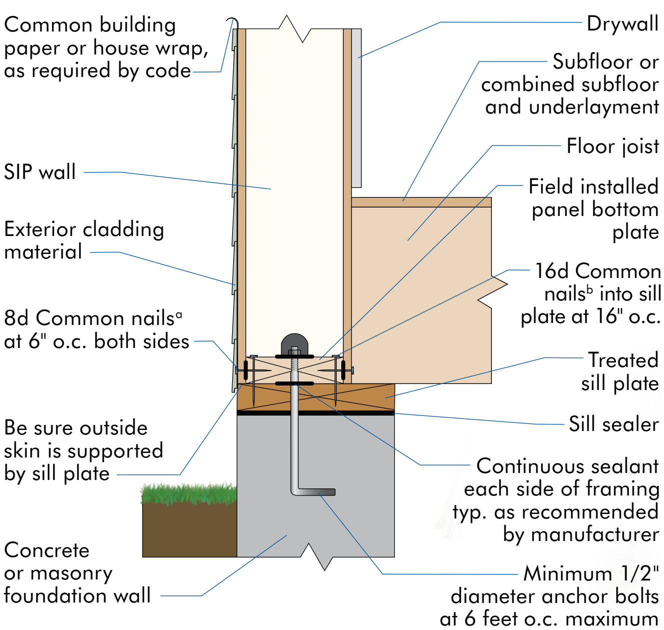
Rim Board® is a registered mark of APA – The Engineered Wood Association

SIP CONNECTION DETAILS

1 SECOND FLOOR CONNECTION DETAIL – HANGING FLOOR

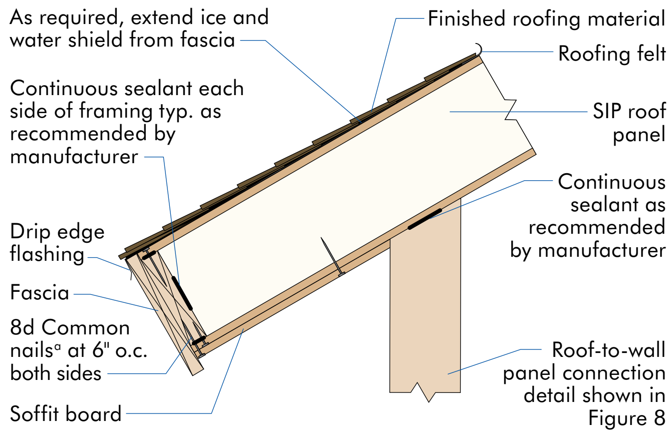


2 FOUNDATION CONNECTION – ELEVATED FLOOR

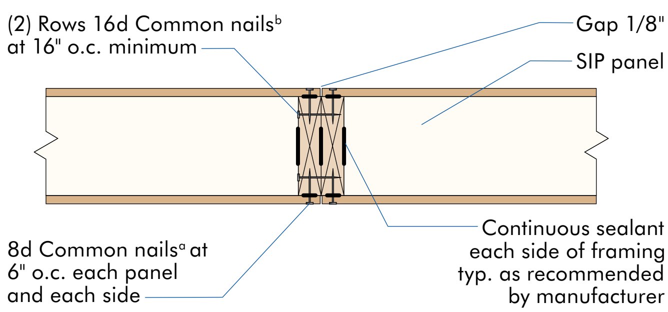


a. 8d Common nail – 0.131" x 2 1/2" full head
b. 16d Common nail – 0162" x 3 1/2" full head

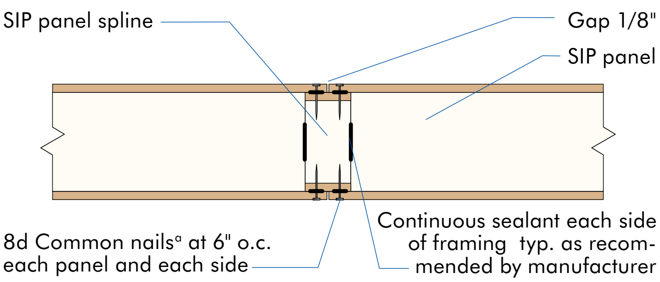
3 EAVES CONNECTION DETAIL



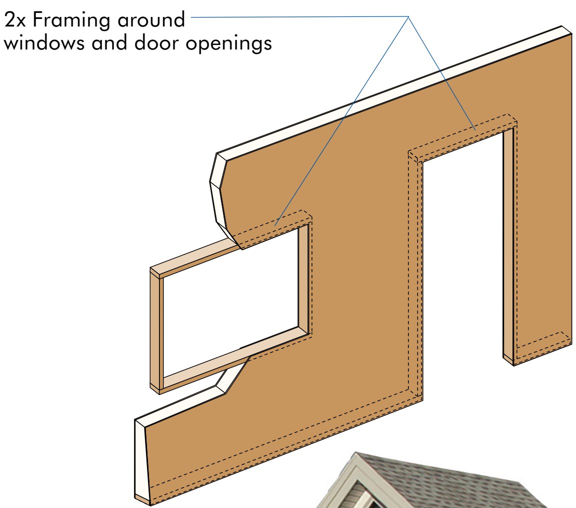
4 WALL-TO-WALL VERTICAL PANEL CONNECTION – DIMENSIONAL LUMBER SPLINE



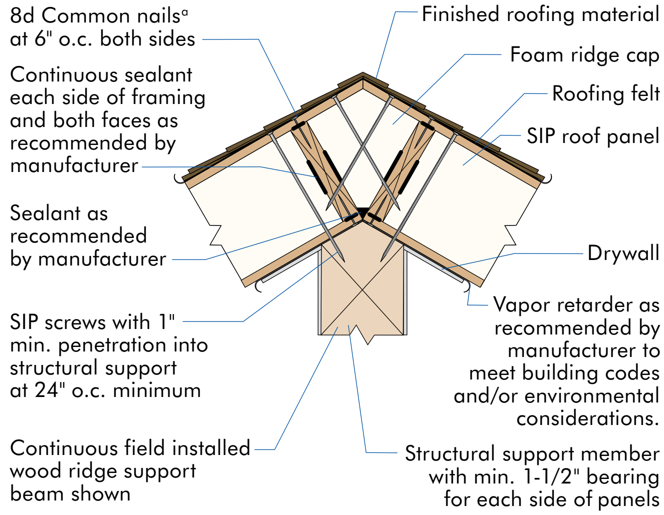
5 WALL-TO-WALL VERTICAL PANEL CONNECTION – BLOCK SPLINE



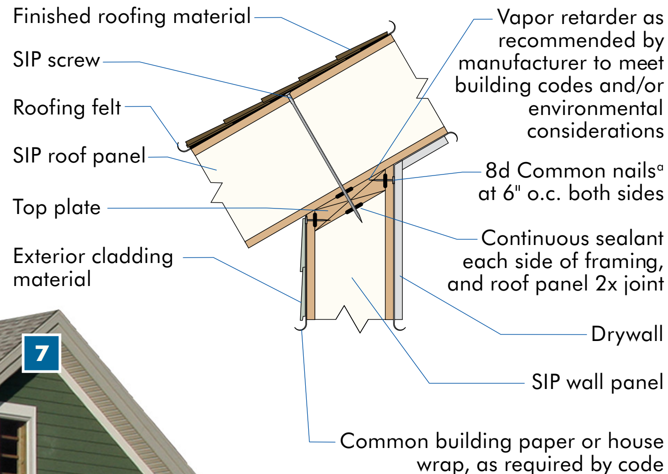
6 DOOR AND WINDOW FRAMING



7 ROOF-TO-ROOF PANEL CONNECTION – FOAM RIDGE CAP DETAIL



8 ROOF-TO-WALL PANEL CONNECTION – BEVELED SIP WALL



a. 8d Common nail – 0.131" x 2 1/2" full head
b. 16d Common nail – 0162" x 3 1/2" full head

MECHANICAL SYSTEMS

Electrical

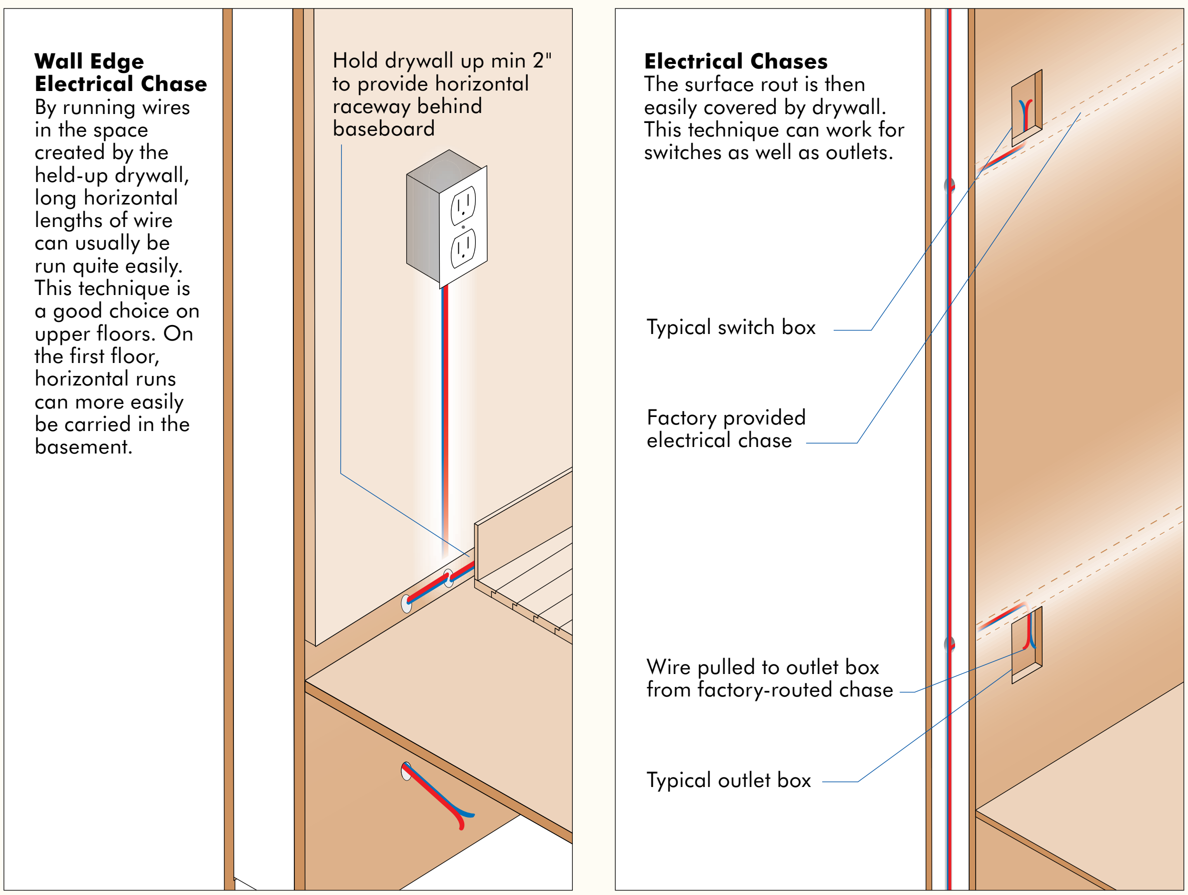
Electrical wires are pulled through precut channels inside the core of the panels called chases. Manufacturers cut or form chases both horizontally and vertically during the fabrication process according to the electrical design of the home. Plug outlets and switch boxes can also be precut at the factory. An RSMeans study found rough in wiring cost 11 percent less in a SIP house.[f]

Chases enable wires to be run through walls without compressing insulation or having to drill through studs. Electricians can access chases by drilling or cutting small access holes in the interior skin of the panel.

Another commonly used technique to run wires through baseboard raceways and in the cavity behind the beveled spacer on SIP roof-to-wall connections. Raceways can be created by using manufactured surface mount wiring mold, furring strips behind baseboards, or holding back drywall and the flooring to create space for wiring.

FIGURE 5

ELECTRICAL CHASES



f. BASF Corporation, *Time & Motion Study*, RSMeans, 2006.

Plumbing

Plumbing should **never** be run horizontally or vertically in SIP walls. Penetrations through SIPs must be well sealed to prevent air leakage and moisture penetration.

HVAC

SIP buildings are extremely tight structures with levels of air infiltration lower than the average stick-built structure. When working with an HVAC contractor, make sure their calculations take into account the low air infiltration and higher R-values of a SIP home. Proper HVAC sizing, according to *Air Conditioning Contractors of America (ACCA)* Manual J calculations is crucial because an oversized HVAC system will fail to reach the steady operating rate for which the equipment was designed. Short-cycling HVAC equipment will be less energy efficient and require more maintenance than properly sized HVAC equipment. Short-cycling HVAC equipment also leads to excessive humidity in structures during cooling seasons. Increased insulation performance of SIP structures, in addition to their airtightness over conventional construction, almost always significantly reduces required HVAC demands beyond what typical contractors estimate. Reduced loads often allow for cost-saving ductless mini-split units. Superior SIP envelopes provide thermal consistency within multilevel homes, allowing for less expensive and complex single zone systems.

SIP construction typically requires mechanical ventilation. Ventilation systems bring fresh air into the building in controlled amounts and exhaust moisture-laden and stale air to the outside. Ventilation systems can be designed to incorporate heat recovery ventilators (HRVs) or energy recovery ventilators (ERVs). These advanced systems harness heat being exhausted from the home and utilize it to heat the fresh air coming into the home for an even more efficient use of energy. Proper ventilation is crucial in structures with low air infiltration to prevent condensation that can lead to mold growth.

ASSEMBLY

Sealing

All joints between panels need to be sealed according to manufacturer specifications. Sealing is typically done with specially designed SIP sealing mastic, expanding foam, and/or SIP sealing tape.

Sealing is crucial to achieve the potential envelope tightness capable with structural insulated panels. An improperly sealed home is not only energy-inefficient but is also subject to moisture damage.

Proper sealing is especially important when installing SIP roofs. The ridge of a SIP roof can use either bevel-cut SIPs for a flush joint or a beveled foam block insert. The ridge detail is a critical construction detail that requires attention to sealing using methods as noted above. Manufacturer specifications will provide specific sealing details designed to prevent moisture movement.

Exterior Finishes

Exterior finishing materials can be applied easily to SIPs. SIPs provide a uniform nailing surface for exterior finishes. A water-resistive barrier must be installed between SIPs and siding in accordance with the code or the recommendation of the SIP manufacturer. This may be either building paper or house wrap. Siding should be attached to SIPs according to the siding manufacturer's specifications.

Roofing

As with siding, roofing needs to be attached to SIP roof panels according to the roofing manufacturer's recommendations. Roofing paper needs to be placed beneath the finish roofing as with a lumber-framed roof, and roofing materials are specified in the same manner as over a conventionally framed roof.

Fire

Residential building codes require that foam insulation be separated from the interior of the building by a material that remains in place for at least 15 minutes of fire exposure. SIPs covered with 1/2-inch gypsum drywall meet this requirement.

Commercial buildings may require a one-hour-fire-rated wall or roof, which is achieved by testing and listing a specific wall or roof assembly to ASTM E119 with an accredited certification agency. Contact individual SIPA member-manufacturers to confirm that they can provide listed assemblies.

IRC AND PRESCRIPTIVE METHOD

Section R610 of the International Residential Code (IRC) provides a Prescriptive Method for the design of SIPs used in wall systems in residential construction, based on structural insulated panels manufactured and identified in accordance with *ANSI/APA PRS 610.1 Standard for Performance-Rated Structural Insulated Panels* (available from www.apawood.org). Performance-rated structural insulated panels manufactured to the standard are sandwich panels consisting of a foam plastic insulation core bonded between two wood structural panel facings. "Performance-rated" refers to SIPs intended for use as wall panels and lintels in above-grade wall applications that meet the performance requirements as specified in this standard. Wall panels shall resist axial, transverse, and racking loads as set forth in ANSI/APA PRS 610.1. Lintels and headers over doors and window shall resist vertical loads. The Prescriptive Method in the IRC allows builders and design professionals using SIP walls in residential projects to show equivalency to the IRC without conducting or supplying additional engineering. Inclusion in the IRC recognizes structural insulated panels as equal to other code-approved building systems.

Section R610 of the IRC only covers SIP wall construction for residential buildings in the applicability limits listed in Table 2. Table 3 shows the maximum allowable loads for wall panel applications.

TABLE 2

APPLICABILITY LIMITS FOR SIPS USED IN SECTION R610 OF THE 2018 IRC

Building Dimension	Maximum building width is 40 feet (12.2 m)
	Maximum building length is 60 feet (18.3 m)
Number of Stories	2 story (above basement)
Basic Wind Speed	Ultimate design wind speed (V_{ULT}) up to 155 miles per hour (69 m/s) for Exposure B[a] or 140 miles per hour (63 m/s) for Exposure C[a]
Ground Snow Load	70 psf (3.35 kPa) maximum ground snow load
Seismic Zone	A, B and C
Building Height	Maximum 35 feet (10.7 m)
Load-Bearing Wall Height	10 feet (3 m) maximum per story

a. As defined by the provisions in ASCE 7-16.

Depending on the size of the window and other structural considerations, openings can be cut into a SIP wall without the addition of a separate header. Table 4 shows the maximum allowable spans for SIP headers in accordance with Section R610 of the 2018 IRC.

Tables 5 and 6 allow design and building professionals to specify SIP wall thicknesses using common load tables that document the performance of a standardized SIP based on various loading conditions.

TABLE 3

DESIGN VALUES FOR SIP WALL PANELS

ADAPTED FROM ANSI/APA PRS 610.1

SIP Panel Nominal Thickness (in.)	SIP Panel Height (ft)	Axial		Transverse		Shear (Racking)	
		Allowable Load (lbf/ft)	Deflection (in.)	Allowable Load (lbf/ft²)	Deflection[a] (in.)	Allowable Load (lbf/ft)	Deflection (in.)
4-1/2	8	3200	0.125	28	0.40	315	0.20[b]
4-1/2	10	3100	0.125	20	0.50	315	0.25
6-1/2	8	3200	0.125	28	0.40	315	0.20[b]
6-1/2	10	3100	0.125	20	0.50	315	0.25

a. Based on H/240, where H is the wall height in inches.

b. Based on the deflection limit for wood structural panels in accordance with PS 2.

TABLE 4

MAXIMUM SPANS FOR 11-7/8-INCH OR DEEPER SIP HEADERS (feet)[a,c,d]

ADAPTED FROM TABLE R610.8 OF THE 2018 IRC

Load Condition	Snow Load (psf)	Building width[b] (feet)				
		24	28	32	36	40
Supporting roof only	20	4	4	4	4	2
	30	4	4	4	2	2
	50	2	2	2	2	2
	70	2	2	2	DR	DR
Supporting roof and one-story	20	2	2	DR	DR	DR
	30	2	2	DR	DR	DR
	50	2	DR	DR	DR	DR
	70	DR	DR	DR	DR	DR

a. Design assumptions:
Maximum deflection criteria: L/240.
Maximum roof dead load: 10 psf.
Maximum ceiling dead load: 5 psf.
Maximum ceiling live load: 20 psf.
Maximum second floor dead load: 10 psf.
Maximum second floor live load: 30 psf.
Maximum second floor dead load from walls: 10 psf.
Maximum first floor dead load: 10 psf.
Strength axis of facing material applied horizontally.
DR = Design Required.

b. Building width is in the direction of horizontal framing members supported by the header.

c. The table provides for roof slopes between 3:12 and 12:12.

d. The maximum roof overhang is 24 inches (610 mm).

TABLE 5

NOMINAL THICKNESS (INCHES) FOR SIP WALLS SUPPORTING SIP OR LIGHT-FRAME ROOFS ONLY (ONE STORY)[a]
ADAPTED FROM TABLE R610.5(1) OF THE 2018 IRC

Ultimate Design Wind Speed V_{ULT} (mph)		Snow Load (psf)	Building Width (ft)														
			24 (ft) Wall Height			28 (ft) Wall Height			32 (ft) Wall Height			36 (ft) Wall Height			40 (ft) Wall Height		
Exp. A/B	Exp. C		8	9	10	8	9	10	8	9	10	8	9	10	8	9	10
110	-	20	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
		30	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
		50	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
		70	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	6.5	4.5	4.5	6.5
115	-	20	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
		30	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
		50	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	6.5
		70	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	6.5	4.5	4.5	DR	4.5	4.5	DR
130	110	20	4.5	4.5	6.5	4.5	4.5	6.5	4.5	4.5	6.5	4.5	4.5	DR	4.5	4.5	DR
		30	4.5	4.5	6.5	4.5	4.5	6.5	4.5	4.5	DR	4.5	4.5	DR	4.5	4.5	DR
		50	4.5	4.5	DR	4.5	4.5	DR	4.5	4.5	DR	4.5	6.5	DR	4.5	DR	DR
		70	4.5	4.5	DR	4.5	DR	DR	4.5	DR	DR	4.5	DR	DR	DR	DR	DR
140	120	20	4.5	6.5	DR	4.5	6.5	DR	4.5	DR	DR	4.5	DR	DR	4.5	DR	DR
		30	4.5	6.5	DR	4.5	DR	DR	4.5	DR	DR	4.5	DR	DR	4.5	DR	DR
		50	4.5	DR	DR	4.5	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR
		70	4.5	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mph = 1.61 km/hr

a. Design assumptions:
Deflection criteria: L/240
Roof dead load: 10 psf maximum
Roof live load: 70 psf maximum
Ceiling dead load: 5 psf maximum
Ceiling live load: 20 psf maximum
DR indicates design required.

TABLE 6

NOMINAL THICKNESS (INCHES) OF SIP WALLS SUPPORTING SIP OR LIGHT-FRAME STORY AND ROOF[a]
ADAPTED FROM TABLE R610.5(2) OF THE 2018 IRC

Ultimate Design Wind Speed V_{ULT} (mph)		Snow Load (psf)	Building Width (ft) (two story)														
			24 (ft) Wall Height			28 (ft) Wall Height			32 (ft) Wall Height			36 (ft) Wall Height			40 (ft) Wall Height		
Exp. A/B	Exp. C		8	9	10	8	9	10	8	9	10	8	9	10	8	9	10
110	-	20	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	6.5	4.5	4.5	DR	4.5	4.5	DR
		30	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	6.5	4.5	4.5	DR	4.5	6.5	DR
		50	4.5	4.5	4.5	4.5	4.5	6.5	4.5	4.5	DR	4.5	DR	DR	DR	DR	DR
		70	4.5	4.5	6.5	4.5	4.5	DR	4.5	DR	DR	DR	DR	DR	DR	DR	DR
115	-	20	4.5	4.5	4.5	4.5	4.5	6.5	4.5	4.5	DR	4.5	4.5	DR	4.5	DR	DR
		30	4.5	4.5	4.5	4.5	4.5	6.5	4.5	4.5	DR	4.5	6.5	DR	4.5	DR	DR
		50	4.5	4.5	6.5	4.5	4.5	DR	4.5	DR	DR	4.5	DR	DR	DR	DR	DR
		70	4.5	4.5	DR	4.5	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR
120	-	20	4.5	4.5	6.5	4.5	4.5	DR	4.5	4.5	DR	4.5	DR	DR	4.5	DR	DR
		30	4.5	4.5	DR	4.5	4.5	DR	4.5	6.5	DR	4.5	DR	DR	DR	DR	DR
		50	4.5	4.5	DR	4.5	DR	DR	4.5	DR	DR	DR	DR	DR	DR	DR	DR
		70	4.5	DR	DR	4.5	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR
130	110	20	4.5	6.5	DR	4.5	DR	DR	4.5	DR	DR	DR	DR	DR	DR	DR	DR
		30	4.5	DR	DR	4.5	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR
		50	4.5	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR
		70	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mph = 1.61 km/hr

a. Design assumptions:
   Deflection criteria: L/240
   Roof dead load: 10 psf maximum
   Roof live load: 70 psf maximum
   Ceiling load: 5 psf maximum
   Ceiling live load: 20 psf maximum
   Second floor live load: 30 psf maximum
   Second floor dead load: 10 psf
   Second floor wall dead load: 10 psf
   DR indicates design required.

ABOUT SIPA

The Structural Insulated Panel Association (SIPA) is a non-profit association dedicated to increasing the use and acceptance of structural insulated panels (SIPs) in sustainable building by providing an industry forum for promotion, communication, education, quality assurance, and technical and marketing research.

Builders and design professionals seeking to reduce energy use and minimize the carbon footprint of their buildings select SIPs as a cost-effective solution for exterior wall and roof systems that also cuts down on framing time, significantly reduces construction waste, and ensures greater jobsite quality control through prefabrication. SIPs are an enabling technology to meet the Architecture 2030 Challenge for net-zero, carbon neutral buildings.

For more information, contact the Structural Insulated Panel Association, P.O. Box 39848, Fort Lauderdale, Florida 33339, or visit the Association's web site at www.sips.org.

More Information on Structural Insulated Panels from SIPA

- ***Structural Insulated Panel Engineering Design Guid***e—More than 200 pages of detailed design specifications and commentary for the design professional, with 11 example calculations and an online interactive software calculation tool. Available upon request at http://www.sips.org/designguide or by emailing info@sips.org.
- ***Residential Design with SIPs and Commercial Design with SIPs***—narrated one-hour video courses with optional AIA continuing education credit. Available online at http://www.sips.org/training/aia-continuing-education.
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- ***www.sips.org***—SIPA's website provides building education, case studies, profiles, project database/map of SIP installations, publications and construction guides, a directory of members and builders, and much more.

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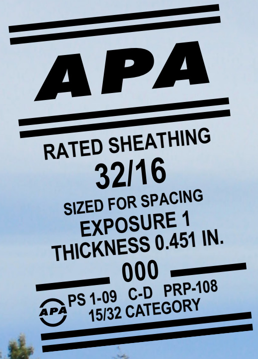

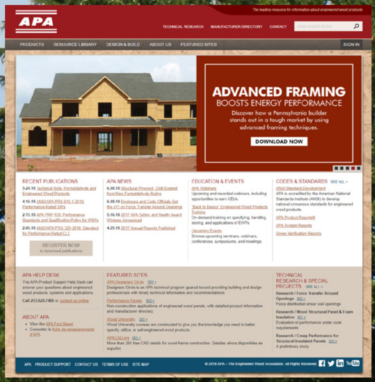

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