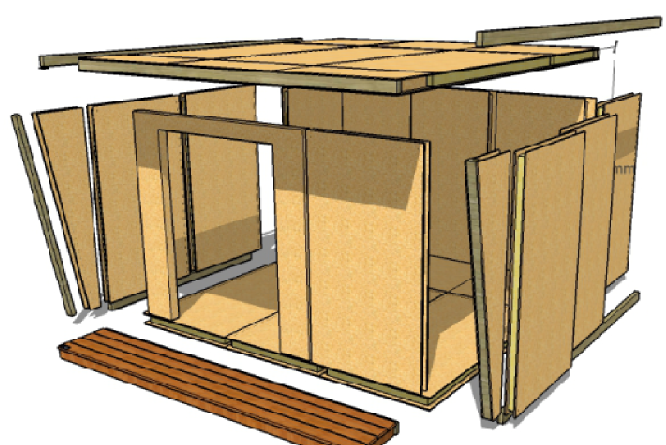
SIPs and Green Building Design

SIPs and Residential Applications

By Karwan Ali Noori



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ADVANTAGES & BENEFITS

Energy Efficiency

- Due to their components and the homogeneous material layers, SIPs have a high R-Value that gives you an excellent thermal performance, therefore lower monthly energy bills. As an example, for a typical SIP panel 12 cm thickness, R-Value = 4,55 m2 K / W.

Environmental Sustainability

· SIP technology sustains the earth's natural resources, due to its GREEN, RECYCLABLE components:

o 65% of the materials can be used again after lifespan period, compared to 25% on concrete, 35% on steel structure and 65% on conventional timber frame

o No "heavy" industry production for iron, cement, aggregates, bricks etc. needed

· SIP comes from one source only, as an integrated building system, therefore there is less impact on the environment:

o Less air and water pollution, gas emission, CO_2 emission compared to other systems (concrete, bricks, steel) on the construction stage as well as on the running period of the building (due to the excellent energy efficiency and air tightness)

o Less transportation and less waste materials being put into our landfills

· SIP panels are very airtight giving you precise control over the indoor air quality of your home, which helps to keep out allergens, humidity or dust

· SIP System is the most compatible with the photovoltaic systems, solar s: close to zero energy buildings

Safety and Strength

· University studies have proven that such buildings are significantly superior to the conventional constructions, therefore you will feel more secure in a SIP home

· As the MGO Board (applied on the two faces of the panels) is fire resistant, a SIP building protects your house and yourself against fire

· SIP is fully designed and fabricated in a controlled factory environment, ensuring accurate dimensioning and tolerances, therefore the end product that arrives on site is accurate and defect free; this assures the quality of your building

· SIP constructions are certified for 60 years lifespan, while the concrete buildings have a scientific lifespan of 50 years

Design Flexibility

· SIP can be erected on any flooring system, giving you unlimited design possibilities, while saving the usable area

· Any changes can be made to existing properties: extra rooms or floors, attic, within a short time to reach the final desired result

Cost efficiency

· SIP basic construction cost is 30% less than conventional concrete buildings

· Exact construction planned costs and precise quantity of materials needed, as on site cutting and fabrication are eliminated. This means you will not have unexpected costs or surprises from your contractor

· Low cost modifications and fast rate of construction, which will minimise the time, cost and labour force on your project

· Major running and maintenance cost savings over the lifetime of the building, therefore extremely low costs on energy, repairs or design changes

Time Savings - Build more in less time

- The SIP wall is load-bearing and pre insulated, meaning the weatherproof, structural shell is completed much quicker than traditional methods of construction
- Erection times are known in advance, therefore SIP technology offers an accurate delivery date of your turn-key building

Cutting Energy Down to Zero

Although often overlooked, U.S. homes account for 15 percent of the nation's energy use. As such, the Department of Energy's (DoE's) Building Technology program has made its goal to reduce residential consumption through the development and market adoption of the zero-energy home (ZEH) concept.[1]

ZEHs produce as much energy as they consume—a quality depending heavily on foam plastic insulation building assemblies, such as structural insulated panels (SIPs), to form an airtight building envelope that cuts energy used for heating and cooling. Relying on both plastics and traditional building materials, the combination of SIPs and other energy-efficient technologies brings the ZEH concept closer to the mainstream than many design professionals might think.

Plastics can be an important part of these zero-energy homes, as they only result in the use of about five percent of all fossil fuels, according to 2005 information from the Energy Information Administration.

Conceptual ZEH development

Hand in hand with the zero-energy concept is the successful integration of energy-efficient technologies and renewable energy sources. Roof-mounted photovoltaic (PV) arrays convert sunlight to energy that can be used in the home. During off-peak hours and during ideal, sunny conditions, these PVs produce more electricity than necessary. The excess is sold back to the local utility through the grid and credited to the home's account to purchase energy during peak times or at night when consumption exceeds generation.

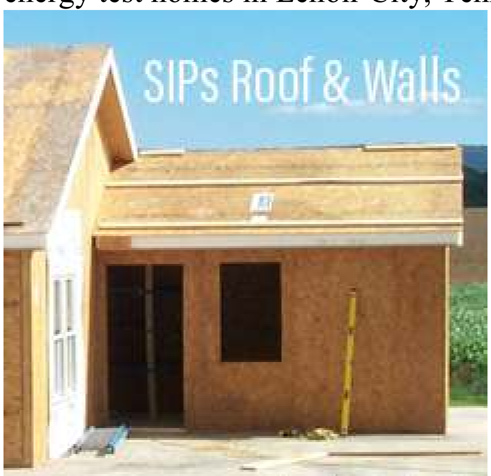
These homes have the potential to significantly affect energy consumption across the nation if the concept can be readily and affordably incorporated into the U.S. housing industry. The DoE recognizes affordability is the primary hindrance barring the widespread acceptance of ZEHs. For this reason, it sponsors continuing research and development, and implements tax credits for PVs and 'whole-house' energy savings under the *Energy Policy Act of 2005 (EPAct 2005)* to make energy-efficient homes an economical option for builders and homebuyers.[2]

Photovoltaic units account for a large portion of the incremental cost of a ZEH versus a conventional home. In recent years, these arrays have become increasingly more efficient and economically justifiable, but the price still hovers around $6500 to $10,000 per kWp.[3] Due to the high costs of photovoltaics, ZEHs must rely heavily on a high-performance building envelope and other energy-efficient technologies to reach the goal of net-zero energy use.

In other words, ZEH is not a single technology, but rather an assembly of integrated systems carefully specified to achieve cost-effective energy savings. An airtight envelope and other technologies can reduce home energy use by approximately 70 percent, leaving the remainder of energy savings to be supplied by a small PV system.[4](Savings may vary. Suppliers should be consulted to understand the energy trade-offs.)

Structural insulated panels

Between 2002 and 2005, Oak Ridge National Laboratory (ORNL)—the DoE's test facility— built and monitored five zero-
energy test homes in Lenoir City, Tennessee. The homes, which ranged in size



from 98 to 241.5 m2 (1056 to 2600 sf), were built as part of a Habitat for Humanity subdivision and designed with construction costs suitable for the non-profit organization. ORNL specified structural insulated panels for walls and roofs in all five homes; this decision was b
ased on the
performance of SIPs in ORNL tests of whole-wall R-value and air tightness for various wall assemblies. In 1996, ORNL began studying the whole-wall R-values of more than 400 wall assemblies.

Whereas insulation R-values measure the thermal resistance of insulation in a cavity, whole-wall testing gauges the insulating ability of an entire wall section, taking into account the thermal bridging of studs and other structural members in the walls. As much as 45 percent of a home's energy use is for heating and cooling, making a well-insulated building envelope a critical ZEH component. [5] SIPs are composed of a rigid foam core of insulation sandwiched between two structural skins. Different core materials can be used, including expanded polystyrene (EPS), polyurethane, polyisocyanurate (polyiso), and extruded polystyrene (XPS). All these materials provide high levels of insulation and are entirely consistent within the panel, interrupted by minimal framing lumber. SIP skins are typically made of oriented strandboard (OSB), but can also be made of other materials for specific applications.

SIPs derive their structural properties from the skins and their laminated construction, meaning

they can be assembled with little dimensional lumber. Traditional framed walls in residential construction average a framing factor (i.e. ratio of stud area to whole opaque exterior wall area) ranging from 25 to 27 percent, depending on seismic requirements, while SIP walls average three percent.[6]

In the ORNL tests, the advantages of consistent foam insulation in SIPs showed a clear advantage over stud-framed walls. A wall with R-19 fiberglass insulation and 2×4 studs 406.4 mm (16 in.) on center (oc) tested at R-9.6 in ORNL's rotatable guarded hot-box apparatus in accordance with ASTM International C 236, Steady-state Thermal Performance of Building Assemblies by Means of a Guarded Hot-box.

A 114.3-mm (4.5-in.) SIP wall with 0.131-kg/m3 (1-pcf) EPS insulation measured at R-14. With conventionally framed homes subject to sizeable energy loss through thermal bridging, advanced foam insulated building systems such as SIPs or insulating concrete forms (ICFs) play an important role in the development of ZEHs (although individual performance may vary).[7]

In addition to requiring high R-value insulation, a functional ZEH needs the building envelope to be effectively sealed. Air infiltration can have an extremely detrimental effect on energy efficiency, with convective loss accounting for as much as 30 percent of a home's heating and cooling expenses.[8]

"When you are talking about high-performance homes even approaching zero energy, you've got to have airtightness," says Jeff Christian, ORNL director of the laboratory's Building Technology Center. "It is easy to get an airtight envelope with SIPs because you can measure the final airtightness of a house with SIP walls and roof prior to installing drywall."

Establishing an air barrier can be simple and effective with OSB rated at 0.9 perms laminated on both sides of the panel.[9] OSB-faced SIPs can be manufactured as large as 2.4 x 7.3 m (8 x 24 ft), with far fewer joints to seal than conventional framing. The U.S. Environmental Protection Agency (EPA) recognizes this advantage of SIP homes and does not require a blower door test to check for air leakage to achieve qualification for the Energy Star program.

According to Sam Rashkin, the national director of Energy Star for Homes, "a SIP house has less cracks, less joints, and less complicated interfaces between conditioned and unconditioned spaces, and is dramatically easier to make tight."

Joints between panels are sealed with insulated splines, SIP sealing mastic, and/or expanding polyurethane foam at every edge where panels meet. A specially designed self-adhesive SIP tape is available for application to interior roof joints to reinforce the seal and prevent the intrusion of warm moist air from the interior into panel joints.

Tests in ORNL's large-scale climate simulator of a small 3.3 x 3.3-m2 (10.9 x 10.9-ft) SIP room showed it to be 14 times tighter than an identical room with 2×6 framing, batt insulation, and sheathing.[10] While performance may vary, the low air infiltration test results capable with structural insulated panels were replicated in the ORNL zero-energy homes and contributed to their energy savings.

Each Oak Ridge home underwent a blower door test before completion to measure airtightness. The natural infiltration rate in these houses is less than 0.1 air change per hour (ach), while other conventional frame homes of similar size built by the same Habitat for Humanity affiliate ranges from 0.2 to 0.25 (see Table 1, page 11).

Low levels of air infiltration can enable better indoor air quality (IAQ), in addition to reducing convective energy loss. SIP homes require mechanical ventilation per American Society of Heating, Refrigerating, and Air-conditioning Engineers (ASHRAE) 62.2, *Ventilation and Acceptable Indoor Air Quality in Low-rise Residential Buildings*, to supply fresh air to occupants. Tight homes can also be effectively dehumidified to reduce mold growth, especially in hot/humid climates.

Energy savings

Each ZEH built by ORNL used a different combination of energy-efficient technologies. All five homes used either 114 or 165-mm (4.5 or 6.5-in.) SIP walls and a SIP roof of 165, 203, or 254 mm (6.5, 8, or 10 in.) thickness. Photovoltaics ranging from 1.98 to 2.2 kWp provided the homes with renewable energy. Other energy-saving equipment used included high-efficiency windows, HVAC, appliances, and lighting. Two homes used a geothermal heat pump, four relied on a heat pump water heater, and one employed a solar water heater.

Oak Ridge scientists installed between 30 and 80 sensors in each home to monitor energy use for the first year of habitation. The occupants were given basic direction in energy-saving measures and were free to operate equipment in the house as they wished. Results from these homes resemble real-world conditions for future ZEHs (Table 2). The homes were serviced by the Tennessee Valley Authority (TVA) at a local rate of \$0.068/kWh and were able to sell all the solar power back to the utility at \$0.15/kWh. The first four homes (data for ZEH 5 was unavailable at the time this article was written) had average energy costs between \$0.75 and \$1.00 a day, falling short of net-zero energy, but achieving significant energy reductions and taking a major step towards achieving the goal of zero energy by 2025.

ZEH 4 was the most efficient home, despite being one of the largest. The The 111.5-m^2 (1200-sf) home features a walk out basement of polyiso T-mass foundations and more doors and windows than the smaller homes. ZEH 4 used only 9934 kWh the first year, amounting to $275 in annual utility costs or an an average of $0.75 daily. The highly efficient SIP building envelope cut heating and cooling costs to $0.49 daily.

Forecasting the future

Although the concept of a net-zero energy home is now feasible, the high costs of PV arrays keep the goal of zero energy slightly out of reach for the average homebuyer. This year's Energy Value Housing Award (EVHA)-winning home, by Anderson Sargent Custom Builder LP, used net-zero energy at a construction cost of $171/sf. The home used 8 kWp of PV array and sold for $1 million.[11] In comparison, ZEH 4 was constructed for $93/sf.

A recent survey conducted by the National Association of Home Builders (NAHB) Research Center showed 83 percent of homebuyers would be willing to purchase a ZEH if the utility savings offset increased mortgage payments.12 The NAHB Research Center claims it would be possible to produce ZEHs to meet such a buyer requirement, assuming research and development continues to lower the costs of PVs and if federal or state governments offer a 30-percent tax credit on photovoltaics similar to EPAct 2005.

Market research into this hypothetical scenario predicts ZEHs would reach 67 percent market penetration into new housing starts by 2050, accounting for 17 percent of the cumulative single-family housing stock. If each home uses net-zero energy, ZEHs would reduce national energy use by approximately three Quads, or 2.55 percent of the nation's total energy use.

Structural insulated panels and other highly efficient plastic insulation products play an important role in the nation's energy state. The concept of zero-energy homes is impossible without the enabling building envelope. Whether used in ZEHs or simply to increase the efficiency of the average home, multifamily structure, or

commercial building, SIPs can help reduce energy consumption and push the United States toward a sustainable future.

Premier SIPS Five quick steps will have you up to speed and ready to frame your structures with SIPS.

Step 1:

Get the basics… view our SIPS Basics page, our SIPS vs. Sticks page and then read our Premier SIPS Advantage Brochure. After, you'll be able to grasp a full outline of SIPS basics, the science behind the energy efficiency in SIPS, energy efficiency documentation, environmental points (LEED, etc.) and the benefits of using SIPS for Contractors, Architects & Building Owners.

– OR –

If you're a design professional or a contractor in need of continuing education credits (or really want to learn more fast!), take our online accredited course 24/7 (anytime) for 1 credit hour. Take the course now.

Step 2:

View the DIY Network's FRAMING episode to discover what the best materials are for framing your building project. The Deconstruction show gives its perspective on "Is it better to frame with two by fours or prefabricated SIPS?" Featuring Premier SIPS, this 20 minute episode shows how our SIPS are made and then put through some impressive stress tests to demonstrate just how strong Premier SIPS really are.

Step 3:

You've grasped the basics, now sign up for instant access to our detailed SIPS virtual training modules. These training courses are complimentary and specifically curated for you to be ready to design and build with Premier SIPS. *Sign up here.*

Step 4:

Browse through all of our SIPS overview & installation videos, for basics, installation tips and testimonials from the last 30 + years that Premier has been involved in manufacturing and distributing SIPS.

Step 5:

Check out our detailed installation tips & tricks, with information grouped by project element to help you grasp our recommendations for best practices when installing SIPS.




Wood:TheNaturalChoice

Engineeredwoodproductsareamongthemostbeautifulandenvironmentally friendlybuildingmaterials.Inmanufacture,theyareproducedefficientlyfroma renewableresource.Inconstruction,thefactthatengineeredwoodproductsare availableinawidevarietyofsizesanddimensionsmeansthereislessjobsitewaste andlowerdisposalcosts.Incompletedbuildings,engineeredwoodproducts arecarbonstorehousesthatdeliverdecadesofstrong,dependablestructural performance. Plus, wood's natural properties, combined with highly efficient wood-frameconstructionsystems,makeitatopchoiceinenergyconservation.

A few facts about wood:

We'regrowingmorewoodeveryday. Forthe 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 woodedlands coverover40percentofNorthAmerica'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 landownersplant more than two-and-a-half billion new trees every year.[5] In addition, millions of trees seednaturally.

Manufacturing wood isenergy efficient. Over 50 percent of the energy

LifeCycleAssessmentmeasuresthelong-termgreenvalueofwood. StudiesbyCORRIM(Consortium for Research onRenewableIndustrialMaterials) give scientific validation tothestrengthof wood as a green building product.Inexaminingbuildingproducts'lifecycles—from

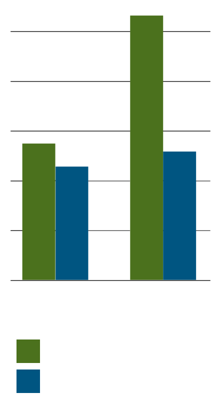
U.S. Forest Growth and AllForestProductRemovals

Billionsofcubicfeet/year

30
25
20
15
10
5
0

extraction of the raw material to dem- olition 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.

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.



Wood adds environmental value throughout the life of a structure.

When the goal is energy- efficient construction,wood's lowthermalcon- ductivitymakesitasuperiormaterial. Asaninsulator,woodissixtimesmore efficient than an equivalent thickness of brick, 105 times more efficient than concrete, and 400 times more efficient than steel.[7]

Goodnewsforahealthyplanet. Foreveryton of wood grown, a young forest produces 1.07 tons of oxygen and absorbs 1.47 tons of carbondioxide.

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

1. UnitedStatesDepartmentofAgriculture,U.S.ForestService,FS-979,June2011;2.FAO,UN-ECE(1996)NorthAmericanTimberTrendsStudy.ECE/TIM/SP/9.Geneva;Smithetal.(1994),ForestStatisticsoftheUnitedStates,1992. Gen.Tech.Rep.NC-168;3.UnitedStatesDepartmentofAgriculture,U.S.ForestService;FS-801RevisedSeptember2009;4.U.S.DepartmentofAgriculture,U.S.ForestService,August2014;5.ForestLandownersAssociation, 2011;6.U.S.EnvironmentalProtectionAgency,March2007;7.ProducedfortheCommonwealthofAustraliabytheInstituteforSustainableFutures,UniversityofTechnology,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.

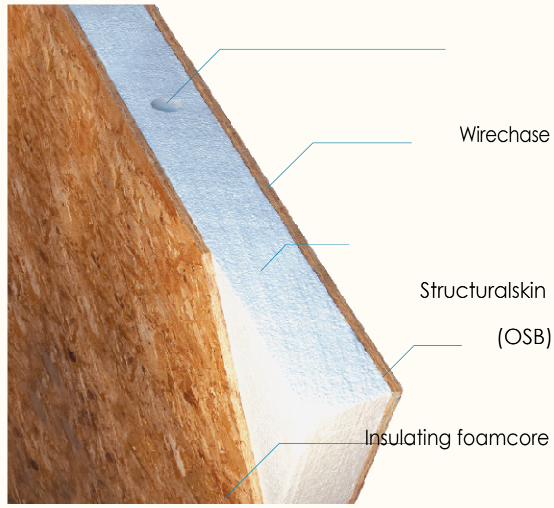
WHAT ARE SIPS?

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 easyinstallation.

FIGURE 1

SIPS PANELDETAILS



TheSIPfabricationprocessusuallybeginswithacomputer aided design(CAD) drawing of the building.Panel manufacturersconverttheCADelectronicdrawingsintoshopdrawingsthatareeitherdigitallytransferredtocomputer numericallycontrolled(CNC)automatedcuttingmachinesorusedtomeasureandcutpanelsbyhand. "Chases" or channelsforelectricalwiringarecutorformedintothefoamcore,andthefoamedgesarerecessedtoacceptconnection splinesforjoiningtoadjacentpanels.FabricatingSIPsunderfactory-controlledconditionsachievestolerancesfarmore 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 seismiczones.

Structuralinsulatedpanelssatisfysingleandmultifamilyresidentialaswellaslightcommercialstructuralrequirements. SIPsaremostcommonlyusedinwallsandroofs,buttheycanalsobeusedinfloorsandfoundations.

WHYSIPS?

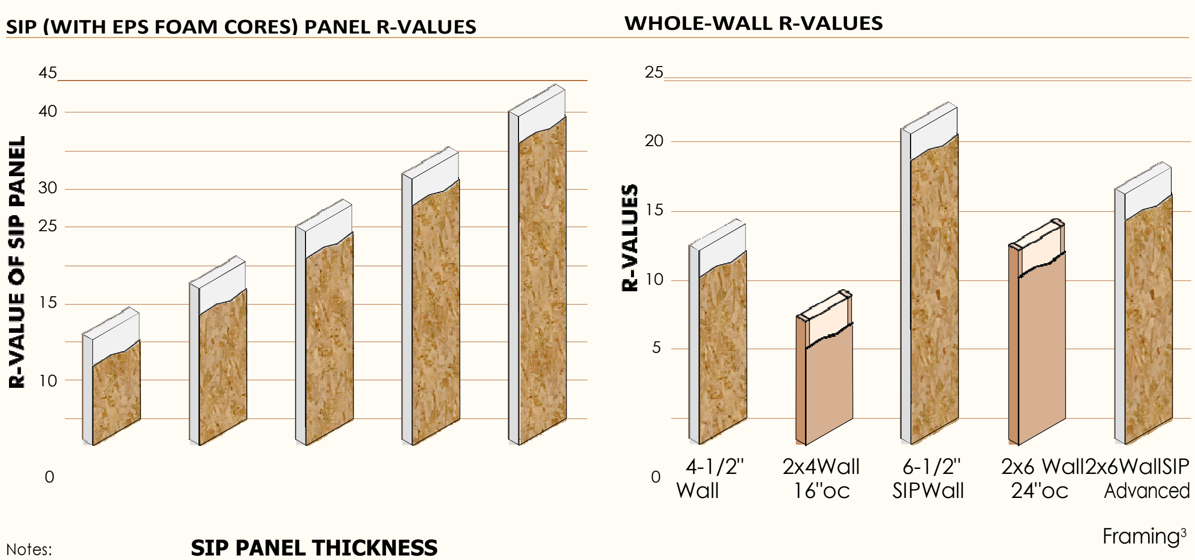
The SIP building system saves builders time, money, and labor while producing high-performance, sustainable, and resilient buildings that economically meet or surpass the newestenergycodes,greenratingsystems,andcontinuous insulation requirements. SIP structures offer occupants superior comfort and indoor environmental quality (IEQ). Thermalstabilitywithconsistenttemperaturesthroughout multistory structures, no drafts from air leakage, and enhancedacousticperformanceallcontributetoSIPs'highp erformance.

SIPS SAVE ENERGY

Energyefficiencyandenvironmentalresponsibilityaretwohallmarksofasustainablebuilding.Buildingsthatuseless energyandgeneratelesscarbondioxideemissionshaveasmallerimpactontheenvironment.

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 asawall's "framingfactor." Theframingfactorcontributestothermal bridging. Themoreframing,thehigherthe 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



Notes:

1. ThefirstgraphshowsdifferentrangesofSIPpanelthickness'sR-Values.
2. Calculatedwhole-wallR-valuesfromOakRidgeNationalLaboratory,*WholeWallRating/LabelforStructuralInsulatedPanels:Steady-StateThermalAnalysis*,1999.
3. SeeAPA*AdvancedFramingConstructionGuide*,FormM400forwhole-wallR-valuesusingadvancedframing.

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 THEENVIRONMENT

Withrisingconcernsoverglobalclimatechange,designers and builders are focusing on reducing the environmental impact of homes and commercial buildings. SIPs help achievethismissionbysavingenergyandvaluablenatural 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 standardsundermanygreenbuildingratingsystems,such as the Leadership in Energy and Environmental Design (LEED),GreenGlobes,andNationalAssociationofHome Builders' NationalGreenBuildingStandard, ICC-700.

SIPs are both energy-efficient and an efficient use of resources, making them an ideal choice for a high-performancebuilding.TheOSBusedinSIPskinsismade from rapidly renewable trees that are harvested from sustainably managedforests.

TheinsulatingcoreusedinSIPsisalightweightstructural foamcomposedof98percentair,andrequiresarelatively small amount of raw material to produce. Both EPS and polyurethane-based foam insulations are made using non-chlorofluorocarbon (CFC) blowing agents that do notthreatentheearth'sozonelayer.

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

SIPsofferseveralinherentadvantagesduetotheirengineeredfabricationandstructuralabilities.SIPsareanintegrated system.ThemanufacturingprocessisfullyintegratedwiththeCADdesignprocess.Thisintroducestheflexibilityand accuracyofCADdesignintotheactualconstructionofthehome.Theentirebuildingprocessfromdesigntofinished constructiontakeslesstimeandisclosertothedesignspecificationswithaSIPstructure.

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.

SIProofsconnectingtoSIPwallscreateacontinuousthermalenvelopeeliminatingtheneedforanattic.Thisnotonly savesresourcesandkeepsairductworkinsidethethermalenvelope,butallowsforalarge,opensensationwithvaulted ceilings which can make small rooms feel more spacious. Complex features such as dormers can be built easily with SIPs and installed rapidly in onepiece.

APPLICATIONS

Custom Homes

For the custom-home market, SIPs offer a cutting-edge product that can deliver a variety of custom designed elements.Inanydesign,SIPscreateasolidandenergy-efficient structure with trim and interior finishes that match the accurate, engineered construction of the exteriorpanels.

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, becauselessskilledlaborisneededtoerectaSIPbuildingthanaconventionalstick-framedhome.

e. Phillips,Judith.*HousingStrategiesforMississippi*. JohnC.StennisInstituteofGovernment,MississippiStateUniversity.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

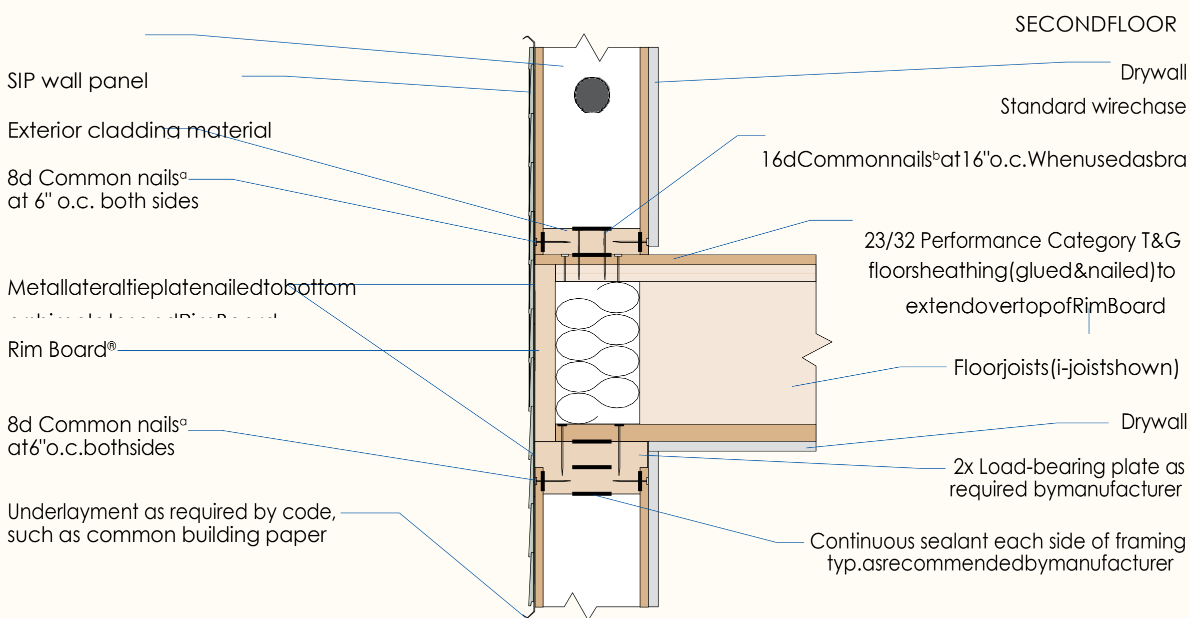
Although 4x8-foot panels can often be unloaded and set by hand, jumbo 8x24-foot panels weigh up to 700 pounds and require the use of equipment to unload and install. To set jumbo wall and roof panels, an extending boom forklift, boom truck, or crane is used. Site conditions need to be taken into consideration 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 f loorsystems when constructingahomewithSIPs.Inahangingfloorsystem, 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 SIPmanufacturers.

FIGURE 3

SECOND FLOOR CONNECTION DETAILS – RIM BOARD®



a. 8dCommonnail–0.131"x21/2"fullhead
b. 16dCommonnail–0162"x31/2"fullhead

RimBoard®isaregisteredmarkofAPA-TheEngineeredWoodAssociation

SIP CONNECTION DETAILS

1 SECONDFLOORCONNECTIONDETAIL–HANGINGFLOOR

SIPwallpanel

SECOND FLOOR

Exterior cladding material

Drywall

Standard wire chase

2x Bottom plate

16dCommonnails[b]at16"o.c. Whenusedasbracing,(3)16dc ommonnailsat16"o.c.

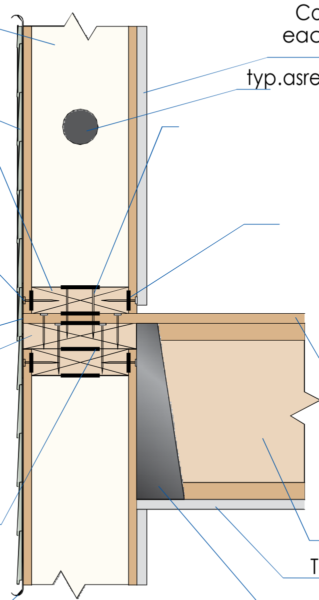
8d Common nails[a] at 6" o.c. both sides

Continuoussealant eachsideofframing typ.asrecommendedby manufacturer

Metal strap as required or LTP4 Simpson clip (or equal)

Cap plate

Continuous sealant each side of framing typ. as recommended by manufacturer



23/32 PERFCATT&G floorsheathing (glued&nailed)t o extendover topofSIPwall

Common building paper or house wrap, as required by code

Floorjoists

Drywall

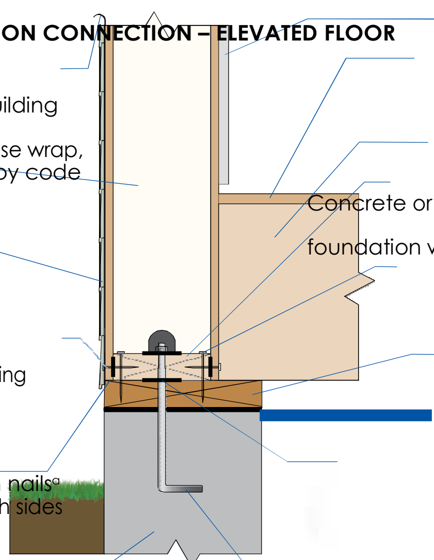
Topflangemetalfl oor joisthangar (byothers)

FIRSTFLOOR

2.FOUNDATION CONNECTION – ELEVATED FLOOR

Common building paper or house wrap, as required by code

Drywall



Concrete or masonry foundation wall

SIP wall

Exterior cladding material

8d Common nails[a] at 6" o.c. both sides

Be sure outside skin is supported by sillplate

3 EAVES CONNECTION DETAIL

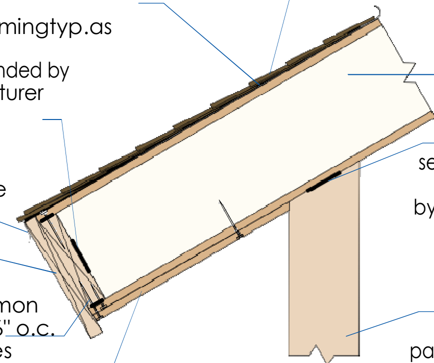
Asrequired,extendiceand watershieldfromfascia

Finished roofing material

Roofingfelt

Continuous sealant each sideofframingtyp.as recommended by manufacturer

SIProof panel



Continuous sealantasrecom mended bymanufacturer

Drip edge flashing

Fascia

8d Common nails[a] at 6" o.c. both sides

Roof-to-wall panelconnection detail shownin Figure8

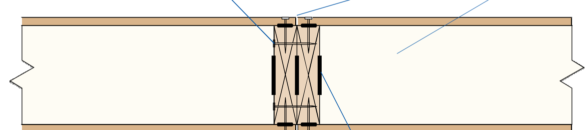
Soffit board

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

Gap 1/8"

(2) Rows 16d Common nails[b] at 16" o.c. minimum

SIP panel



8d Common nails[a] at 6" o.c. each panel and each side

Continuous sealanteach side of framingtyp. as recommendedby manufacturer

1.

Subfloor or combined subfloor and underlayment

Floorjoist

Fieldinstalled panelbottom plate

3.

16dCommon nails[b] intosillpl ateat16"o.c.

Treated sillplate

Sillsealer

Continuoussealant eachsideofframingty p.asrecommendedby manufacturer

Minimum1/2" diameter anchor bolts at6feeto.c.maximum

a. 8dCommonnail–0.131"x21/2"fullhead

b. 16dCommonnail–0162"x31/2"fullhead

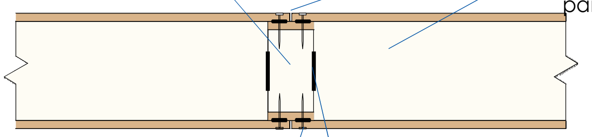
5 WALL-TO-WALL VERTICAL PANEL CONNECTION – BLOCK SPLINE

SIP panel spline

Gap

1/8"SIP

panel

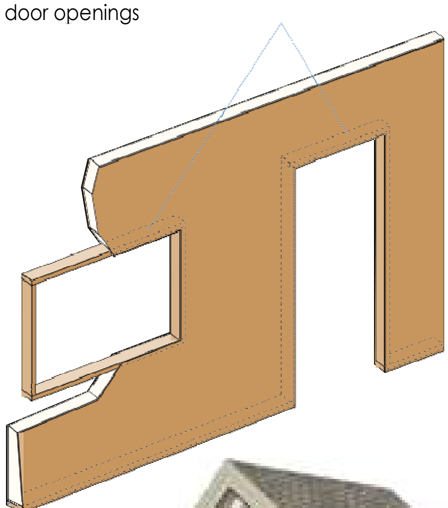


8dCommonnails[a]at6"o.c.e achpanelandeachside

Continuous sealant each side of framing typ. as recommended by manufacturer

6 DOOR AND WINDOW FRAMING

2x Framing around windows and door openings



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

8d Common nails[a] at 6" o.c. both sides

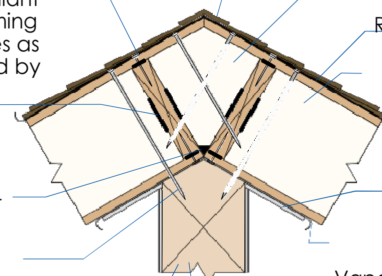
Finished roofingmaterial

Continuous sealant eachsideofframing and both faces as recommended by manufacturer

Foamridgecap

RoofingfeltSIP

roofpanel



Sealant as recommended bymanufacturer

Drywall

SIPscrewswith1"

min. penetrationinto

structural support

at 24" o.c. minimum

Vaporretarderas recommendedby

manufacturer to

meetbuildingcodes and/orenvironmental

considerations.

Continuous field installed wood ridge support beam shown

Structuralsupportmember withmin.1-1/2"bearingforeachsid eofpanels

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

Finished roofing material

Vapor retarder as recommended by

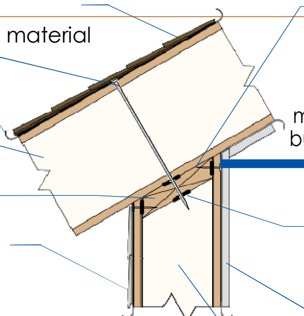
manufacturertomeet building codesand/or

environmental considerations

SIPscrew

Roofing felt

SIP roofpanel



8dCommonnails[a] at6"o.c.bothsides

Topplate

Exterior cladding material

Continuoussealant eachsideofframing,a ndroofpanel2xjoint

Drywall

SIPwallpanel

Common building paper or housewrap, as required by code

a. 8d Common nail – 0.131" x 2 1/2" fullhead

b. 16d Common nail – 0162" x 3 1/2" fullhead

MECHANICAL SYSTEMS

Electrical

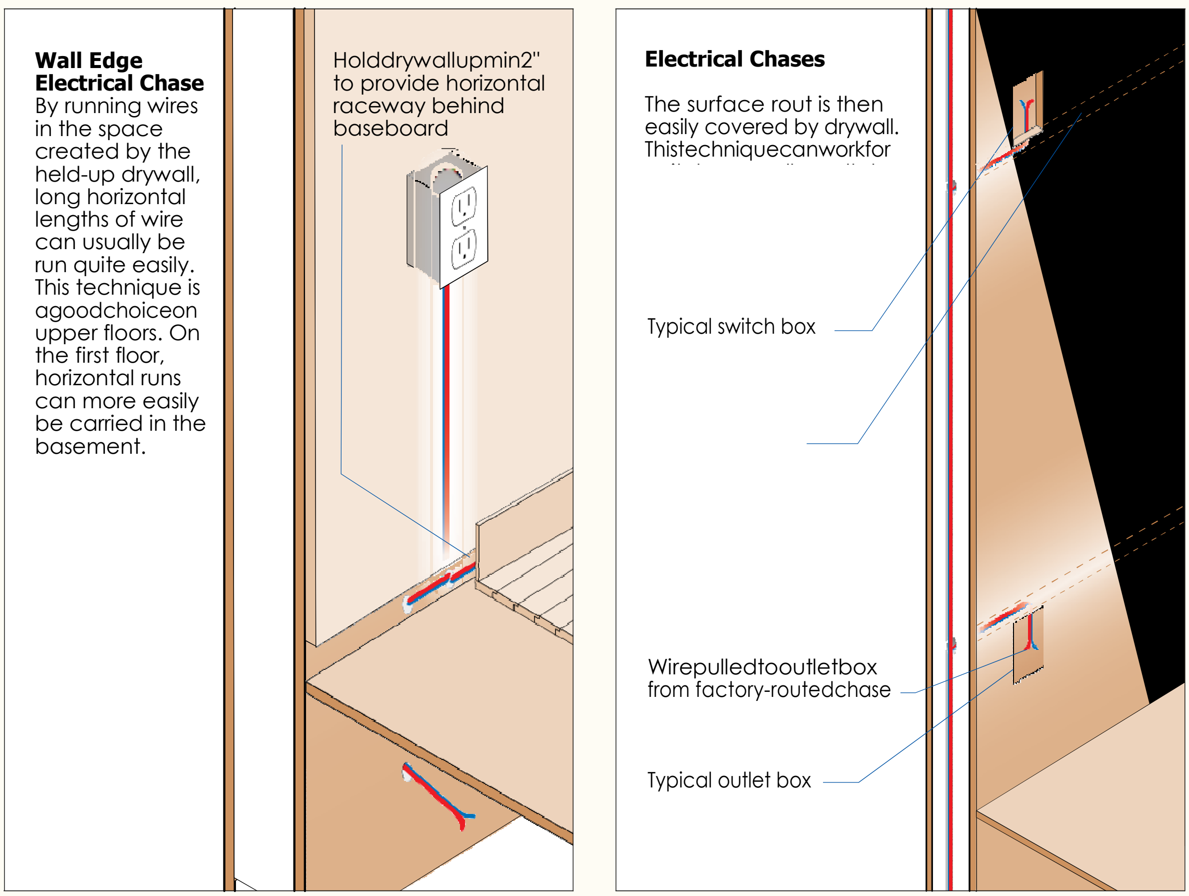
Electrical wires are pulled through precut channels inside the core of the panels called chases. Manufacturers cut or form chases both horizontally and vertically during the fabrication process according to the electrical design of the home. Plug outlets and switch boxes can also be precut at the factory. 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

SIPbuildingsareextremelytightstructureswithlevelsofairinfiltrationlowerthantheaveragestick-built structure.WhenworkingwithanHVACcontractor,makesuretheircalculationstakeintoaccountthelowairinfiltration andhigherR-valuesofaSIPhome.ProperHVACsizing,accordingto*AirConditioningContrActorsofAmericA(ACCA)* ManualJcalculationsiscrucialbecauseanoversizedHVACsystemwillfailtoreachthesteadyoperatingratefor whichtheequipmentwasdesigned.Short-cyclingHVACequipmentwillbelessenergyefficientandrequiremore maintenancethanproperlysizedHVACequipment.Short-cyclingHVACequipmentalsoleadstoexcessivehumidityin structuresduringcoolingseasons.IncreasedinsulationperformanceofSIPstructures,inadditiontotheirairtightness overconventionalconstruction,almostalwayssignificantlyreducesrequiredHVACdemandsbeyondwhattypical contractorsestimate.Reducedloadsoftenallowforcost-savingductlessmini-splitunits.SuperiorSIPenvelopesprovide thermalconsistencywithinmultilevelhomes,allowingforlessexpensiveandcomplexsinglezonesystems.

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 heatbeingexhaustedfromthehomeandutilizeittoheatthefreshaircomingintothehomeforanevenmoreefficient use of energy. Proper ventilation is crucial in structures with low air infiltration to prevent condensation that can lead to moldgrowth.

ASSEMBLY

Sealing

All joints between panels need to be sealed according to manufacturerspecifications.Sealingistypicallydonewith specially designed SIP sealing mastic, expanding foam, and/or SIP sealingtape.

Sealing is crucial to achieve the potential envelope tightness capable with structural insulated panels. An improperlysealedhomeisnotonlyenergy-inefficientbut is also subject to moisturedamage.

ProperSealingisespeciallyimportantwheninstallingSIProofs.TheridgeofaSIProofcanuseeitherbevel-cutSIPs for a flush joint or a beveled foam block insert. The ridge detail is a critical construction detail that requires attention tosealingusingmethodsasnotedabove.Manufacturerspecificationswillprovidespecificsealingdetailsdesignedto prevent moisturemovement.

Exterior Finishes

ExteriorfinishingmaterialscanbeappliedeasilytoSIPs.SIPsprovideauniformnailingsurfaceforexteriorfinishes.A water-resistive barrier must be installed between SIPs and siding in accordance with the code or the recommendation oftheSIPmanufacturer.Thismaybeeitherbuildingpaperorhousewrap.SidingshouldbeattachedtoSIPsaccording tothesidingmanufacturer'sspecifications.

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 windows 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 (12.2m)
	Maximum building length is 60 feet (18.3m)
Number of Stories	2 story (above basement)
Basic WindSpeed	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 SnowLoad	70 psf (3.35 kPa) maximum ground snowload
Seismic Zone	A, B and C
Building Height	Maximum 35 feet (10.7m)

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.

Tables5and6allowdesignandbuildingprofessionalstospecifySIPwallthicknessesusingcommonloadtablesthat documenttheperformanceofastandardizedSIPbasedonvariousloadingconditions.

TABLE 3

DESIGN VALUES FOR SIP WALL PANELS

ADAPTED FROM ANSI/APA PRS 610.1

SIP Panel		Axial		Transverse		Shear(Racking)	
Nominal Thickness (in.)	SIP Panel Height (ft)	Allowable Load (lbf/ft)	Deflection (in.)	Allowable Load (lbf/ft^2)	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 ininches.

b. BasedonthedeflectionlimitforwoodstructuralpanelsinaccordancewithPS2.

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
	20	4	4	4	4	2
	30	4	4	4	2	2
	50	2	2	2	2	2
	70	2	2	2	DR	DR
	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. Designassumptions:

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. Buildingwidthisinthedirectionofhorizontalframingmemberssupportedbytheheader.

TABLE 5

NOMINALTHICKNESS(INCHES)FORSIPWALLSSUPPORTINGSIPORLIGHT-FRAMEROOFSONLY(ONESTORY)[a]ADAPTED FROM TABLE R610.5(1) OF THE 2018IRC

Ultimate Design		Snow Load	Building Width (ft)														
			24 (ft) Wall Height			28(ft) WallHeight			32(ft) WallHeight			36(ft) WallHeight			40 (ft) WallHeight		
Exp.A/B	Exp.C	(psf)	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
		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

a. Design assumptions:

Deflection criteria: L/240

Roofdeadload:10psfmaximum

Roof live load: 70 psf maximum

Ceilingdeadload:5psfmaximum

Ceilingliveload:20psfmaximum

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

UltimateDesign		Snow Load	Building Width (ft) (twostory)														
Exp.A/B	Exp.C																
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
		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

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

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.

Buildersanddesignprofessionalsseeki ngtoreduceenergy 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 greaterjobsitequalitycontrolthroughpr efabrication.SIPs are an enabling technology to meet the Architecture 2030 Challenge for net-zero, carbon neutralbuildings.

For more information, contact the Structural Insulated Panel Association, P.O. Box 39848, Fort Lauderdale, Florida 33339,orvisittheAssociation'swebsiteatwww.sips.org.