Building with SIPs:
NEED TO KNOW

SIP BUILDING BEST PRACTICES

SIPA

Structural Insulated
Panel Association

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NEED TO KNOW

BUILDING CONSIDERATIONS

This document was created specifically for builders by the manufacturing members of the Structural Insulated Panel Association (SIPA). It highlights important considerations during the construction phase of a structural insulated panel (SIP) structure. Decades of combined knowledge from SIPA manufacturers will help reduce the learning curve and leverage SIPs' exceptional qualities to achieve the high-performance results owners expect when building with SIPs. The content provides a common industry platform for SIP construction. SIPA hopes to make your building process easier and more efficient.

Photo courtesy of SIPA

High-performance building envelopes use SIPs

SIPs yield high-performance building envelopes with energy performance well beyond conventional framing. SIPs provide a core of high R-value solid insulation typically requiring no additional continuous insulation on the building exterior. Elimination of traditional batt or spray insulations eradicates the installation quality challenges these products create and removes the need for insulation subcontractors. The large size of SIPs results in fewer air gaps, reduced thermal bridging from fewer lumber connections (lower framing factor) and elimination of air spaces within the wall cavity. SIPs provide a virtually airtight envelope improving indoor air quality (IAQ) and creating healthier homes and businesses. Airtightness also reduces HVAC sizing and dramatically improves occupant comfort by providing consistent room temperatures, regardless of the number of floors. A SIP's thickness determines its insulation R-value, but the greatest gain comes from the tightness of the engineered design and the other high-performance components (HVAC, windows, etc.) as specified.

SIP performance is based on more than its stated R-value

R-values of SIPs are readily available from SIP manufacturers. These are useful insulation metrics but only one component in the evaluation of a high-performance building envelope. Integration of all system components and airtightness of the envelope assembly are more important considerations when seeking performance over individual component metrics. To illustrate this, the Department of Energy's Oak Ridge National Laboratory (ORNL) tested the performance of large section wall assemblies. The resulting whole-wall R-value data revealed that a 4-inch SIP wall rated at R-14 outperformed a 2×6-inch wall with R-19 fiberglass insulation. The whole-wall R-value was R-21 for a 6-inch SIP wall or 96% higher than the whole-wall R-value of R-11 for the 2x6-inch wall using theoretically R-19 fiberglass insulation. ORNL also tested a SIP structure side by side with a conventional 2x4 structure to evaluate air leakage. The SIP structure had only 7% the air leakage of the conventional structure. In short, unlike for SIPs, joining real-world air-leakage rates and thermal bridging for conventionally framed structures lowers performance far below their theoretically calculated effective insulation R-values. For more information relating to key, high-performance building envelope metrics, visit the technical drop-down menu at www.sips.org.

Kelly's 1862 Timber Frame Home, Columbus OH

HVAC system rightsizing reduces costs and enhances comfort and performance

SIP envelopes deliver a high-performance, virtually airtight shell. Because of this, the building must have mechanical make-up air. Several options introduce fresh air with varying degrees of complexity and cost. To ensure a balanced HVAC system, consider specifying a Heat Recovery Ventilator (HRV) or Energy Recovery Ventilator (ERV). Superior SIP energy efficiency and airtightness reduce HVAC equipment load and often provide savings via smaller unit requirements. Design should also include HVAC installed inside the conditioned SIP envelope. Conventional practice cannot be used in sizing HVAC equipment for SIP structures. Oversized equipment is not only more costly but short cycles inhibiting the building's ability to dehumidify causing comfort and mold concerns. SIP building designers, HERS raters and HVAC professionals can accurately calculate thermal performance of SIP envelopes using energy modeling with ASHRAE Manual J or REM/Rate or Ekotrope design software. Actual air leakage performance is best determined by a pre-drywall blower door test. SIP structures typically achieve less than 2 ACH@50pa at this stage, but values less than 1 ACH50 are often achieved with proper design and installation. While SIPs provide the basis for an airtight structure, overall performance can be compromised if proper consideration for energy load calculation inputs or installation is not given to the other critical system components (e.g. windows, HVAC, plumbing, etc.).

Purtee Project, Moscow ID

SIP structural capabilities cater well to virtually any design

SIP structural capacities comply with building codes through evaluation reports from third-party evaluators including ICC NTA, Intertek, and IAPMO. SIPs' increased strength over conventional framing enables greater design flexibility. A SIP can span up to 24 feet when incorporating structural connections (splines) eliminating intermediate support structures and creating spectacular vaulted ceilings. Many designs eliminate headers with conscious awareness of where point loads are located, reducing costs, labor and thermal breaks. SIP manufacturers publish charts to determine load capacities and work with designers and builders to ensure code conformance. SIPA manufacturing members are an invaluable resource; each provides understanding on how SIP height, thickness and connection methods affect the structure's design. Manufacturers can provide lists of structural engineers experienced with SIPs.

Trillium Studios, Norwell MA

SIPs are typically factory cut for accuracy, quality and reduced onsite labor

The cost and scarcity of construction labor is a challenge; the more that can be done by the SIP manufacturer, the less demand for what has become a scarce resource – jobsite labor. Because SIPs are manufactured in very large sizes (up to 8 x 24 feet), there are fewer connections, resulting in faster installations and a much tighter envelope. Working with SIPA manufacturers, designers and builders can reduce costs by employing common SIP dimensional sizes of 4', 8', 12', 16', etc. in their designs. Factory lumber installations minimize jobsite labor while ensuring joint and boundary connection quality.

SIPs are manufactured using "SIP shop (or panelized) drawings"

SIPA manufacturers convert architectural drawings into SIP shop drawings. Shop drawings specify SIP size, layout, assembly details and installation specifications. They are also used for factory fabrication purposes. Shop drawings are provided to the client, or their authorized representative, for review and approval. Commitment to the drawing review process is crucial. Attention to detail during review ensures fabricated panel accuracy, installation ease and meeting SIP performance expectations. Early interaction with the SIP manufacturer helps design optimization resulting in material cost savings and installation speed. SIPA manufacturers can share samples of SIP shop drawings for your review and understanding.

Photo courtesy of SIPA

SIPs are customized to varying levels depending on client needs

SIPA manufacturers offer differing levels of SIP fabrication. They include blank SIPs, prefabricated SIPs and ready-to-assemble (RTA) packages.

BLANK SIPs are the least expensive, but limit your installation speed advantage, create additional waste, and require a higher degree of installation skill as all cutting is performed onsite.

PREFABRICATED SIPs are designed and cut in the factory increasing site installation speed, improving fit and finish.

RTA packages include factory preinstalled internal lumber and headers maximizing onsite speed and efficiency.

Prefabricated is typical although, as labor becomes scarce, RTA packages are gaining in popularity. SIPA manufacturers can provide detail concerning benefits of each option.

Roof and wall assemblies

SIPs are compatible with conventional roof and wall claddings. Unlike traditional framing, there is no internal air cavity within the SIP. The foam core of SIPs is solid and continuous throughout the wall and roof, eliminating convection and condensation issues occurring in conventional cavities. It is important to ensure a code-approved weather-resistive barrier is specified under wall claddings and approved underlayments for roof covering. Designing for the appropriate climate zone will help maximize durability. In some climate zones, a back-ventilated assembly may be appropriate. Because SIPs use very little solid lumber, an increased fastener schedule could be required when attaching exterior cladding. Application of fully adhered products to SIPs roofs is not recommended. A separation layer should be added between the SIP roof and underlayment to avoid damage to the exterior SIP facing should there be a need to remove and replace the underlayment in the future.

Melody Lane, Wauseon OH

Factory cut electrical chases reduce electrician time in the field

Electrical chases are typically provided by SIPA manufacturers simplifying electrical rough-in and saving electrician labor by eliminating time spent drilling holes in studs. Vertical and horizontal chases are provided in SIP walls to assist with wiring. Standard practice is to cut chases horizontally at outlet and switch heights. Chases can be added to SIP roofs upon request. Use of surface mounted LED lighting is recommended in place of recessed lighting as they don't penetrate the envelope and jeopardize airtightness. Determining electrical requirements prior to SIP manufacturing reduces the inefficiency of field installation. Plan a shop drawing review with the electrician prior to final approvals to verify chase locations, accommodate electrical layout and ensure code compliance.

Design plumbing into interior walls

Eliminating the possibility of condensation or supply lines freezing within a SIP wall is an important design consideration. Plumbing should be relocated to interior walls wherever possible. If plumbing must be located on an exterior wall, it is recommended that an external chase be installed on the interior side of the SIP wall to conceal plumbing. Plumbing penetrations such as drain waste vent pipes can be placed perpendicularly through SIPs if thoroughly sealed to prevent air infiltration. Consult with a SIPA manufacturer if this is necessary.

To better understand the science of building with SIPs

Review "Builder's Guide to Structural Insulated Panels for all Climates" by Joseph Lstiburek. This resource provides invaluable assistance in Building Science related details and can be purchased online at Amazon or www.sips.org.

Heather's Home, Lake Weatherford TX

Building with SIPs:
CHECKLIST

The Structural Insulated Panel Association (SIPA) provides this checklist sharing the members' decades of knowledge to ensure the best experience and outcome for designers, builders, and owners of structural insulated panel (SIP) buildings. The Association's well-versed nuances of SIP design and construction will help you take advantage of SIP best practices and incorporate them into your projects.

CHECKLIST

High-Performance Building Envelope

SIPs are used to design high-performance building envelopes offering energy performance beyond conventional framing.

KEY POINTS:

- ☐ 1. SIP envelopes are intended to be high-performing. The objective is to build the building as tight as possible and allow mechanical ventilation to manage air flow. This will make for a healthier, more comfortable structure with improved indoor air quality (IAQ).

ACTION ITEMS:

- ☐ 1. Utilize SIP manufacturer approved sealing methods to limit air and vapor transmission through SIP joints.
- ☐ 2. Seal all penetrations (pipes, vents, chimneys) through the SIP envelope with manufacturer approved sealants.
- ☐ 3. Use a blower door test to verify your SIP installation.
- ☐ 4. Contact a SIPA manufacturing member at www.sips.org to learn about the benefits of SIP construction.

CHECKLIST

HVAC Systems

SIP envelopes deliver high-performance, extremely airtight envelopes. The energy efficiency and airtightness positively affect the HVAC design resulting in smaller unit requirements.

KEY POINTS:

- ☐ 1. Oversizing equipment jeopardizes building and equipment durability while needlessly increasing expenses.
- ☐ 2. SIP building designers, HERS raters, and HVAC professionals must accurately calculate thermal performance of SIP envelopes.
- ☐ 3. An energy model using ASHRAE Manual J or REM/Rate or Ekotrope design software should be used to verify proper equipment sizing.
- ☐ 4. High-performance structures designed and built extremely airtight must have mechanical make-up air. There are several options with varying degrees of complexity and cost ensuring a balanced HVAC system that will introduce fresh air.
- ☐ 5. Penetrations in the SIP envelope should be sealed to maximize airtightness.

ACTION ITEMS:

- ☐ 1. Work with an HVAC professional that is familiar with high-performing, extremely airtight structures.
- ☐ 2. Use energy calculations reflecting proper SIP foam core long-term thermal R-values along with energy efficiency and the extreme airtightness of the envelope to avoid HVAC equipment oversizing.
- ☐ 3. Keep all HVAC equipment and duct work inside the conditioned SIP envelope.
- ☐ 4. Consider specifying a heat recovery ventilator (HRV) or energy recovery ventilator (ERV), as referenced in ASHRAE 62.2 guidelines, for balanced fresh make-up air.

CHECKLIST

Structural Capabilities

SIPs have the structural strength to work well in virtually any design.

KEY POINTS:

- ☐ 1. The entire SIP works together to carry and manage loads. Therefore cross cutting SIP facings should only be done with manufacturer's or engineer's approval. Trimming of facings to attain a good fit is acceptable, as well as making cuts for small openings, such as electrical boxes.
- ☐ 2. Manufacturers publish construction manuals and load design charts that can be accessed to understand structural capacities.
- ☐ 3. SIPs are compatible with internal conventional framing when special structural requirements are met.
- ☐ 4. Point loads may dictate the need for additional structural components to be embedded internally. Avoid point loads over openings to allow SIPs to act as the header without the need for additional structural elements.

ACTION ITEMS:

- ☐ 1. Contact a SIPA manufacturing member at www.sips.org to request their structural information and evaluation report.
- ☐ 2. Follow manufacturer's recommended spline fastening schedules.
- ☐ 3. Check foundation or floor deck for square, level, and correct dimensions. Shim and adjust as needed.

CHECKLIST

SIP Sizes

SIPs can be manufactured in very large sizes (up to 8 x 24 feet). Large monolithic SIPs provide faster installation and reduce the number of connections which results in a much tighter envelope.

KEY POINTS:

- ☐ 1. SIPs are large and adequate room is needed for receiving, staging, and lifting panels. Three-inch-wide supports are recommended every 8 feet minimum to keep SIPs off the ground and to keep them level.
- ☐ 2. Lifting equipment such as a SkyTrak or telehandler (all terrain forklift) is recommended for unloading and stacking SIPs. Fork extensions for 8-foot-wide SIPs are recommended.
- ☐ 3. If the crew size or site conditions dictate smaller hand setting of SIPs is needed, be sure to make your manufacturer aware of limitations upfront.

ACTION ITEMS:

- ☐ 1. Contact a SIPA manufacturing member at www.sips.org to learn about their SIP size capabilities.
- ☐ 2. Use appropriate methods for moving, stacking, handling and erecting SIPs to maintain the integrity of the SIPs and promote the safety of the construction team.
- ☐ 3. Protect the SIPs from weather upon delivery until time of installation.

CHECKLIST

Shop Drawings

SIP manufacturers typically convert your architectural drawings into SIP shop drawings. Shop drawings specify SIP size, layout, assembly details and installation specifications. They are also used by the SIP manufacturer for accurate CNC fabrication.

KEY POINTS:

- ☐ 1. Understand the difference between purchasing SIPs without any fabrication, fabricated SIPs, and a full ready-to-assemble (RTA) package. Fabricated or ready-to-assemble SIP packages reduce waste onsite and require less time and skill.
- ☐ 2. Depending on complexity of design, need for engineering, permitting and possible revisions, the development of shop drawings is a process that relies on engagement from those reviewing these drawings on behalf of the building owner.
- ☐ 3. Window/door schedule will have to come with the plans so the designer can draw the proper plans.
- ☐ 4. SIPs are pre-cut in the factory per the shop drawings. Building the foundation as accurately as possible will help reduce onsite adjustment. Slightly larger in size is preferred to allow for minor adjustments onsite.
- ☐ 5. Shop drawings are provided for client review and approval.
- ☐ 6. There will be a lead time from shop drawing approval to delivery.

ACTION ITEMS:

- ☐ 1. Contact a SIPA manufacturing member at www.sips.org and ask for a sample SIP shop drawing for your review and understanding.
- ☐ 2. Involve the SIP manufacturer early to ensure SIP design optimization. Minor alterations can provide dramatic savings in material costs and speed of installation.
- ☐ 3. Communicate with manufacturer regarding any unique needs such as backers, structure in SIPs, solar panels, or hanging floor system to assure a quality build.
- ☐ 4. Understand what lumber and other accessories are coming with the SIP package and what must be ordered (top/bottom plates, bucks, posts, beams, etc.). This will reduce onsite delays.

CHECKLIST

SIP Fabrication

Different levels of SIP fabrication are offered by SIP manufacturers. They include blank SIPs, prefabricated SIPs, and ready-to-assemble (RTA) packages.

KEY POINTS:

- ☐ 1. Blank SIPs are the least expensive, but limit your speed of installation advantage, create additional onsite waste, and require a higher degree of installation skill as all cutting is performed onsite.
- ☐ 2. Prefabricated SIPs are designed and cut in the factory to increase speed of installation and improved fit and finish on the jobsite.
- ☐ 3. An RTA package includes internal lumber and headers provided and preinstalled in the factory to maximize speed and efficiency onsite.

ACTION ITEM:

- ☐ Contact a SIP manufacturing member at www.sips.org to learn about their SIP fabrication capabilities.

CHECKLIST

SIP Installation

SIPs are high-performance building envelopes and an experienced SIP installer is strongly recommended.

KEY POINTS:

- ☐ 1. Assure there is a capillary break between the SIPs and concrete floors, foundations and walls.
- ☐ 2. Typically, it is best to start installation of wall SIPs at a corner.
- ☐ 3. The use of ratchet straps to pull SIPs together can be very helpful during installation.
- ☐ 4. During installation, it is important to drill plates and connectors to allow access to electrical chases.
- ☐ 5. Brace SIPs appropriately during construction to withstand wind-related issues.
- ☐ 6. When installing roof SIPs, install splines and “chicken sticks” on the ground, to make the process easier.
- ☐ 7. Due to the “stack effect” (air exfiltration), the ridge joint is the most important joint in the house. Follow manufacturer’s ridge sealing detail to the letter!
- ☐ 8. A factory representative is recommended during the initial stages of installation for a first time SIP user, to help expedite the SIP installation, ensuring the system is installed as required and meets performance targets.
- ☐ 9. After the project has been erected, review all SIP joints to ensure properly nailed and sealed.
- ☐ 10. Training programs ensure that an educated installer understands the importance of properly installing and sealing the SIP package. Available programs include:
  - o SIPA online training course
  - o SIPA Registered Master Builder program
  - o SIPschool hands-on field training
  - o Carpenters International Training Fund for SIPs
  - o SIP manufacturer in-house training programs.

ACTION ITEMS:

- ☐ 1. Contact SIPA at www.sips.org to find experienced SIP installers.
- ☐ 2. Use a blower door test to verify your SIP installation and look for problems that can be fixed pre-drywall.
- ☐ 3. Ensure appropriate installation tools are available, such as lifting plates, sealant applicators, foam scoop, hot wire kit, 8’ level, sledgehammer, Fork Extensions, etc.
- ☐ 4. Spot check site dimensions versus SIPs is suggested, to assure a good fit, prior to lifting roof panels.
- ☐ 5. Use semi-permeable membranes on SIP roofs to allow for water vapor / moisture escape. Peel and stick membranes are generally not recommended to cover the entire roof. Use of non-permeable membranes on roof edges and valleys is acceptable.

CHECKLIST

Roof and Wall Assemblies

SIPs are compatible with conventional roof and wall claddings. As with all high-performance building envelopes, proper detailing is critical.

KEY POINTS:

- ☐ 1. Verify manufacturer recommended sealing of SIP joints is completed prior to installation of cladding.
- ☐ 2. In climate zones 4 and colder, SIP Tape should be installed on the interior of the structure. Do not provide complete coverage on the exterior of a vapor barrier such as peel and stick underlayment. Standard application of ice and water underlayment at eaves and valleys is acceptable over a SIP roof.
- ☐ 3. Application of fully adhered products to SIP roofs is not recommended. A separation layer is recommended to facilitate future roofing replacement.
- ☐ 4. SIPs can withstand minor wetting during the construction process. Covering SIPs with roof and wall cladding should be completed as soon as practical but only when SIPs are dry.

ACTION ITEMS:

- ☐ 1. Review “Builder’s Guide to Structural Insulated Panels for all Climates” by Joseph Lstiburek. This resource will provide invaluable assistance in Building Science related details and can be purchased online at Amazon or at www.sips.org.
- ☐ 2. Verify manufacturer recommended sealing of SIP joints is completed prior to installation of cladding.
- ☐ 3. Use code-approved underlayment and roof covering.
- ☐ 4. Use code-approved weather-resistive barrier under cladding for walls.
- ☐ 5. Follow cladding manufacturer’s recommendations for fastening to SIPs. If not available, review fastener capacities in OSB to determine fastening schedule.
- ☐ 6. Provide specific instructions to the wall cladding and roofing trades. This input should be consistent with the detailing needed for the climate and type of cladding.

CHECKLIST

Electrical

Electrical chases are typically provided by the SIP manufacturer to simplify the electrical rough-in, saving the electrician a great deal of time in the field.

KEY POINTS:

- ☐ 1. Vertical and horizontal chases are provided in SIP walls assisting with wiring at outlet and switch heights.
- ☐ 2. Wall and roof chases can be added or removed, prior to SIP manufacture.
- ☐ 3. Shop drawings will confirm all chase locations to avoid cutting SIPs in the field unnecessarily. Pre-planning for installation and special chase locations is critical.
- ☐ 4. Electrical chases should be sealed after electrical rough-in inspection to maximize airtightness.
- ☐ 5. An experienced SIP installer is your best insurance that the electrical rough-in will go smoothly.
- ☐ 6. Recessed lights are not recommended for installation in SIP roofs. Use of surface mounted LED lighting is recommended.

ACTION ITEMS:

- ☐ 1. Plan a review of the shop drawings with the electrician to verify chase locations to accommodate electrical layout and code compliance.
- ☐ 2. Do not cross cut SIP facings for electrical access.
- ☐ 3. Mark wiring holes on the deck or SIP so the electrician can easily find them.
- ☐ 4. Consult with your SIP manufacturer concerning electrical chases in roofs.

CHECKLIST

Plumbing

Plumbing should be placed within interior walls to protect the integrity of the high-performance envelope and to avoid the freezing of the supply lines in cold climates.

KEY POINTS:

- ☐ 1. Plumbing is recommended to be placed in interior walls to provide for an optimal exterior building envelope.
- ☐ 2. Minimize roof penetrations and consider consolidating all vents away from south facing roof planes for potential solar array.

ACTION ITEM:

- ☐ If plumbing needs to be placed in exterior walls, consult with SIP manufacturer.

Ford Residence, Hedgesville WV

Photo courtesy of SIPA

Discover how easily you can start or deepen your understanding of designing, installing, and excelling with SIPs in your next commercial or residential project with the decades of industry learnings, tips, and resources at your fingertips:

- SIP Industry AIA/MasterSpec Specification
- Designing with SIPs: Design Considerations
- Building with SIPs: Need to Know
- SIP Best Practice Deeper Dives
- Technical Bulletins
- Structural Insulated Panel (SIP) Engineering Design Guide
- Builder's Guide to SIPs book by Joseph Lstiburek of Building Science Corporation
- Building Education with SIPs Training (BEST) Videos and Certification
- AIA Continuing Education Courses, Lunch & Learns and YouTube videos
- Detailed case studies, award-winning project briefs, and SIP project USA map

Get all this and much, much more at www.sips.org

SIPA **Structural Insulated Panel Association**