SIPA

Structural Insulated Panel Association

An AIA Continuing Education Program

Designing With Structural Insulated Panels

Credit for this course is 1 AIA HSW CE Hour

The Structural Insulated Panel Association (SIPA) is a nonprofit association representing manufacturers, suppliers, dealer/distributors, design professionals and builders committed to providing quality structural insulated panels (SIPs) for all segments of the construction industry.

CONTINUING EDUCATION AIA

Course Sponsor

Structural Insulated Panel Association

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sip06c

AN AMERICAN INSTITUTE OF ARCHITECTS (AIA) CONTINUING EDUCATION PROGRAM

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AN AMERICAN INSTITUTE OF ARCHITECTS (AIA) CONTINUING EDUCATION PROGRAM

Course Format: This is a structured, web-based, self study course with a final exam.

Course Credit: 1 AIA Health Safety & Welfare (HSW) CE Hour

Completion Certificate: A confirmation is sent to you by email and you can print one upon successful completion of a course or from your RonBlank.com transcript. If you have any difficulties printing or receiving your Certificate please send requests to certificate@ronblank.com

Design professionals, please remember to print your certificate of completion after successfully completing a course conclusion quiz. Email confirmations will be sent to the email address you have provided in your RonBlank.com account.

COURSE DESCRIPTION

Become familiar with structurally insulated panels (SIP) and their applications, energy strategies and current industry assembly standard. Illustrate SIP design and engineering methods.

LEARNING OBJECTIVES

Upon Completion of this course the design professional will be able to:

- Describe SIPs and their applications
- Explain SIP energy strategies
- Illustrate SIP design and engineering methods
- List current industry assembly standards

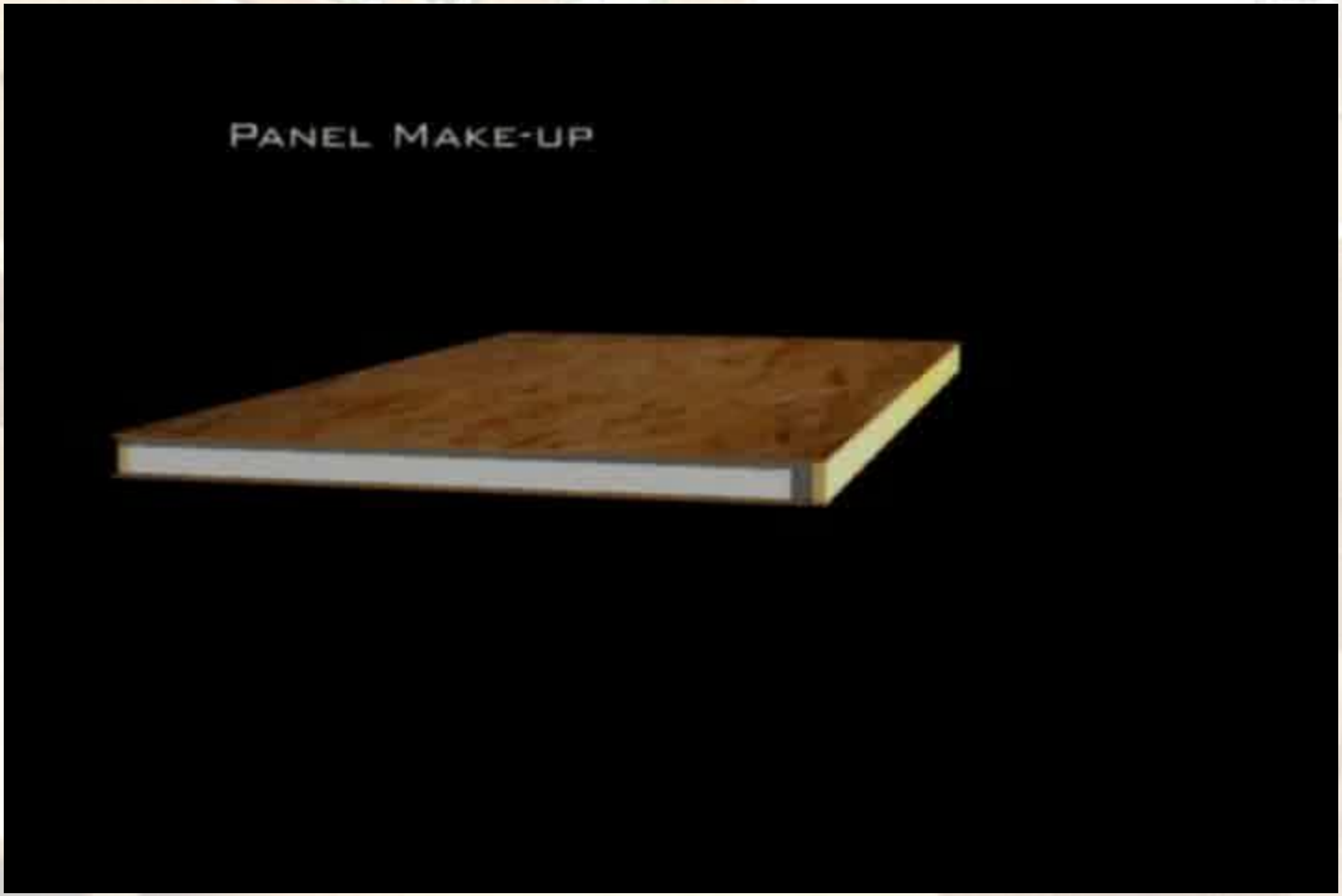
COURSE OUTLINE

- SIP Basics
- SIP Applications
- Energy Efficiency and Green Building with SIPs
- Designing with SIPs
- Engineering for SIPs
- SIP Manufacturing
- SIP Construction

WHAT ARE SIPS?

Structural Insulated Panels (SIPs) are a composite structural panel with an insulating core of rigid foam – usually EPS or polyurethane – and structural facings, most commonly of 7/16” thick oriented strand board (OSB).

WHAT ARE SIPS?



Please Click to View Animation

A BRIEF HISTORY

Development of “stressed-skin” panels for buildings began in the 1930s. Engineering and durability testing was conducted at the Forest Products Laboratory (FPL) in Madison, Wisconsin, a facility operated by the U.S. Forest Service.

FPL tested the concept of using skins to carry a portion of structural loads by building a small house in 1937. Wall studs in the panels were 3/4” x 2 ½,” rather than the usual 2” x 4.” First Lady Eleanor Roosevelt dedicated the house, and the structure is currently a daycare center run by the University of Wisconsin.

A BRIEF HISTORY

FPL scientists reasoned that if skins could take part of the structural loads, maybe they could eliminate framing entirely. Engineering theory was developed and tested, and a complete structure was built in 1947 using corrugated paperboard. This structure was heated, humidified, and exposed to Wisconsin weather for 31 years.

The structure was disassembled periodically for testing to observe changes in panel stiffness, and bowing was minimal.

A BRIEF HISTORY

- Famed architect Frank Lloyd Wright used structural insulated panels in some of his affordable Usonian houses built throughout the 1930s and 1940s.

- SIPs took a major leap in technology when one of Wright's students, Alden B. Dow, The Dow Chemical Company, created the first foam core SIP in 1952.

- By the late 1960s rigid foam insulating products became readily available, resulting in SIPs as we know them today.

SIPS TODAY

- Today, SIPs consist of a foam core and structural facings (typically OSB)
- Manufactured and fabricated under factory controlled conditions for greater accuracy
- Quick to assemble onsite
- Structurally sufficient – they do not use studs at regular intervals

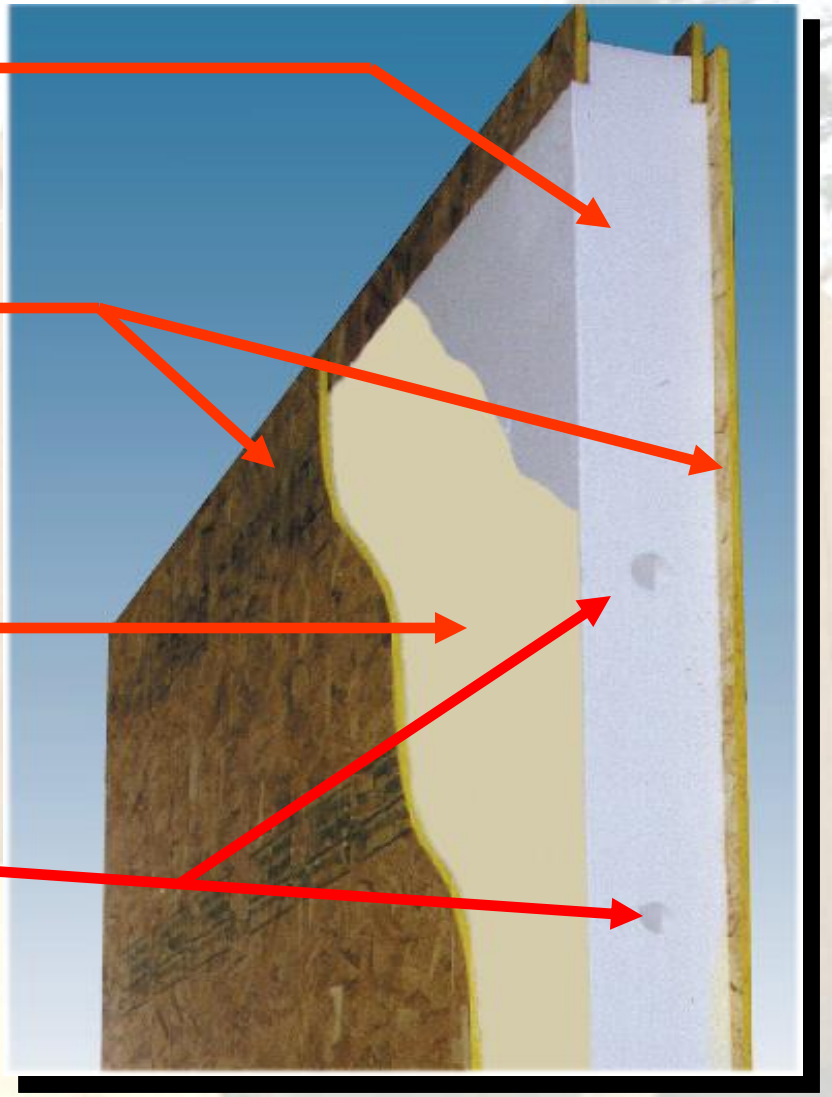
SIPS TODAY

Rigid Foam Insulation

Structural Facings

Structural Adhesive

Optional Electrical Chases



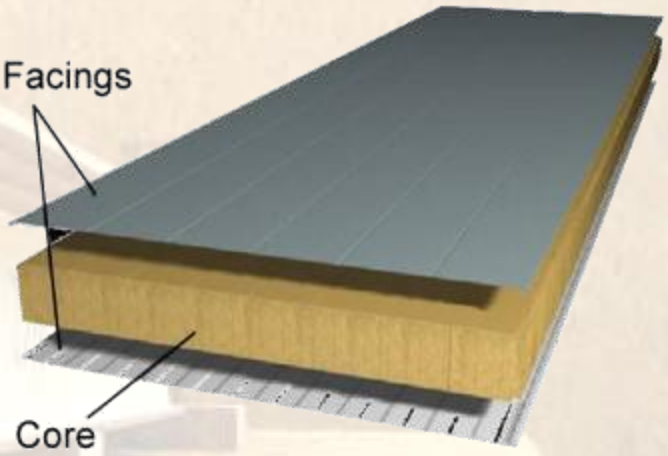
RIGID FOAM CORE

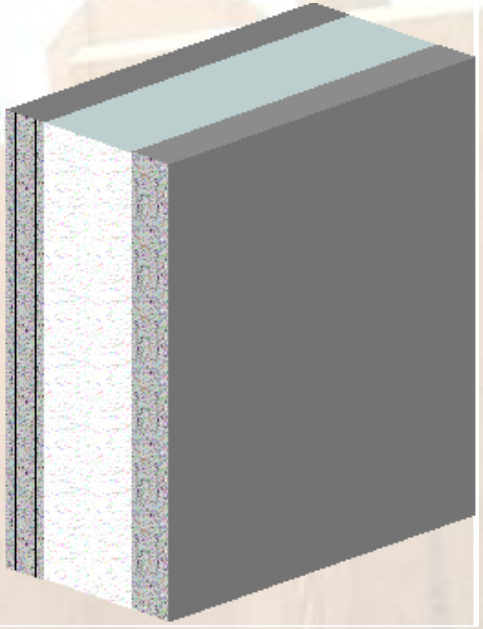
Four different types of foam core materials are used:

- **Expanded Polystyrene (EPS)**
- **Extruded Polystyrene (XPS)**
- **Polyurethane**
- **Polyisocyanurate**

STRUCTURAL FACING

Although OSB is most common, material may be:





OSB

Metal

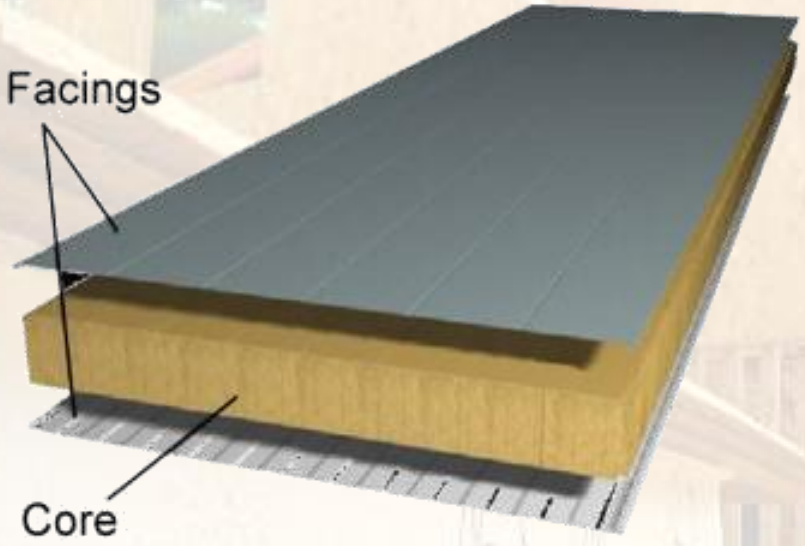
Cementitious/ Composite

STRUCTURAL FACING

Oriented Strand Board (OSB):

- Large sizes, up to 8’ x 24’
- Easy to work with using standard carpentry tools and techniques
- Can be combined with nearly any type of cladding or interior finish system
- Combines seamlessly with standard dimensional lumber

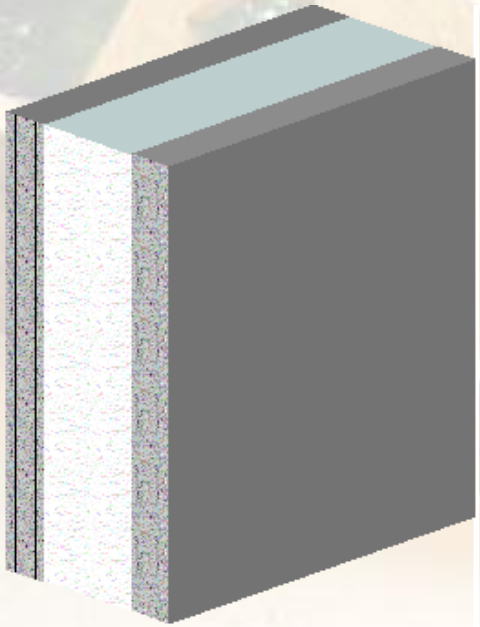
STRUCTURAL FACING



Metal:

- Usually of 24 or 26 gauge thickness
- Either steel or aluminum

STRUCTURAL FACING



Cementitious/Composite:

- Size of panels is usually limited
- Considerably heavier than the OSB or metal SIPs
- OSB SIPs weigh about 4 lbs. per sq. ft. Cementitious SIPs can weigh over 6 lbs. per sq. ft. A 4’ x 12’ cementitious SIP would weigh 288 lbs, compared to 192 pounds for the same size OSB SIP

SIP STRENGTHS

- **SIPs reduce the number of man hours per building**
  - Easy to train laborers to install SIPs
  - BASF R.S. Means study shows residential builders cut framing time by 55% over stick framing
- **Less site waste, greener product and process**
- **Faster weatherproofing reduces moisture exposure for all products**

SIP STRENGTHS

- **Better control over indoor air quality**
  - Less air infiltration gives the opportunity to control IAQ through HVAC
- **Design flexibility**
  - Automated manufacturing makes complex designs easy
  - Problems identified during the design process

SIP STRENGTHS

- Straight walls, faster drywall and trim installation
- Reduced callbacks due to nail popping and cracks due to lumber shrinking
- Less building material theft during construction
- Less or no temporary heat required during building in cold climates
- Integrates easily with other building systems such as steel frame, timber frame, and wood framing

SIP APPLICATIONS

WALL SYSTEMS

A Superior Building Product for Walls:

- Control over materials and labor – have exactly what is needed onsite
- Problems solved prior to construction
- Straighter walls
- Tighter construction, less air infiltration
- Panel thicknesses sized to accept dimensional lumber

ROOF SYSTEMS

A Superior Building Product for Roofs:

- Vaulted ceilings
- Much faster dry-in
- Greater spans than stick framing
- Pre-insulated
- Pre-engineered
- Tighter construction and less air infiltration
- Panel thicknesses sized to accept dimensional lumber

FLOOR SYSTEMS

A Superior Building Product for Floors:

- Capping crawl spaces
- Pre-insulated
- Simple, easy, and fast
- Efficient over unconditioned spaces such as a living space over a garage
- Pre-engineered
- Floors that don’t squeak
- Panel thicknesses sized to accept dimensional lumber

PANEL SIZES AND THICKNESSES

Typical Panel Sizes:

- 4’ x 8’ – 4’ x 24’
- 8’ x 24’
- Up to 9’ x 24’ custom in some areas

Typical Panel Thicknesses:

4 ½”, 6 ½”, 8 ¼”, 10 ¼”, 12 ¼”

ENERGY EFFICIENCY AND GREEN BUILDING WITH SIPS

SIPS AS THE BACKBONE OF A GREEN BUILDING STRATEGY

Starting with SIPs as the primary structural and enclosure system gets your green building project started on the right foot.

An efficient building envelope creates design opportunities such as creative daylighting without sacrificing thermal performance.

SIPS AS THE BACKBONE OF A GREEN BUILDING STRATEGY

High performance SIP building envelope:

- Reduces energy used for heating and cooling
- Allows for better indoor air quality
- Uses less raw materials, generates less construction waste
- Allows for creative daylighting without sacrificing thermal performance
- Maximizes the effectiveness of other technologies, such as HVAC equipment and onsite generation

OAK RIDGE NATIONAL LABORATORY

Whole-wall R-value studies measure the real world performance of insulation:

- Measures the “thermal bridging” of structural members
- Tests include the common installation imperfections of fiberglass insulation

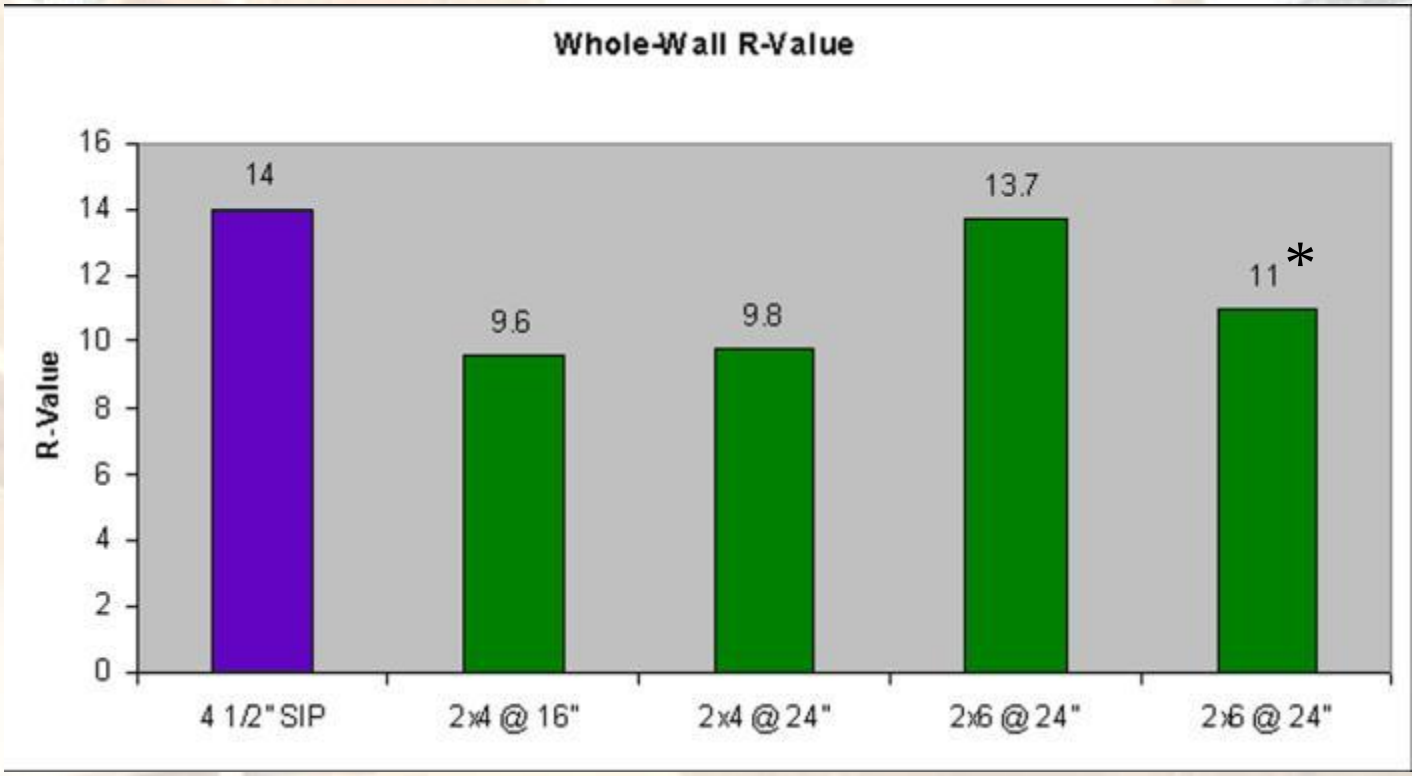
SIPs have very few structural members and continuous, uninterrupted insulation:

- 15% – 25% of the surface area on a wood frame wall is solid lumber, compared to 3% of a typical SIP wall

OAK RIDGE NATIONAL LABORATORY

ORNL Studies:

4 ½” SIP wall with EPS core outperforms a 2” x 6” stud wall with R-19 fiberglass BATT insulation



*Shows “worst case commonly found of procedures for installing batt insulation”

Source: *Whole Wall Rating for Structural Insulated Panel*. ORNL, June 4, 1999

Air Infiltration Tests:

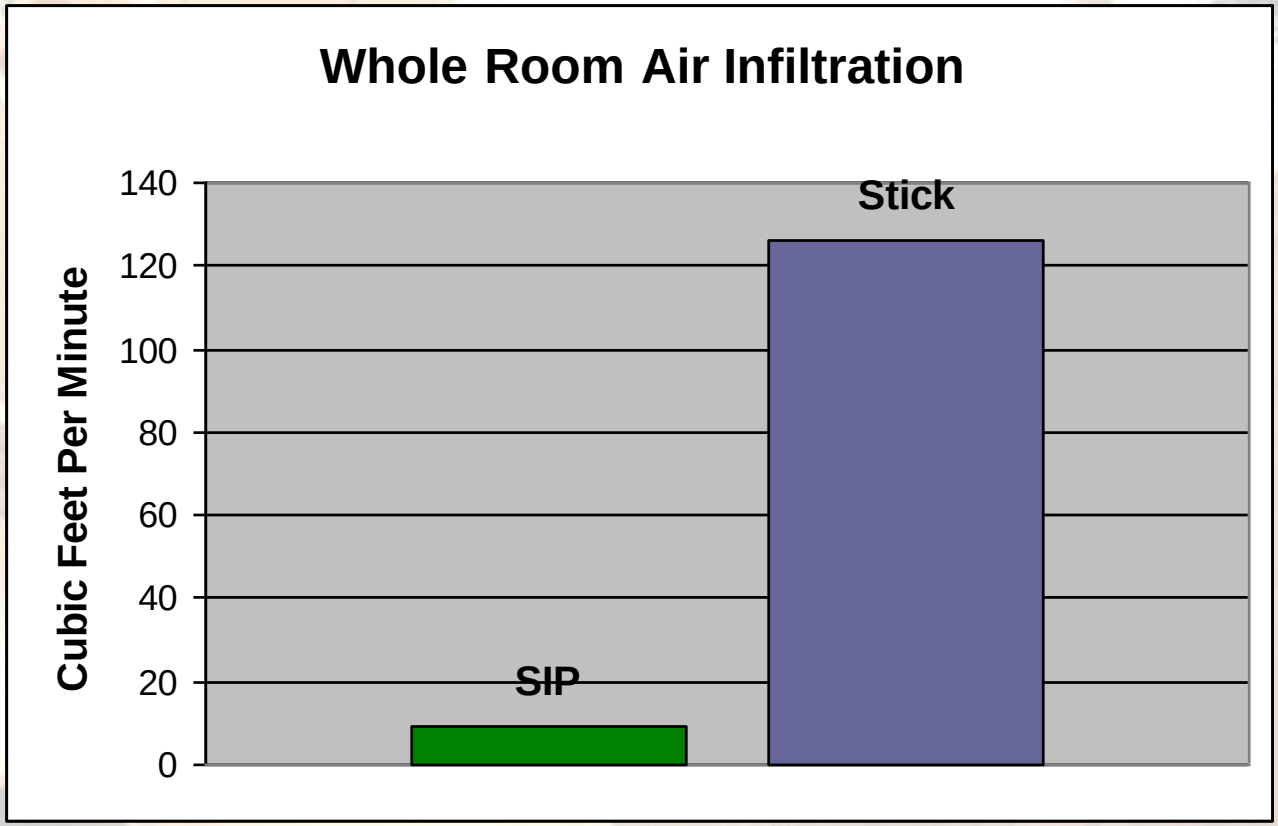
- Conductive losses (heat loss through insulation) are only a portion of thermal loss in a building
- Convective losses (caused by air infiltration and exfiltration) are of much greater importance when designing an energy efficient building
- ORNL tests compare a SIP test room to a stick framed room with OSB sheathing, fiberglass insulation, and drywall

OAK RIDGE NATIONAL LABORATORY

ORNL Studies:

Test room is 15 times tighter than stick built

50-70% annual savings over Model Energy Code



Source: *Heating and Blower Door Tests of the Rooms for the SIPA/Reiker Project*. ORNL, March 15, 2002.

INFILTRATION REDUCTION

More than 50% of a home's total envelope loss may be due to infiltration!

SIPs have:

- Very few gaps
- Industry standard sealing details
- Superior IAQ

ENERGY STAR does not require a blower door test for SIPs homes because of proven performance

HVAC ‘RIGHT-SIZING’

- **Because SIP buildings have low air infiltration, smaller HVAC units should be specified**
- **Blower door test and ASHRAE methodology should be used to size equipment**
- **Oversized equipment operates inefficiently and reduces equipment life**
- **Oversized AC units fail to properly dehumidify**

HVAC ‘RIGHT-SIZING’

- **HVAC duct runs in SIP homes may be reduced because of low air infiltration**
- **All ducts are inside the conditioned space**
  - **Eliminates duct leakage outside of building envelope**
  - **No condensation on ducts in cooling climates that can lead to mold issues**

MOLD REDUCTION

Mold needs the following requirements in order to flourish:

- **Food**
- **Oxygen**
- **Water**

Reduce any one of these sources to levels below those required for mold growth and mold problems will be prevented.

MOLD REDUCTION

Removing oxygen is not practical.

Cellulose materials (such as OSB) provide abundant food for mold.

Regulating the relative humidity of the building between 40% and 50% is the most effective mold prevention strategy.

Airtight SIP construction makes it much easier to dehumidify (remove water), creating an environment where mold cannot exist.

WASTE REDUCTION

Pre-cut SIPs help to dramatically control and limit site waste.

- **Reduce waste disposal fees**
- **Contributes to LEED® points**

GREEN BUILDING – LEED® POINTS

SIPs help projects qualify for Leadership in Energy and Environmental Design (LEED®) certification.

Energy & Atmosphere:
Optimize Energy Performance

- Space heating and cooling account for 44% of energy use in commercial buildings

- SIPs reduce amount of energy for heating and cooling

GREEN BUILDING – LEED® POINTS

Materials and Resources:
Certified Wood

SIPs with Forest Stewardship Council certified OSB are available from some manufacturers

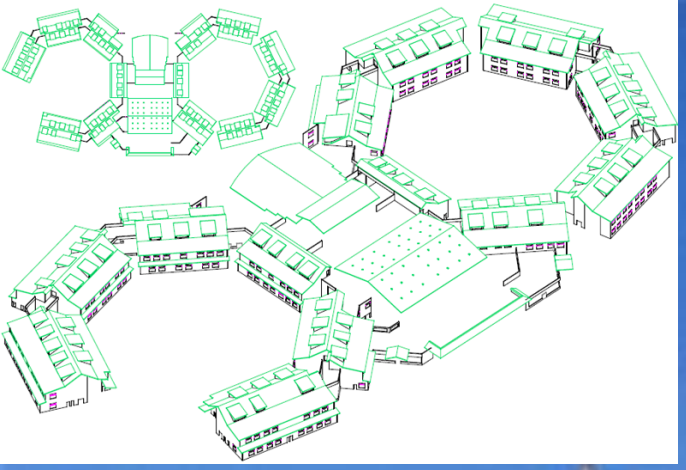
Environmental Quality:
Low Emitting Materials: Adhesives and Sealants

The adhesives used in SIPs do not off gas VOCs or other harmful chemicals

GREEN BUILDING – LEED® POINTS

Environmental Quality:
Low Emitting Materials: Wood and Agrifiber Products

The OSB used in SIPs meets the requirements for low emitting composite wood materials



DESIGNING WITH SIPS

SIP APPLICATIONS

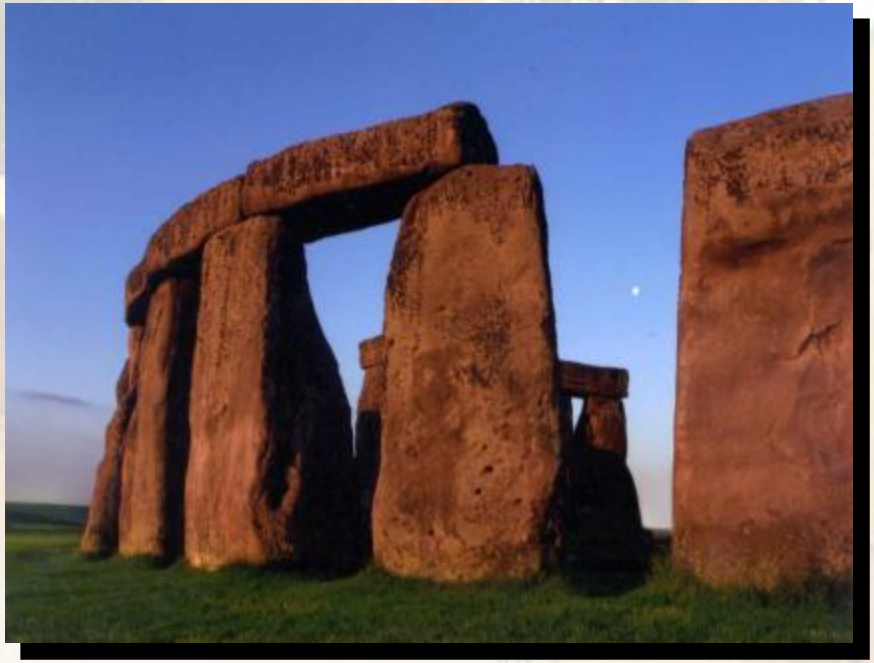
SIPs over a steel frame

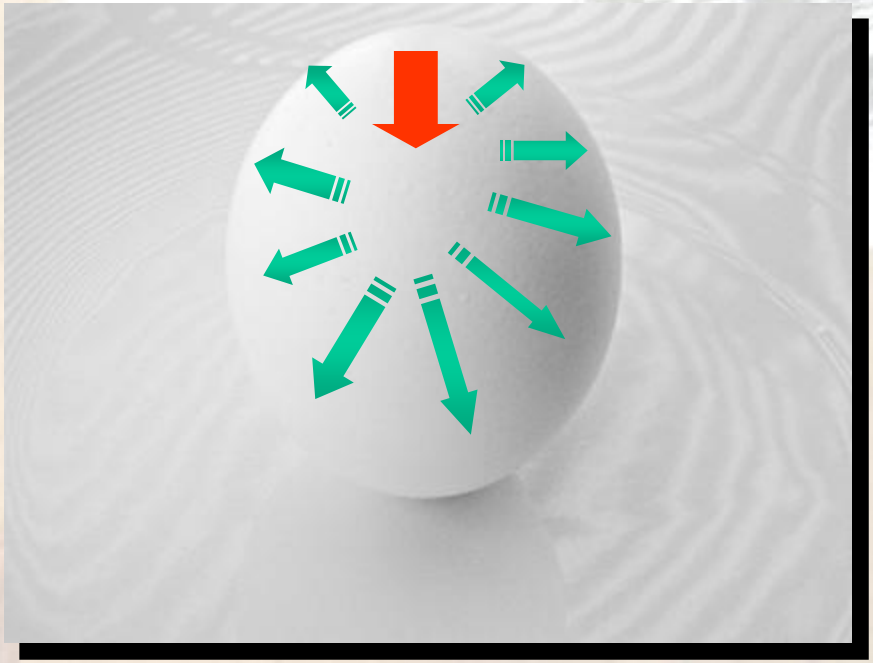
Raised SIP floor

SIP APPLICATIONS

Custom log home

SIPS VS. STICK FRAME





STICK FRAME

Stick frame is essentially post and beam construction. Point loads are transferred from one member to another.

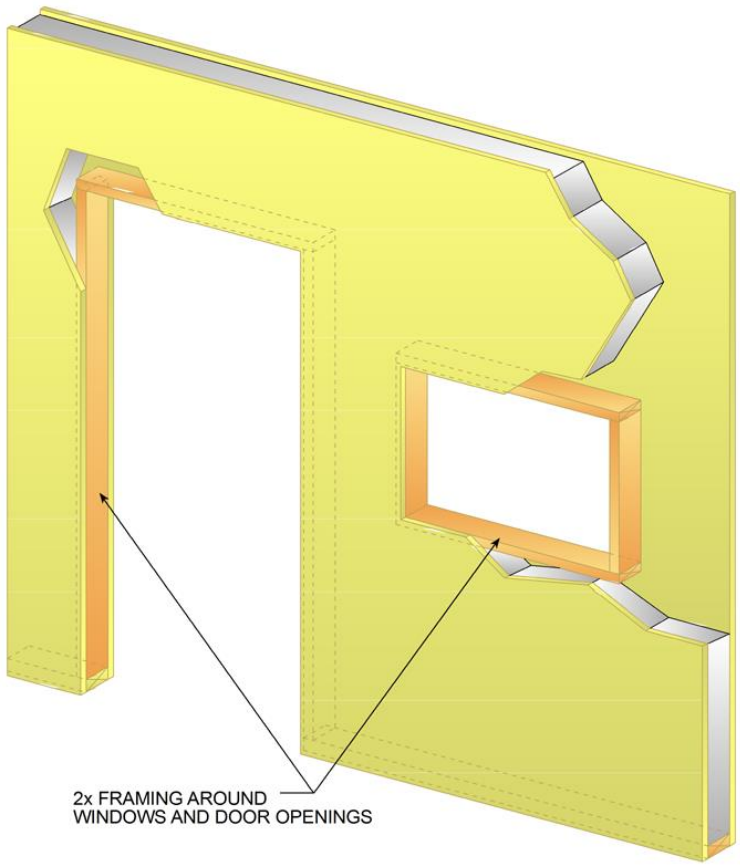
SIPs

SIP construction is a type of shell construction. Point loads are dispersed in all directions.

HEADERLESS CONSTRUCTION

In many cases, headers can be eliminated completely.

Refer to manufacturer load tables or header tables in the *Prescriptive Method for SIPs Used in Wall Systems in Residential Construction.*



DOOR AND WINDOW FRAMING

VAULTED CEILINGS

Vaulted SIPs **vs.** **Vaulted Stick**

- **Structural members sized for span condition**

- **Structural members oversized for insulation plus venting space depth**

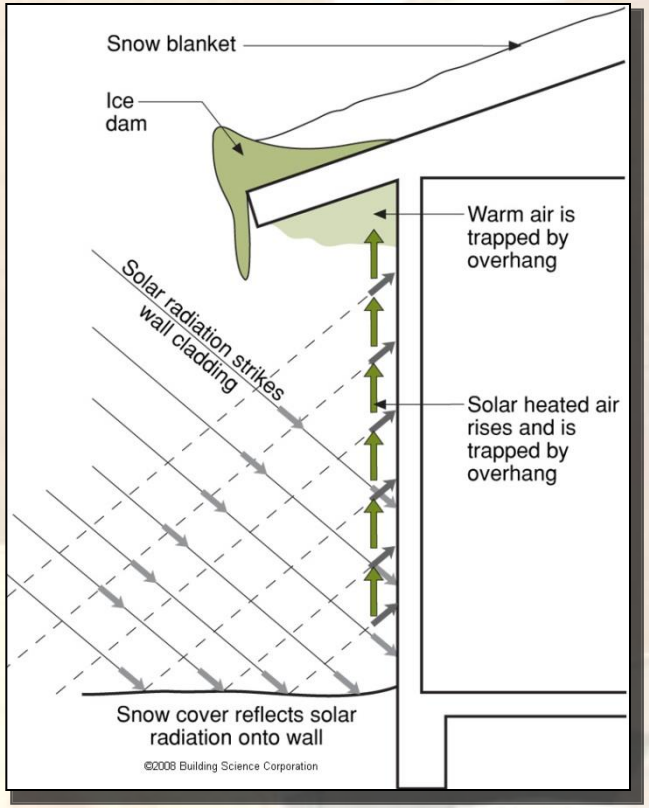
- **Insulation requirements call for more expensive structural framing members**

VAULTED CEILINGS

Vaulted SIPs vs. Vaulted Stick

- Ice dams? What are they?
- SIP roofs reduce air leakage—the main cause of ice dams
- Insulated SIP overhangs eliminate solar heating that can cause ice dams

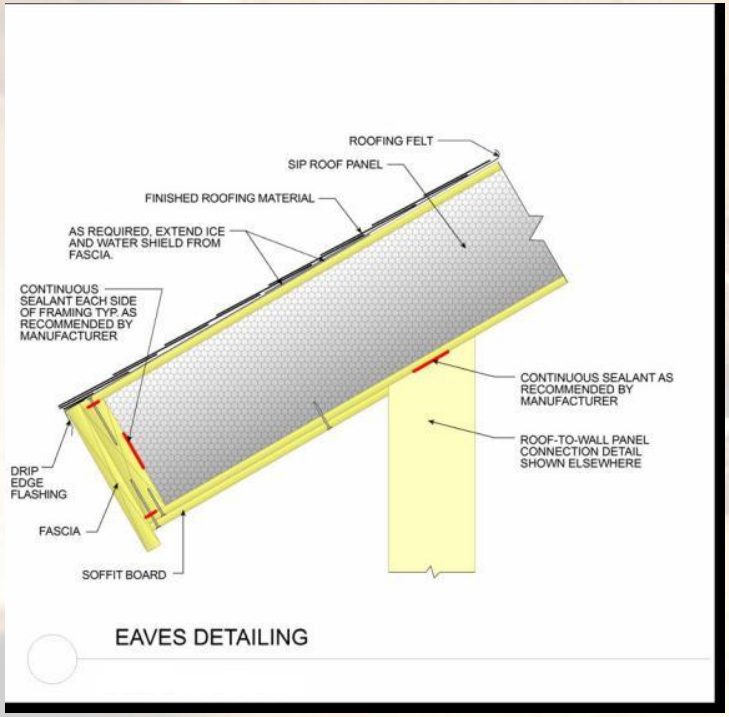
- Concern about possible ice dams



VAULTED CEILINGS

Vaulted SIPs

- Eave and gable details simplified



vs.

Vaulted Stick

- Eave details need to include venting
- Gables or ridges need to include venting detail

BEYOND STICK FRAME

Sometimes, stick framing just won't do…
In these cases, SIPs are the desirable way to go

Note:
Curved SIPs may not be available in all areas.

ENGINEERING FOR SIPS

PRESCRIPTIVE METHOD FOR SIPS

The SIP industry has undertaken an initiative to create standard performance criteria for SIPs.

Prescriptive Method and IRC Section R614 allow for the resolution of simple designs into SIP structures *without* the need for engineering.

Although the scope is limited, SIPs can be engineered to nearly any design application using manufacturer specific engineering data.

PRESCRIPTIVE METHOD FOR SIPS

The Prescriptive Method is a guideline to facilitate the use of SIP wall systems in the construction of one- and two-family dwellings. By providing prescriptive guidelines for the construction of typical homes with SIP systems, the need for engineering can be eliminated for many typical applications.

Applicability Limits:

- Wall panels only
- 4 ½" and 6 ½" thick panels
- 40' x 60' building dimensions
- Up to two stories above a basement
- 10' maximum wall height
- 130 mph wind speed
- 70 psf ground snow load
- Seismic design categories A, B, and C

PRESCRIPTIVE METHOD FOR SIPS

Prescriptive Method includes:

- **Standardized SIP information**
- **Wall thickness requirements for various geometric and loading conditions**
- **Prescriptive SIP lintel (header) tables**

Additional engineering information available from individual SIP manufacturers

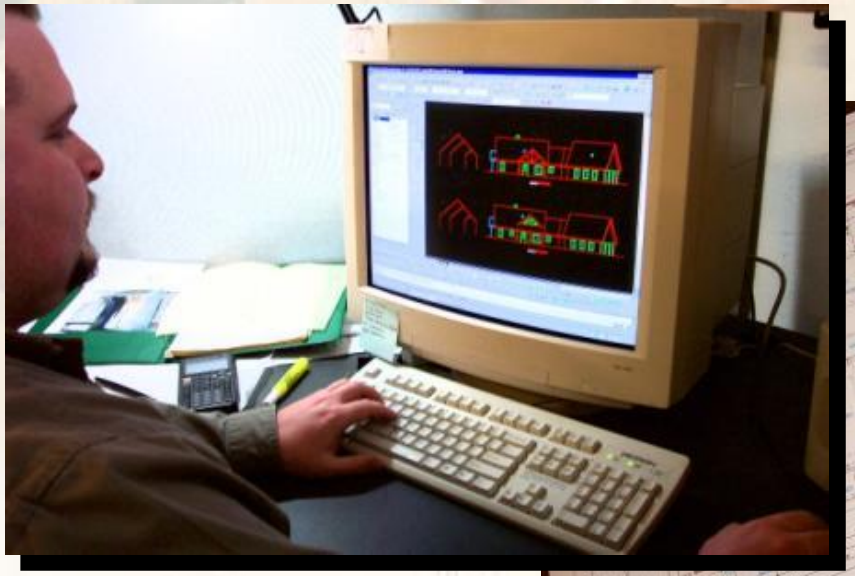
SIP FABRICATION

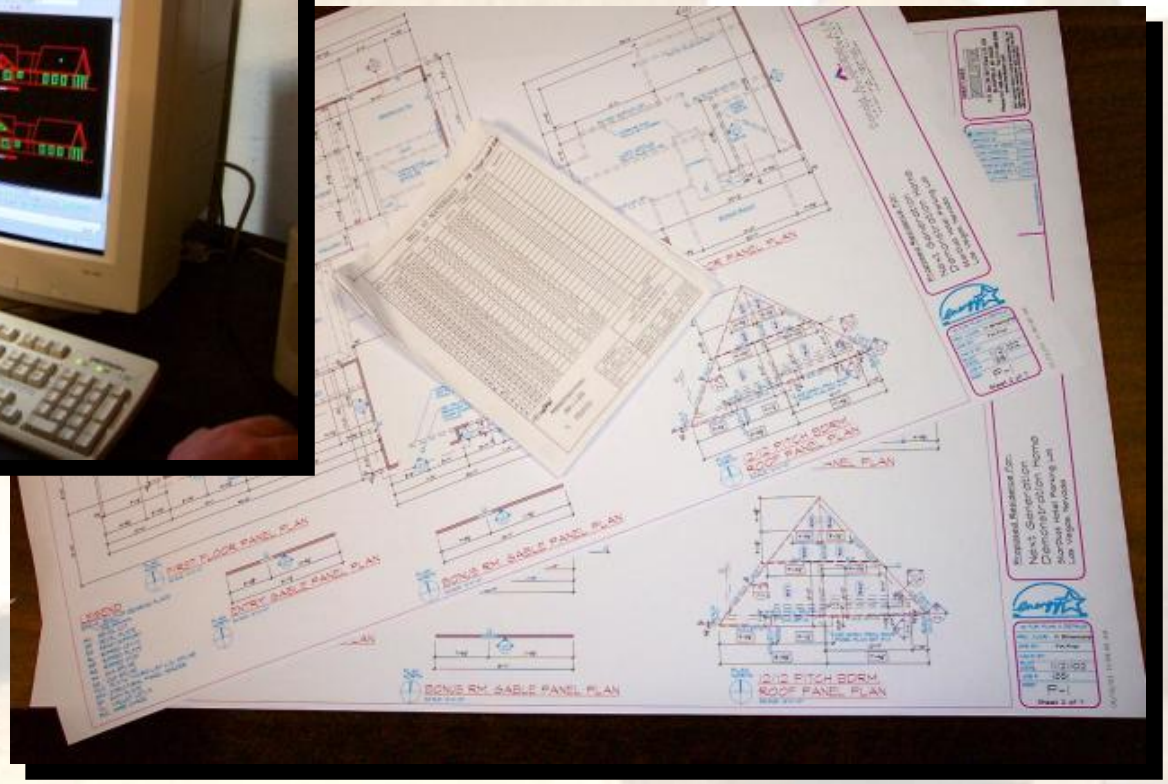
SIP FABRICATION

1. **Design – any plan can be converted to SIPs. CAD drawings are converted to shop drawings that lay out cutting plans for the panels**
2. **Fabrication – the finalized shop drawings are fed into CNC machines or used to cut panels by hand**
3. **Shipped to jobsite – ready to install**
4. **Complete packages available with additional components installed**

SIP SHOP DRAWINGS

SIP software converts architectural plans into shop drawings and material lists.





CAD/CAM

SIP Software converts SIP shop drawings into Machine Instructional Code.

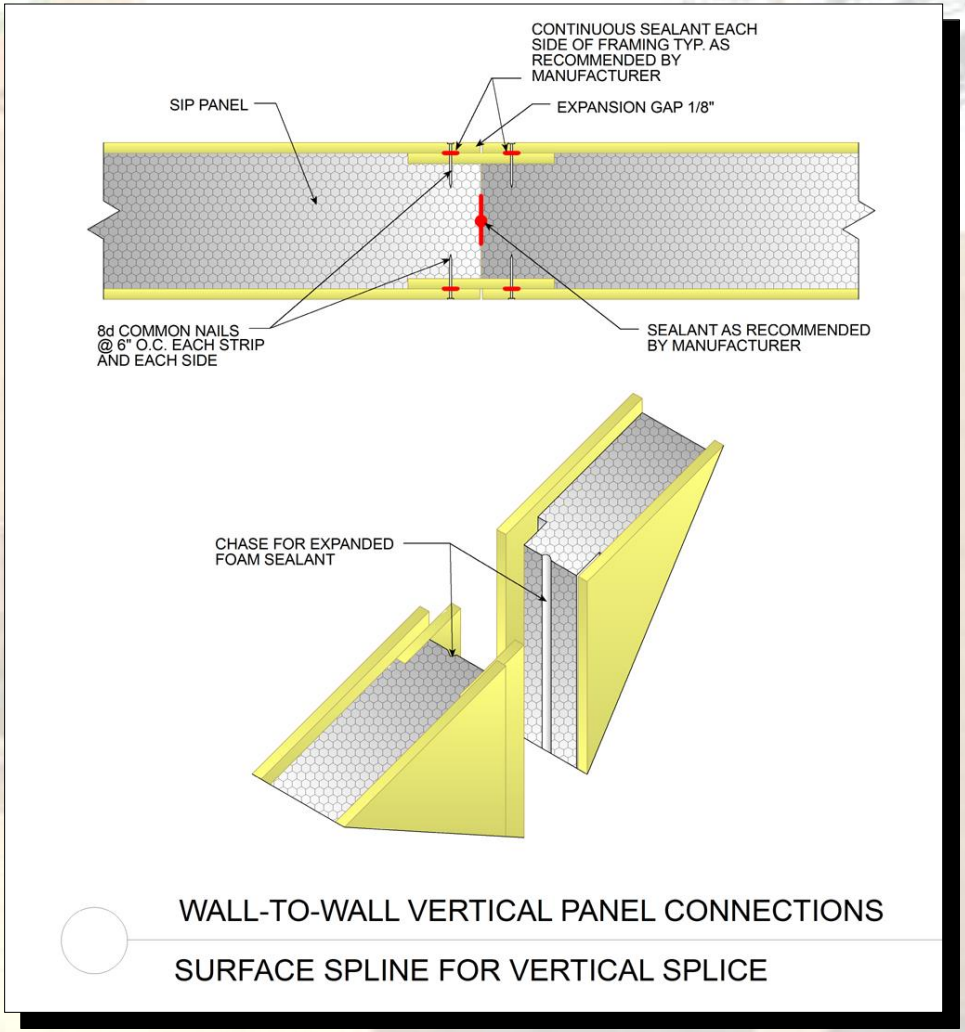
SIP CONSTRUCTION

INDUSTRY ASSEMBLY STANDARDS

Surface Spline Condition:

- **Nails, staples or screws may be specified**
- **Red markings indicate continuous sealant**
- **CAD details available at www.apacad.org**

Note: Some manufacturers may use different details.



INDUSTRY ASSEMBLY STANDARDS

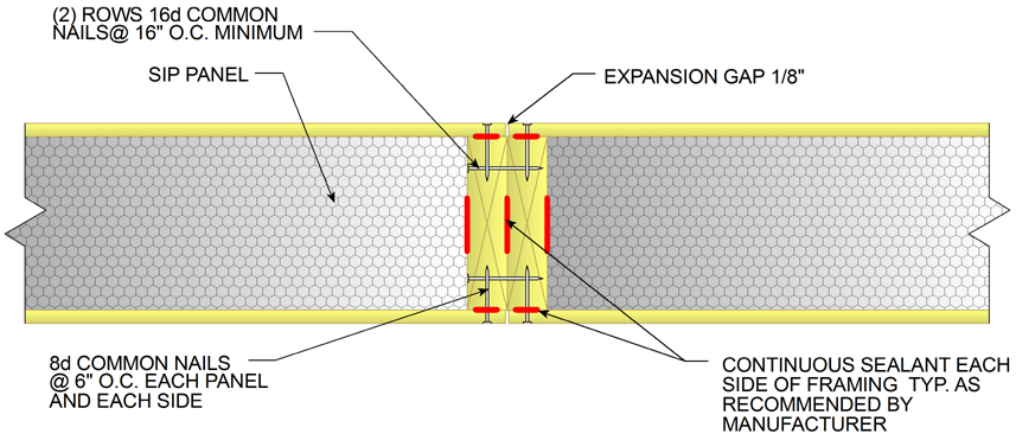
Double Dimensional Lumber Spline:

- **Used either vertically (walls) or horizontally (roofs or floors) when additional structural elements are required**
- **Allows for tall walls and long spans**
- **Avoided except when necessary because of thermal bridging**
- **In all cases lumber members should be well sealed**

INDUSTRY ASSEMBLY STANDARDS

Double Dimensional Lumber Spline:

Structural splines may be single or double members 3 ½” wide, such as parallams or other composites



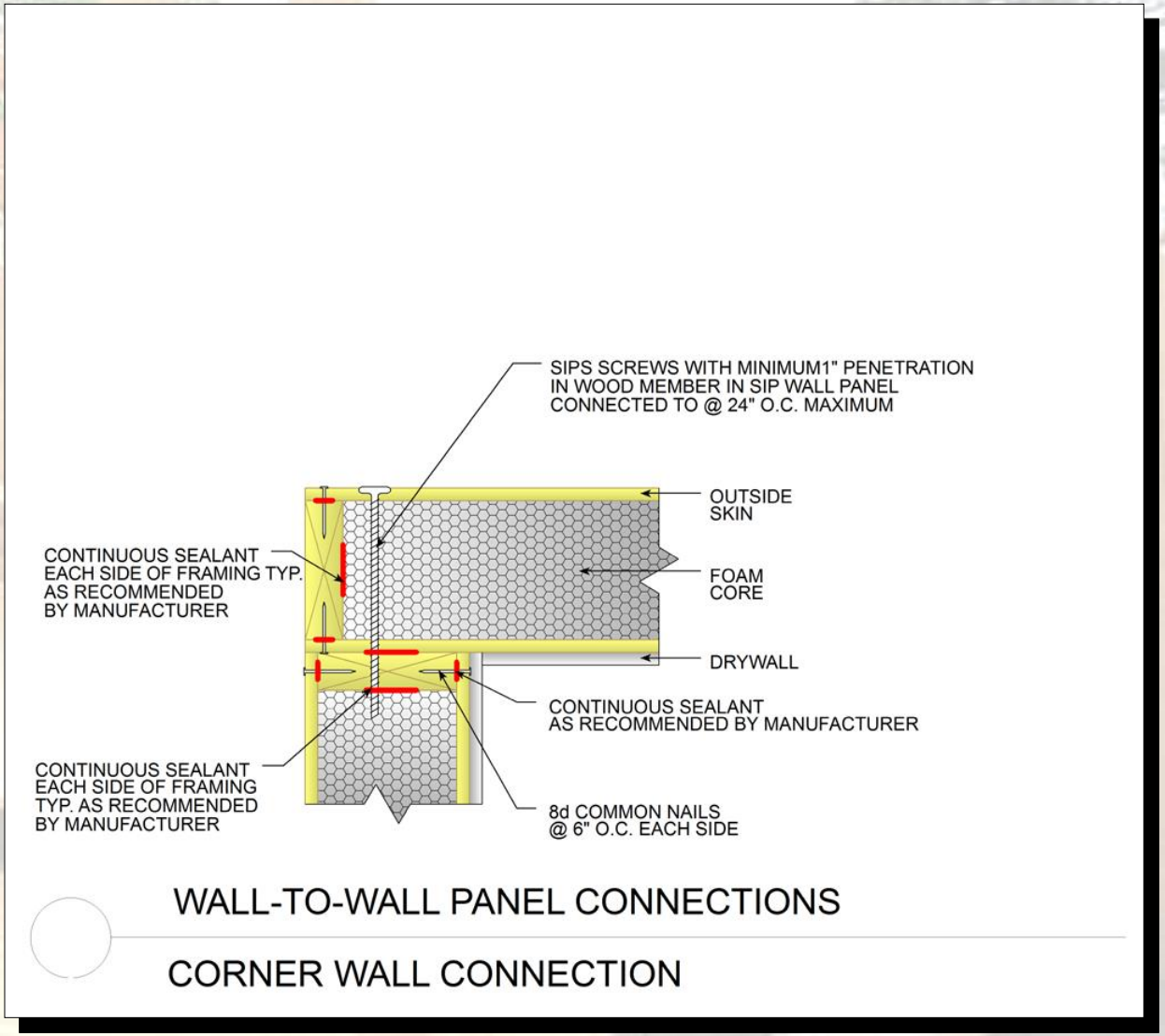
WALL-TO-WALL VERTICAL PANEL CONNECTIONS

DIMENSIONAL LUMBER SPLINE

INDUSTRY ASSEMBLY STANDARDS

Wall-to-Wall or Wall-to-Roof Connection:

Washers used on long screws will double the pull-through resistance



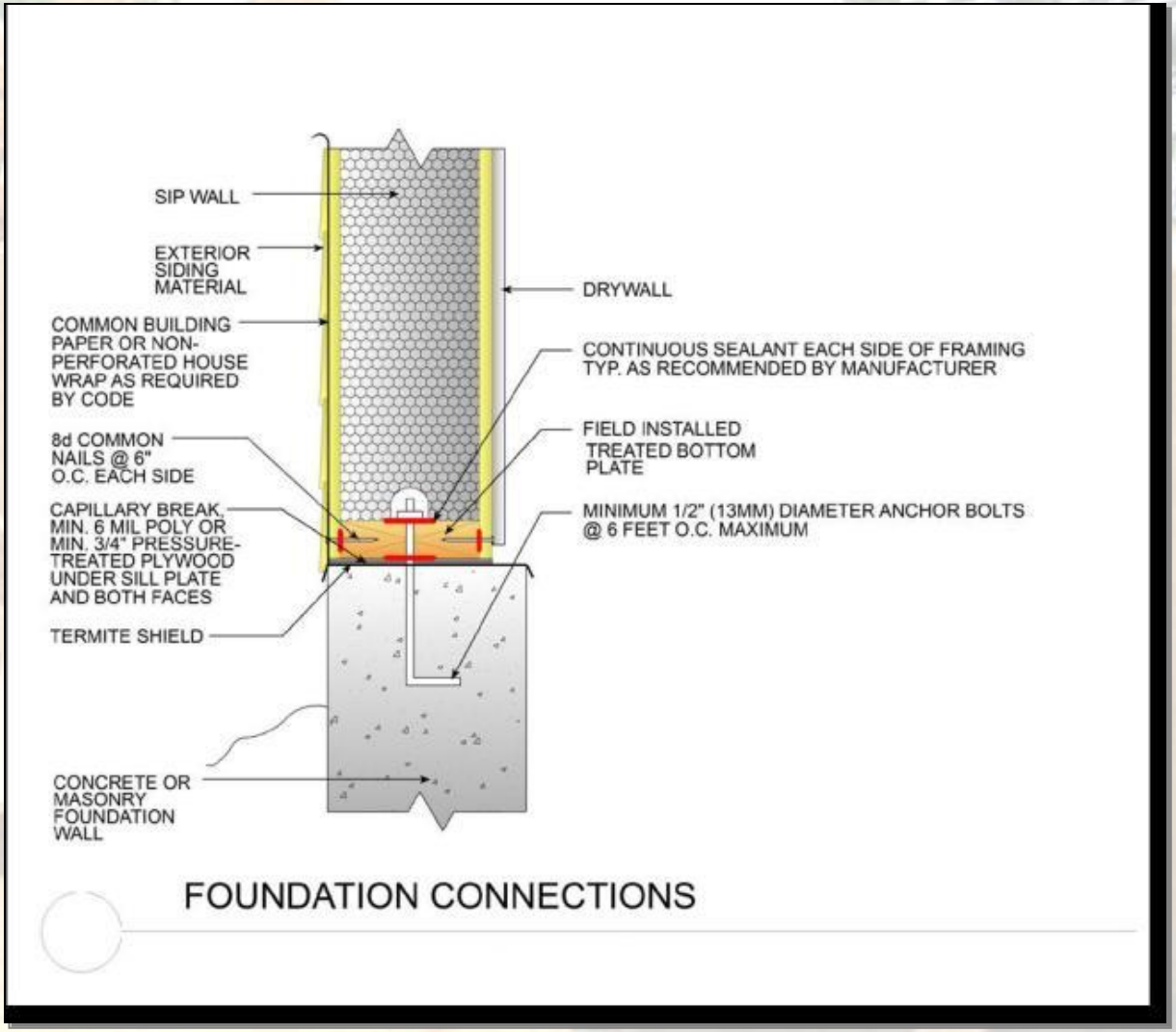
INDUSTRY ASSEMBLY STANDARDS

Sill Condition:

Pressure treated plywood is often used as a capillary break.

Foundation wall or floor must be insulated to comply with ICC thermal requirements.

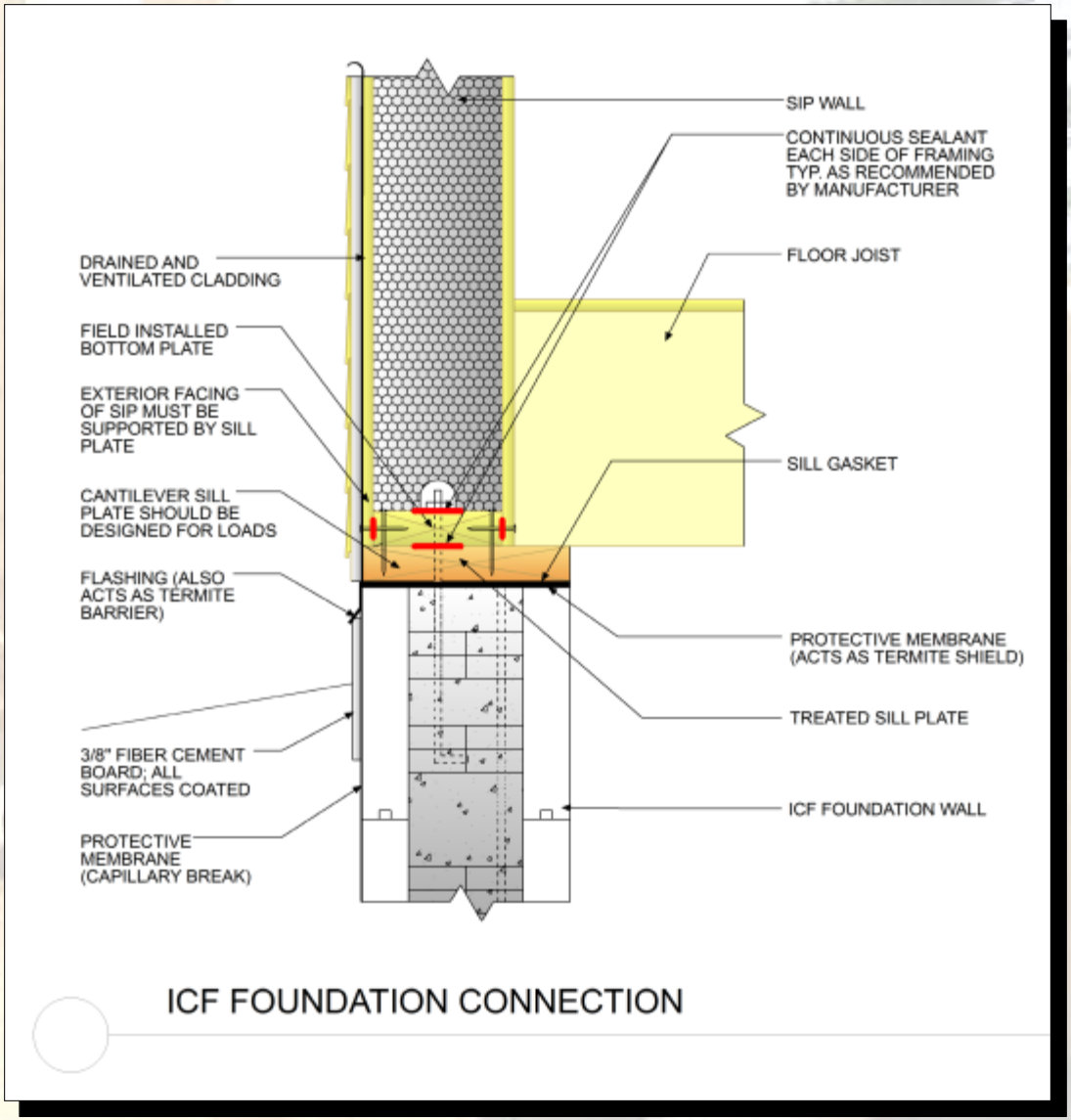
Note: Outside facing is supported by sill plate



INDUSTRY ASSEMBLY STANDARDS

Wall-to-Basement Connection:

Note: Outside facing is supported by sill plate



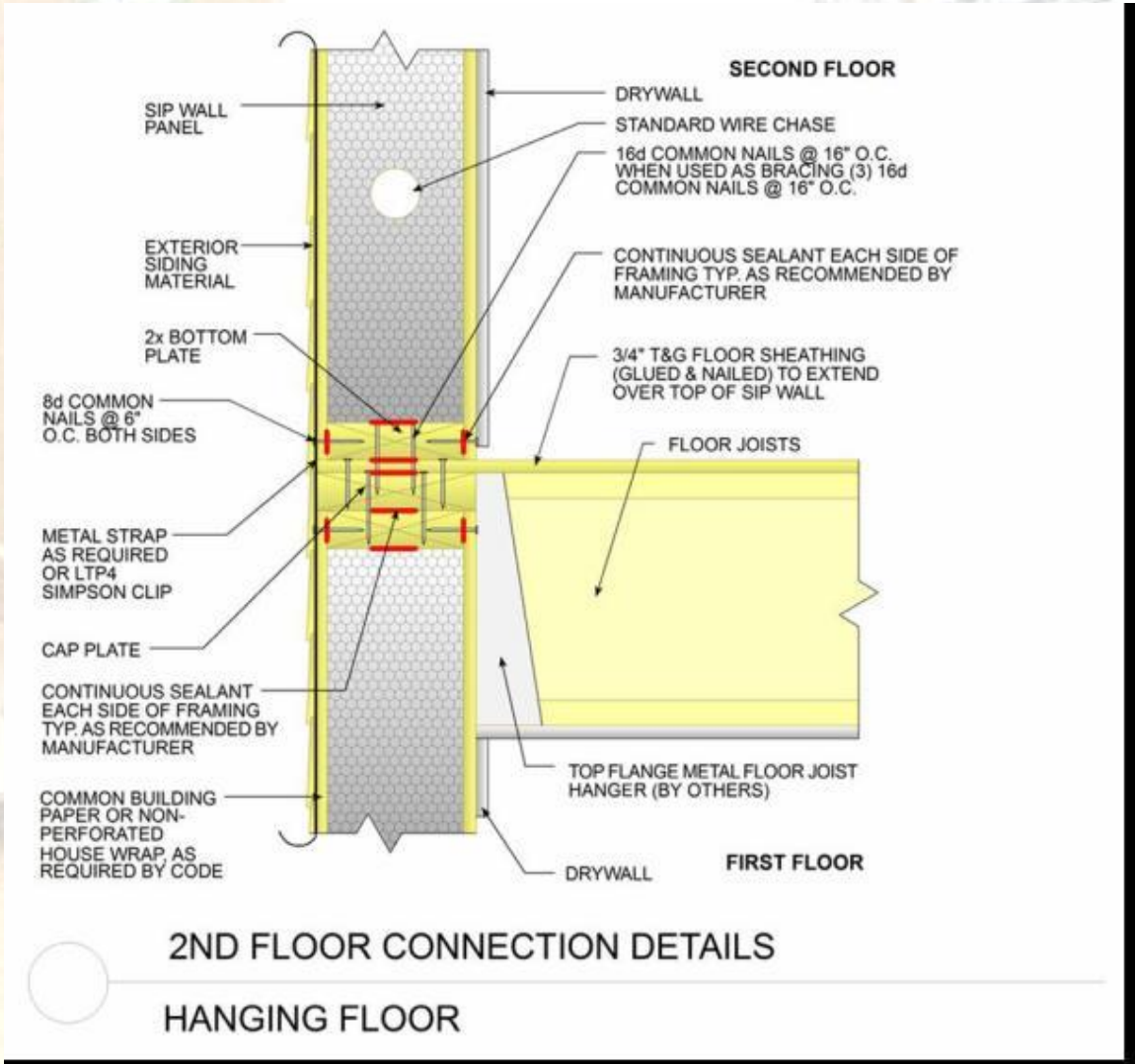
INDUSTRY ASSEMBLY STANDARDS

Second Floor Connection:

Significantly less thermal bridging and air leakage than a conventional rim board assembly

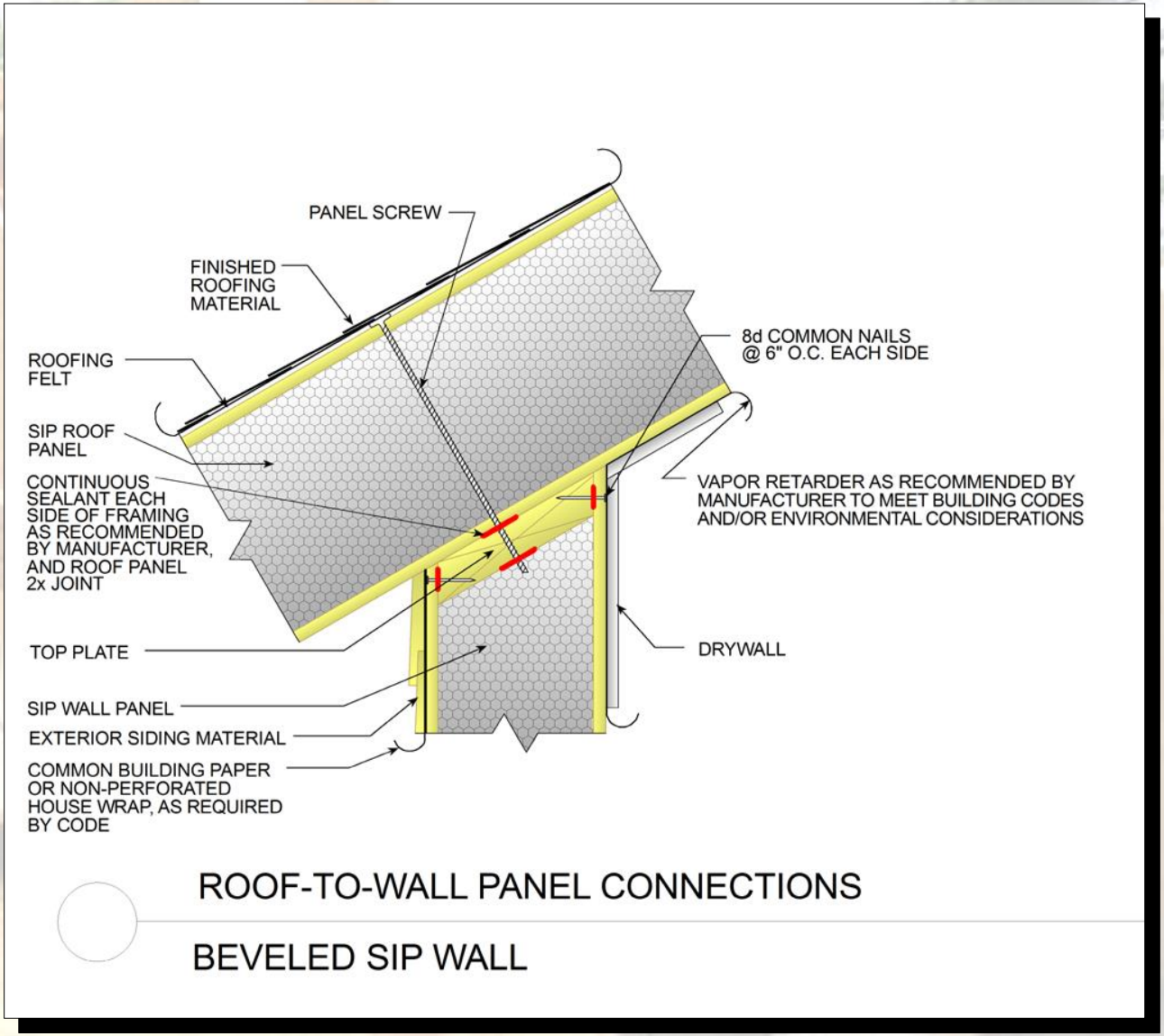
Note strapping for uplift resistance

First floor wall panels need to be sized accordingly to accommodate floor depth



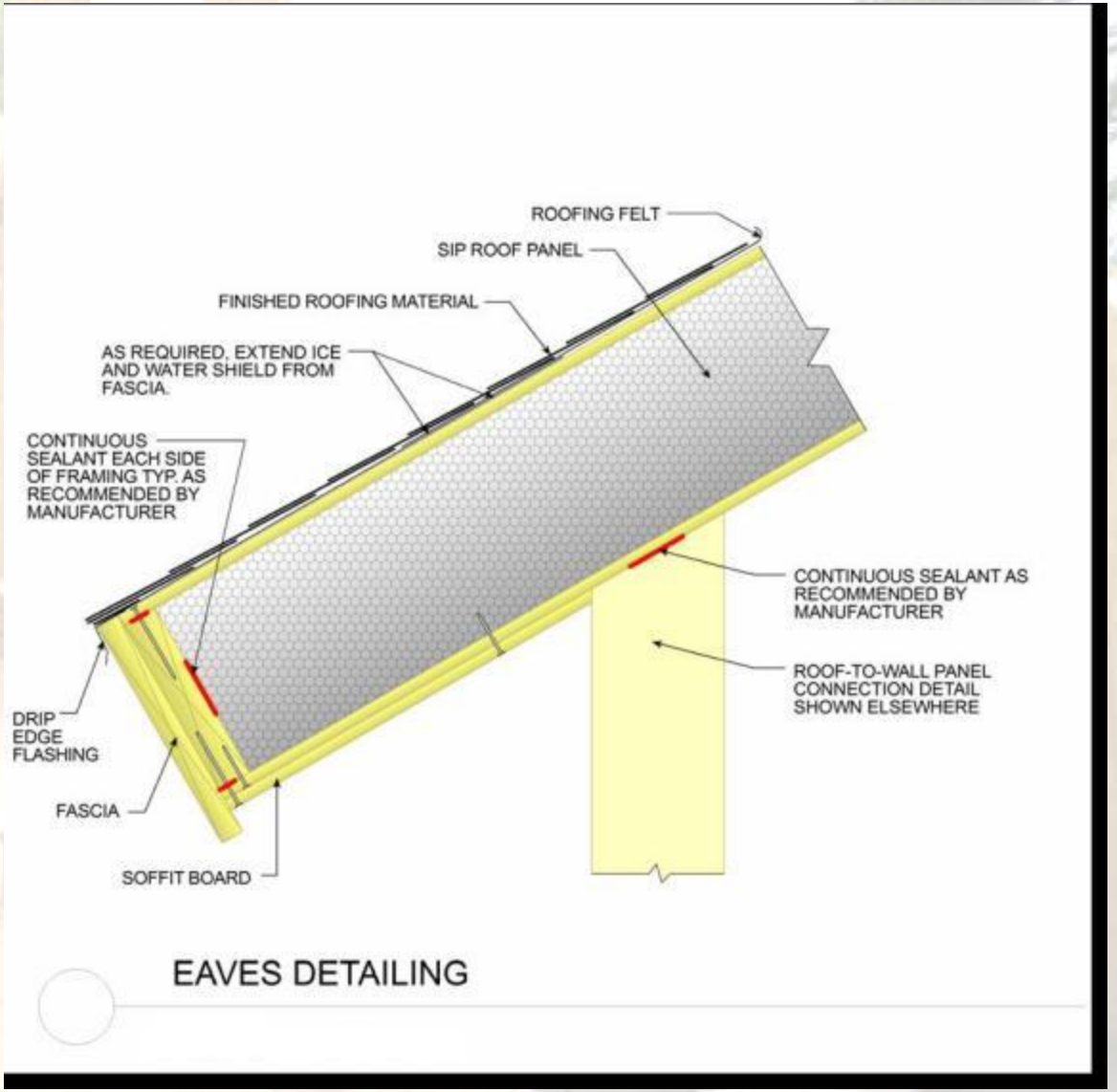
INDUSTRY ASSEMBLY STANDARDS

Roof-to-Wall Connection:



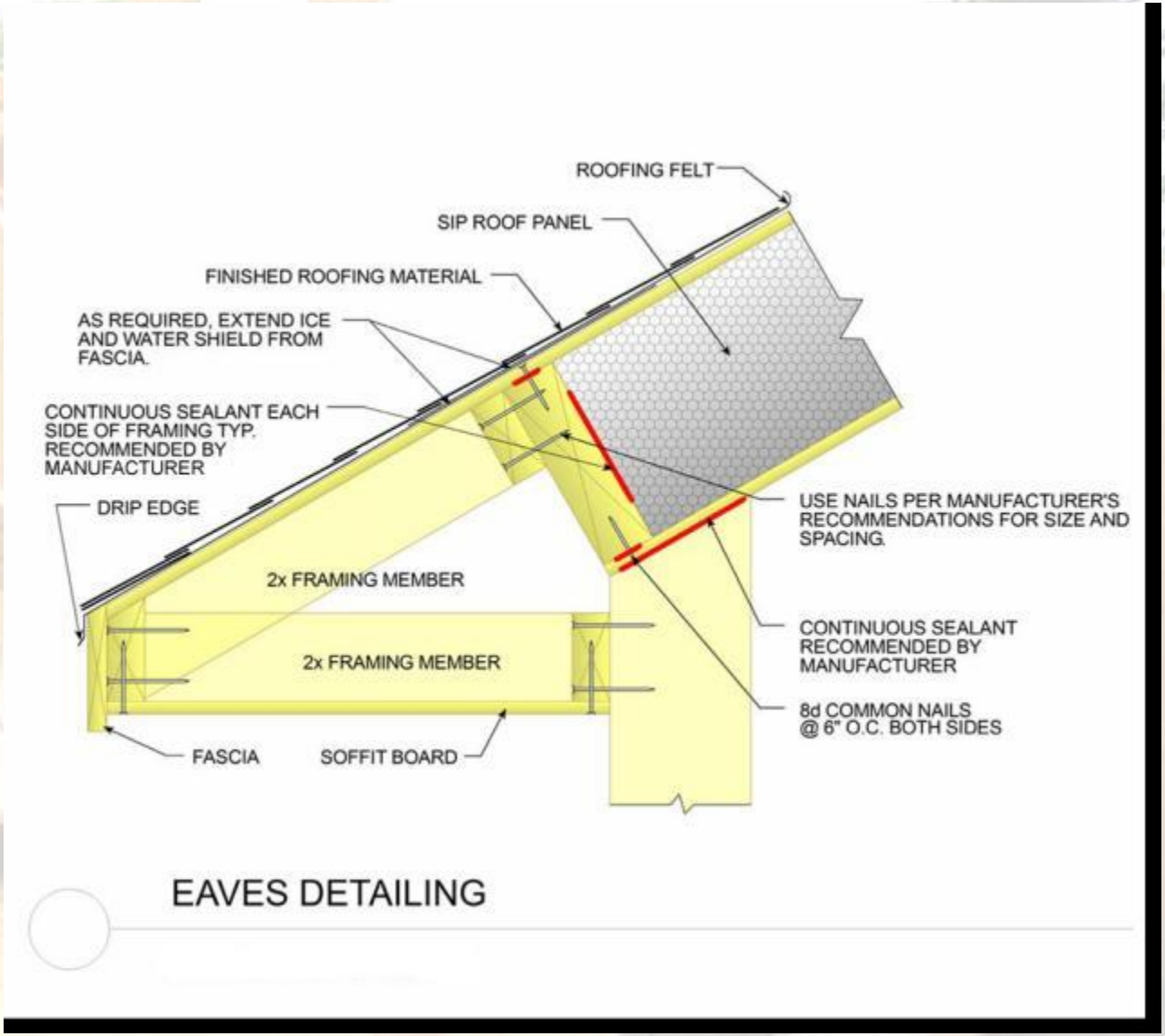
INDUSTRY ASSEMBLY STANDARDS

Typical Eave Condition:



INDUSTRY ASSEMBLY STANDARDS

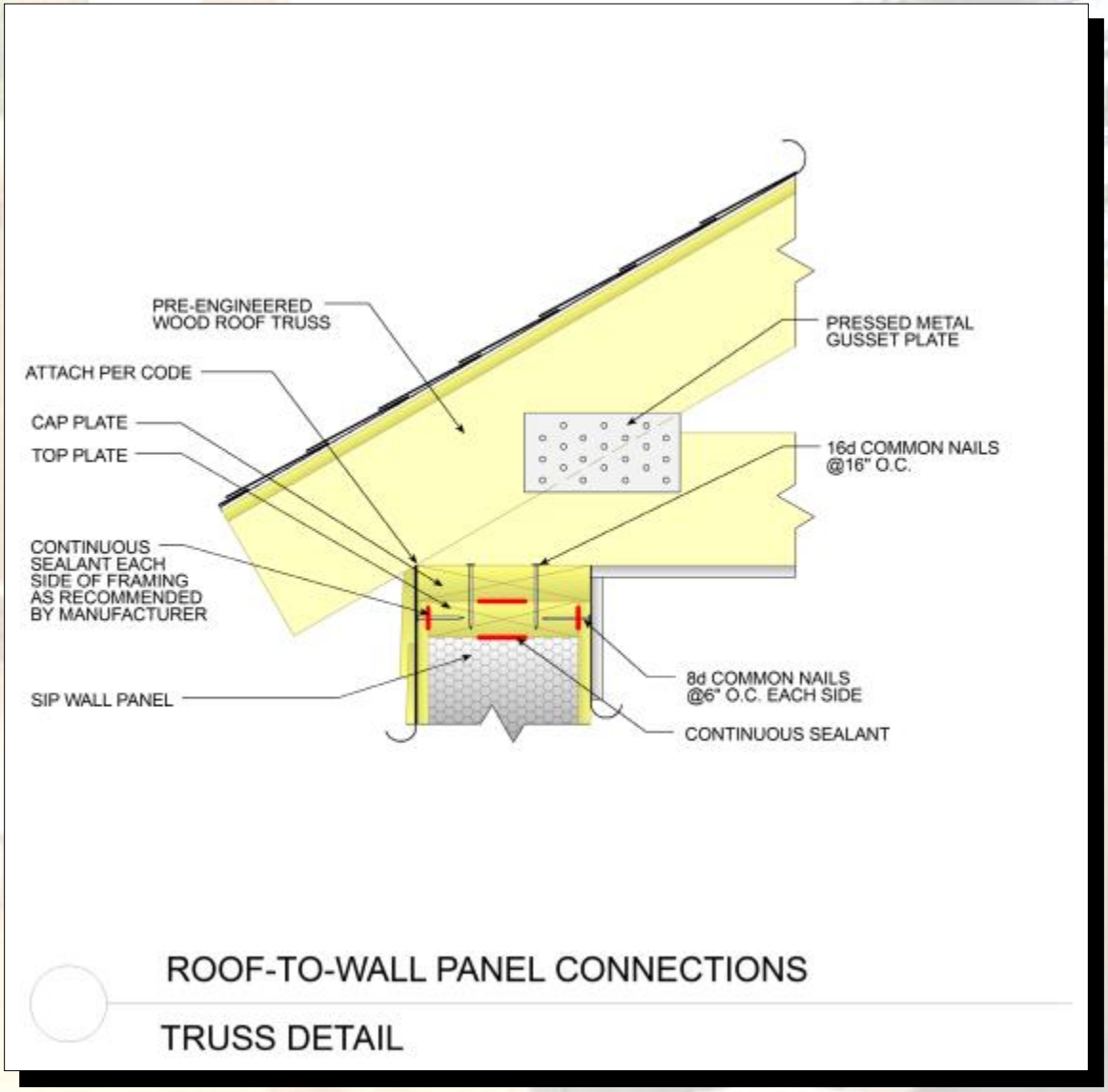
Typical Soffit Condition:



INDUSTRY ASSEMBLY STANDARDS

Typical Truss Condition:

SIPs easily integrate with conventional wood framing

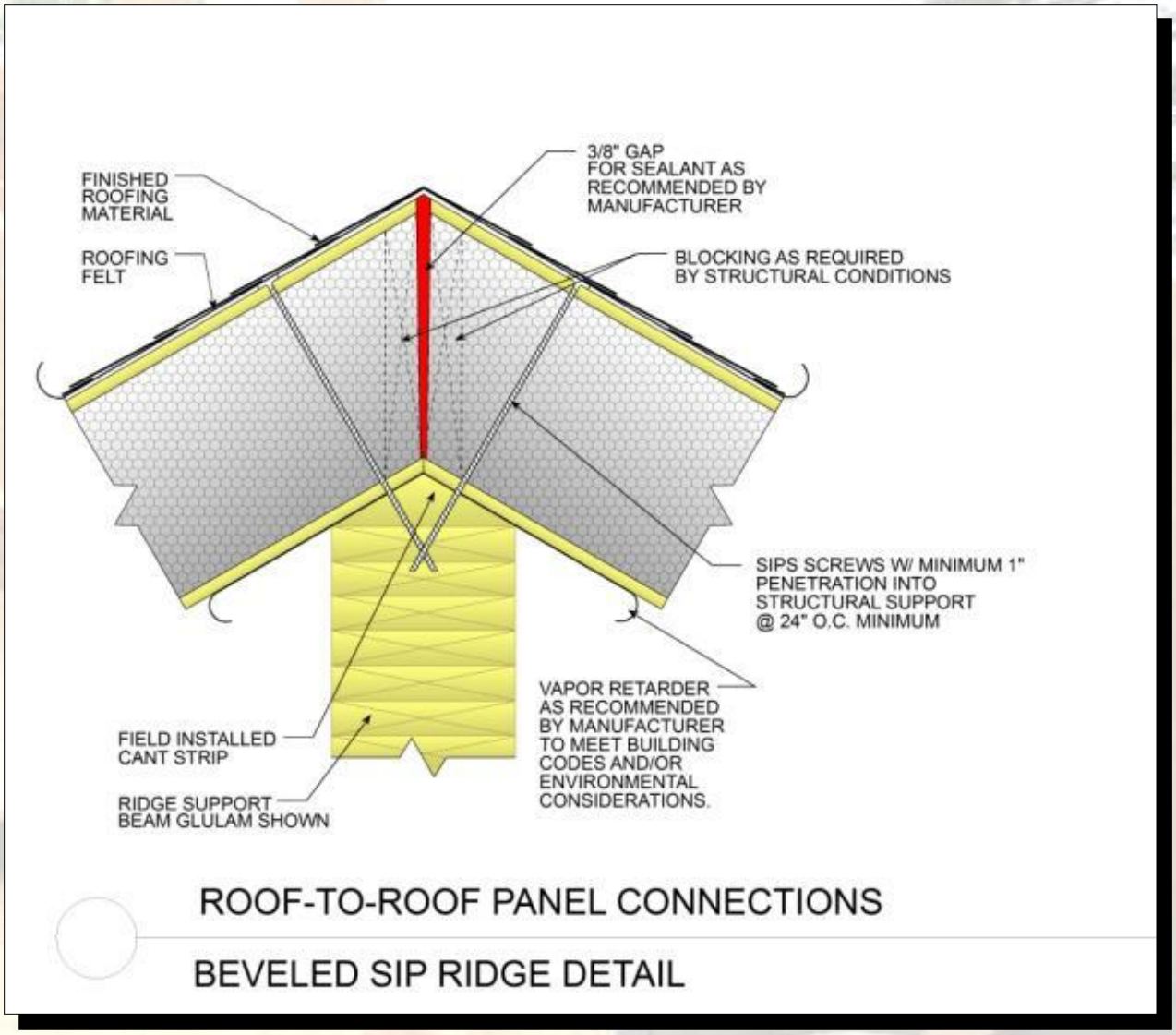


INDUSTRY ASSEMBLY STANDARDS

Typical Ridge Beam Condition:

Depending on load conditions, continuous blocking at panel edges may not be required

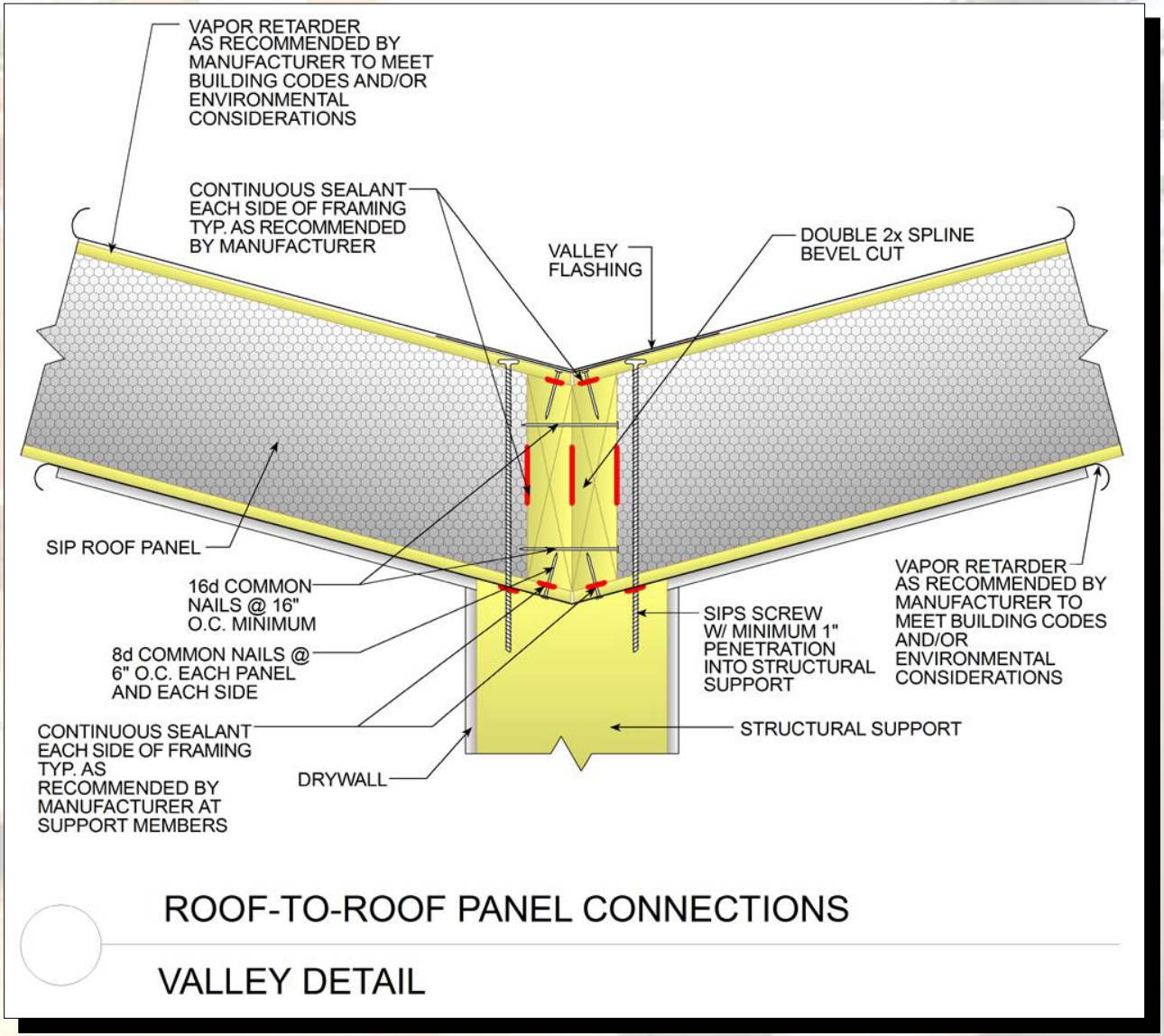
Minimum 3/8” gap at ridge to fill with expanding foam sealant



INDUSTRY ASSEMBLY STANDARDS

Typical Valley Condition:

Valley blocking as required by structural conditions



ELECTRICAL WIRING

Electrical, Including Low Voltage:

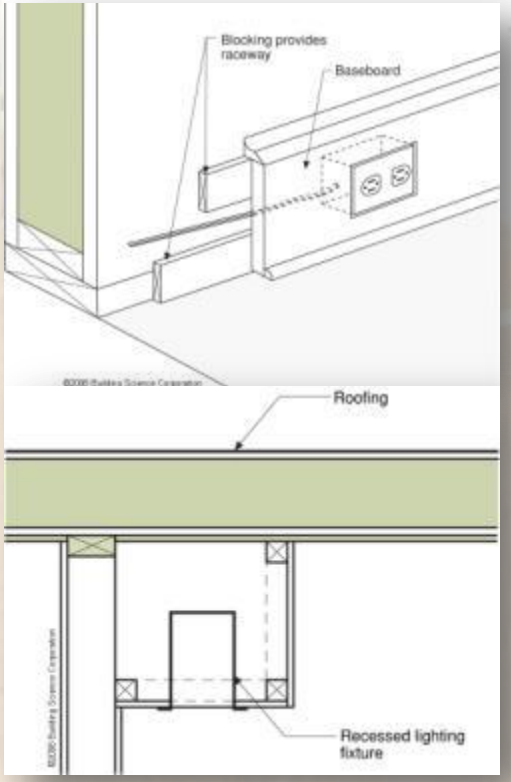
Horizontal and vertical chases are offered by most manufacturers:

- Horizontal chases at 16” & 45” or as required
- Vertical chases every 4’ or as required

ELECTRICAL WIRING

Wiring may be concealed in chases and/or soffits

Small access holes and surface routs can also be used



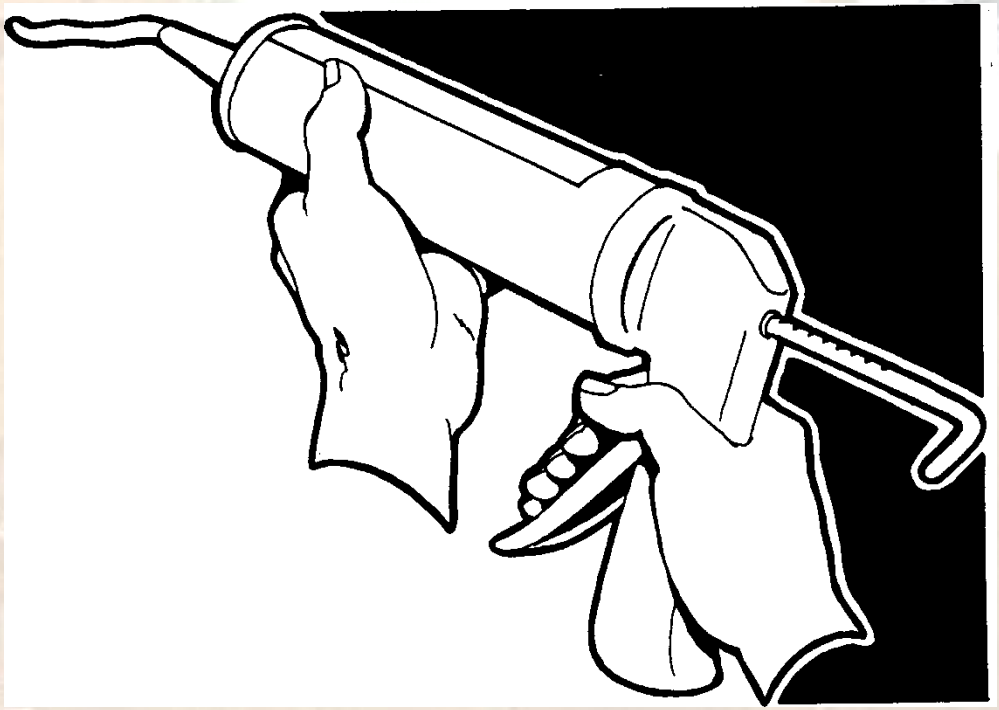
BASF R.S. Means Study:

An independent third party time and motion study conducted by R.S. Means showed SIPs reduce wiring time by 11% in a residential building.

SEALING METHODS

Sealant:

For proper installations that yield SIP benchmark performance, sealing of all joints in strict accordance with the manufacturer's explicit requirements is absolutely critical and necessary



SEALING METHODS

SIP TAPE:

- **Provides a backup to internal sealant that can be visually inspected**
- **At in-plane SIP roof joints**
- **Applied to roof/wall connection**

SEALING METHODS

SIP TAPE:

Note SIP tape draped over ridge beam

COURSE SUMMARY

By now the design professional should be able to:

- Describe SIPs and their applications
- Explain SIP energy strategies
- Illustrate SIP design and engineering methods
- List current industry assembly standards

This course is also available as a Lunch and Learn

Structural Insulated Panel Association

An AIA Continuing Education Program

Designing With Structural Insulated Panels

Credit for this course is 1 AIA HSW CE Hour

The Structural Insulated Panel Association (SIPA) is a nonprofit association representing manufacturers, suppliers, dealer/distributors, design professionals and builders committed to providing quality structural insulated panels (SIPs) for all segments of the construction industry.

Course Sponsor

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