



# PRESCRIPTIVE METHOD FOR STRUCTURAL INSULATED PANELS (SIPs) USED IN WALL SYSTEMS IN RESIDENTIAL CONSTRUCTION



U.S. Department of Housing and Urban Development  
 Office of Policy Development and Research

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Prepared for

U.S. Department of Housing and Urban Development  
Office of Policy Development and Research  
Washington, DC

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### About the NAHB Research Center

The NAHB Research Center, located in Upper Marlboro, Md., is known as America's Housing Technology and Information Resource. In its nearly 40 years of service to the home building industry, the Research Center has provided product research and building process improvements that have been widely adopted by home builders throughout the United States. The Research Center carries out extensive programs of information dissemination and interchange among members of the home building industry and between the industry and the public.



### About Building Works, Inc.

Building Works, Inc. is a consulting firm focused exclusively on the development, engineering, and commercialization of innovative construction products. Established in 1997, the company has conducted projects on a wide range of products made from concrete, wood, plastic, and steel. Its work includes engineering analysis, market research, and strategy development.



### About the Structural Insulated Panel Association (SIPA)

The Structural Insulated Panel Association (SIPA) is the trade organization for the SIPs industry. SIPA's mission is to increase the use and acceptance of SIPs through a strong trade association that provides an industry forum for promotion, communication, education, research, and quality assurance.

#### **Disclaimer**

This report was prepared by the NAHB Research Center and Building Works for the U.S. Department of Housing and Urban Development, Office of Policy Development and Research. The contents of this report are the views of the contractor and do not necessarily reflect the views or policies of the U.S. Department of Housing and Urban Development, the U.S. Government, or any other person or organization.

## *Foreword*

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This document, *Prescriptive Method for Structural Insulated Panels (SIPs) Used in Wall Systems in Residential Construction* (Prescriptive Method), is the third in a series of prescriptive provisions for alternative materials in residential construction.

The Partnership for Advancing Technology in Housing (PATH), administered by the Department of Housing and Urban Development, is focused on improving the affordability and value of new and existing homes. Through public and private efforts, PATH is working to improve affordability, energy efficiency, environmental impact, quality, durability and maintenance, hazard mitigation, and labor safety. HUD, through PATH initiative, has been geared toward removing the primary barriers to efficient use of innovative home building materials such as cold-formed steel (CFS) and insulating concrete forms (ICF). For these materials the primary barriers were very basic - lacking prescriptive construction guidelines and building code approvals. This was done by the development of prescriptive provisions for those materials. While many past achievements have advanced affordable, durable, energy efficient, and safe innovative housing construction and design methods, more work is needed to expand the choice of construction material for builders and contractors. A wider selection of building materials can significantly improve efficiency and expand the realm of applications to more building conditions. Structural Insulated Panels (SIPs) is just one example of systems where structural properties need to be properly prescribed.

This document provides prescriptive methods for using SIPs in residential wall systems. The prescriptive provisions include wall thickness selection tables, and construction details to design and construct residential wall systems using SIPs.

## Acknowledgements

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## INTRODUCTION

The *Prescriptive Method for Structural Insulated Panels (SIPs) Used in Wall Systems in Residential Construction (Prescriptive Method)* provides prescriptive requirements to facilitate the use of SIPs in wall systems for the construction of one- and two-family dwellings. By providing prescriptive provisions for the construction of typical homes with SIP systems, the need for engineering can be eliminated or reduced for most applications. The provisions in this document were developed by applying accepted engineering practices, standard test procedures and practical construction techniques. The provisions in this document comply with the loading requirements of the most recent U.S. model building codes at the time of publication. However, the users of this document should verify its compliance with local code requirements. The user is advised to refer to the applicable building code requirements where the provisions of this document are not applicable or where engineered design is called out.

This document is not a regulatory instrument, although it is written for that purpose. The user should refer to applicable building code requirements when exceeding the limitations of this document, when the requirements conflict with the building code, or when an engineering design is specified. This document is not intended to restrict the use of sound judgment or engineering analysis of specific applications that may result in designs with improved performance and economy.

## 1.0 GENERAL

### 1.1 Purpose

The purpose of the *Prescriptive Method for Structural Insulated Panels (SIPs) Used in Wall Systems in Residential Construction (Prescriptive Method)* is to provide prescriptive requirements for the use of structural insulated panels (SIPs) in wall systems in the construction of residential structures. These provisions include definitions, span tables, material requirements, and other related information appropriate for use by home builders, design professionals, and building code officials.

### 1.2 Approach

The prescriptive requirements were developed by applying accepted engineering principles and supported with relevant structural test data. The provisions of the Prescriptive Method were also based on the *Minimum Design Loads for Buildings and Other Structures (ASCE 7)* [1], the *International Building Code* [2], and the *International Residential Code* [3].

### 1.3 Scope

The provisions of the Prescriptive Method apply to the construction of detached one- or two-family dwellings, townhouses, and other attached single-family dwellings and accessory structures in compliance with the general limitations to Table I.1. SIP wall system construction in accordance with this Prescriptive Method shall be limited by the applicability limits set forth in Table I.1. The limitations are intended to define an appropriate use of this document for most one- and two-family dwellings. Intermixing of these provisions with other construction materials, such as wood or steel framing, in a single structure shall be in accordance with the applicable building code requirements for that material and the applicability limits set forth in Table I.1.

Engineering design shall be required for houses built in regions where the wind speed is greater than 130 mph (209 km/hr), regions along the immediate hurricane-prone coastline subjected to storm surge (i.e., beach front property), regions in Seismic Design Categories D<sub>0</sub>, D<sub>1</sub> and D<sub>2</sub>, and regions in near-fault seismic hazard conditions (i.e., Seismic Design Category E) as defined by the provisions of ASCE 7.

Additional criteria as established by the local jurisdiction shall be considered and addressed for buildings constructed in accordance with the provisions of this document as limited by the provisions of this section.

**Table I.1  
Applicability Limits**

ATTRIBUTE	LIMITATION
<b>GENERAL</b>	
Building Dimension	Maximum building width is 40 feet (12.2 m) Maximum building length is 60 feet (18.3 m)
Number of Stories	2 story (above basement)
Basic Wind Speed	Up to 130 mph (209 km/h)
Wind Exposure	Exposures B <sup>1</sup> (suburban/wooded) Exposures C <sup>1</sup> (open terrain)
Ground Snow Load	70 psf (3.35 kN/m <sup>2</sup> ) maximum ground snow load
Seismic Zone	A, B and C <sup>1</sup>
Building Height	Maximum 35 feet (10.7 m)
<b>FLOORS</b>	
Floor dead load	10 psf (0.48 kN/m <sup>2</sup> ) maximum
Floor live load	
First floor	40 psf (1.92 kN/m <sup>2</sup> ) maximum
Second floor (sleeping rooms)	30 psf (1.44 kN/m <sup>2</sup> ) maximum
<b>WALLS</b>	
Wall dead load	10 psf (0.48 kN/m <sup>2</sup> ) maximum
Load bearing wall height	10 feet (3 m) maximum
Deflection Criteria	L/240
<b>ROOFS</b>	
Roof dead load	10 psf (0.48 kN/m <sup>2</sup> ) maximum
Roof snow/live load	70 psf (3.35 kN/m <sup>2</sup> ) maximum ground snow load (16 psf (0.77 kN/m <sup>2</sup> ) minimum Roof Live Load).
Ceiling dead load	5 psf (0.24 kN/m <sup>2</sup> ) maximum
Roof slope	3:12 to 12:12
Rake overhang	12 inches (305 mm) maximum
Attic live load (Limited Storage)	20 psf (0.96 kN/m <sup>2</sup> ) maximum

For SI: 1 inch = 25.4 mm, 1 psf = 0.0479 kN/m<sup>2</sup>, 1 mph = 1.61 km/hr = 0.447 m/sec, 1 foot = 0.3 m.

<sup>1</sup> As defined by the provisions in ASCE 7.

## 1.4 Definitions

**Accepted Engineering Practice:** An engineering approach that conforms with accepted principles, tests, technical standards, and sound judgment.

**Anchor Bolt:** A bolt, headed or threaded, used to connect a structural member of different material to a concrete member.

**Approved:** Reference to approval by the building code authority having jurisdiction. Product testing or a rational design by a competent design professional is commonly accepted by the code body as grounds for approval.

**Attic:** The enclosed space between the ceiling joists of the top-most floor and the roof rafters of a building not intended for occupancy but sometimes used for storage.

**Authority Having Jurisdiction:** The organization, political subdivision, office, or individual charged with the responsibility of administering and enforcing the provisions of applicable building codes.

**Axial Load:** A force acting in line with a member's longitudinal axis. Examples are the gravity loads carried by columns or wall panels.

**Basement:** That portion of a building, which is partly, or completely below grade and which may be used as habitable space.

**Building:** Any one- or two-family dwelling or portion thereof that is used for human habitation.

**Building Height:** The vertical distance between the average grade, as measured against the building foundation, to either the highest point of the roof beams (for flat-roofed buildings) or the mean height between the eaves and the roof peak for pitched roofs.

**Building Length:** The dimension of a building that is perpendicular to roof rafters, roof trusses, or floor joists (L).

**Building Width:** The dimension of a building that is parallel to roof rafters, roof trusses, floor joists, or roof SIPs (W).

**Ceiling Joist:** A horizontal structural framing member that supports ceiling components and which may be subject to attic loads.

**Core:** The lightweight middle section of the sandwich structural insulated panel composed of molded expanded polystyrene (EPS) insulation or alternative, which provides the link between the two facing shells.

**Dead Load:** Forces resulting from the weight of walls, partitions, framing, floors, ceilings, roofs, and all other permanent construction entering into, and becoming part of, a building.

**Deflection:** Elastic movement of a loaded structural member or assembly (i.e., beam or wall).

**Design Professional:** An individual licensed to practice their respective design profession as defined by the statutory requirements of the state in which the project is to be constructed.

**Design (or Basic) Wind Speed:** Related to winds that are expected to be exceeded once every 50 years at a given site (i.e., 50-year return period). Wind speeds in this document are given in units of miles per hour (mph) by 3-second gust measurements in accordance with ASCE 7 [1].

**Dwelling:** Any building that contains one or two dwelling units for living purposes.

**Endwall:** The exterior wall of a building which is perpendicular to the roof ridge and parallel to floor framing, roof rafters, or trusses. It is normally the shorter dimension of a rectangular building's footprint.

**Exposure Categories:** Reflects the effect of the ground surface roughness on wind loads in accordance with ASCE 7 [1]. Exposure Category B includes urban and suburban areas or other terrain with numerous closely spaced obstructions having the size of single-family dwellings or larger. Exposure Category C includes open terrain with scattered obstructions having heights generally less than 30 ft (9.1 m) and shorelines in hurricane prone regions.

**Facing:** The wood structural panel facers that form the two outmost rigid layers of the structural insulated panel.

**Floor Joist:** A horizontal structural framing member that supports floor loads and superimposed vertical loads.

**Foundation:** The structural elements through which the loads of a structure, both vertical and lateral, are transmitted to the earth.

**Foundation Wall:** The structural element of a foundation that transmits the load of a structure to the earth; includes basement, stem, and crawlspace walls.

**Grade:** The finished ground level adjoining the building at all exterior walls.

**Ground Snow Load:** Measured load on the ground due to snow accumulation developed from a statistical analysis of weather records expected to be exceeded once every 50 years at a given site.

**In-Line Framing:** A framing method where all vertical and horizontal load carrying members are aligned.

**Lateral Load:** A horizontal force, created by wind or earthquake, acting on a structure or its components.

**Lateral Support:** A horizontal member providing stability to a column or wall across either of its smaller dimensions. (Lateral support can be applied to either of the minor dimensions of an axially-loaded member.)

**Live Loads:** Those loads produced by the use and occupancy of the building or other structure and do not include construction or environmental loads such as wind load, snow load, rain load, earthquake load, flood load or dead load.

**Load Bearing Walls:** Walls subject to loads that exceed the limits for non-load bearing walls.

**Multiple Span:** The span made by a continuous member having intermediate supports.

**Non-Load Bearing Walls:** Walls that are limited to a lateral (transverse) load of not more than 5 psf (240 Pa), a superimposed vertical load per member, exclusive of sheathing materials, of not more than 100 lb/ft (1460 N/m), or a superimposed vertical load per member of not more than 200 lbs (890 N).

**Oriented Strand Board (OSB):** Sheets made from narrow strands of wood fiber oriented lengthwise and crosswise in layers, with a resin binder, conforming to DOC PS2 [11]. In the building codes it is included in the class of products called “wood structural panels”.

**Panel Thickness:** Thickness of core plus two layers of wood structural panel facers.

**R-Value, Thermal Resistance:** The inverse of the time rate of heat flow through a building thermal envelope element from one of its bounding surfaces to the other for a



unit temperature difference between the two surfaces, under steady state conditions, per unit area (h.ft<sup>2</sup>. °F/Btu).

**Ridge:** The horizontal line formed by the joining of the top edges of two sloping roof surfaces.

**Roof Snow Load:** Uniform live load on the roof due to snow accumulation as given in ASCE 7 [1].

**Seismic Load:** The force exerted on a building structure resulting from seismic (earthquake) ground motions.

**Seismic Design Category:** A classification assigned to a structure based on its Seismic Group and the severity of the design earthquake ground motion at the site. Seismic Design Categories A, B, C, correspond to successively greater seismic design loads.

**Sill Plate:** A horizontal member constructed of wood, steel, or other suitable material that is fastened to the top of a concrete wall, providing a suitable surface for fastening structural members constructed of different materials to the concrete wall.

**Structural Insulated Panel (SIP):** A structural sandwich panel which consists of a light weight core securely laminated between two rigid facings (such as wood structural panels).

**Smoke-Development Rating:** The combustibility of a material that contributes to fire impact through life hazard and property damage by producing smoke and toxic gases; refer to ASTM E 84 [4].

**Solid Wall Length:** The length of wall which is without openings. It could be comprised either of a single or multiple SIPs.

**Span:** The clear horizontal distance between bearing supports.

**Spline:** A long, narrow strip that fits into a groove cut into the longitudinal edges of the two structural insulated panels to be joined (refer to Figure 6.1). Alternately, the strip (spline) can be a section of structural insulated panel (insulated panel spline) with overall thickness equal to the core thickness of the two structural insulated panels to be connected (refer to Figure 6.2).

**Story:** That portion of the building included between the upper surface of any floor and the upper surface of the floor next above, except that the top-most story shall be that habitable portion of a building included between the upper surface of the top-most floor and the ceiling or roof above.

**Story Above-Grade:** Any story with its finished floor surface entirely above grade except that a basement shall be considered as a story above-grade when the finished surface of the floor above the basement is (a) more than 6 feet (1.8 m) above the grade plane, (b) more than 6 feet (1.8 m) above the finished ground level for more than 50 percent of the total building perimeter, or (c) more than 12 feet (3.7 m) above the finished ground level at any point.

**Strap:** Flat or coiled sheet steel material typically used for bracing and blocking which transfers loads by tension and/or shear.

**Stud:** Vertical structural element of a wall assembly, which supports vertical loads and/or transfers lateral loads.

**Townhouse:** A single-family dwelling unit constructed in a group of three or more attached units in which each unit extends from foundation to roof and with open space on at least two sides.

**Truss:** A coplanar system of structural members joined together at their ends usually to construct a series of triangles that form a stable beam-like framework.

**Wall Height:** The clear vertical distance between the finished floor and the finished ceiling. Where a finished floor does not exist (i.e., crawlspace), the wall height is the clear vertical distance between the interior finish grade and the finished ceiling.

**Structural Walls:** See Load Bearing Walls.

**Non-Structural Walls:** See Non-Load Bearing Walls.

**Wind Exposure:** Refer to Exposure Categories.

**Wind Load:** The force or pressure exerted on a building structure and its components resulting from wind. Wind loads are typically measured in pounds per square foot (psf) or Pascals (Pa).

**Wind Speed:** Refer to Design Wind Speed.

## 2.0 MATERIALS, SHAPES, AND STANDARD SIZES

### 2.1 Physical Dimensions

Walls for residential structures constructed with structural insulated panels (SIP) systems in accordance with this document shall comply with the shapes and minimum cross-sectional dimensions required in this section. SIP walls not in compliance with this section shall be constructed in accordance with accepted engineering practices, manufacturer's recommendations, or an approved design.

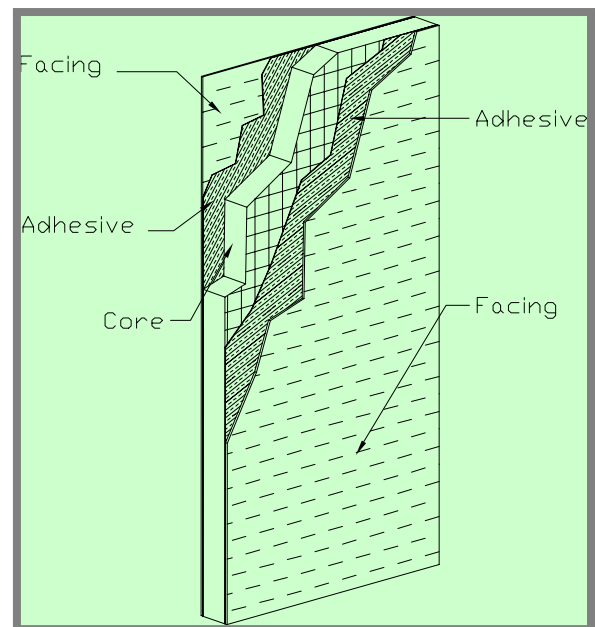
#### 2.1.1 SIP Wall Systems

SIPs for above grade wall construction shall comply with Figures 2.1 and 2.2 and shall have minimum panel thickness as specified in Section 2.2. Alternate SIP wall panel configurations that can demonstrate equivalency to SIP wall panels specified in this document shall be permitted. Each SIP wall panel shall be identified by grade mark and/or certificate of inspection issued by an approved agency as per Section 2.7.

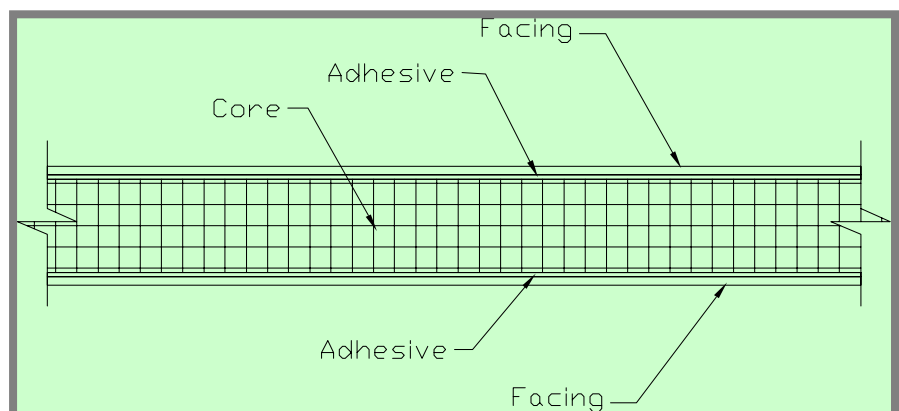
### 2.2 Core Materials

The core material of SIPs used in wall construction shall be composed of molded expanded polystyrene (EPS) meeting the requirements of ASTM C 578 [5], type I, with minimum density of 0.90 lb/ft<sup>3</sup> (14.42 kg/m<sup>2</sup>), or an approved alternate. Flame-spread rating of SIP cores shall be less than 75 and the smoke-development rating shall be less

**Figure 2.1**  
**SIP Wall Components**



**Figure 2.2**  
**Cross Sectional View of SIP**



than 450, as tested in accordance with ASTM E 84 [4]. The minimum thickness of the core for SIP walls shall be 3.5 inches (89 mm). SIP core insulation shall bear a label containing the following as a minimum:

- Manufacturer identification,
- Product standard and type,
- Flame-spread/smoke-developed,
- Name, logo or identification of quality assurance agency.

### 2.3 Facing Materials

Facing material for SIP walls shall be of wood structural panels used for structural purposes conforming to DOC PS 1 [12], DOC PS 2 [11] or, when manufactured in Canada, CSA O437 [14] or CSA O325 [13] and shall meet the following requirements:

- a. 7/16 inch (11 mm) thickness or greater,
- b. Panels identified by a trademark issued by an approved agency in accordance with DOC PS2 [11],
- c. Strength, stiffness, tension, and density meeting the requirements of Table 2.1 [6].

**Table 2.1**  
**Minimum Properties for OSB Skins Used in SIP Walls<sup>(a)</sup>**

Thickness (in.)	Flatwise Stiffness <sup>(b)</sup> (lbf-in. <sup>2</sup> /ft)		Flatwise Strength <sup>(c)</sup> (lbf-in./ft)		Tension <sup>(c)</sup> (lbf/ft)		Density <sup>(b,d)</sup> (pcf)
	Along	Across	Along	Across	Along	Across	
7/16	54,700	27,100	950	870	6,800	6,500	35

<sup>(a)</sup> Tested in accordance with ICC-ES *Qualification of Alternate Sources of OSB for Facers of Sandwich Panels with Foam Plastic Cores* dated August 3, 2005.

<sup>(b)</sup> Mean test value.

<sup>(c)</sup> Characteristic test value (5<sup>th</sup> percentile with 75% confidence).

<sup>(d)</sup> Based on oven-dry weight and oven-dry volume.

### 2.4 Adhesive Materials

Expanded polystyrene (EPS) core insulation shall be adhered to wood structural panel facers with adhesives specifically intended for the lamination of SIPS conforming to

ASTM D2559 [7] or type II class 2 in accordance with ICC ES Acceptance Criteria AC 05 [17]. Each container of adhesive shall bear a label with the adhesive manufacturer identification (such as name or logo), adhesive name and type and the name (or logo) of the certifying quality assurance agency.

## **2.5 Lumber**

Lumber framing material used for SIPs prescribed in the Prescriptive Method shall be No. 2 Spruce-pine-fir (SPF) or equivalent. The use of wood species/grades that meet or exceed the mechanical properties and specific gravity of No. 2 SPF shall be permitted.

## **2.6 Fasteners**

Fasteners (such as screws) used for the connection of SIP wall to wood members as specified in this document shall be corrosion resistant, have threaded or drill point and shall be sized to penetrate a minimum of 1 inch (25.4 mm) into the wood member to which the SIP assembly is being attached as shown in Figure 6.3. SIP Fasteners shall meet the following requirements:

- Nominal thread diameter 0.255 inch (7 mm),
- Nominal shank diameter 0.190 inch (5 mm)
- Nominal head diameter 0.625 inch (16 mm).

SIP fasteners shall have a minimum edge distance of 1-9/16 inch (40 mm) and a maximum edge distance of 2-7/8 inch (73 mm).

Galvanized screws, nails or staples shall be permitted for spline and plate attachments.

## **2.7 Labeling**

All SIPs used in wall construction shall be identified by grade mark and/or certificate of inspection issued by an approved agency. The identification shall have the following minimum requirements:

- Manufacturer Identification (such as name or logo)
- Quality Assurance Agency Identification (such as name or logo)
- Conformance with this document

### **3.0 FOUNDATIONS**

The building foundations shall comply with the applicable building code(s). Structural insulated wall panels shall be anchored to the foundation structure according to the requirements of Sections 4.0 and 6.0 of this document.

### **4.0 SIP ABOVE-GRADE WALLS**

#### **4.1 SIP Above-Grade Wall Requirements**

SIPs used for above-grade walls shall be constructed in accordance with the provisions of this section and Figures 4.1 to 4.7. The minimum length of SIP wall without openings and lintel requirements above wall openings shall be in accordance with Section 5.0. Lateral support for above-grade SIP walls shall be provided by the roof, floor, and interior braced framing systems in accordance with standard engineering practice. Connection details are provided in Section 6.0. The minimum SIP wall thickness shall be greater than or equal to the SIP wall thickness given in Tables 4.2 and 4.3.

Wood framing and structural insulated wall panels shall be fastened through both facing surfaces to other wood building components in accordance with Table 4.1, unless otherwise provided for in this document.

The nominal SIP wall thickness, for wall panels not taller than 10 feet (3048 mm), shall be determined in accordance with Tables 4.2 and 4.3. SIP walls taller than 10 feet (3048 mm) shall be constructed in accordance with an approved design.

#### **4.2 Top Plate**

SIPs used in wall construction shall be capped with a top plate to provide overlapping at corners, intersections and splines in accordance with Figure 4.6. End joints in top plates shall be offset at least 24 inches (610 mm). Plates shall be a nominal 2 inches (51 mm) in depth and have a width equal to the width of the SIP (wall) core.

#### **4.3 Bottom (sill) Plate**

SIP walls shall have full bearing on pressure treated sill plates each having a width equal to the nominal width of the SIP core. When structural insulated wall panels are supported directly on continuous foundations in accordance with Figure 4.8, the wood sill plate at exterior walls on monolithic slabs and wood sill plates shall be anchored to the foundation with anchor bolts spaced a maximum of 6 feet (1,829 mm) on center. There shall be a minimum of two bolts per plate section with one bolt located not more than 12 inches (305 mm) or less than seven bolt diameters from each end of the plate

section. Bolts shall be at least 1/2 inch (12.7 mm) in diameter and shall extend minimum of 7 inches (178 mm) into masonry or concrete. Foundation anchor straps, spaced as required can be used to provide equivalent anchorage to 1/2-inch-diameter (12.7 mm) anchor bolts.

Interior bearing wall sill plates on monolithic slab foundations shall be positively anchored with approved fasteners. A nut and washer shall be tightened on each bolt to the plate.

#### **4.4 SIP Wall Bracing**

Walls constructed with SIPs shall be considered fully sheathed walls (i.e., continuous wood structural panel sheathing). Tables 4.4 and 4.4a shall be used for determining the length requirements for braced wall panels (full height braced wall panels). Openings (such as for doors and windows) in SIP walls shall be permitted provided that the wall bracing requirements meet or exceed those specified in Tables 4.4 and 4.4a.

The bracing amounts in Table 4.4a shall be permitted to be multiplied by a factor of 0.9 for walls with a maximum opening height that does not exceed 85 percent of the wall height or a factor of 0.8 for walls with a maximum opening height that does not exceed 67 percent of the wall height. Braced wall panels (i.e., full height SIP) shall begin no more than 12.5 feet (3,810 mm) from each end of a braced wall line. Braced wall panels (i.e., full height SIPs) that are counted as part of a braced wall line shall be in line, except that offsets out-of-plane of up to 4 feet (1,219 mm) shall be permitted provided that the total out-to-out offset dimension in any braced wall line is not more than 8 feet (2,438 mm).

##### **4.4.1 Spacing of SIP Wall Bracing**

Spacing of braced SIP wall lines shall not exceed 35 feet (10,668 mm) on center along both the length and the width of each story of a building.

**Exception:** Spacing of braced SIP wall lines not exceeding 50 feet shall be permitted where:

1. The wall bracing provided equals or exceeds the amount of bracing required by Table 4.4 multiplied by a factor equal to the braced wall line spacing divided by 35 feet (10,668 mm), and
2. The length-to-width ratio for the floor/wall diaphragm does not exceed 3:1.

## **4.5 Above-Grade SIP Wall Coverings**

### **4.5.1 Interior Covering**

The interior facing of SIP walls located along interior habitable spaces shall be covered with a minimum of ½-inch (13-mm) gypsum board or an approved finish material that provides a thermal barrier to limit the average temperature rise of the unexposed surface to no more than 250 degrees F (139 °C) after 15 minutes of fire exposure as tested in accordance with ASTM E119 [8]. The use of vapor retarders and air barriers shall be in accordance with the authority having jurisdiction.

### **4.5.2 Exterior Covering**

SIP walls shall be protected from physical damage. All SIP walls in exterior applications shall be covered with approved materials installed to provide a barrier against the weather (such as sunlight, snow, and rain). The exterior wall envelope shall be designed with a water-resistive barrier behind the exterior veneer. The water-resistive barrier shall be one layer of No. 15 felt, free from holes and breaks, complying with ASTM D226 [15] for Type I felt or other approved equal.

## **4.6 SIP Wall Penetrations**

The internal vertical chase penetration in the SIP core shall have a maximum side dimension of 2-inches (51 mm) centered in the panel core. Vertical chases shall have a minimum spacing of 24-inches (610 mm) on center. A maximum of 2 horizontal chases shall be permitted in each wall panel—one at 14-inches (360 mm) and one at 4-feet (1,219 mm) from the bottom of the panel.

The maximum allowable penetration size in a SIP wall panel shall be limited to a 12-inch (305 mm) circular or 12-inch by 12-inch (305 mm x 305 mm) rectangular section in accordance with Figure 4.7. Over-cutting of holes in facing panels shall not be permitted without an approved design.

## **4.7 Interior Load-Bearing Walls**

Interior load-bearing walls shall be constructed as specified in the building code or by the authority having jurisdiction.



**Table 4.1**  
**Fastener Schedule for SIP Construction**

<b>Building Elements</b>	<b>Number and Type of Fasteners<sup>a, b, c, d</sup></b>	<b>Spacing of Fasteners</b>
3/8" gypsum board	13 gage, 1-1/4" long, 19/64" head; 0.098 diameter, 1-1/4" long, annular-ringed; or 4d cooler nail, 0.080" diameter, 1-3/8" long, 7/32" head.	Nails: 8" o.c.  Screws: 16" o.c.
1/2" gypsum board	13 gage, 1-3/8" long, 19/64" head; 0.098 diameter, 1-1/4" long, annular-ringed; or 5d cooler nail, 0.086" diameter, 1-5/8" long, 15/64" head, or gypsum board nail, 0.086 diameter, 1-5/8" long, 9/32" head.	Nails: 8" o.c.  Screws: 16" o.c.
5/8" gypsum board	13 gage, 1-5/8" long, 19/64" head; 0.098 diameter, 1-3/8" long, annular-ringed; or 6d cooler nail, 0.092" diameter, 1-7/8" long, 1/4" head, or gypsum board nail, 0.0915 diameter, 1-7/8" long, 19/64" head.	Nails: 8" o.c.  Screws: 12" o.c.
Sole (sill) plate face nailed to joist or blocking	16d common nails	16" o.c.
Top plate to cap plate	16d common nails	16" o.c.
Sole (sill) plate to monolithic concrete foundation	Minimum 1/2 inch (13 mm) diameter anchor bolts	6 feet o.c. maximum
SIP wall panel to SIP wall panel corner connection	SIP screws with minimum 1 inch penetration into wood member in SIP wall panel connected to	24" o.c. maximum
SIP wall panel to top wood plate	8d common nails	6" o.c. both sides
SIP wall panel to top/bottom steel track	Min. No. 8 screw	
SIP wall panel to wood sill plate	8d common nails	6" o.c. both sides
SIP wall panel to steel track (on foundations)	Min. No. 8 screw	6" o.c.
SIP wall panel to framing or cripple studs	8d common nails	6" o.c.
SIP wall panel to SIP wall panel	8d common nails	6" o.c. each strip and each side

For SI: 1 inch = 25.4mm, 1 foot = 304.8 mm, 1 mph = 1.61 km/h, 1 ksi = 6.895 MPa (Notes cont. on page 16)

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- a. All nails are smooth-common, box or deformed shanks except where otherwise stated. Nails used for framing and sheathing connections shall have minimum average bending yield strengths as shown: 80 ksi for shank diameter of 0.192 inch (20d common nail), 90 ksi for shank diameters larger than 0.142 inch but not larger than 0.177 inch, and 100 ksi for shank diameters of 0.142 inch or less.
- b. Staples are 16-gage wire and have a minimum 7/16-inch crown width.
- c. Nails shall be spaced at not more than 6 inches on center at all supports where spans are 48 inches or greater.
- d. Screws shall be Type S or W per ASTM C 1002 [16] and shall be sufficiently long to penetrate wood framing not less than 5/8 inch and metal framing not less than 3/8 inch.

**Table 4.2**  
**Nominal Thickness (Inches) for SIP Walls Supporting**  
**SIP or Light-Frame Roofs Only<sup>1</sup>**

Wind Speed (3-sec gust)		Snow Load (psf)	Building Width (ft)														
			24			28			32			36			40		
Exp. A/B	Exp. C		Wall Height (ft)			Wall Height (ft)			Wall Height (ft)			Wall Height (ft)			Wall Height (ft)		
			8	9	10	8	9	10	8	9	10	8	9	10	8	9	10
85		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	4.5	4.5	4.5	4.5
100	85	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	4.5	4.5	4.5	4.5
110	100	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	4.5	4.5	4.5	4.5
120	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
130	120	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	6.5	4.5	4.5	6.5	4.5	4.5	6.5
		70	4.5	4.5	4.5	4.5	4.5	6.5	4.5	4.5	6.5	4.5	6.5	N/A	4.5	6.5	N/A
	130	20	4.5	4.5	6.5	4.5	4.5	N/A	4.5	4.5	N/A	4.5	4.5	N/A	4.5	6.5	N/A
		30	4.5	4.5	N/A	4.5	4.5	N/A	4.5	4.5	N/A	4.5	6.5	N/A	4.5	6.5	N/A
		50	4.5	6.5	N/A	4.5	6.5	N/A	4.5	N/A	N/A	6.5	N/A	N/A	6.5	N/A	N/A
		70	4.5	N/A	N/A	6.5	N/A	N/A	6.5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

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

<sup>1</sup> Deflection criteria: L/240.

Roof dead load: 10 psf maximum.

Roof live load: 70 psf maximum

Ceiling dead load: 5 psf maximum.

Ceiling live load: 20 psf maximum.

N/A indicates not applicable (design required).

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**Table 4.3  
Nominal Thickness (Inches) of SIP Walls Supporting  
SIP or Light-Frame Story and Roof<sup>1</sup>**

Wind Speed (3-sec gust)		Snow Load (psf)	Building Width (ft)														
			24			28			32			36			40		
Exp. A/B	Exp. C		Wall Height (ft)			Wall Height (ft)			Wall Height (ft)			Wall Height (ft)			Wall Height (ft)		
		8	9	10	8	9	10	8	9	10	8	9	10	8	9	10	
85		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	
		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	
		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	
		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	6.5	6.5	
100	85	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	
		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	6.5	
		50	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
		70	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	6.5	6.5	6.5	6.5	N/A	N/A	
110	100	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	6.5	
		30	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	6.5	4.5	6.5	6.5	
		50	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	6.5	6.5	6.5	N/A	
		70	4.5	4.5	4.5	4.5	4.5	6.5	6.5	6.5	N/A	6.5	N/A	N/A	N/A	N/A	N/A
120	110	20	4.5	4.5	4.5	4.5	4.5	4.5	4.5	6.5	4.5	4.5	6.5	4.5	6.5	N/A	
		30	4.5	4.5	4.5	4.5	4.5	6.5	4.5	4.5	6.5	4.5	6.5	N/A	6.5	6.5	N/A
		50	4.5	4.5	6.5	4.5	4.5	6.5	4.5	6.5	N/A	6.5	N/A	N/A	N/A	N/A	N/A
		70	4.5	4.5	6.5	4.5	6.5	N/A	6.5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
130	120	20	4.5	4.5	6.5	4.5	4.5	6.5	4.5	6.5	N/A	4.5	6.5	N/A	6.5	N/A	N/A
		30	4.5	4.5	6.5	4.5	4.5	N/A	4.5	6.5	N/A	6.5	N/A	N/A	6.5	N/A	N/A
		50	4.5	6.5	N/A	4.5	6.5	N/A	6.5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		70	4.5	6.5	N/A	6.5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
130	130	20	6.5	N/A	N/A	6.5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		30	6.5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		50	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		70	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

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

- <sup>1</sup> Deflection criteria: L/240  
 Roof dead load: 10 psf maximum  
 Roof live load: 70 psf maximum  
 Ceiling load: 5 psf maximum  
 Ceiling live load: 20 psf maximum  
 Second floor live load: 30 psf maximum  
 Second floor dead load: 10 psf  
 Second floor wall dead load: 10 psf  
 N/A indicates not applicable (design required)

**Table 4.4  
SIP Wall Bracing Requirements**

Seismic Design Category or Wind Speed	Condition	Amount Of Bracing
Categories A and B or 100 mph and less	One story Top of two-story	Full height SIP panel with minimum length per Table 4.4a located at each end (within 12.5 feet from each corner) and at least every 25 feet on center but not less than 16% of braced wall line
	First story of two-story	Full height SIP panel with minimum length per Table 4.4a located at each end (within 12.5 feet from each corner) and at least every 25 feet on center but not less than 16% of braced wall line
Category C or less than 110 mph	One story Top of two-story	Full height SIP panel with minimum length per Table 4.4a located at each end (within 12.5 feet from each corner) and at least every 25 feet on center but not less than 16% of braced wall line
	First story of two-story	Full height SIP panel with minimum length per Table 4.4a located at each end (within 12.5 feet from each corner) and at least every 25 feet on center but not less than 30% of braced wall line

For SI: 1 inch = 25.4 mm, 1 foot = 304. 1 mph = 1.61 km/h.

**Table 4.4a  
Requirements for Braced SIP walls<sup>1,2</sup>**

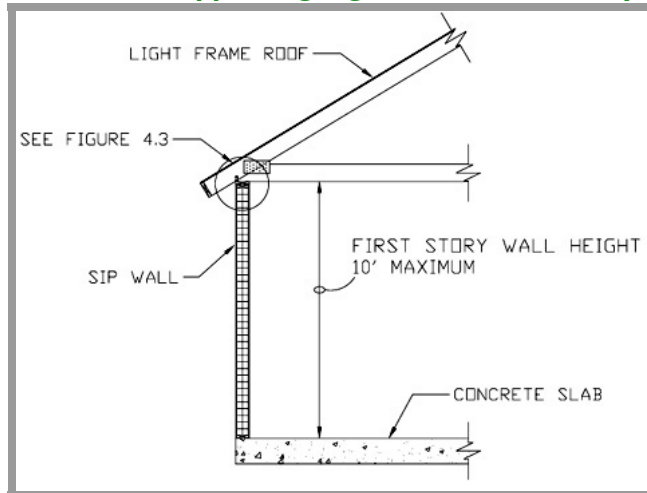
Length of Braced SIP Walls (inches)			Maximum Opening Height Next to the Braced SIP wall (% of wall height)
8-Foot	9-Foot	10-Foot	
48	54	60	100%
32	36	40	85%
24	27	30	67%

For SI: 1 inch = 25.4 mm, 1 foot = 305 mm.

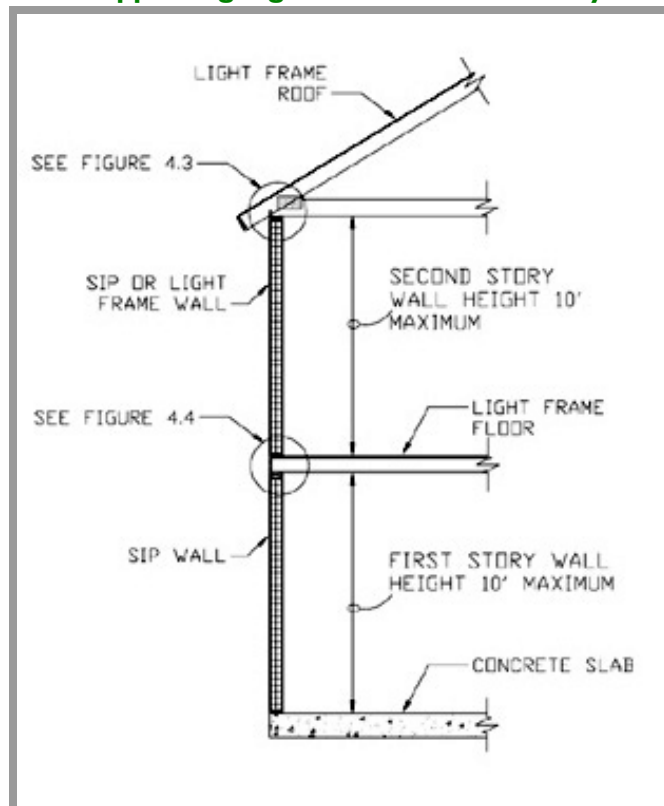
1 Linear interpolation shall be permitted.

2 Full-height SIP to either side of garage openings that support light frame roofs with roof covering dead loads of 3 psf or less shall be permitted to have a 4:1 aspect ratio.

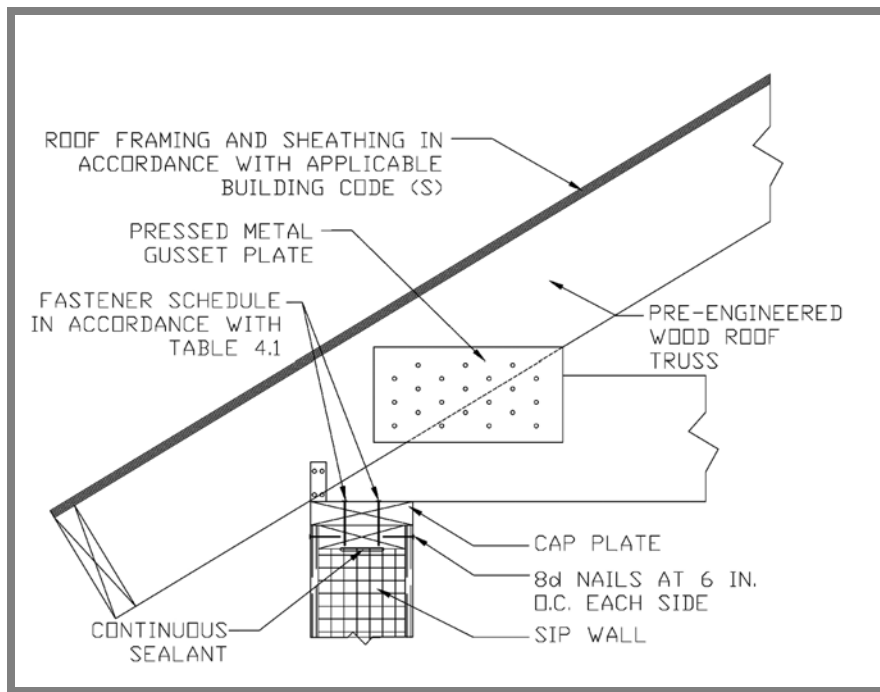
**Figure 4.1**  
**SIP Wall Supporting Light-Frame Roof Only**



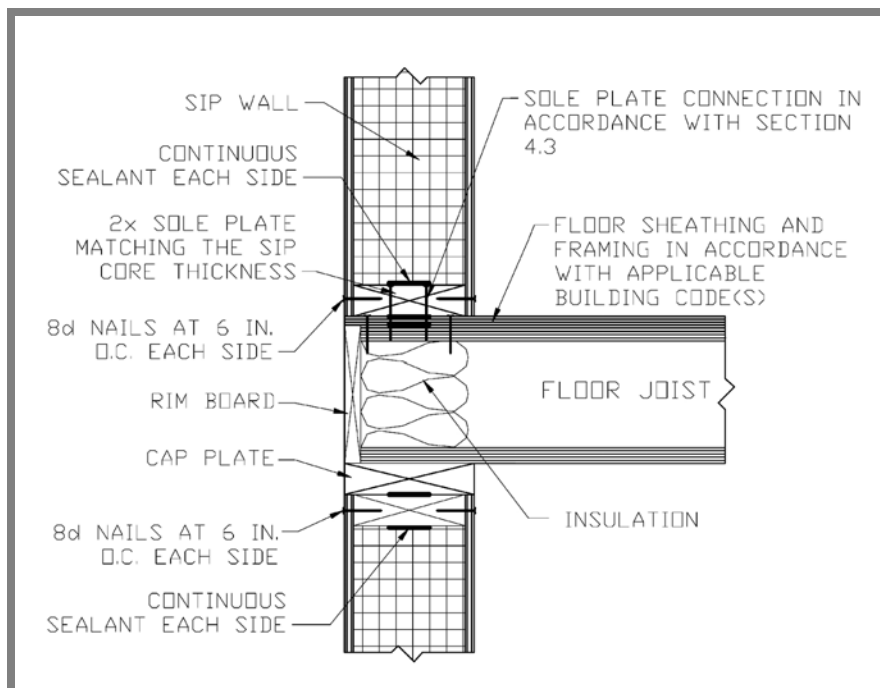
**Figure 4.2**  
**SIP Wall Supporting Light-Frame Second Story and Roof**



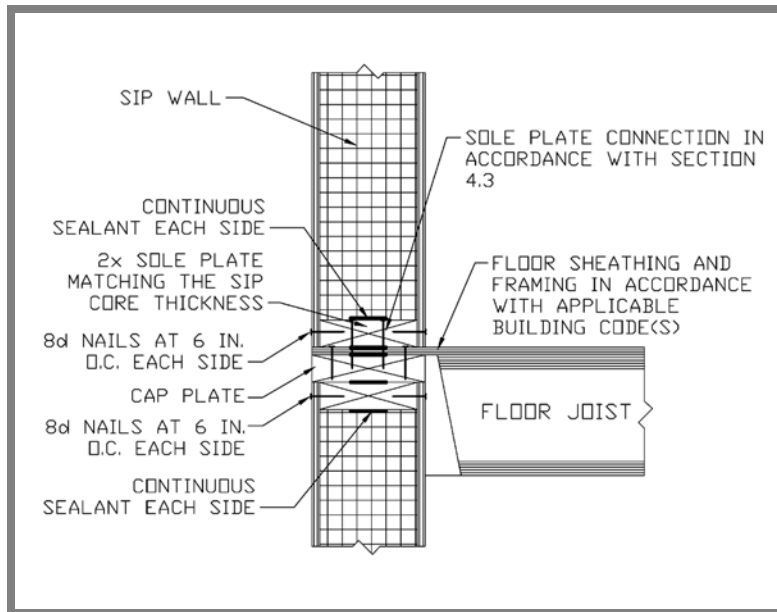
**Figure 4.3**  
**SIP Wall to Roof Connection**



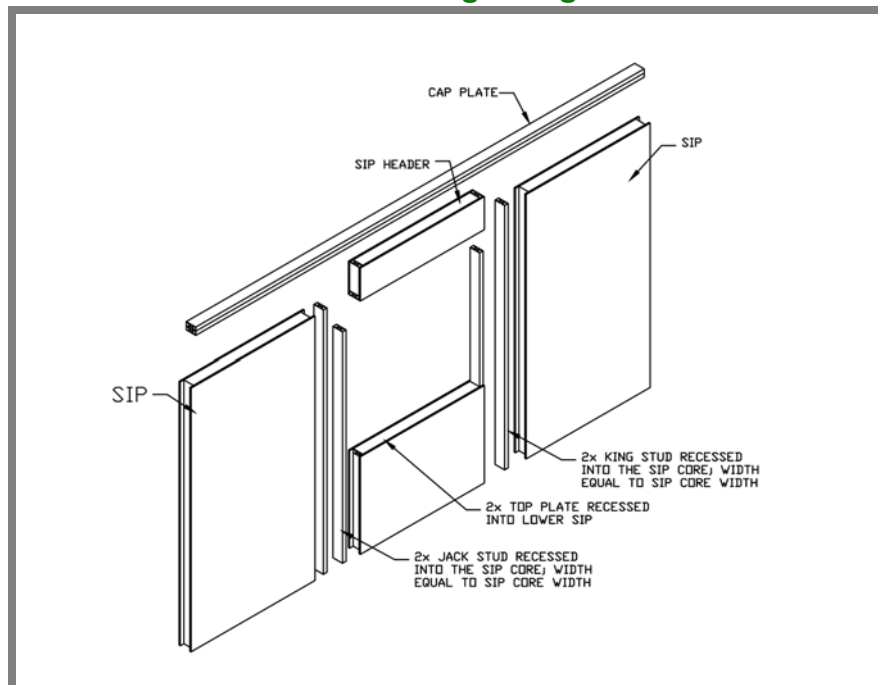
**Figure 4.4**  
**SIP Wall to Wall Platform Frame Connection**



**Figure 4.5**  
**SIP Wall to Wall Balloon Frame Connection**



**Figure 4.6**  
**SIP Wall Framing Configuration**



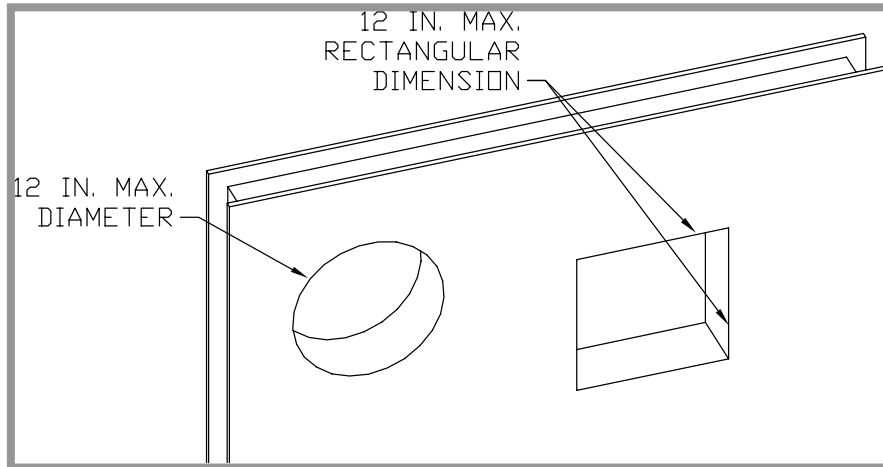
**Notes:**

1. Top plates shall be continuous over header.
2. SIP facing surfaces shall be nailed to framing and cripples with 8d common or box nails spaced 6 inches (152 mm) on center, staggering alternate nails 1/2 inch (13 mm).

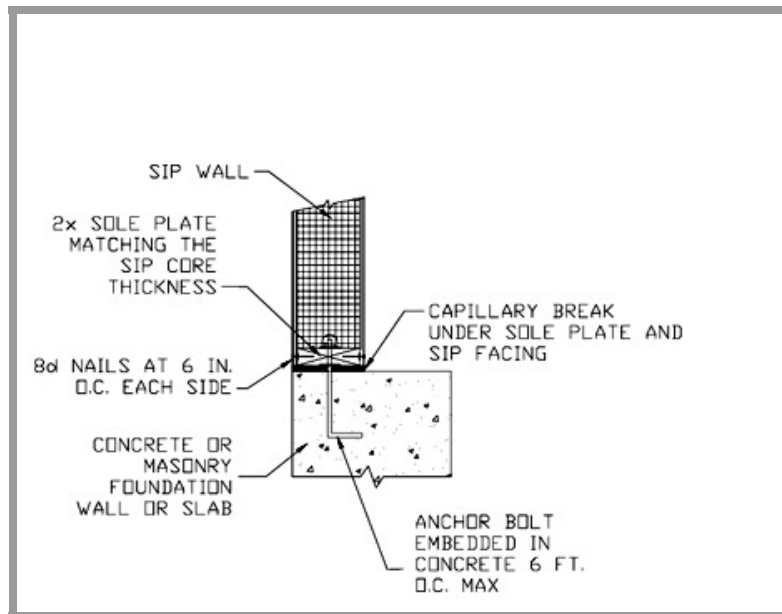


- Galvanized nails shall be hot-dipped or tumbled. Framing shall be attached in accordance with building code requirements unless otherwise provide for in this document.

**Figure 4.7**  
**SIP Wall Penetrations**



**Figure 4.8**  
**SIP Wall to Concrete Slab or Foundation Wall Attachment**



## 5.0 SIP HEADER REQUIREMENTS

Structural insulated panel (SIP) wall headers shall be designed and constructed according to Table 5.1 and Figure 4.6. SIP headers shall be continuous sections without splines. Headers longer than 4 ft (1,219 mm) shall be constructed according to Section 5.1. The top plate shall be continuous over the header.

**Table 5.1  
Maximum Span (Feet) For SIP Headers**

Load Condition	Snow Load (psf)	Building Width (ft)				
		24	28	32	36	40
Supporting Roof Only	20	4	4	4	4	2
	30	4	4	4	2	2
	50	2	2	2	2	2
	70	2	2	2	N/A	N/A
Supporting Roof and One-Story	20	2	2	N/A	N/A	N/A
	30	2	2	N/A	N/A	N/A
	50	2	N/A	N/A	N/A	N/A
	70	N/A	N/A	N/A	N/A	N/A

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm  
 Deflection criteria: L/240  
 Roof dead load: 10 psf maximum  
 Ceiling dead load: 5 psf maximum  
 Second floor live load: 30 psf maximum  
 Second floor dead load: 10 psf maximum  
 Second floor dead load from walls: 10 psf maximum  
 N/A indicates not applicable (design required)

### 5.1 Wood structural panel box headers

Wood structural panel box headers are permitted to be used where SIP headers are not applicable. Wood structural panel box headers shall be constructed in accordance with Figure 5.1 and Table 5.2. The top plate shall be continuous over the header. Jack studs shall be used for spans over 4 feet (1,219 mm). Wood structural panel faces shall be single pieces of 15/32-inch-thick (12 mm) or thicker Exposure 1, installed on the interior or exterior or both sides of the header. Wood structural panel faces shall be nailed to framing and cripples with 8d common or galvanized box nails spaced 3 inches (76 mm) on center, staggering alternate nails 1/2 inch (12.7 mm).

**Table 5.2**  
**Maximum Span (Feet) for Wood Structural Panel Box Headers <sup>a</sup>**

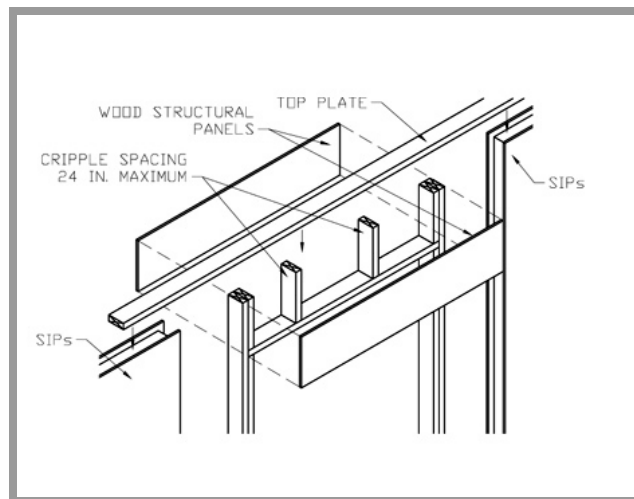
Header Construction <sup>b</sup>	Header Depth (inches)	House Depth (ft)				
		24	26	28	30	32
Wood structural panel – one side	9	4	4	3	3	-
	15	5	5	4	3	3
Wood structural panel – both sides	9	7	5	5	4	3
	15	8	8	7	7	6

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

a. Spans are based on single story with clear-span trussed roof, top story of two-story with a clear-span trussed roof, or two-story with floor and roof supported by interior-bearing walls.

b. See Figure 5.1 for construction details.

**Figure 5.1**  
**Typical Wood Structural Panel Box Header Construction**

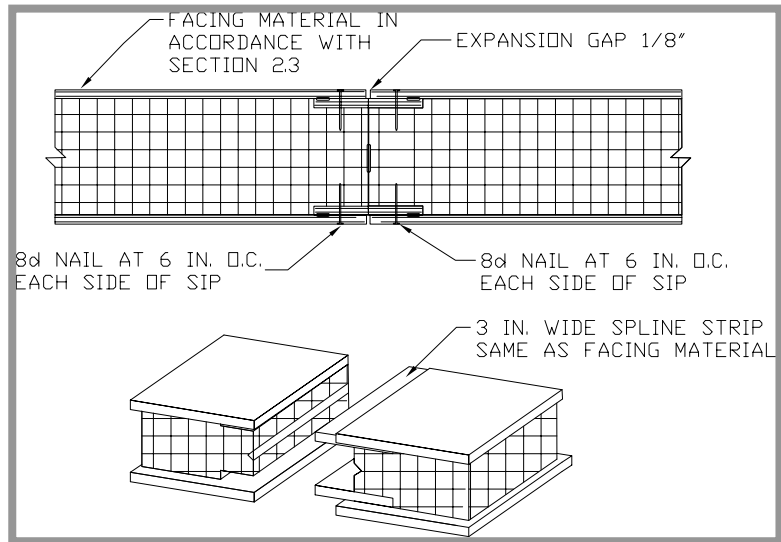


## 6.0 SIP CONNECTION DETAILS

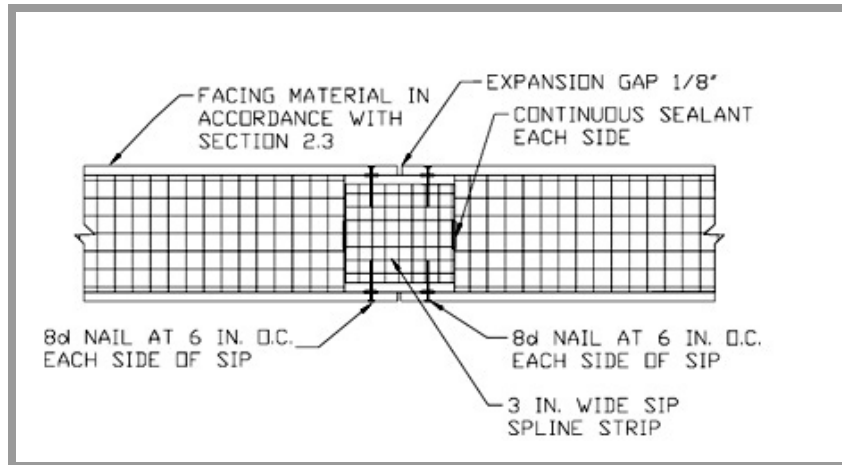
### 6.1 Wall Panel to Wall Panel Connection

Structural insulated panel walls shall be connected in accordance with Figures 6.1, Figure 6.2, or by other approved method.

**Figure 6.1**  
**Surface Spline**



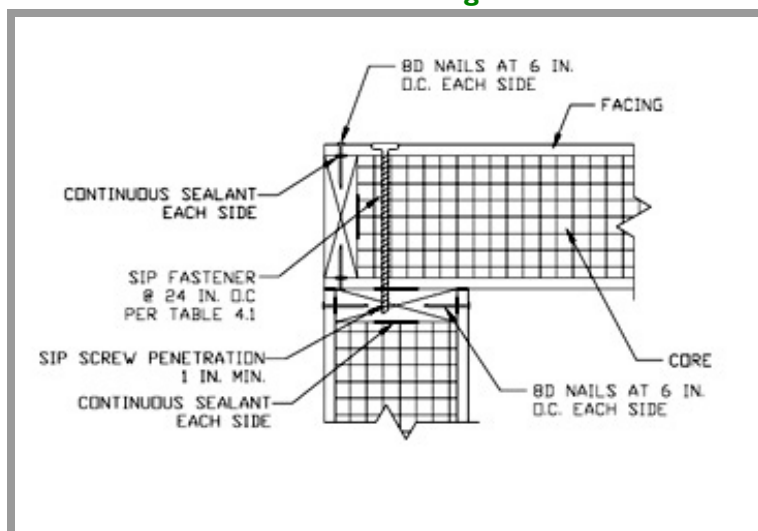
**Figure 6.2**  
**Insulated Spline**



## 6.2 Corner Framing

Corner framing of structural insulated panel walls shall be constructed in accordance with Figure 6.3 or other approved method.

**Figure 6.3**  
**SIP Corner Framing Detail**



## 7.0 UTILITIES

### 7.1 Plumbing Systems

Plumbing shall comply with the provisions of the IRC or the applicable plumbing code.

### 7.2 HVAC Systems

HVAC installation shall comply with the provisions of the IRC or the applicable mechanical and/or energy code.

### 7.3 Electrical Systems

Electrical system installation shall comply with the National Electric Code [9].

## 8.0 THERMAL GUIDELINES

### 8.1 Energy Code Compliance

The insulation value (R-value) of SIP wall systems shall meet or exceed the applicable provisions of the IRC, local energy code, or the ICC Energy Conservation Code [10].

### 8.2 Moisture

SIP wall panels shall be protected from moisture intrusion through the use of approved exterior wall finishes in accordance with Section 4.0. SIP walls that become excessively

wet or damaged shall be removed and replaced before proceeding with the installation of additional panels or other work.

### 8.3 Ventilation

The natural ventilation rate of SIP buildings shall not be less than that required by the local code or 0.35 ACH when no local code exists. When required, mechanical ventilation shall be provided to meet the minimum air exchange rate of 0.35 ACH.

## 9.0 REFERENCES

- [1] *Minimum Design Loads for Buildings and Other Structures (ASCE 7-05)*. American Society of Civil Engineers, New York, New York. 2005.
- [2] *International Building Code (IBC)*. International Code Council (ICC). Country Club Hills, IL. 2006.
- [3] *International Residential Code (IRC)*. International Code Council (ICC). Country Club Hills, IL. 2006.
- [4] *ASTM E 84-05 Standard Test Method for Surface Burning Characteristics of Building Materials*. ASTM International. West Conshohocken. Pennsylvania. 2005.
- [5] *ASTM C 578-06 Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation*. ASTM International. West Conshohocken. Pennsylvania. 2006.
- [6] *APA Report T2006P-28: Evaluation of OSB as Facers in Structural Insulated Panels for Ainsworth Engineered, (USA) LLC*. APA – The Engineered Wood Association. Tacoma, WA. 2006.
- [7] *ASTM D 2559-04 Standard Specification for Adhesives for Structural Laminated Wood Products for Use Under Exterior (Wet Use) Exposure Conditions*. ASTM International. West Conshohocken. Pennsylvania. 2003.
- [8] *ASTM E 119-05a Standard Test Methods for Fire Tests of Building Construction and Materials*. ASTM International. West Conshohocken. Pennsylvania. 2005.
- [9] *National Electrical Code*. National Fire Protection Association (NFPA). Quincy, MA, 2006.
- [10] *International Energy Conservation Code (IECC)*. International Code Council (ICC). Country Club Hills, IL. 2006.

- [11] *PS 2-04 Performance Standard for Wood-Based Structural-use Panels*. APA – The Engineered Wood Association. Tacoma, WA. 2004
- [12] *PS 1-95 Voluntary Product Standard for Construction and Industrial Plywood*. APA – The Engineered Wood Association. Tacoma, WA. 2004
- [13] *CAN/CSA-O325.0-92. Construction Sheathing*. Canadian Standards Association. Mississauga, Canada. 1992 (Reaffirmed 1998).
- [14] *CAN/CSA-O437 SERIES-93 Standards on OSB and Waferboard*. Canadian Standards Association. Mississauga, Canada. 1993 (Reaffirmed 2001).
- [15] *ASTM D226-05 Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing*. ASTM International. West Conshohocken. Pennsylvania. 2005.
- [16] *C1002-04 Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs*. ASTM International. West Conshohocken. Pennsylvania. 2004.
- [17] *AC 05 Acceptance Criteria for Sandwich Panel Adhesives*. ICC Evaluation Service, Inc. Country Club Hills, IL. 2005

## **Appendix A - Commentary on the Prescriptive Method for Structural Insulated Panels (SIPS) Used in Wall Systems in Residential Construction**

### **Commentary**

The Commentary on the Prescriptive Method for Structural Insulated Panels (SIPS) Used in Wall Systems in Residential Construction (Commentary) is developed to provide the background, supplemental information, engineering assumptions and methods, of the Prescriptive Method.

The loads, load combinations, and other design parameters used to develop the provisions in the *Prescriptive Method* are based on the *International Residential Code* (ICC, 2006), the *International Building Code* (ICC, 2006) (where no provisions are included in the IRC) and the *Minimum Design Loads for Buildings and Other Structures* (ASCE 7-05).

*Commentary* is provided only for those sections of the *Prescriptive Method* where background or supplemental information is of benefit to the user. Sections thought to need no explanation are left blank.



## Commentary on the Prescriptive Method for Structural Insulated Panels (SIPS) Used in Wall Systems in Residential Construction

### C1.0 GENERAL

#### C1.1 Purpose

The purpose of the *Prescriptive Method* is to provide prescriptive provisions for the design and construction of structural insulated panels (SIPs) used in wall systems of one and two family dwellings, townhouses, and other detached and attached single-family dwellings not more than two stories in height (above a basement).

#### C1.2 Approach

The requirements, figures, and tables provided in the *Prescriptive Method* are based on test data, interpretive application of ASCE *Minimum Design Loads for Building and Other Structures* (ASCE 7-2005) and the pertinent requirements of the International Residential Code (IRC 2006) and the International Building Code (IBC 2006).

#### C1.3 Scope

The *Prescriptive Method* is not applicable to all possible conditions of use and is subject to the applicability limits set forth in Tables I.1. The applicability limits are necessary to define reasonable boundaries to the conditions that must be considered in developing prescriptive construction requirements. The applicability limits should be carefully understood as they define important constraints on the use of the *Prescriptive Method*.

The applicability limits strike a reasonable balance between engineering theory, available test data, and proven field practices for typical residential construction applications. The applicability limits are intended to prevent misapplication while addressing a reasonably large percentage of new housing conditions. The *Prescriptive Method*, however, does not limit the application of alternative methods or materials through engineering design.

**Building Geometry:** The provisions in the *Prescriptive Method* apply to detached one- and two-family dwellings, townhouses, and other attached single-family dwellings not more than two stories in height. Its application to homes with complex architectural configurations is subject to careful interpretation by the user and therefore, engineering design support may be required. The most common building widths (or depths) range from 24 feet to 40 feet (7.3 to 12.2 m), with structural wall heights up to 10 feet (3.1 m). The building width as used in the *Prescriptive Method* is the dimension measured along the length of the trusses or joists (floor or ceiling) between the outmost structural walls. The maximum length of building is limited to

60 feet (18.3 m) where the length is measured in the direction parallel to the roof ridge or perpendicular to the floor joists or roof trusses.

**Site Conditions:** Conditions for each site must be established by the user. Local conditions include ground snow loads, basic wind speeds, and the Seismic Design Category (SDC).

**Snow Loads:** Snow load values are typically given in a ground snow load map such as provided in the building code, ASCE 7 (ASCE, 2005) or by local practice. The national model building codes in the U.S. either adopt the ASCE 7 snow load requirements or have a similar map published in the code. The 0 to 70 psf (0 to 3.35 kN/m<sup>2</sup>) ground snow load used in the *Prescriptive Method* covers approximately 90 percent of the United States, which was deemed to include the majority of the buildings that are expected to utilize this document. Buildings in areas with greater snow loads than 70 psf (3.35 kN/m<sup>2</sup>) should not use this document without consulting a design professional.

**Basic Wind Speed:** All areas of the U.S. fall within the 90 to 130 mph (3-sec gust) (145 to 209 km/hr) range of design wind speeds, per ASCE 7. The *wind exposure* category in the *Prescriptive Method* is limited to Exposures A, B, and C. Wind speed and exposure are defined in the *Prescriptive Method*. Wind exposure is a critical determinant of the wind loads to be expected at a given site, and it should be determined by good judgment on a case-by-case basis. Buildings built along the immediate coastline (i.e. beach front property) are classified as Exposure D and therefore, cannot use this document without consulting a design professional. The three-second-gust wind speeds were used in the *Prescriptive Method* as identified in ASCE 7. Although ASCE 7 has wind contours up to 150 mph (241 km/hr), the 150 mph (241 km/hr) contour only occurs at the tip of southern Florida. Therefore, limiting the wind speed in the *Prescriptive Method* to 130 mph (209 km/hr) is appropriate.

**Seismic Design Category:** The *Prescriptive Method* covers all residential constructions in Seismic Design Categories A, B, and C (within the limits of applicability of Table 1.1).

**Loads:** Loads and load combinations as shown in the 2006 IRC, 2006 IBC, and ASCE 7-2005 were used to develop the tables and other provisions in the *Prescriptive Method*.

## C1.4 Definitions

Many of the terms in the *Prescriptive Method* are self-explanatory. Only definitions of terms not self-explanatory or not defined in the referenced documents are provided in the *Prescriptive Method*.

## C2.0 MATERIALS, SHAPES, AND STANDARD SIZES

### C2.1 Physical Dimensions

The structural insulated panel (SIPs) sizes specified in the *Prescriptive Method* are commonly available among SIP manufacturers. The dimensions and material requirements are specified in this section.

#### C2.1.1 SIP Wall Systems

SIP wall panels shall comply with Figures 2.1 and 2.2 of the *Prescriptive Method* and are limited to two nominal wall thicknesses, 4-1/2" (114 mm) and 6-1/2" (165 mm). Other SIP panel geometries, thicknesses, and composition are permitted by the *Prescriptive Method* provided that the manufacturer of such alternate panels proves equivalency to the panels prescribed in this *Prescriptive Method*. To show equivalency, other structural insulated panels shall meet the minimum requirements of Sections C2.2 through C2.7, inclusive.

### C2.2 Core Materials

The majority of SIPs used today have molded expanded polystyrene (EPS) as the core material, and hence the provisions in the *Prescriptive Method* are based on such core materials. The *Prescriptive Method* does not, however, prohibit the use of other core materials (such as Polyurethane core). SIPs utilizing alternate core materials must show equivalency to the SIPs specified in this document. This equivalency includes, but not limited to, structural, flame spread, smoke density, durability, and insulation values.

### C2.3 Facing Materials

The facings of the majority of SIPs produced today consist of oriented-strand-board (OSB) and therefore, the provisions and tables in the *Prescriptive Method* were determined based on OSB facing materials.

The *Prescriptive Method* steering committee worked with the Structural Insulated Panel Association (SIPA), APA, the Engineered Wood Association, and the wood structural panel industry to develop minimum design properties for the wood structural panel skins.

Testing at APA, The Engineered Wood Association, of the facing materials used in the development of the *Prescriptive Method* resulted in the values shown in Table 2.1, *Minimum Properties for OSB Skins Used in SIP Walls*. Complete results from APA tests are available in *APA Report T2006P-28*.

Using these industry-developed minimum properties for panels, APA conducted a series of tests on SIPs manufactured to reflect these minimums, including shear, axial, transverse, and lintel testing. These tests were conducted in accordance with recognized test methods (ASTM E72, ASTM D198, ASTM E1803, and ICC-ES AC04). From these tests design capacities were established and used in the development of the provisions in the *Prescriptive Method*. Results from APA Tests (reference APA Report T2006P-33) are summarized in Table C2.3-1.

**Table C2.3-1 - Ultimate Load Values for SIP Wall Panels**

Test Type	Panel Size	Panel Thickness	Test Method	Test Specifics	Mean Ultimate Load	Units of Measure
Racking Shear	8- foot x 8-foot	4-1/2"	ASTM E72	ASTM E72 Monotonic, Section 14	981	plf
	8- foot x 10-foot	4-1/2"			973	
	8- foot x 8-foot	6-1/2"			943	
	8- foot x 10-foot	6-1/2"			969	
Axial Test	4- foot x 8-foot	4-1/2"	ASTM E72	ASTM E72 Section 9	10,857	plf
	4- foot x 10-foot	4-1/2"			9,398	
	4- foot x 8-foot	6-1/2"			9,650	
	4- foot x 10-foot	6-1/2"			10,957	
Transverse Test	4- foot x 8-foot	4-1/2"	ASTM E72	ASTM E72 Section 11	3,622	plf
	4- foot x 10-foot	4-1/2"			3,278	
	4- foot x 8-foot	6-1/2"			3,606	
	4- foot x 10-foot	6-1/2"			3,442	

Reference APA, The Engineered Wood Association Test Report No. T2006P-33.

The allowable shear, axial, and bending capacities used to develop the provisions in the *Prescriptive Method* are shown in tables C2.3-2 and C2.3-3.

**Table C2.3-2 - Allowable Design Values (plf) for SIP Wall Panels**

Load Type	Nominal Wall Thickness			
	4-1/2 in.		6-1/2 in.	
	Wall Height		Wall Height	
	96 in.	120 in.	96 in.	120 in.
Shear (plf)	315	315	315	315
Axial (plf)	3,200	3,200	3,100	3,100

Reference APA, The Engineered Wood Association Test Report No. T2006P-33.

**Table C2.3-3 - Allowable Transverse Load Design Values (psf) for SIP Wall Panels**

Panel Height	Panel Nominal Thickness	Allowable Transverse Load for Deflection Limits (psf)			
		L/360	L/240	L/180	L/120
8-Foot	4-1/2"	30	38	38	38
10-Foot	4-1/2"	18	27	27	27
8-Foot	6-1/2"	38	38	38	38
10-Foot	6-1/2"	29	29	29	29

Reference APA, The Engineered Wood Association Test Report No. T2006P-33.

Other facing materials (e.g. cementitious boards) are permitted in the *Prescriptive Method* provided that they show equivalency to those specified in the *Prescriptive Method* (Tables C2.3-1 through C2.3-3).

### **C2.4 Adhesive Materials**

The adhesives used in the manufacturing of SIPs used in the *Prescriptive Method* shall conform to the requirements of ASTM D2559 or Type II, Class 2 of ICC ES AC 05. This adhesive was used in manufacturing the SIP wall sections that were used in the series of tests conducted by APA as described in Section C2.3. Other adhesives or methods of laminating the facers to the core are permitted provided that the SIP shows equivalency to those used in the *Prescriptive Method*.

### **C2.5 Lumber**

Lumber is typically used at top and bottom of SIP walls as well as between panels and around window and door openings. The provisions in the *Prescriptive Method* are based on No. 2 Spruce-pine-fir (SPF) lumber. Other lumber species are permitted provided that their mechanical properties and specific gravity are equal to or exceed those for No. 2 SPF.

### **C2.6 Fasteners**

Fastening of SIPs to wood framing members is limited to screws in the *Prescriptive Method*. Self-drilling tapping screws are typically used to fasten SIPs to light gauge steel. Requirements for sharp point screws connecting gypsum board to SIPs are found in most residential codes (such as the IRC 2006). Screw manufacturer recommendations should be consulted for each screw application. The edge distance and center-to-center spacing of SIP screws follow industry recommendations.

This section in the *Prescriptive Method* is not intended to limit the fastening techniques to screws. Other fastening methods are permitted to be used, provided that the connection

capacity is shown to exceed that implied in the *Prescriptive Method*. Testing, design, or code approvals may be necessary for alternate fastening techniques.

## **C2.7 Labeling**

The labeling (or identification) system specified in the *Prescriptive Method* is a minimum requirement. Additional information may be added to the label. The label can be in the form of stamp, logo, embossment, or stencil. The identification in this section closely follows what is currently used in the industry. The labeling and identification requirements are necessary for building code enforcement, construction coordination, and quality control.

## **C3.0 FOUNDATIONS**

The *Prescriptive Method* does not provide prescriptive requirements for foundation construction. The model building code is referenced for the design, construction, and installation of the foundation. The user needs to ensure that the foundations are designed to support all superimposed loads, and comply with applicable building codes. The *Prescriptive Method* provides prescriptive provisions for the connection of SIPs to the foundations.

## **C4.0 SIP ABOVE-GRADE WALLS**

### **C4.1 SIP Above-Grade Wall Requirements**

This section prescribes the minimum required thickness of SIPs for different wind speeds, wind exposure categories, wall heights, building widths, and ground snow loads. SIP Nominal Thickness selection tables are limited to one- and two-story buildings with structural wall heights up to 10 feet (3,048 mm). The 8-foot (2438 mm) walls are widely used in residential construction; however, SIP framed buildings often take advantage of higher ceilings such as 9- and 10-foot (2,743 and 3,048 mm) walls.

The SIP Nominal Thickness Tables are grouped in two categories:

- SIP walls for one-story or second floor of two-story building (supporting roof only)
- SIP walls for first story of a two-story building (supporting roof + one floor)

All exterior walls are treated as structural walls in the *Prescriptive Method*. The following design assumptions were made in developing the SIP wall nominal thickness selection tables.

- Maximum roof overhang of 24 inches (610 mm)
- Roof slopes limited to a range of 3:12 to 12:12
- Deflection limit of L/240

- Ceilings, roofs, attics, and floors span the full width of the house (no interior bearing walls)
- Permitted attic live load is limited to 20 psf (0.96 kN/m<sup>2</sup>), unless an adjustment in the snow loads is made
- Second floor live load is 30 psf (1.44 kN/m<sup>2</sup>) unless an adjustment is made to the snow loads

Fastening of SIP walls to other wood or light gauge steel framing members (such as to sill plate) is done in accordance with building code requirements. The values in Table 4.1 of the *Prescriptive Method* are extracted from the IRC 2006.

#### **C4.2 Top Plate**

The requirement for a capping top plate is common in the industry.

#### **C4.3 Bottom (sill) Plate**

The requirement for the bottom sill plate and for anchoring SIP walls to the bottom sill are extracted from the IRC 2006.

#### **C4.4 Wall Bracing**

Several racking shear tests in accordance with ASTM E72 were conducted by APA-The Engineered Wood Association, to determine the shear strength of SIPs used in the *Prescriptive Method*. The mean test results are shown in Table C4.4-1. The tested mean shear values closely match those for wood framed walls with structural wood sheathing. Therefore, the 2006 IRC wall bracing provisions for fully sheathed walls is used for SIP wall bracing requirements in the *Prescriptive Method*.

**Table C4.4-1 - Racking Shear Test Mean Value (plf)**

	Wall Height (Feet)			
	8	10	8	10
	Nominal SIP Wall Thickness			
	4-1/2"		6-1/2"	
Ultimate	981	973	943	969
Ultimate/3.0	327	324	314	323
Deflection @ 1/8"	442	335	384	335
Reference APA, The Engineered Wood Association Test Report No. T2006P-33.				

## **C4.5 Above-Grade Wall Coverings**

### **C4.5.1 Interior Covering**

Most building codes require interior wall and ceiling surfaces covering foam insulations to provide a 15-minute rated fire barrier. Gypsum wall board (drywall) is a common interior covering for SIP walls.

### **C4.5.2 Exterior Covering**

Exterior coverings are typically installed in accordance with manufacturer's recommendations. It is essential though not to directly connect exterior coverings to SIP walls that weight more than the allowable 10 psf (0.479 kN/m<sup>2</sup>) without an approved design. The weather resistive exterior barrier is required for the durability of the SIP.

SIPs should not to be used in applications where they will be used for permanent exposure to the weather. A rain screen is recommended to be used in conjunction with all siding materials. An acceptable rain screen is any non-perforated housewrap installed per the manufacturer's recommendations or 15# or 30# asphalt impregnated building felt installed shingle style with a minimum 4" (102 mm) lap.

Any type of conventional siding can be used on SIP walls. The OSB laminated to the panel provides a sound nailing base for attaching siding. With the addition of a brick ledge to the foundation, brick and stone can also be used.

## **C4.6 Wall Penetrations**

The size and number of cutouts in each SIP wall is provided in this section. These cutout limitations were used in the testing done to establish the strength values for each SIP wall.

## **C5.0 SIP HEADER REQUIREMENTS**

Headers are horizontal members used to transfer loads around openings in SIP walls. SIP header spans were determined from the testing performed at APA as described in Section C2.3. Results of APA lintel testing are shown in Table C5.0-1.



**Table C5.0-I - Allowable SIP Header Design Values**

Header Span (Feet)	Allowable Load (plf)
2	1060
4	540
6	300
8	175

Reference APA, The Engineered Wood Association Test Report No. T2006P-33.

The following design assumptions were made in determining header spans:

- Headers are simply supported beams
- Maximum roof overhang of 24 inches (610 mm)
- Roof slopes limited to a range of 3:12 to 12:12
- Ceilings, roofs, attics, and floors span the full width of the house, no interior load bearing walls, except as noted
- Deflection limit of L/240

### **C5.1 Wood Structural Panel Box Headers**

Span tables for wood structural box headers were taken from the 2006 IRC.

## **C6.0 SIP CONNECTION DETAILS**

### **C6.1 Wall Panel to Wall Panel Connection**

The details provided for connecting SIP walls are common details. Other approved or properly designed details are permitted.

### **C6.2 Corner Framing**

The detail provided for corner framing is a common detail. Other properly designed details are permitted.

## **C7.0 UTILITIES**

### **C7.1 Plumbing Systems**

Plumbing is not normally run through foam core panels. The panels are typically used for exterior walls, and as is consistent with good building practice, plumbing should be kept out of exterior walls to avoid freezing.

### **C7.2 HVAC Systems**

SIP homes require no special heating system. Forced air, electric, solar, radiant and wood burning systems are all suitable, though some are more appropriate than others for a specific home design. Central air conditioning requires ductwork and is therefore most compatible with forced-air heating systems. Because of the home's tight construction, the fireplaces, wood burners, furnaces and any other combustion appliances should be supplied with an outside source of combustion air.

### **C7.3 Electrical Systems**

Wiring a SIP wall is not difficult but does require planning. Much of the wiring is typically run in the conventionally framed interior walls, but there will be some wiring in the exterior panels. SIP wall panels are typically manufactured with a wire chase at specified height above the sub floor. Wire chases can also be located at counter height for kitchen outlets. The wire can be accessed by cutting outlet openings just above the chase. Vertical chases can be provided, but are often not needed because the wire can be run along a door opening or through interior wall framing

## **C8.0 THERMAL GUIDELINES**

### **C8.1 Energy Code Compliance**

Walls constructed of SIPs typically provide superior insulating qualities. The foam core of the panels provides a high R-value in less space than fiberglass or cellulose insulations. SIPs also inherently have significantly less air infiltration (if properly installed). The solid foam cores in correctly installed SIPs create a tight building envelope.

### **C8.2 Moisture**

Moisture condensation is an area of concern with fibrous insulations. In the past few years there has been growing concern about the effects water vapor has on wall systems in tightly constructed buildings.

The theoretical basis for this concern is as follows: vaporized water generated by daily living activities penetrates the interior sheathing (usually drywall) and enters the wall cavity. As the vapor contacts the cold outside wall, it can condense into actual water droplets which create the potential for mold or mildew, blistering paint, degraded insulation and even structural damage due to rotten studs.

The degree to which these concerns are realized depends upon the tightness of the structure. Moisture condensation in a tighter, energy conscious building with blocked escape routes has the potential for creating problems.

The condensed water can saturate the insulating material, thereby increasing the conductivity (reducing its R-value) and causing considerable heat loss. Even relatively small amounts of moisture in fiberglass and cellulose insulations are known to significantly reduce their insulation capabilities.

In an attempt to prevent this, vapor barriers are installed. These barriers can be created with many different materials, so long as they restrict (though not eliminate) the water vapor that passes through. So, in order to evaluate the insulating performance of a given wall system, it is important to consider the tightness of construction, the R-value of the materials, the quality of the installation, and the wall's susceptibility to moisture condensation.

### **C8.3 Ventilation**

A properly constructed SIP home has a very low air infiltration rate. That's great for reducing heating and cooling costs, but it isn't always healthy for the home or its occupants. It is strongly recommended that a whole-house ventilating system be installed at the time of construction.



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