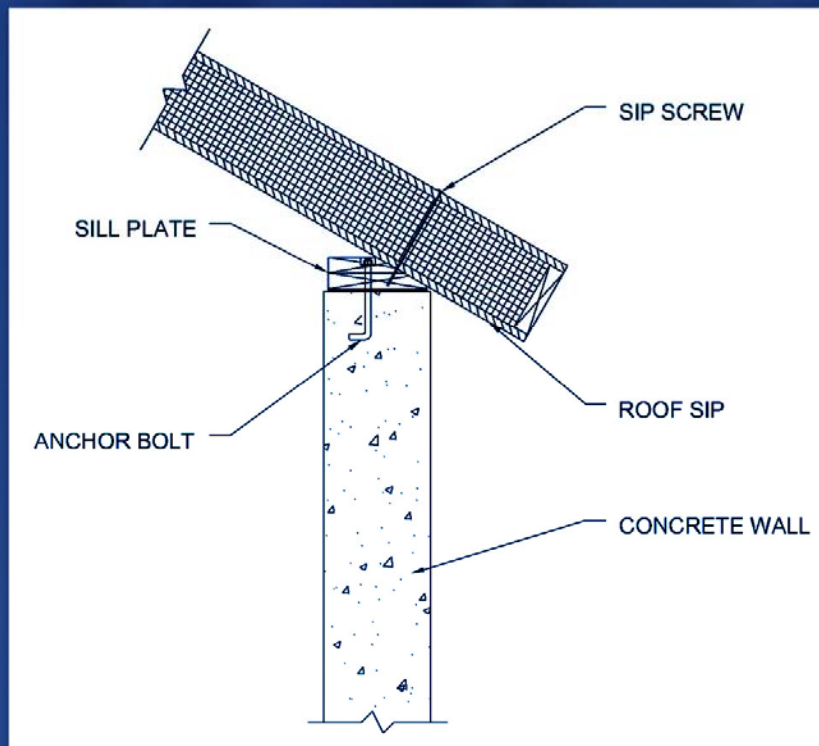


Prescriptive Method for Connecting Structural Insulated Panel Roofs to Concrete Wall Systems



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Prescriptive Method for Connecting Structural Insulated Panel Roofs to Concrete Wall Systems

Prepared for

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

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May 2008



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 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.



About the Portland Cement Association (PCA)

The Portland Cement Association, an organization of cement companies to improve and extend the uses of portland cement and concrete through market development, engineering, research, education and public affairs work.

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Foreword

This document, *Prescriptive Method for Connecting Structural Insulated Panel Roofs to Concrete Wall Systems* (Prescriptive Method), is the fourth in a series of prescriptive provisions for alternative materials in residential construction:

Prescriptive Methods for Residential Cold-Formed Steel Framing

Prescriptive Method for Insulating Concrete Forms in Residential Construction

Prescriptive Method for Structural Insulated Panels (Sips) Used In Wall Systems 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), insulating concrete forms (ICF) and structural insulated panels (SIPs). 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 connections of SIP roof panels to concrete wall systems need to be properly prescribed.

This document provides prescriptive methods for connecting SIP roofs to concrete wall systems in residential applications. The prescriptive provisions include connection capacities and construction details.

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INTRODUCTION

The *Prescriptive Method for Connecting Structural Insulated Panel Roofs to Concrete Wall Systems* (Prescriptive Method) provides prescriptive requirements to facilitate the use of SIP roofs on concrete wall systems (such as poured concrete and insulated concrete form walls) for the construction of one- and two-family dwellings. By providing prescriptive provisions for the roof connections for typical concrete homes with SIP roof systems, the need for engineering can be 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 Connecting Structural Insulated Panel Roofs to Concrete Wall Systems (Prescriptive Method)* is to provide prescriptive requirements for the roof connections of structural insulated panels (SIPs) to several concrete wall systems for 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 in Table 1.1. SIP roofs connected to concrete wall systems in accordance with this Prescriptive Method shall be limited by the applicability limits set forth in Table 1.1. The limitations are intended to define an appropriate use of this document for most one- and two-family dwellings.

The Prescriptive Method is not intended to restrict the use of connection details based on sound judgment or use of exact engineering analysis of specific applications that may result in improved designs and economy.

Engineering design shall be required for roof connections in regions where the wind speed is greater than 110 mph (177 km/hr), regions along the immediate hurricane-prone coastline subjected to storm surge (i.e., beach front property), regions in Seismic Design Categories D₀, D₁ and D₂, 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.

If the basic wind speed velocities in the building code of the jurisdiction where the Prescriptive Method is to be used are based on fastest-mile wind speeds, the designer shall convert those wind speeds to 3-second gust wind speeds in accordance with Table 1.2 for use with the tables in this Prescriptive Method.

1.4 Conflicting Requirements

Where differences occur between provisions of this Prescriptive Method and the applicable building code, the provisions of the applicable code shall apply.

**Table 1.1
Applicability Limits**

ATTRIBUTE	LIMITATION
GENERAL	
Building Dimension	Maximum building width is 40 feet (12.2 m)
Number of Stories	2 story (above basement)
Basic Wind Speed	Up to 110 mph (177 km/h) 3-second gust
Wind Exposure	Exposures B ¹ (suburban/wooded) Exposures C ¹ (open terrain)
Wind Importance Factor	$I \leq 1.0$
Wind Enclosure Classification	Enclosed
Ground Snow Load	70 psf (3.35 kN/m ²) maximum ground snow load
Snow Importance Factor	$I \leq 1.0$
Seismic Design Category	A, B and C ¹
Building Height	Maximum 35 feet (10.7 m)
ROOFS	
Roof Dead Load	10 psf (0.48 kN/m ²) maximum
Roof Snow/Live Load	70 psf (3.35 kN/m ²) maximum ground snow load (16 psf (0.77 kN/m ²) minimum Roof Live Load).
Ceiling Dead Load	5 psf (0.24 kN/m ²) maximum
Roof Clear Span	(unsupported) 40 feet (12.2 m)
Roof Slope (Pitch)	3:12 to 12:12
Rake Overhang	2 feet (610 mm) horizontal projection beyond exterior wall

For SI: 1 inch = 25.4 mm, 1 psf = 0.0479 kN/m², 1 mph = 1.61 km/hr = 0.447 m/sec, 1 foot = 0.3 m.
¹ As defined by the provisions in ASCE 7.

**Table 1.2
Wind Speed Conversions**

Fastest Mile (mph)	70	75	80	90	100	110
3-Sec Gust (mph)	84	89	95	105	116	126

1.5 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 horizontal span of SIP roofs (L).

Building Width: The dimension of a building that is parallel to horizontal span of SIP roofs (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.

Flat Wall: A solid concrete wall of uniform thickness

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.

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.

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 ($\text{h}\cdot\text{ft}^2\cdot^\circ\text{F}/\text{Btu}$).

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].

Screen-Grid Wall: A perforated concrete wall with closely spaced vertical and horizontal concrete members (cores) with voids in the concrete between the members created by the stay-in-place form.

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.

Stay-in-Place Concrete Forms: A concrete forming system using stay-in-place forms of foam plastic insulation, a composite of cement and foam insulation, a composite of cement and wood chips, or other insulating material for constructing cast-in-place concrete walls.

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].

Spline: A long, narrow strip that fits into a groove cut into the longitudinal edges of the two structural insulated panels to be joined. 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.

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.

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.

Waffle-Grid Wall: A solid concrete wall with closely spaced vertical and horizontal concrete members (cores) with a concrete web between the members created by the stay-in-place form. The thicker vertical and horizontal concrete cores and the thinner concrete webs create the appearance of a breakfast waffle. It is also called an uninterrupted-grid wall in other publications.

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.

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 SIP MATERIALS, SHAPES, AND STANDARD SIZES

2.1 Physical Dimensions

Roofs for residential structures constructed with structural insulated panel (SIP) systems in accordance with this document shall comply with the shapes and minimum cross-sectional dimensions required in this section. SIP roofs 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 Roof Systems

SIPs for roof panel construction shall comply with Figure 2.1 and shall have minimum panel thickness as specified in Section 2.2. Alternate SIP roof panel configurations that can demonstrate equivalency to

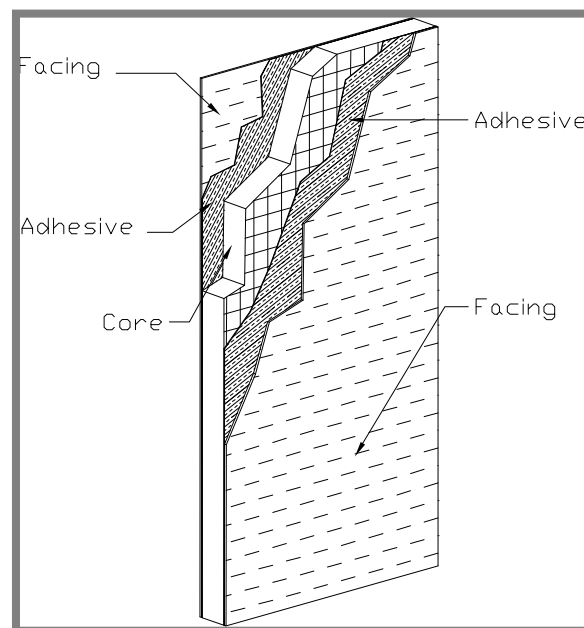


Figure 2.1
Cross Sectional View of SIP

SIP roof panels specified in this document shall be permitted. Each SIP roof panel shall be identified by grade mark and/or certificate of inspection issued by an approved agency as per Section 2.6.

2.2 Core Materials

The core material of SIPs used in roof 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/ft³ (14.42 kg/m³), or an approved alternate. Flame-spread rating of SIP cores shall be less than 75 and the smoke-development rating shall be less than 450, as tested in accordance with ASTM E 84 [4]. The minimum thickness of the core for SIP roofs shall be 5.5 inches (140 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 roofs 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.

Table 2.1
Minimum Properties for OSB Skins Used in SIP Roofs^(a)

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

^(a) Mean test value.

^(b) Characteristic test value (5th percentile with 75% confidence).

^(c) 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 Labeling

All SIPs used in roof 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 TYPES OF CONCRETE WALL SYSTEMS

Concrete wall systems used for SIP roof connections prescribed in the Prescriptive Method shall conform to one of the following types:

- Poured in place concrete wall
- Stay-in place concrete form wall systems (such as Insulated concrete form (ICF) wall systems)
 - Flat walls
 - Screen grid walls
 - Waffle-grid wall systems
- Concrete Masonry Unit (CMU) block walls.

4.0 ANCHOR BOLTS AND FASTENERS

4.1 SIP Fasteners

Fasteners (such as screws) used for the connection of SIP roofs to wood top plate(s) as specified in this document shall be corrosion resistant, have threaded or drill point and shall be sized to penetrate a minimum of 1-3/4 inch (44.5 mm) into the wood member to which the SIP assembly is being attached. SIP Fasteners shall meet the following requirements:

- Minimum thread diameter 0.17 inch (4.3 mm),
- Nominal shank diameter 0.190 inch (5 mm),
- Minimum head diameter 0.4 inch (10.2 mm).

SIP fasteners shall have a minimum edge distance of 1-9/16 inch (40 mm).

4.2 Fasteners for Wood Top Plates

Fasteners (such as nails and screws) used for the connection of wood top plates together as specified in this document shall be corrosion resistant. Galvanized screws, nails or staples shall be permitted for plate attachments.

4.3 Anchor Bolts

Anchor bolts for use with connection details as specified in this document shall be bolts with heads complying with ASTM A 307 or ASTM F 1554. In lieu of using bolts with heads, it is permissible to use rods with threads on both ends fabricated from steel complying with ASTM A 36. The threaded end of the rod to be embedded in the concrete shall be provided with a hex or square nut.

4.4 Proprietary Connectors

Proprietary connectors are permitted provided that the selected connector's capacity is equivalent to or exceeds the capacity used in the Prescriptive Method.

5.0 DESIGN AND CONSTRUCTION OF SIP ROOFS

5.1 SIP Roofs Requirements

SIP roofs used in this Prescriptive Method shall be constructed in accordance with the provisions of this section and manufacturers installation instructions. The minimum nominal SIP roof panel thickness shall be 6-1/2 inches (165 mm).

5.2 Panel to Panel Connection

SIP roofs shall be inter-connected in accordance with manufacturer's installation instructions or approved method.

5.3 SIP Roofs Exterior Covering

SIP roof panels shall be protected from physical damage. All SIP roof panels shall be covered with approved materials installed to provide a barrier against the weather (such as sunlight, snow, and rain). The outer roof panel 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.

6.0 DESIGN AND CONSTRUCTION OF CONCRETE WALL SYSTEMS

6.1 Design of Concrete Wall Systems

Design, specification, and construction of concrete wall systems and anchoring the wood top plate to the top of the concrete wall systems used in this Prescriptive Method shall be in accordance with any of the following codes/standards:

- PCA NSDC 2007 *Prescriptive Design of Exterior Concrete Walls for One- and Two-Family Dwellings* [18]
- ACI 332- *Requirements for Residential Concrete Construction and Commentary* [19]
- ACI 318 *Building Code Requirements for Structural Concrete* [20]
- IBC 2006 *International Building Code* [2]
- IRC 2006 *International Residential Code* [3]

- NCMA TR 68.A.75 *Design and Construction of Plain and Reinforced Concrete Masonry and Basement and Foundation Walls* [21]

6.2 Wood Top Plate

All concrete wall systems shall be capped with a wood top plate unless designed otherwise. Wood top plates shall be a nominal 2 inches (51 mm) in depth and have a width equal to the nominal width of the concrete wall below. Double wood top plate shall be face nailed using two 10d smooth shank box nails spaced at a maximum of 12 inches (305 mm) on center.

6.3 Wood Top Plate Anchors to Concrete Wall Systems

All wood top plates shall be anchored directly to the top of the concrete wall systems with anchor bolts spaced as required in Section 6.1 with 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. Anchor straps, per approved design, can be used to provide equivalent anchorage to 1/2-inch-diameter (12.7 mm) anchor bolts.

7.0 ROOF SIPs CONNECTION DETAILS

Roof SIPs complying with the provisions of the Prescriptive Method shall be connected to the top of concrete wall systems in accordance with this Section, Tables 7.1 through 7.7 and Details 7.1 through 7.4. Wood top plate anchors to concrete wall systems shall be in accordance with Section 6.1.

7.1 Fastening of SIP Roof Panels to Top Sill Plate

Roof assemblies using structural insulated panels shall be attached to the top sill plate on concrete wall system in accordance with this section. The wood top plate (sill) shall be anchored to the top of concrete wall systems in accordance with Section 6.3. The thickness of the sill plate shall permit a minimum 1-3/4 inch (44.5 mm) penetration of the screw fastener per Section 7.1.1.

7.1.1 Minimum Screw Fastener

The screw fastener used to attach SIP roof panels to the top sill plate on a concrete wall system shall provide a minimum design lateral strength of 230 lbs/ea (104 Kg) (perpendicular and parallel to grain for screw penetration per Section 7.1) based on AF&PA/NDS-2005 [6]. Design withdrawal capacity, including head pull-through the SIP skin shall not be less than 220 lbs/ea (100 Kg) except as modified by footnote 3 of Table 7.1. The minimum head diameter of the screw shall be 0.4 inches (10.2 mm) and the minimum thread root diameter shall be 0.17 inches (4.3 mm).

The length of screw shall be such that the threaded portion of the screw (including the threaded or drill point) penetrates a minimum of 1-3/4 inches (44.5 mm) into a sill plate with a minimum specific gravity of $G=0.42$ (e.g., spruce-pine-fir lumber or a denser species group). Pre-drilling a lead hole for the screw shall be permitted in accordance with Section 11.1.4 of AF&PA/NDS-2005 or the manufacturer's recommendations.

7.1.2 Fastener Spacing

Fasteners shall be installed along eaves and gable ends in accordance with the lesser fastener spacing required by Section 7.1.3 for wind loading or Section 7.1.4 for seismic loading. Fastener spacing shall not exceed 24 inches (610 mm) on center.

Exception: Fasteners for connections for SIP roofs located in regions with ground snow load greater than or equal to 50 psf (2.4 KPa) and roof slopes steeper than 6:12 shall be spaced not to exceed 12 inches (305 mm) on center.

7.1.3 Fastener Spacing to Resist Wind Loading

Fasteners along eaves shall be installed in accordance with Table 7.1. Fasteners along gable ends shall be installed in accordance with the lesser spacing required by Tables 7.2, 7.3, and 7.4.

7.1.4 Fastener Spacing to Resist Seismic Loading

Fasteners along eaves shall be installed in accordance with Table 7.5. Fasteners along gable ends shall be installed in accordance with the lesser spacing required by Tables 7.5 and 7.6.

7.2 Ridge Beam

SIP roofs in structural applications shall have a ridge beam to support the panels at the ridge. Larger roofs often require intermediate supports, in the form of purlins or rafters, as well. In addition, temporary cross-bracing may be required to prevent flexing of the beams during panel installation. Ridge beams and other intermediate supports shall be constructed in accordance with an approved design.

7.3 Ridge Beam Details

Panels shall be miter-cut at the ridge, at an angle that is slightly less than the roof pitch, leaving a 3/8-inch (9.5 mm) gap for foam sealing. To provide structural support at the ridge, the ridge joint shall be supported by a ridge beam or per an approved design.

7.4 Roof Overhangs

SIP roofs are permitted to overhang beyond the outside rough face of sheathing, or exterior concrete face of the exterior wall assembly by up to 24 inches (610 mm) provided that the portion of the panel not overhanging is at least twice as long as the overhang.

7.5 Roof Penetrations

Panel edges at all roof penetrations (such as for skylights, chimneys, dormers, flues, and others) shall be reinforced with inset 2x blocking and shall have integral structural support in the form of specially reinforced panel sections or external support (rafters, purlins) under the openings per an approved design. Panel edge reinforcements are outside the scope of this Prescriptive Method.

7.6 SIP Screw Size

SIP screws shall have the minimum length as shown in Table 7.7, unless designed otherwise.

Table 7.1
SIP Roof Panel Wind Uplift Connection to Wood Sill Plate Along Eaves

Roof Pitch	Panel Horiz. Span (feet)	Maximum Fastener Spacing (inches) Along Roof Eave (30' mean roof height)							
		Wind Speed, Exposure B				Wind Speed, Exposure C			
		85	90	100	110	85	90	100	110
1.5:12	8	33	28	21	17	23	20	15	12
	12	29	24	18	14	20	17	13	10
	16	26	21	16	12	18	15	11	8
	20	23	19	14	11	16	13	10	8
3:12	8	26	22	17	13	18	15	12	9
	12	23	20	15	12	16	14	11	8
	16	22	18	14	11	15	13	10	8
	20	20	17	12	10	14	12	8	7
6:12	8	22	19	15	12	15	13	11	8
	12	20	17	13	11	14	12	9	8
	16	18	16	12	10	13	11	8	7
	20	17	14	11	9	12	10	8	6
9:12	8	22	19	15	12	15	13	11	8
	12	20	17	13	11	14	12	9	8
	16	17	15	12	9	12	11	8	6
	20	16	13	10	8	11	9	7	6
12:12	8	19	16	13	10	13	11	9	7
	12	16	14	11	9	11	10	8	6
	16	14	13	10	8	10	9	7	6
	20	13	11	9	7	9	8	6	5

For SI: 1 inch = 25.4 mm, 1 foot = 0.3 m. 1lb = 0.45 Kg

1. Maximum eave overhang shall be 2 feet.
2. For mean roof height of 15' (4,572 mm) or less in Exposures C, multiply fastener spacing by 1.15. For a mean roof height of greater than 30 feet (9,144 mm) and no more than 45 feet (13,716 mm) in any exposure, multiply fastener spacing by 0.9.
3. If fastener head or washer diameter is 0.6 inches (15 mm) or greater, multiply fastener spacing by 1.4. When this factor is used, the minimum design withdrawal capacity of the fastener shall be 308 lbs (140 Kg).

Table 7.2
SIP Roof Panel Wind Uplift Connection to Wood Sill Plate Along Gable End

All Roof Slopes	Rake Overhang (feet)	Maximum Fastener Spacing (inches) at Gable End Wall Connection (30' mean roof height)							
		Wind Speed, <u>Exposure B</u>				Wind Speed, <u>Exposure C</u>			
		85	90	100	110	85	90	100	110
	0	61	51	38	30	43	36	27	21
	1	42	36	28	22	29	25	20	15
	2	32	28	22	17	22	20	15	12

For SI: 1 inch = 25.4 mm, 1 foot = 0.3 m. 1lb = 0.45 Kg.

1. For mean roof height of 15' (4,572 mm) or less in Exposures C, multiply fastener spacing by 1.15. For a mean roof height of greater than 30 feet (9,144 mm) and no more than 45 feet in any exposure, multiply fastener spacing by 0.9.
2. If fastener head or washer diameter is 0.6 inches (15 mm) or greater, multiply fastener spacing by 1.4. When this factor is used, the minimum design withdrawal capacity of the fastener shall be 308 lbs (140 Kg).

Table 7.3
SIP Roof Panel Connection to Wood Sill Plate for Top for Wall Anchorage Against Lateral Wind Loads

Height of Wall Between Roof and Bottom Support (feet)	Maximum Fastener Spacing (inches) Along Eave and Gable End (30' mean roof height)							
	Wind Speed, <u>Exposure B</u>				Wind Speed, <u>Exposure C</u>			
	85	90	100	110	85	90	100	110
8	52	46	38	31	36	32	27	22
9	46	41	33	28	32	29	23	20
10	42	37	30	25	29	26	21	18
12	35	31	25	21	25	22	18	15
14	30	27	22	18	21	19	15	13
16	26	23	19	16	18	16	13	11
18	23	21	17	14	16	15	12	10
20	21	19	15	12	15	13	11	8

For SI: 1 inch = 25.4 mm, 1 foot = 0.3 m. 1ksi = 6.895 MPa.

1. For mean roof height of 15' (4572 mm) or less in Exposures C, multiply fastener spacing by 1.15. For a mean roof height of greater than 30 feet (9144 mm) and no more than 45 feet in any exposure, multiply fastener spacing by 0.9.
2. If wood sill plate species is Douglas Fir or a more dense species group (specific gravity, G, equal to 0.5 or greater), multiply fastener spacing by 1.1.
3. If screw thread root diameter is increased to 0.2" (5 mm), multiply fastener spacing by 1.1. Screws of this size shall be permitted to have a minimum F_{by} of 180 ksi (1241 MPa).

Table 7.4
SIP Roof Panel Connection to Wood Sill Plate for Roof Diaphragm Shear Transfer

Panel Horizontal Span (feet)	Maximum Fastener Spacing (inches) Along Sloped Top of Wall at Gable End (30' mean roof height)							
	Wind Speed, <u>Exposure B</u>				Wind Speed, <u>Exposure C</u>			
	85	90	100	110	85	90	100	110
8	20	18	14	12	14	13	10	8
12	17	15	12	10	12	11	8	7
16	14	13	10	8	10	9	7	6
20	12	11	9	7	8	8	6	5

For SI: 1 inch = 25.4 mm, 1 foot = 0.3 m.

1. Table is based on a maximum 2:1 diaphragm aspect ratio (i.e., length of roof diaphragm in one direction is not greater than twice the width in the other direction).

Table 7.5
SIP Roof Panel Connection to Wood Sill Plate for Top for Wall Anchorage Against Lateral Seismic Loads

Height of Wall Between Roof and Bottom Support (feet)	Maximum Fastener Spacing (inches) Along Eave and Gable End (30' mean roof height)		
	Seismic Design Category (SDC)		
	SDC A	SDC B	SDC C
8	245	30	30
9	217	30	27
10	196	30	24
12	163	30	20
14	140	30	17
16	122	30	15
18	109	30	14
20	98	30	12

For SI: 1 inch = 25.4 mm, 1 foot = 0.3 m. 1 psf = 0.0479 KPa.

1. Table values apply to concrete wall system walls with total weight, including finishes, not exceeding 82 psf (3.93 KPa).
2. For 4" (102 mm) Flat, 6" (152 mm) Waffle-grid, or 6" (152 mm) Screen-grid ICF wall systems, multiply table values by 0.75.
3. For 8" or 10" concrete (203 and 254 mm), CMU, or Flat ICF wall systems, multiply table values by 1.3 or 1.6, respectively.

Table 7.6
SIP Roof Panel Connection to Wood Sill Plate for Roof
Diaphragm Seismic Shear Transfer

Height of Wall Between Roof and Bottom Support (feet)	Maximum Fastener Spacing (inches) Along Slope of Top of Wall at Gable End (30' mean roof height)		
	Seismic Design Category (SDC)		
	SDC A	SDC B	SDC C
8	50	26	17
12	46	24	16
16	43	22	15
20	40	21	14

For SI: 1 inch = 25.4 mm, 1 foot = 0.3 m.

1. Table is based on a maximum 2:1 diaphragm aspect ratio (i.e., length of roof diaphragm in one direction is not greater than twice the width in the other direction).

Table 7.7
SIP Screw Sizes

SIP Panel Thickness	Min. Screw Length
6-1/2"	8-1/4" (210 mm)
8-3/4"	10-1/2" (267 mm)
10-1/4"	12" (305 mm)
12-1/4"	14" (356 mm)

For SI: 1 inch = 25.4 mm.

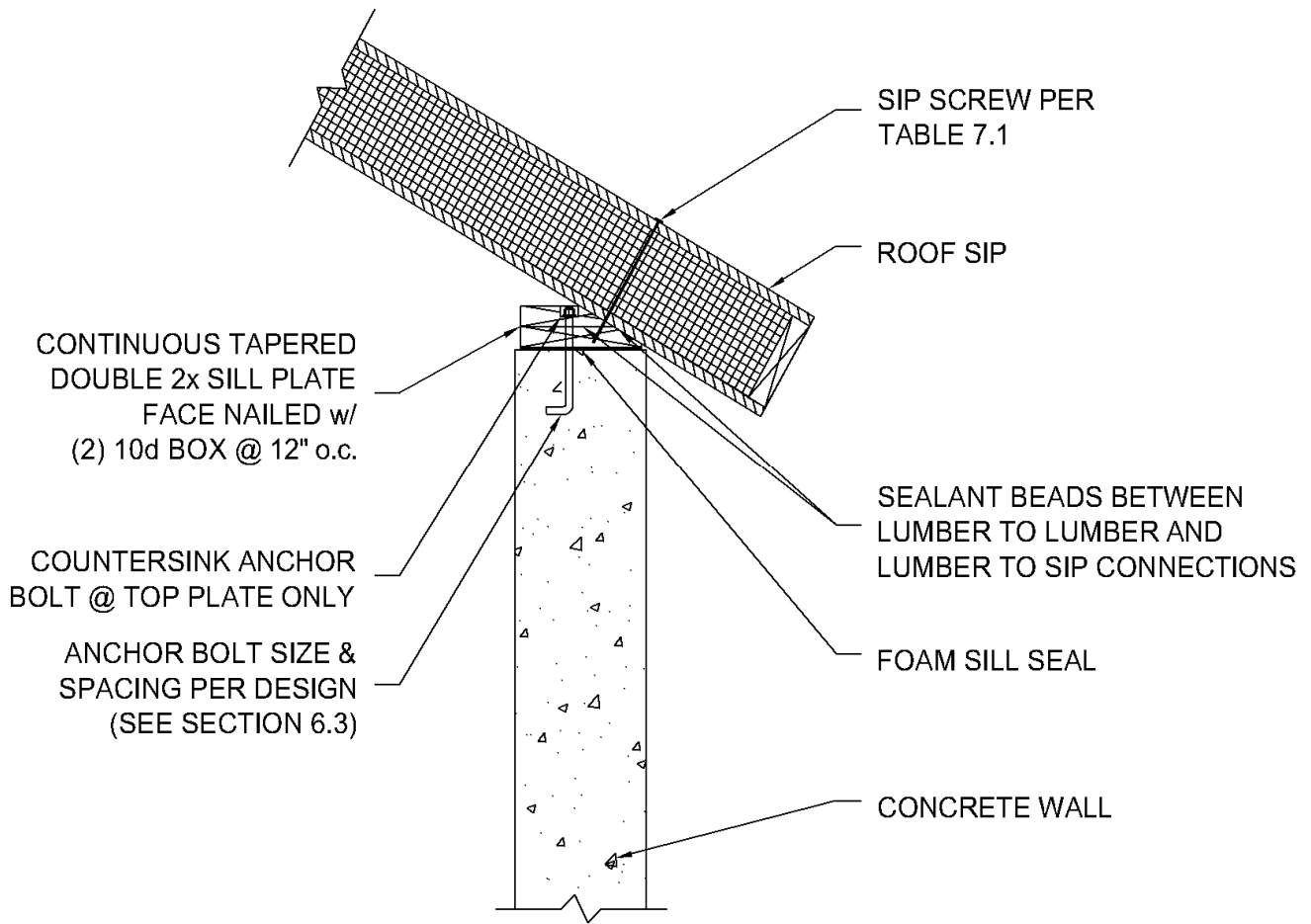


Figure 7.1
SIP Roof to Concrete Wall Connection – Continuous Solid Sill Plate, Taper to Match Roof Slope

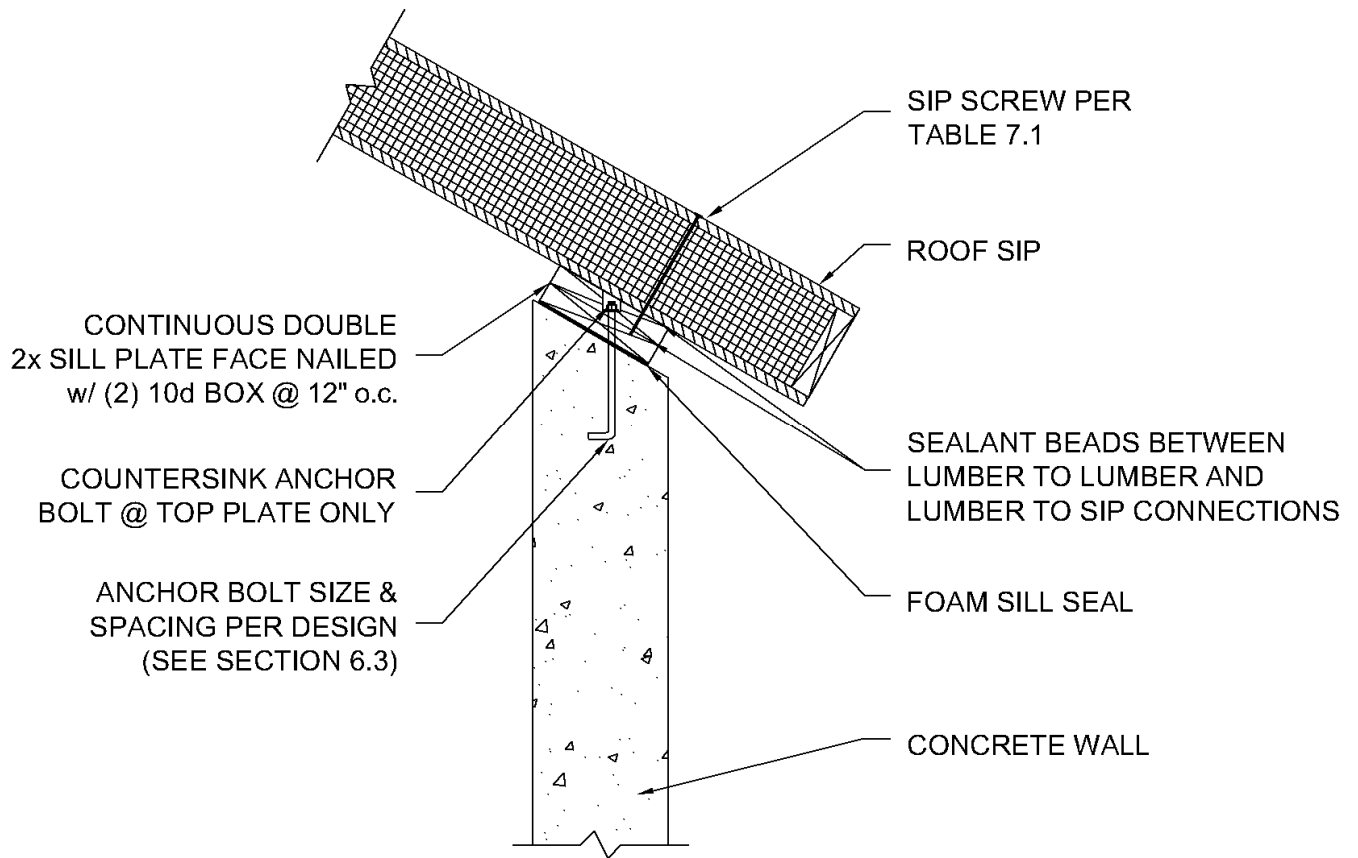


Figure 7.2
SIP Roof to Concrete Wall Connection – Top of Concrete Wall Sloped

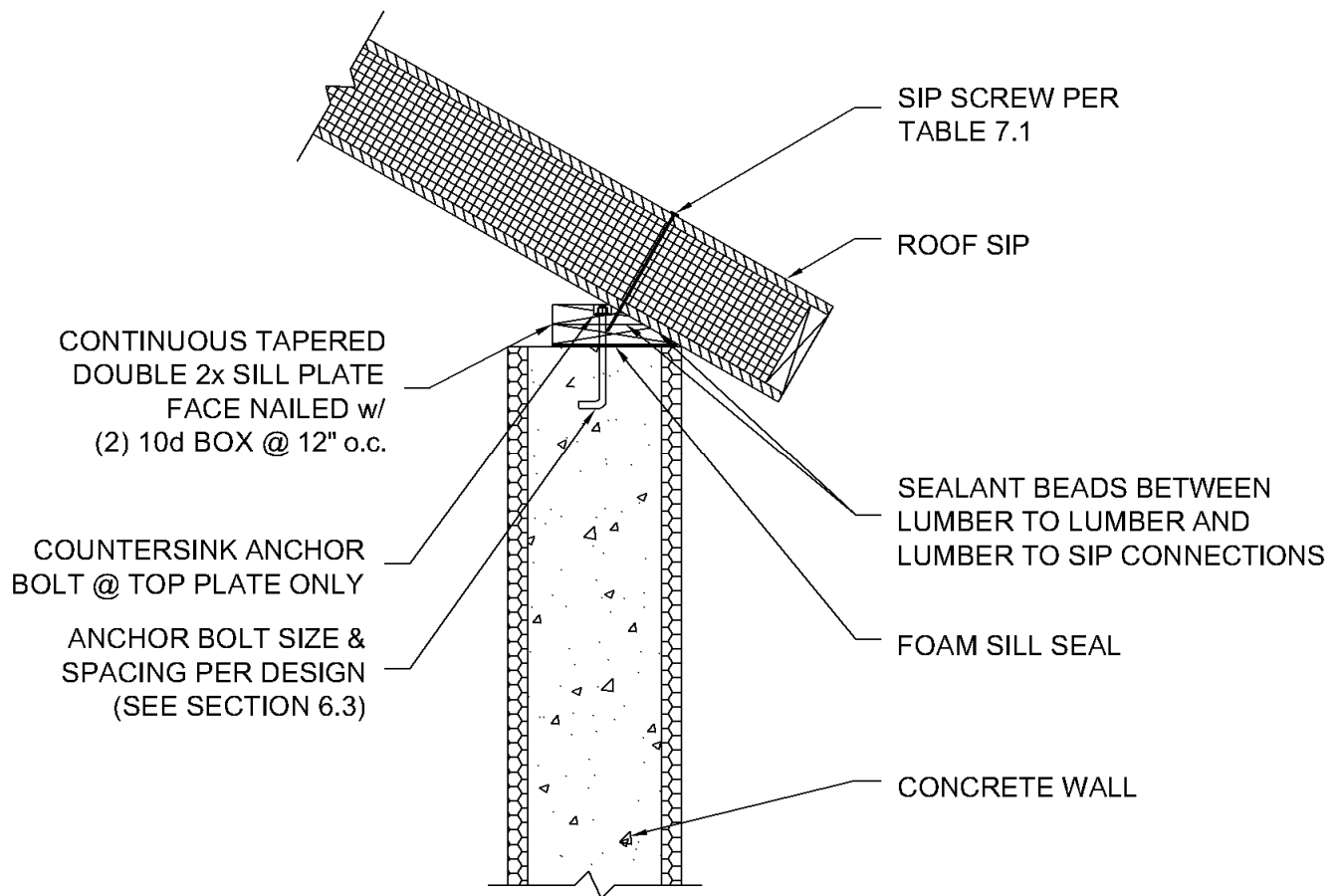


Figure 7.3
SIP Roof to ICF Wall Connection - Continuous Solid Sill Plate, Taper to Match Roof Slope

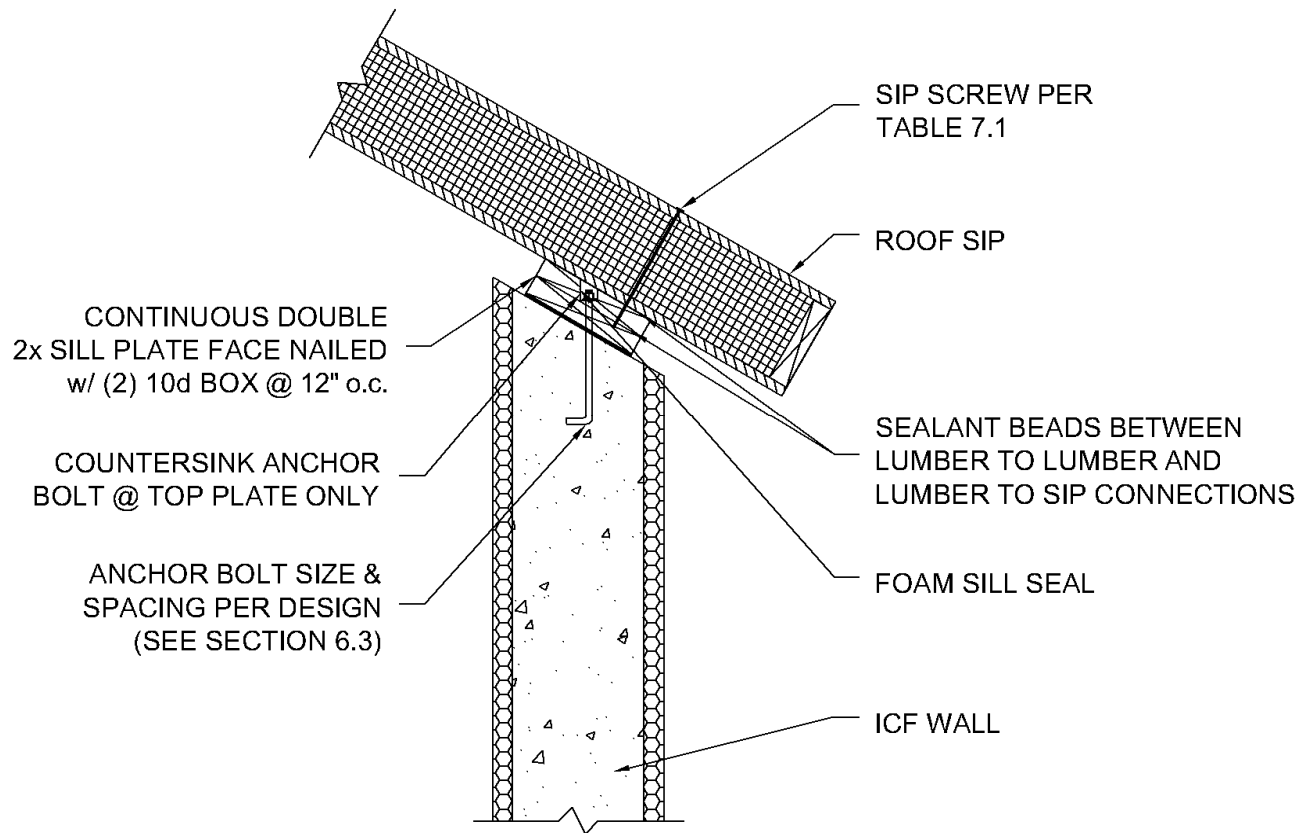


Figure 7.4
SIP Roof to ICF Wall Connection – Top of Concrete Wall Sloped

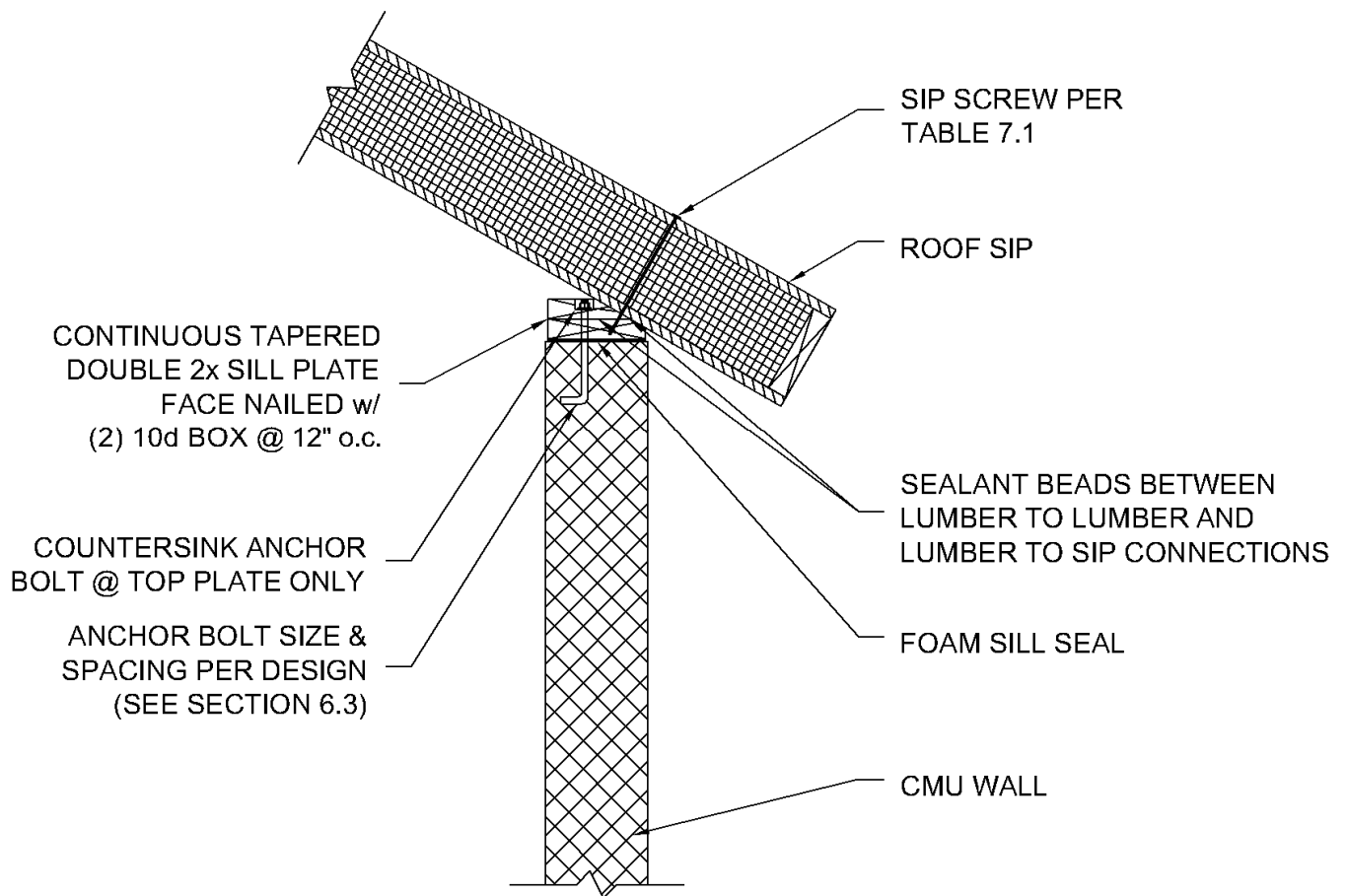


Figure 7.5
**SIP Roof to CMU Wall Connection – Continuous Solid Sill Plate,
Taper to Match Roof Slope**

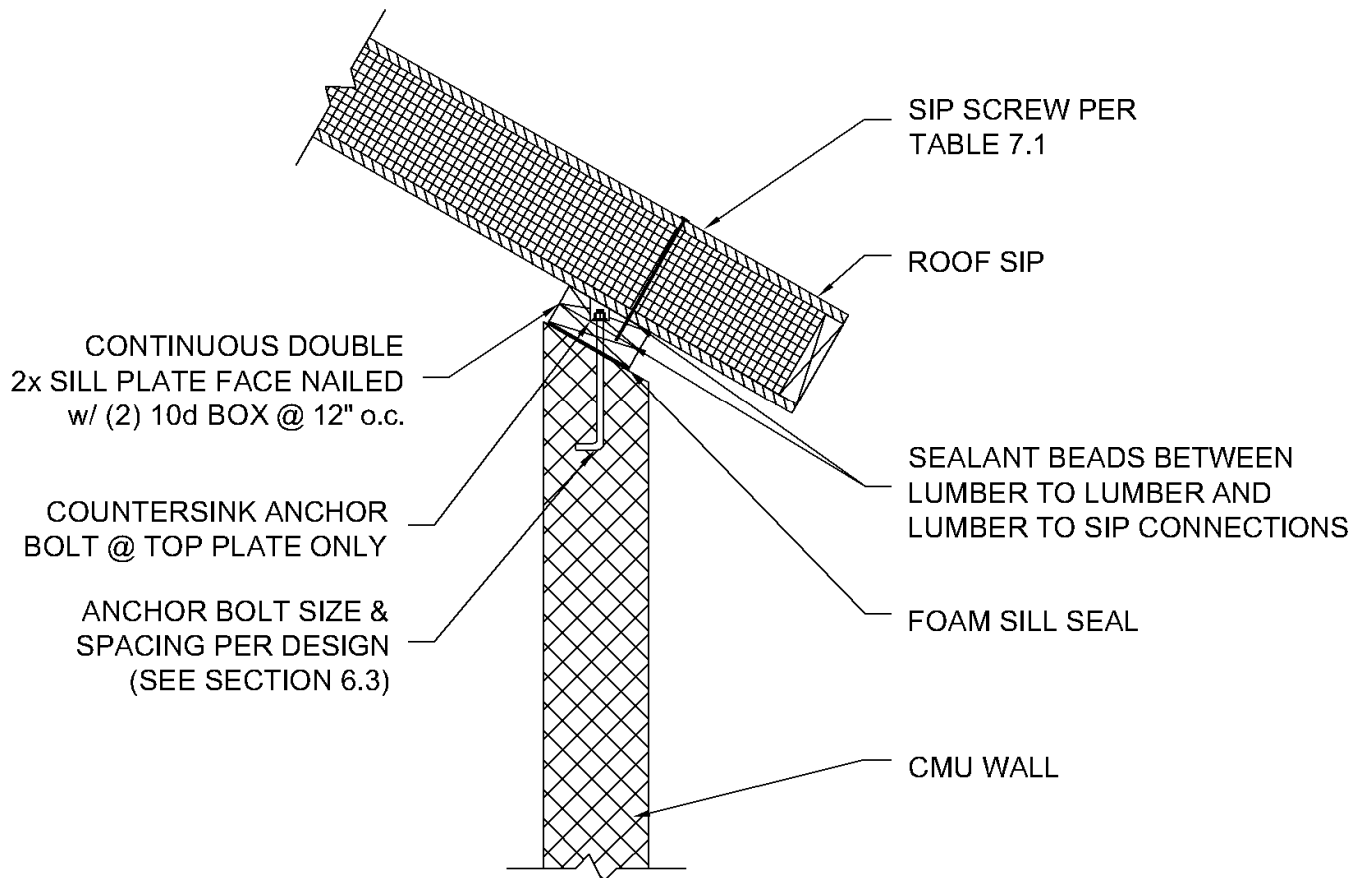


Figure 7.6
SIP roof to CMU Wall Connection – Top of Concrete Wall Sloped

8.0 THERMAL GUIDELINES

8.1 Energy Code Compliance

The insulation value (R-value) of SIP roof 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 roof panels shall be protected from moisture intrusion through the use of approved exterior finishes in accordance with Section 5.3. SIP roofs 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 where no local code exists. When required, mechanical ventilation shall be provided to meet the minimum air exchange rate.

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