Appendices

Appendix A
Windstorm Offices

AUSTIN
333 Guadalupe
(512) 322-2203

Mailing Address: P.O. Box 149104, MC103-1E
78714-9104
(512) 322-2273 FAX

Toll Free: (800) 248-6032

01-BEAUMONT
5550 Eastex Freeway, Suite EE 77708
(409) 892-4677 (409) 898-7463 FAX

02- La Marque
7124 Mark 45 Blvd., Suite B
La Marque, TX 77568
(409) 986-9552
(281) 474-5025 (Houston) (409) 986-5802 FAX

03-BAY CITY
2200 Avenue A, Suite D
Bay City, TX 77414
(979) 244-9451 (979) 244-9433 FAX

04-CORPUS CHRISTI
606 N. Carancahua, #200 78476
(361) 881-9463 (361) 881-9479 FAX

05-HARLINGEN
630 Ed Carey Drive, Suite 200 78550
(956) 421-4675
(956) 233-4549 (Brownsville/Los Fresnos) (956) 421-4549 FAX

06-ANGLETON
2512 North Velasco, Suite B 77515
(979) 848-0953 (979) 848-1235 FAX

07-PORT LAVACA (CALHOUN COUNTY)
(361) 552-2501 (361) 244-9433 FAX

08-MONT BELVIEU
10616 Eagle Drive 77580 ***Mailing Address:*** P.O. Box 1424, 77580-1424
(281) 385-1798 (Houston Metro) (281) 576-2368 FAX

Appendix B
Glossary

Addition: An extension or increase in floor area or height of a building or structure.

Agricultural: Relating or used in producing or storing crops and livestock or their properties.

Anchorage: The principle of securing one member to another in a manner that does not allow for easy separation except under extreme conditions.

Annular ring shank nail: A nail having a rough shank consisting of ridges which form rings around the shank.

Approved: Refers to approval by the Texas Department of Insurance.

Basic (Fastest Mile) Wind Speed: The wind speed measured in terms of the time it takes one mile of wind to pass a reference point. It is measured at 33 feet above the ground in Exposure C terrain. It is associated with an annual probability of occurrence of 0.02.

Batten: A strip of wood placed across a surface to cove joints or provide a nailing strip.

Beam: A principle structural member used between posts, columns or walls to support loads.

Blocking: A solid wood block that provides lateral support. Typically used for bridging and for edge support for sheathing.

Board: Lumber measuring two inches (2") or less in thickness.

Bond Beam: A masonry or concrete beam with horizontal reinforcement. Bond beams are designed for masonry walls to resist lateral and uplift forces.

Bottom Plate: A horizontal member attached to the bottom of a frame wall.

Breakaway Walls: Walls which are designed to break away from their structural supports when subjected to wind and/or water loads.

Brick Ledge: That portion along the exterior of a slab on grade foundation which is reserved for and supports the brick veneer.

Brick Ties: Non-corrosive metal strips or heavy wire which are used to secure masonry veneer to a structure.

Brick Veneer: An exterior finish for walls which consists of a single layer of brick.

Building Exposure Category C: ASCE 7-93 term for buildings located in fairly open terrain with scattered obstructions less than 30 feet in height.

Built-up Roof: A type of roof composed of asphalt felt laminated with coal tar, pitch or asphalt. The top is finished with crushed slag or gravel.

Butt Joint: Formed when two members are placed end to end without overlapping.

Cantilever: A projecting beam or member which is supported only at one end.

Ceiling Joist: One of a series of parallel wood framing members used to support ceiling loads.

Clear Span: The clear distance between inside face of bearing structural supports.

Commercial Buildings: Structures designed and used for business purposes.

Compliance: The act or process of conforming to official requirements, or to a desire or proposal.

Corrosion Resistant: Treated in such a way as to deter or retard weakening, wear and decay.

Cripple Stud: A short wood stud used above a wall opening. It extends from the header above the opening to the top plate. Also used beneath the opening between the sole plate and the rough sill.

Dead Load: The weight of all permanent construction, including walls, floors, roofs, ceilings, stairways, and fixed service equipment.

Designated Catastrophe Areas: Areas specified by the Texas Department of Insurance that are eligible for windstorm and hail insurance coverage through the Texas Windstorm Insurance Association.

Diameter: The width or thickness of a circular, or somewhat circular, object.

Diaphragm: A structural unit composed of sheathing, framing members, and perimeter members which act as a deep, thin beam to transfer lateral forces to vertical resisting elements.

Dimension Lumber: Lumber which is two to five inches (2'-5") thick and up to twelve inches (12") wide.

Discontinuous Member: A member which has one or more break points and is not considered a whole unit unless tied or fastened together.

Drip Edge: A strip, usually metal, placed on the edges of a roof to alter water flow freely away from the underlying cornice and protect the area from water damage.

Eaves: The part of a roof structure which projects over an exterior wall. Also called overhang. This area of a structure is subject to very high wind loads.

Elevation: The height of an object or specific part of an object above grade level.

Embedment; Embedded: Set firmly into a surrounding mass.

Equivalent: Having an equal value, amount or force.

Fascia: A wood member used for the outer face of a box cornice where it is nailed to the ends of the rafters and lookouts.

Felt: A heavy paper of organic or asbestos fibers impregnated with asphalt.

Flashing: Sheet metal or other material used in roof and wall construction (especially around chimneys and vents, and at roof valleys), to prevent moisture from entering the structure.

Floor Joist: One of a series of parallel wood framing members used to support floor loads and supported, in turn, by larger beams, girders or bearing walls.

Footing: The spreading course or courses at the bases or bottom of a foundation wall, pier or column.

Foundation: The supporting portion of a structure below the first floor construction, or grade, including the footings and floor joists.

Framing Anchor: A corrosion-resistant (galvanized) pre-engineered metal piece designed to fasten wooden members together or to masonry. They prevent lateral motion and/or uplift. Also called hurricane clips.

Gable Roof: A roof shape characterized by two sections of roof of constant slope which meet at the ridge and which form a vertical triangle at the end of the structure.

Gable Stud: A stud which is a component of the framing of the gable end of a structure. These members normally extend from the top plate to the end of the rafter.

Girder: The largest or principal horizontal beam used to support concentrated loads at particular points along its path.

Grade (Finish Grade): A reference plane representing the average finished ground level adjoining a structure.

Grade (Lumber Grade): The designation of the quality of a manufactured piece of wood.

Grade (Natural Grade): A reference plane representing the undisturbed natural ground level adjoining or around a structure.

Green Lumber: Lumber which has not been dried or seasoned. Moisture content greater than 19 percent.

Grout: A mixture of portland cement, aggregates (gravel or sand), and water.

Header: (1) A horizontal structural member which supports the load over an opening, such as a window or door; also called a lintel. (2) A beam placed perpendicular to joists and to which joists are nailed in framing for a chimney, stairway, or other similar openings.

Header Stud: A wood stud which supports a header over a wall opening. The header stud extends from the sole plate to the bottom of the header. Also call trimmer stud.

Horizontal: Parallel to the horizon.

Hurricane Clip: See framing anchor.

Inward: Directed toward the interior.

Knee Brace: A diagonal member (usually at a 45 degree angle) that is attached from a piling to a main structural beam or girder, and serves to stiffen the foundation.

Lateral: See horizontal.

Lateral Brace: A wall brace which stiffens a structure against loads acting on the side walls.

Lath: A building material fastened to the sides of a structure to act as a base for plaster. Can also refer to spaced boards used for roof decking.

Ledger: A wood member attached to framing or structural members which supports joists or other horizontal framing.

Lintel: See definition (1) under header.

Live Load: The loads produced by the use and occupancy of the structure. They do not include environmental loads such as wind, snow, rain, and earthquake loads. **Live Load (Roof):** The loads produced during maintenance by workers, equipment, and materials and during the life of the structure by moveable objects.

Loadbearing Wall: A wall that supports vertical load in addition to its own weight.

Masonry: Stone, brick, hollow tile, concrete block, tile, poured concrete, gypsum block, or similar materials, or a combination of the above, bonded together with mortar to form a wall, pier, buttress, column, etc.

Mean Roof Height: The distance from the average grade to the average roof height.

Mechanical Equipment: Any mechanical device located on the exterior of a structure.

Mobile Home: A structure, transportable in one or more sections, which is eight body feet or more in width, and is 40 body feet or more in length, built on a permanent chassis, and designed to be used as a dwelling with or without a permanent foundation when connected to the required utilities, and includes the plumbing, heating, air conditioning and electrical systems contained therein.

Moisture Content: The weight of the water in wood expressed as a percentage of the weight of oven dry wood.

Monolithic: Term used for concrete construction poured and cast in one unit without joints.

Non-Expansive Soil: A soil which does not contain a significant amount of clay minerals which experience considerable volume changes in response to changes in the moisture content.

Non-loadbearing Wall: A wall that does not support vertical loads other than its own weight.

On Center (abbreviated by o.c.): The measurement of spacing for framing members, fasteners, etc., which designate the distance from the center of one member or component to the center of the next. Also called center to center spacing.

Outward: Directed toward the outside, usually at a 90-degree angle (perpendicular to) the exterior surface.

Overhang: That area of a roof or upper story which projects beyond the wall of the lower part.

Partition: Any wall which subdivides spaces within any story of a structure.

Pier Height: The vertical distance measured from the bottom of an opening to the top of an opening. The pier height is used to determine the minimum shearwall segment widths for masonry walls.

Perpendicular: Being at right angles (90 degrees) to a given line, plane or surface.

Powder Actuated Fasteners: A fastener which is set (usually into masonry or concrete) by a powder charge.

Purlins: Horizontal wood members which, when laid over roof framing members are used to support rafters or other roofing, and, when placed over vertical wall framing members, are used to fasten siding to.

Rafter: One of a series of wood structural members of a roof designed to support roof loads and which generally run from the ridge to the wall top plate. The rafters of a flat roof are sometimes called roof joists.

Rake Edge: The edge of a gable roof system which runs parallel to the roof slope, from the eave to the ridge.

Repair: The reconstruction or renewal of any part of an existing building for the purpose of maintenance.

Ridge Beam: The load carrying wood beam placed on edge at the ridge (peak) of the roof into which the upper ends of the rafters are framed.

Ridge Board: The non structural wood nailer board placed on edge at the ridge (peak) of the roof into which the upper ends of the rafters are framed.

Roof Diaphragm: A specially designed wood roof section which resists vertical and lateral forces resulting from wind loading of the structure.

Running Bond: Placement of masonry blocks so that the head joints in successive courses are offset a minimum one quarter of the block length.

Scouring: The erosion of sand and soil caused by wave action.

Shall: Used to denote a mandatory condition.

Shearwall: A specially designed wall section which resists lateral forces resulting from wind loading of the structure.

Shearwall Segment: The vertical sections of a shearwall without openings that form a structural unit composed of sheathing, framing members, and perimeter members which act as a deep, thin, vertical cantilever beam. It is designed to resist lateral forces parallel to the plane of the wall.

Sheathing: Structural wood panels. Consists of wood boards or prefabricated structural-use panels that are attached to the exterior studs or rafters on a structure.

Siding: The finished covering on the outside wall of a building.

Soffit: The underside of the members of a building, such as overhangs, staircases, cornices, arches, etc.

Sole Plate: A horizontal member anchored to concrete or masonry.

Span: The horizontal distance between structural supports such as walls, columns, piers, beams, girders and trusses.

Standard 90-Degree Hook: Reinforcing steel which has a 90-degree turn. See Figure 301.1.3.

Start of Construction: The first placement of a permanent construction of a structure on a site, such as pouring slabs or footings, or any other work beyond the stage of excavation.

Story: That portion of a building included between the upper surface of a floor and the upper surface of the floor or roof next above.

Strongback: An L-shaped wooden support attached to tops of ceiling joists.

Structure: That which is built, constructed, or composed of parts joined together in some definite manner.

Stud: The vertical wood framing member of a wall.

Suspense: A term used to describe the status of an inspection in which an inspection is not yet approved, but the basic method being used is correct.

T.W.I.A.: Texas Windstorm Insurance Association. Formerly known as the Texas Catastrophe Property Insurance Association (T.C.P.I.A.).

Top Plate: The horizontal wood member resting on top of the wall studs which the joists and rafters rest on and are anchored or fastened to.

Truss: A structural member consisting of such members as beams, bars, webs and ties, usually arranged to form triangles. It provides rigid support over wide spans with a minimum amount of material.

Unapproved: A term used to describe the status of an inspection in which the procedure or material being used is not correct and changes need to be addressed.

Underlayment: A thin cover of asphalt saturated felt or other material which acts as water barrier.

Unit: A group of rooms arranged as a private residence and permanently equipped for housekeeping.

Uplift: An upward exerted force or pressure.

V Zone: An area, as defined by the National Flood Insurance Program, within the 100-year flood plain which is subject to high velocity waters, including hurricane storm surge and wave action.

Vapor Barrier: A watertight material used to prevent the passage of moisture or water vapor into or through a structural element.

Veneer: A facing attached to a wall for the purpose of providing ornamentation, protection or insulation, but not counted as adding strength to the wall.

Vertical: Perpendicular to the plane of the horizon; straight up and down.

Water Repellent: Treated so as to retard changes in moisture content.

Weep Hole: A small hole, usually used in masonry to drain water to the outside.

Windward Wall: The wall of a structure which is facing the direction from which the wind is blowing. As a hurricane passes, the wind changes directions so that every wall may act as the windward wall at one time or another.

Withdrawal: Removal of a fastener or pulling it out by applying a force in the opposite direction from the force used to install it.

Wind Load: The force exerted on a structure by the wind.

Wood Preservative: A treatment of wood used to protect against decay and insects.

Appendix C

Lumber grading or inspection bureaus or agencies which are accredited by the American Lumber Standards Committee.

California Lumber Inspection Service *

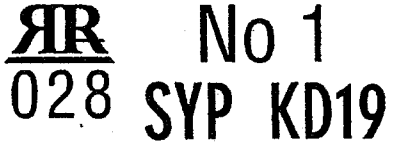
Northeastern Lumber Manufacturers Association, Inc. *

Northern Softwood Lumber Bureau *

Pacific Lumber Inspection Bureau, Inc.

Redwood Inspection Service

Renewable Resource Associates, Inc.



Southern Pine Inspection Bureau *

SPIB® No.2
KD19 (7)

Timber Products Inspection *

TP® NO.1 KD-19
000 S-DRY SYP

TP® No 1
000 S-DRY
D.FIR WWPA Rules

West Coast Lumber Inspection Bureau *

MILL 10
WCLB® NO. 2
DOUG FIR S-DRY

Western Wood Products Association *

12
WWP® 2 S-DRY
D. FIR

The following are also acceptable under the National Lumber Grades Authority:

Alberta Forest Products Association *

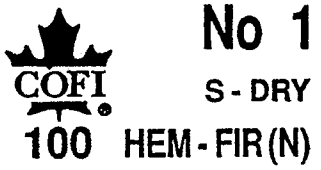
A.F.P.A® 60
S—P—F
S-DRY STAND

Canadian Lumbermen's Association

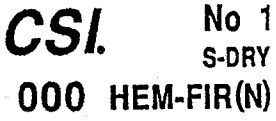
CL®A
S-P-F
100
No. 2
S-GRN.

CL®A 100
SPRUCE-PINE-FIR
NO. 1 S-DRY

Canadian Mill Services Association *



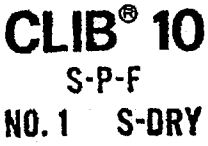
Canadian Softwood Inspection Agency, Inc. *



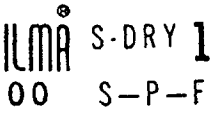
Cariboo Lumber Manufacturers Association *

Central Forest Products Association, Inc.

Coniferous Lumber Inspection Bureau *

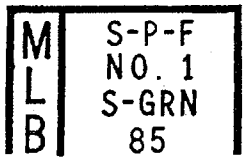


Interior Lumber Manufacturers Association *



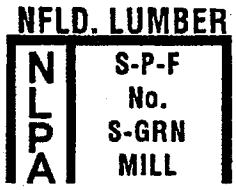
MacDonald Inspection *

Maritime Lumber Bureau *

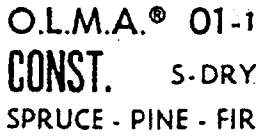


Northern Forest Products Association *

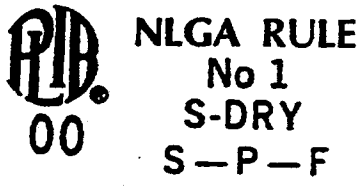
Newfoundland Lumber Producers Association



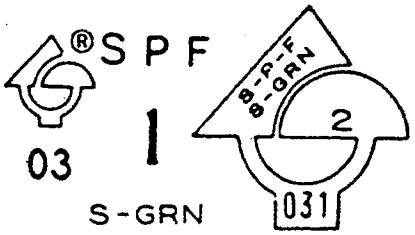
Ontario Lumber Manufacturers Association *



Pacific Lumber Inspection Bureau *



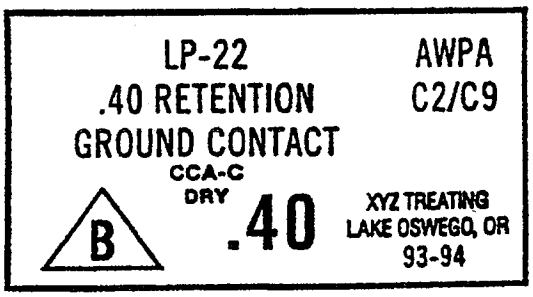
Quebec Lumber Manufacturers Association *



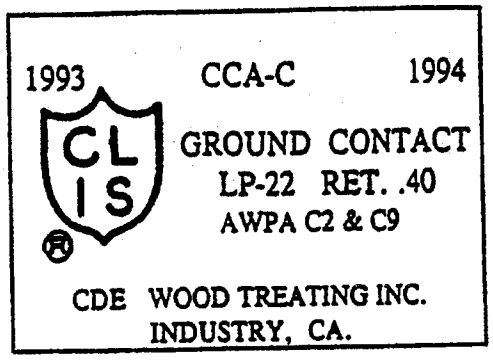
Note: * designates agencies which are approved to supervise finger jointing.

The following agencies are accredited by the American Lumber Standards Committee for the inspection of pressure treated wood products:

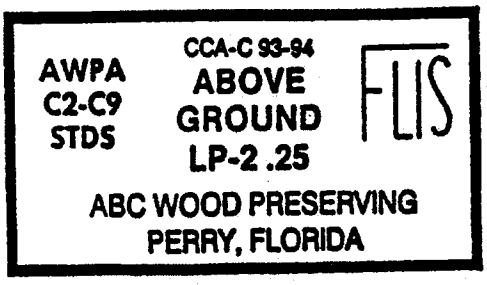
Bode Inspection, Inc.



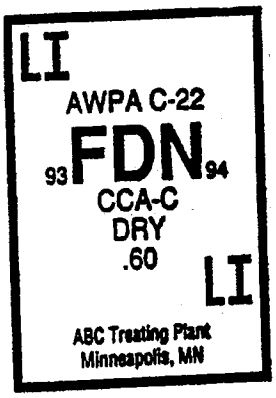
California Lumber Inspection Service



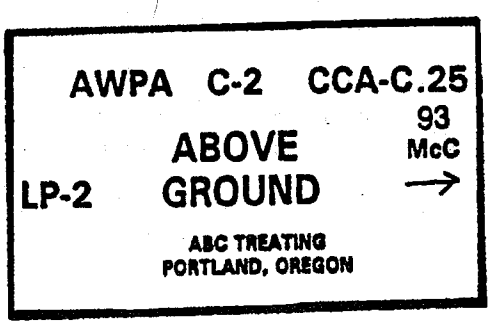
Florida Lumber Inspection Service



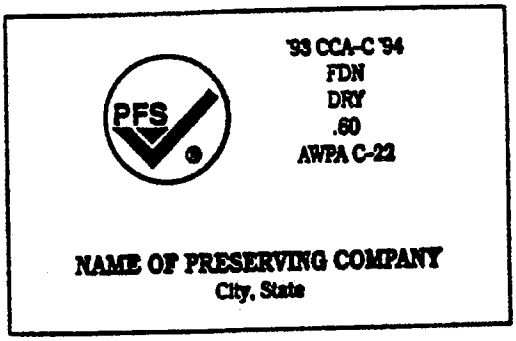
Lundell Inspection, Inc.



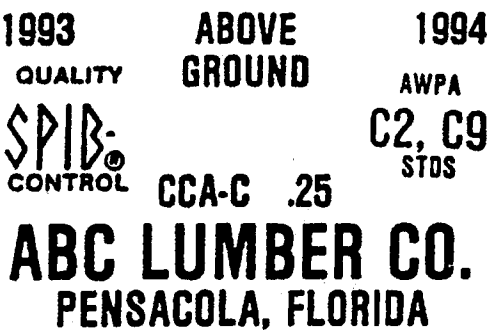
McCutchan Inspection, Inc.



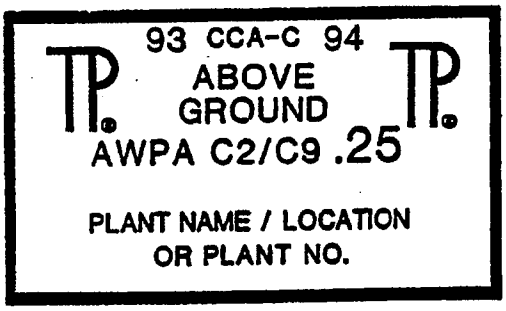
PFS Corporation



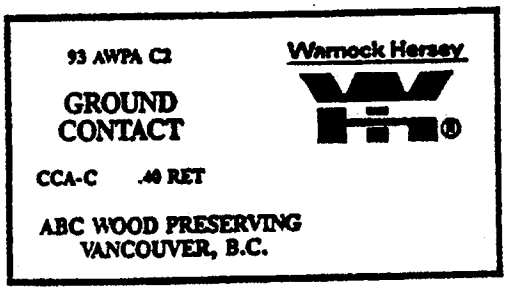
Southern Pine Inspection Bureau



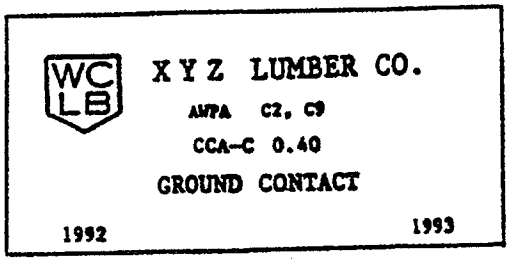
Timber Products Inspection



Warnock Hersey

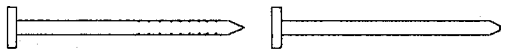


West Coast Lumber Inspection Bureau



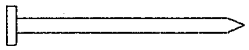
Appendix D
Specifications and Withdrawal Values for Fasteners

Specifications for Box Nails



Size	Length (in.)	Diameter (in.)	Head Diameter (in.)
2d	1	0.067	0.188
3d	1¼	0.076	0.219
4d	1½	0.080	0.219
5d	1¾	0.080	0.219
6d	2	0.099	0.266
7d	2¼	0.099	0.266
8d	2½	0.113	0.297
9d	2¾	0.113	0.297
10d	3	0.128	0.312
12d	3¼	0.128	0.312
16d	3½	0.135	0.344

Specifications for Common Nails



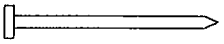
Size	Length (in.)	Diameter (in.)	Head Diameter (in.)
2d	1	0.072	0.172
3d	1¼	0.080	0.203
4d	1½	0.099	0.250
5d	1¾	0.099	0.250
6d	2	0.113	0.266
7d	2¼	0.113	0.266
8d	2½	0.131	0.281
9d	2¾	0.131	0.281
10d	3	0.148	0.312
12d	3¼	0.148	0.312
16d	3½	0.162	0.344

Specifications for Gypsum Wallboard Nails

Length (in.)	Diameter (in.)	Head Diameter (in.)
1⅛	0.092	0.297
1⅛	0.092	0.375
1¼	0.092	0.297
1¼	0.106	0.375
1¾	0.092	0.375

Specifications for Cooler Nails

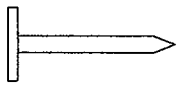
(Type II, style 7)



Size	Length (in.)	Diameter (in.)	Head Diameter (in.)
2d	1	0.062	0.172
3d	1⅛	0.067	0.188
4d	1⅜	0.080	0.219
5d	1⅝	0.086	0.234
6d	1⅞	0.092	0.250
7d	2⅛	0.099	0.266
8d	2⅜	0.113	0.281
9d	2⅝	0.113	0.281
10d	2⅞	0.120	0.297

Specifications for Roofing Nails

(Type II, style 20)

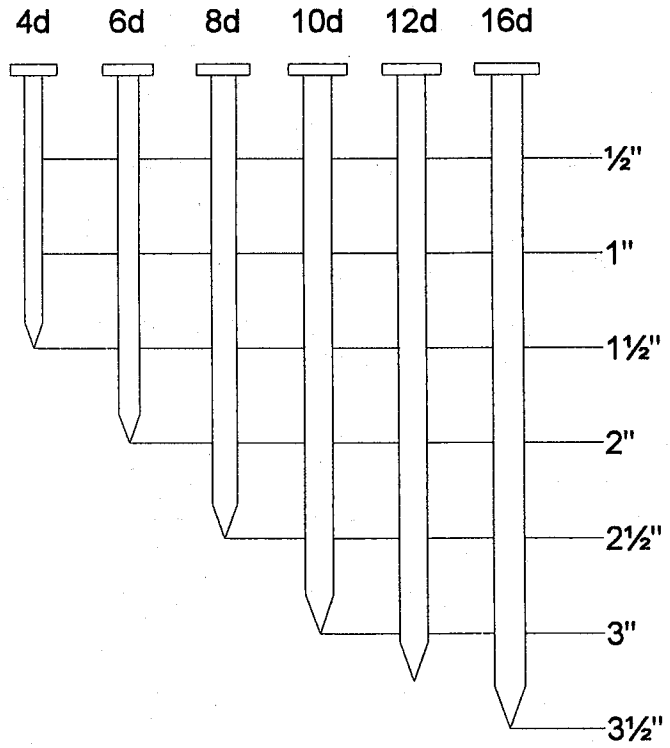


Length (in.)	Diameter (in.)	Head Diameter (in.)	No. Nails per Pound
¾	0.120	0.438	936
¾	0.135	0.438	746
⅞	0.120	0.438	832
⅞	0.135	0.438	663
1	0.120	0.438	759
1	0.135	0.438	605
1	0.135	0.562	580
1¼	0.120	0.438	616
1¼	0.135	0.438	491
1½	0.120	0.438	523
1½	0.135	0.438	417
1¾	0.135	0.438	368
2	0.135	0.438	336
2½	0.145	0.438	227

Nail Withdrawal Design Values
(in pounds per Inch of Penetration into Solid Wood)

Species of Wood	Size of Nail						
	6d Box	6d Com. 8d Box	10d Box 12d Box	8d Com.	16d Box	10d Com. 12d Com.	16d Com.
	0.099"	0.113"	0.128"	0.131"	0.135"	0.148"	0.162"
Southern Pine	49.6	56.0	64.0	65.6	67.2	73.6	80.0
Douglas Fir-Larch	38.4	44.8	49.6	51.2	52.8	57.6	64.0
Hem-Fir	27.2	30.4	33.6	35.2	36.8	40.0	43.2
Spruce-Pine-Fir	25.6	28.8	32.0	33.6	33.6	36.8	41.6

Note: These values have already been increased by the wind load duration factor (1.6).



Common Wire Nail Sizes

Appendix E

Texas Department of Insurance
Standard TDI 1-98
Test for Impact and Cyclic Wind Pressure Resistance of Impact Protective Systems and Exterior Opening Systems

Section 1: Purpose and Objective

1.1 The purpose of this Standard is to minimize public and private losses due to wind and windborne debris damage to impact protective systems and exterior opening systems.

1.2 The objective of this Standard is to evaluate the performance of impact protective systems and exterior opening systems that are subject to impacts from windborne debris in high wind events.

1.3 This standard provides general guidance for impact locations and cyclic wind pressure loading requirements for impact protective systems and exterior opening systems. The configuration of some types of impact protective systems and exterior opening systems may require additional guidance for the appropriate location and number of missile impacts and for the appropriate magnitude of the cyclic wind pressure loading. Examples include, but are not limited to:

- Systems with vertical and/or horizontal mullions;
- Systems with horizontal and/or vertical supporting members; and
- Systems with component that are operable (move horizontally, vertically, or swing open).

Before testing a product, the engineering staff of the Texas Department of Insurance should be consulted regarding the appropriate impact locations and cyclic wind pressure loading requirements.

Section 2: Definitions

2.1 **Impact protective systems.** Operable or removable devices that shall be applied, attached, or locked over an exterior opening system to protect that system from impact from windborne debris. Impact protective systems that apply to this standard may consist of permanently mounted shutters (examples are accordion or roll-up), wood structural panels, corrugated metal shutters, chain-link systems, or other similar types of protective devices. Impact protective systems may be porous or non-porous.

2.2 **Porosity.** In this Standard, the term α is the total porosity of the impact protective system. The total porosity is the sum of the porosity attributed to openings in the surface area of the impact protective system (α_1) and the porosity attributed to any open areas between the impact protective system and the surface of the structure to which it is attached (α_2). The porosities are calculated by dividing the areas of the openings by the total surface area of the impact protective system. The value of α_2 used for purposes of calculating α shall not exceed 0.30. This relationship can be expressed by the following equation:

$$\alpha = \alpha_1 + \alpha_2 \text{ where } \alpha_2 \leq 0.30$$

2.3 **Porous impact protective system.** An impact protective system with a porosity greater than 0.05.

2.4 **Non-porous impact protective system.** An impact protective system with a porosity of 0.05 or less.

2.5 **Exterior opening systems.** Systems that are subject to and may become breached by windborne debris during high wind events. Exterior opening systems may or may not contain glazing.

Section 3: Test Program and Test Specimens

3.1 A test series shall consist of three identical specimens. Each specimen shall be subjected to the large and/or small missile impact test and then to the cyclic pressure loading test except as noted in **Sections 5** and **6**. A specimen is considered to have passed the test if it satisfies the acceptance criteria of this Standard. At least two of the specimens shall pass the acceptance criteria of this Standard.

3.2 The test specimen shall consist of the entire unit, as supplied by the manufacturer. All parts of the test specimen, including glazing and structural framing, shall be full size. The test specimen shall consist of the same materials, glass type and construction, details, and fastening as proposed for field installation.

Section 4: Large Missile Impact Test

4.1 General

4.1 The large missile is described in **Section 7.3**.

4.2 The large missile shall impact the surface of the test specimen at a speed between 50 and 52 ft/s.

4.3 The missile shall impact the surface of the test specimen "end on". The speed of the missile shall be measured electronically.

4.2 Impact Protective Systems

4.2.1 The large missile test shall be conducted in accordance with either **Sections 4.2.2** or **4.2.3**.

4.2.2 The test shall consist of three identical test specimens. Each test specimen shall receive two impacts from the missile. The first impact shall occur within a 5-inch radius circle having its center on the midpoint of the test specimen. The second impact shall occur within a 5-inch radius circle having its center at a point 6 inches away from the supporting members.

4.2.3 The test shall consist of six identical test specimens. The specimens shall be divided into two groups of three specimens. One group shall be impacted once within a 5-inch radius circle having its center on the midpoint of the test specimen. The second group shall be impacted once within a 5-inch radius circle having its center at a point 6 inches away from the supporting members. At least two specimens from each group shall pass the test.

4.2.4 The following test criteria shall apply to both **Sections 4.2.2** and **4.2.3**:

4.2.4.1 The impacts shall be to the thinnest cross section of the assembly.

4.2.4.2 If the impact protective system contains bracing, then the impacts shall be within areas that are not reinforced.

4.3 Exterior Opening Systems

4.3.1 The large missile test shall be conducted in accordance with either **Sections 4.3.2** or **4.3.3.**

4.3.2 The test shall consist of three identical test specimens. Each test specimen shall receive two impacts from the missile, except as specified in **Section 4.3.2.1**. The first impact shall occur within a 5-inch radius circle having its center on the midpoint of the test specimen. The second impact shall occur within a 5-inch radius circle having its center at a point 6 inches away from the supporting members.

4.3.2.1 If the exterior opening system is sufficiently small such that the 5-inch radius circles overlap, then two separate glass lites shall be impacted. One impact shall occur at the center of one glass lite and one impact shall occur at the corner of another glass lite. If the system contains only one such glass lite, then a single impact at the center is required.

4.3.3 The test shall consist of six identical test specimens. The specimens shall be divided into two groups of three specimens. One group shall be impacted once within a 5-inch radius circle having its center on the midpoint of the test specimen. The second group shall be impacted once within a 5-inch radius circle having its center at a point 6 inches away from the supporting members. At least two specimens from each group shall pass the test.

4.3.4 The following test criteria shall apply to both **Sections 4.3.2** and **4.3.3**:

4.3.4.1 For windows, the impacts shall be to the glass.

4.3.4.2 For exterior opening systems that contain glass, the glass shall be impacted and the thinnest section through the assembly shall be impacted.

4.3.4.3 For exterior opening systems that contain multiple panels of glazing, the innermost panel shall be impacted.

4.3.4.4 For exterior opening systems consisting of different glass thicknesses and/or glass types, each different glass thickness and glass type shall be impacted.

4.3.4.5 For exterior opening systems without glass, the thinnest section through the assembly shall be impacted.

4.3.4.6 For exterior opening systems that consist of vertical and/or horizontal bracing, the impacts shall be within areas that are not reinforced.

4.4 Acceptance Criteria for Impact Test

4.4.1 If the impact protective system is porous, then the test specimen shall resist the large missile impact(s) without penetration.

4.4.2 If the impact protective system is non-porous, then the test specimen shall resist the large missile impact(s) with no opening forming through which a 3-inch diameter sphere can pass.

4.4.3 The exterior opening system shall resist the large missile impact(s) with no opening forming through which a 3-inch diameter sphere can pass.

4.5 Post Impact Test Procedure

4.5.1 If the test specimen passes the acceptance criteria of the large missile impact test, it shall then be subjected to the cyclic wind pressure loading test specified in **Section 6**.

Section 5: Small Missile Impact Test

5.1 General

5.1.1 Test specimens passing the large missile impact test do not need to be tested for the small missile impact test.

EXCEPTION: Impact protective systems with openings larger than $\frac{3}{16}$ inch.

5.1.2 The small missile is described in **Section 7.5.1**.

5.1.3 The small missiles shall impact the surface of the test specimen successively from a single propelling device at a speed between 130 and 132 ft/s. The speed of the missiles shall be measured electronically.

5.2 Impact Protective Systems

5.2.1 Each test specimen shall receive 30 small missile impacts. The distribution of the impacts shall be as follows: The first 10 impacts shall be distributed uniformly over a 2 square foot area located at the center of the test specimen. The second 10 impacts shall be distributed uniformly over a 2 square foot area located at the center of the long dimension of the test specimen near the edge. The final 10 impacts shall be distributed uniformly over a 2 square foot area located at a corner of the specimen.

5.2.2 If the impact protective system varies in thickness, then the impacts shall occur at the location of the thinnest cross section.

5.2.3 If the impact protective system contains bracing, then all impacts shall be to areas that are not reinforced.

5.3 Exterior Opening Systems

5.3.1 Each test specimen shall receive 30 small missile impacts, except as specified in **Sections 5.3.1.1** and **5.3.1.2**. The distribution of the impacts shall be as follows: The first 10 impacts shall be distributed uniformly over a 2 square foot area located at the center of the test specimen. The second 10 impacts shall be distributed uniformly over a 2 square foot area located at the center of the long dimension of the test specimen near the edge. The final 10 impacts shall be distributed uniformly over a 2 square foot area located at a corner of the specimen.

5.3.1.1 If the test specimen contains more than one lite of glass, a single lite closest to the center shall be impacted.

5.3.1.2 If a lite of glass is sufficiently small such that the 2 square foot areas overlap, then separate lites shall be impacted; one at the center, one at the corner, and one at the midspan of an edge. If only two such lites are contained in the test specimen, then only the center of one lite and the corner of the other lite shall be impacted. If only one such lite is contained in the test specimen, then only the center of the lite shall be impacted. Each location shall receive 10 small missile impacts.

5.3.2 For windows, all impacts shall be to the glass.

5.3.3 For exterior opening systems that contain glass, the glass shall be impacted in accordance with **Section 5.3.1** and the thinnest section through the assembly which is not glass shall be impacted in accordance with **Section 5.3.1**.

5.3.5 For exterior opening systems with more than one lite of identical glass, the glass lite closest to the center of the system shall be impacted in accordance with the requirements of **Section 5.3.1**.

5.3.6 For exterior opening systems consisting of different glass thicknesses and/or glass types, each different glass thickness and glass type shall be impacted in accordance with the requirements of **Section 5.3.1**.

5.3.7 For exterior opening systems that do not contain glass, the thinnest section through the assembly shall be impacted.

5.4 Acceptance Criteria for Impact Test

5.4.1 If the impact protective system is porous, then the test specimen shall resist the small missile impacts without penetration.

5.4.2 If the impact protective system is non-porous, then the test specimen shall resist the small missile impacts with no opening forming through which a 3-inch diameter sphere can pass.

5.4.3 For exterior opening systems, the test specimen shall resist the small missile impacts with no opening forming through which a 3-inch diameter sphere can pass.

5.5 Post Impact Test Procedure

5.5.1 If the test specimen passes the acceptance criteria of the small missile impact test, it shall then be subjected to the cyclic wind pressure loading test specified in **Section 6**.

Section 6: Cyclic Wind Pressure Loading Test

6.1 General

6.1.1 This test shall apply to impact protection systems and exterior opening systems that have passed the acceptance criteria of the large and/or small missile impact tests.

6.1.2 The specimens tested for impact shall be used for the cyclic wind pressure loading test.

6.1.3 If air leakage through the test specimen is excessive, then tape may be used to cover any cracks and joints through which air leakage is occurring. Tape shall not be used when there is a probability that it may significantly restrict differential movement between adjoining members. It is also permissible to cover both sides of the entire specimen and mounting panel with a single thickness of polyethylene film no thicker than 0.050 mm (2 mils). This technique of application is important in order that the full load is permitted to be transferred to the specimen and that the membrane does not prevent movement or failure of the specimen. The film shall be applied loosely with extra folds of material at each corner and at all offsets and recesses. When the load is applied, there shall be no fillet caused by tightness of the plastic film.

6.2 Impact Protective Systems

6.2.1 Each test specimen shall be subjected to the loading sequence outlined in Table E1 with P_{max} replaced with $(1 - \alpha)\ P_{max}$, where α denotes the total porosity of the impact protective system.

EXCEPTION: Porous impact protective systems with a porosity of 0.5 or greater need not be subjected to the cyclic wind pressure loading.

6.3 Exterior Opening Systems

6.3.1 Each test specimen shall be subjected to the loading sequence outlined in Table E1.

EXCEPTION: For windows and sliding glass doors, if at least one ply of an impacted lite does not fracture during either the large or small missile impact test and that ply is designed to withstand the applied wind pressure, then the cyclic loading test is not required.

Table E1
Cyclic Wind Pressure Loading Sequence

Pressure Direction	Loading Sequence	Range	No. of Cycles
Inward Acting Pressure P_{max} = maximum positive Wind pressure in accordance with **Section 103**	1	$0.2P_{max}$ *to* $0.5P_{max}$	3500
	2	0 *to* $0.6P_{max}$	300
	3	$0.5P_{max}$ *to* $0.8P_{max}$	600
	4	$0.3\ P_{max}$ *to* $1.0P_{max}$	100
Outward Acting Pressure P_{max} = maximum negative Wind pressure in accordance with **Section 103**	5	$0.3\ P_{max}$ *to* $1.0P_{max}$	50
	6	$0.5P_{max}$ *to* $0.8P_{max}$	1050
	7	0 *to* $0.6P_{max}$	50
	8	$0.2P_{max}$ *to* $0.5P_{max}$	3350

E1.1 Each pressure cycle shall have a minimum duration of one (1) second and a maximum duration of three (3) seconds.

E1.2 The cyclic wind pressure loading test must be performed in a continuous manner.

EXCEPTION: For windows and sliding glass doors, if at least one lite in an insulating glass unit does not fracture during either the large or small missile impact test and that lite is designed to withstand the applied wind pressure, then the cyclic loading test is not required.

Section 7: Acceptance Criteria for Impact Protective Systems and Exterior Opening Systems

7.1 Impact Protective Systems

7.1.1 Porous impact protective systems shall resist the missile impacts prescribed in **Section 4** and **Section 5** without penetration.

7.1.2 For porous impact protective systems, the maximum deflection following missile impact and, if required, cyclic wind pressure loading, shall be measured and recorded. This deflection shall be used to determine the required installation separation distance between the impact protective system and the exterior opening system over which it is installed while in service.

7.1.3 Non-porous impact protective systems shall resist the missile impacts prescribed in **Section 4** and **Section 5** and resist the cyclic wind pressure loading prescribed in **Section 6** with no crack growth forming longer than 5 inches through which air can pass or no opening forming through which a 3 inch diameter sphere can pass. At the conclusion of the test, the system shall remain fastened in its original position.

7.2 Exterior Opening Systems

7.2.1 Exterior opening systems shall resist the missile impacts prescribed in **Section 4** and **Section 5** and resist the cyclic wind pressure loading prescribe in **Section 6** with no crack forming longer than 5 inches through which air can pass or no opening forming through which a 3 inch diameter sphere can pass.

Section 8: Major Test Components

8.1 Test Chamber

8.1.1 The specimens shall be mounted on a test frame and on a pressure chamber in such a manner that will permit impact testing as specified in **Sections 4** and **5** followed by pressure cycling as specified in **Section 6**.

8.1.2 The pressure chamber shall be designed for the pressures which will be experienced during the cyclic pressure testing. The test chamber shall not deflect under the test pressures in such a manner that the performance of the specimens is affected.

8.2 Air System

8.2.1 The air system shall consist of either a controllable blower, a compressed air supply and/or a vacuum system, or a reversible controllable blower capable of providing the required maximum air pressure differences (inward acting and outward acting) across the specimen.

8.2.2 The air system shall be connected to the pressure chamber in such a manner that its use does not impinge directly upon the test specimen or does not affect the pressure measuring instrumentation. Pressure differences across the specimen shall be measured by manometers, mechanical pressure gages, or pressure transducers.

8.3 Large Missile

8.3.1 The large missile shall be a solid nominal 2x4 Southern Pine or Douglas Fir-Larch lumber. The lumber shall be minimum Stud Grade.

8.3.2 The missile shall have a minimum length of 7 feet and a maximum length of 9 feet.

8.3.3 A sabot shall be fastened to the trailing edge of the missile to facilitate launching.

8.3.4 The combined weight of the missile and the sabot shall be between 9 and 9.5 lbs.

8.3.5 The large missile shall be propelled through a cannon described in **Section 8.4**.

8.4 Large Missile Cannon

8.4.1 The large missile cannon shall use compressed air to propel the large missile. The cannon shall be capable of propelling the large missile at the speed specified in **Section 4**.

8.4.2 The large missile cannon shall consist of five major components: (1) a compressed air supply, (2) a pressure release valve, (3) a pressure gauge, (4) a barrel and a support frame, and (5) a timing system for determining the missile speed. The barrel of the missile cannon shall consist of a 4-inch inside diameter pipe and shall be at least as long as the missile. The barrel shall be mounted on a support frame in a manner to facilitate aiming the missile so that it impacts the specimen at the desired location. The distance from the end of the cannon to the specimen shall be between 2 and 6 feet greater than the length of the missile.

8.5 Small Missile

8.5.1 The small missiles shall consist of 10 spherical steel balls each weighing 2 grams ± 10 percent.

8.5.2 The small missile shall be propelled through a cannon described in **Section 8.6**.

8.6 Small Missile Cannon

8.6.1 The small missile cannon shall use compressed air to propel the small missiles. The cannon shall be capable of propelling the small missiles at the speed specified in **Section 5**.

8.6.2 The small missile cannon shall consist of five major components: (1) a compressed air supply, (2) a remote firing device and pressure release valve, (3) a pressure gauge, (4) a barrel and support frame, and (5) a timing system. The small missile cannon shall be mounted on a support frame designed to permit movement of the cannon so that it can propel missiles to impact the test specimen at points defined in **Section 5**. The timing system shall be positioned to measure missile speed within 5 feet of the impact point on the test specimen.

8.7 Timing System

8.7.1 The timing system shall be comprised of two, through-beam photoelectric sensors, spaced at a known distance apart. The timing system shall be used to start and stop an electronic clock and shall be capable of measuring missile speeds accurate to ± 2%. The speed of the missile shall be measured anywhere between the point where 90% of the missile is outside of the cannon, to the point where the missile is one foot away from the test specimen. The missile speed shall not be measured while the missile is accelerating.

8.7.2 The through-beam photoelectric sensors shall be of the same model. The electronic clock shall be activated when the reference point of the missile passes through the timing system. The electronic clock shall have an operating frequency of no less than 10 kHz with a response time not to exceed 0.15 milliseconds.

8.7.3 The speed of the missile shall be determined by dividing the distance between the two through-beam photoelectric sensors by the total time interval counted by the electronic clock.

8.8 Calibration of Timing Equipment

8.8.1 The timing system shall be calibrated and certified at six-month intervals using one of the following methods:

(a) Photographically, using a strobe light,

(b) Photographically, using a high speed camera with a frame rate exceeding 500 frames per second,

(c) Photographically, using a high speed video camera with a frame rate exceeding 500 frames per second, or

(d) By using an independently certified timing system with an accuracy of ± 1%.

8.8.2 Calibration of the timing system shall be certified by an independent agency.

8.8.3 The calibration report shall include: (1) the date of the calibration, (2) the name of the agency conducting the calibration, (3) the name and signature of person(s) conducting the calibration, (4) the distance between the through-beam photoelectric sensors (if used), (5) the speed of the missile as measured by the timing system, (6) the speed of the missile as determined from the calibration system, and (7) the percentage difference in speeds.

8.8.4 The timing system shall be deemed to be accurate if the speed of the missile measured by the timing system and the speed measured by the calibration system agree within 2%.

Section 9: Information to be Reported

9.1 The following information shall be reported:

1. The date(s) of the test, the date of the report, and the report number.
2. The name of the author of the report.
3. The names and addresses of both the testing laboratory that conducted the tests and the requestor of the tests.
4. Signatures of individuals responsible for supervision of the tests and a list of official observers.
5. A description of the test specimens, prior to impact and cyclic wind pressure loading, including all parts and components of a particular system along with the manufacturer's model or series number or any other identification.
6. Detailed drawings of the specimen, showing dimensioned section profiles, sash or door dimensions and arrangement, framing location, weather-stripping, locking arrangements, hardware, sealants, glazing details, test specimen sealing methods, and any other pertinent construction details. Any deviation from the drawings or any other modification made to the specimen to obtain the reported values shall be noted on the drawings and in the final report.
7. The results of all specimens tested with each specimen being properly identified. A separate drawing for each test specimen shall not be required if all differences between them are noted on the drawings provided.
8. The location(s) of the impact(s) on each test specimen.
9. The speeds of the large and/or small missiles.
10. The weight of the missiles.
11. The maximum positive and negative pressures used in the cyclic wind pressure loading.
12. A description of the condition of the test specimens after testing, including details of any damage and any other pertinent observations.
13. For porous impact protective systems, the maximum deflection of the system following impact and cyclic wind pressure loading.
14. A statement that the tests were conducted in accordance with the test methods described in this test standard.
15. A statement of whether or not, upon completion of all testing, the test specimens meet the requirements of Sections 4, 5, 6, and 7 of this test standard.
16. A statement whether or not tape or film or both were used to seal the test specimen against air leakage, and whether in the judgment of the test engineer, the tape or film influenced the results of the test.

Appendix F
Shear Capacities for Sheathing Materials

Table F1
Wood Structural Panel Shear Capacities for Shearwall Assemblies (plf)[1]

Sheathing Material	Sheathing Thickness	Nail Size[5]	Southern Pine Douglas Fir-Larch			Hem Fir Spruce-Pine-Fir		
			Panel Edge Nail Spacing (in.)					
			6	4	3	6	4	3
Plywood, OSB, or Panel Siding	5/16"[4]	6d	180	270	350	165	245	320
	3/8"[4]	8d	220	320	410	220	320	410
	7/16"[2,3]	8d	240	350	450	230	355	450
	15/32"	8d 10d	260 310	380 460	490 600	230 280	355 420	450 545
	19/32"[3]	10d	340	510	665	280	420	545

[1] The tabulated shear values may be increased by 40 percent for wind design.

[2] The shear capacities for 3/8 inch and 7/16 inch sheathing can be increased to those capacities for 15/32 inch with the same nailing pattern provided: (1) the wall studs are spaced 16 inch on center or less or (2) the panels are applied with the long dimension across the studs.

[3] Panel siding: 7/16 inch panel siding nailed at shiplap edges use 5/16 inch shear values; 19/32 inch panel siding nailed at shiplap edges use 3/8 inch shear values.

[4] Panel siding: Shiplap edges shall be double nailed. One nail shall be placed in the underlap and a second nail shall be placed in the overlap.

[5] Common wire nails.

Table F2
Material Shear Capacities for Shearwall Assemblies (plf)

Sheathing Material	Sheathing Thickness	Wall Construction	Fastener Size	Max. Fastener Spacing (in.) Panel Edge	Max. Fastener Spacing (in.) Intermediate Supports	Shear Capacity
Gypsum Wallboard	1/2"	Blocked	5d Cooler Nails	7	7	125
Gypsum Wallboard	1/2"	Blocked	5d Cooler Nails	4	4	150
Gypsum Wallboard	1/2"	Unblocked	5d Cooler Nails	7	7	100
Gypsum Wallboard	1/2"	Unblocked	5d Cooler Nails	4	4	125

Table F3
Wood Structural Panel Shear Capacities for Horizontal Diaphragm Assemblies (plf)[1]

Sheathing Material	Sheathing Thickness	Nail Size	Southern Pine Douglas Fir-Larch Panel Edge Nail Spacing (in.) Blocked Diaphragms 6[2]	6	4	Hem-Fir Spruce-Pine-Fir Panel Edge Nail Spacing (in.) Blocked Diaphragms 6[2]	6	4
Structural Sheathing	7/16"	8d	170	255	340	150	220	295
	15/32"	8d	180	270	360	150	220	295
		10d	190	290	385	175	260	350
	19/32"	10d	215	320	425	175	260	350

[1] The tabulated shear values may be increased by 40 percent for wind design.
[2] When panel edges are staggered over common framing members, and the wind load is parallel to the framing members, the shear capacities may be increased by 33 percent.

Table F4
Material Shear Capacities for Horizontal Diaphragm Assemblies (plf)

Sheathing Material	Sheathing Thickness	Fastener Size	Max. Fastener spacing (in.) Panel Edge	Intermediate Supports	Shear Capacity[1]
Gypsum Wallboard	½"	5d Cooler Nails	7	7	70

Note: [1]The shear capacity is based on a framing spacing of 24 inches o.c. If the framing spacing is reduced to 16 inches o.c., the shear capacity may be increased to 90 plf.

Appendix G
Reference Material Sources

ACI 318-89, *Building Code Requirements for Reinforced Concrete*

ACI 530-92/ASCE 5-92/TMS 402-92, *Building Code Requirements for Masonry Structures*

ACI 530.1-92/ASCE 6-92/TMS 602-92, *Specifications for Masonry Structures*

AFPA NDS, 1991, *National Design Specification for Wood Construction*

AFPA NDS Supplement, 1991, *Design Values for Wood Construction*

ANSI/ASME B18.2.1, *Square and Hex Bolts and Screws*

ASCE 7-93, *Minimum Design Loads for Buildings and Other Structures*

ASTM A 123-89, *Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products*

ASTM A 153-95, *Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware*

ASTM A 641-92, *Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire*

ASTM A 653-94, *Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process*

ASTM B 695-91, *Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel*

ASTM C 36-92, *Specification for Gypsum Wallboard*

ASTM D 4586-93, *Standard Specification for Asphalt Roof Cement, Asbestos-Free*

ASTM F 1667-95, *Standard Specification for Driven Fasteners: Nails, Spikes, and Staples*

AWPA C2-90, *Pressure Treatment (General Requirements), All Timber Products*

AWPA C24-86, *Sawn Timber Piles Used for Residential Commerce Building*

FEMA-55, 1986, *Coastal Construction Manual*

Federal Specification FF-N-105B, 1971, *Wire, Cut, and Wrought Nails, Staples, and Spikes*

PS 1-92, *Construction and Industrial Plywood*

PS2-92, *Performance Standard for Wood-Based Structural-Use Panels*

UL 997-86, *Wind Resistance of Prepared Roof Coverings*

Appendix H
Shearwall Examples

Included in this appendix are examples that show how to use the shearwall sections of the T.W.I.A. Building Code for Windstorm Resistant Construction. The first example is for wood stud wall construction. The second example is for masonry wall construction.

Example 1H: Wall Bracing Example for Wood Stud Wall Construction (Section 303.4.1)

Example Building:
One story slab-on-grade
8 foot wall height
Building Width: 50 feet
Building Length: 60 feet
Maximum Roof Span: 30 feet
Roof slope: 5:12
Building is located in the Inland region

1. **Determine the minimum required shearwall segment width.**

   Since the wall height is 8 feet, a minimum of 2'-4" of solid full-height sheathing is required as specified in Table 303.4.3.1.

2. **Determine the sheathing required at the building corners.**

   In accordance with **Section 303.4.2**, a minimum shearwall segment is required at each building corner. EXCEPTION: If a wall is less than 4 feet in length, then corner sheathing is not required along that wall. Figure H1 shows where corner sheathing is required.

3. **Determine the minimum length of sheathing required along the exterior walls.**

   The minimum length of solid full height sheathing required along each side of the building is determined from Tables 303.4.2A-D. The shearwall lengths specified in Tables 303.4.2B-D are based on minimum $\frac{7}{16}$ inch thick wood structural panels. The wood structural panels are fastened to the wall framing with minimum 8d common nails or equivalent fasteners specified in Appendix I. A three step process is required.

   Step One: Determine the Shearwall Location Code
   The shearwall location code is determined from Table 303.4.2A. The roof slope of the building is 5:12. The type of construction is "Walls Beneath Roof and Ceiling" since the structure is a one-story building. For walls beneath a roof and ceiling with a roof slope less than 7:12, the shearwall location code is A.

   Step Two: Determine the minimum length of shearwalls required for walls facing the front and rear.
   The walls facing the front are labeled 3, 4, and 5 in Figure H2. The walls facing the rear are labeled 1 and 2 in Figure H2. The "Windward Building Dimension" of the structure is the overall dimension of the structure perpendicular to the front and rear walls of the structure. In this example, the windward building dimension is 60 feet. The wind is applied to the windward building dimension as shown by the arrow labeled 'A' in Figure H2.

Since the maximum roof span of the structure is 30 feet, Table 303.4.2C must be used (maximum roof span of 36 feet). Enter Table 303.4.2C with a shearwall location code 'A' and a windward building dimension of 60 feet. If a 6 inch on center panel edge nail spacing is used for the sheathing, then a minimum of 17 feet of solid full height sheathing is required on the walls facing the front and on the walls facing the rear. If a 4 inch on center panel edge nail spacing is used, then a minimum of 12 feet of solid full height sheathing is required. If a 3 inch on center panel edge nail spacing is used, then a minimum of 10 feet of solid full height wall sheathing is required.

If we assume that a 6 inch on center panel edge nail spacing is used, then a minimum of 17 feet of solid full height sheathing is required along walls labeled 1 and 2 and a minimum of 17 feet of solid full height sheathing is required along walls labeled 3, 4, and 5. See Figures H3 and H4 for and illustration of the walls that require shearwalls.

The shearwall may be applied anywhere along the length of the wall. The total required length of shearwall may be divided into smaller shearwall segments so they may fit around doors and windows. For this example, the minimum width of the shearwall segments is 2'-4". A shearwall segment width is required at each building corner and a shearwall segment width is required for each 20 feet of wall length (the maximum unbraced wall length shall be 20 feet). These segments shall count towards the minimum required length of shearwall.

Step Three: Determine the minimum required shearwall lengths for the walls facing the left side and the right side.

The walls facing the left side are labeled 8, 6, and 9 in Figure H2. The walls facing the right side are labeled 7 and 10 in Figure H2. The "Windward Building Dimension" of the structure is the overall dimension of the structure perpendicular to the left and right side walls of the structure. In this example, the windward building dimension is 50 feet. The wind is applied to the windward building dimension as shown by the arrow labeled 'B' in Figure H2.

Since the maximum roof span of the structure is 30 feet, Table 303.4.2C must be used (maximum roof span of 36 feet). Enter Table 303.4.2C with a shearwall location code 'A' and a windward building dimension of 50 feet. If a 6 inch on center panel edge nail spacing is used for the sheathing, then a minimum of 14 feet of solid full height sheathing is required on the walls facing the front and on the walls facing the rear. If a 4 inch on center panel edge nail spacing is used, then a minimum of 10 feet of solid full height sheathing is required. If a 3 inch on center panel edge nail spacing is used, then a minimum of 8 feet of solid full height wall sheathing is required.

If we assume that a 6 inch on center panel edge nail spacing is used, then a minimum of 14 feet of solid full height sheathing is required along walls labeled 8, 6, and 9 and a minimum of 14 feet of solid full height sheathing is required along walls labeled 7 and 10. See Figures H5 and H6 for and illustration of the walls that require shearwalls.

The shearwall may be applied anywhere along the length of the wall. The total required length of shearwall may be divided into smaller shearwall segments so they may fit around doors and windows. For this example, the minimum width of the shearwall segments is 2'-4". A shearwall segment width is required at each building corner and a shearwall segment width is required for each 20 feet of wall length (the maximum unbraced wall length shall be 20 feet). These segments shall count towards the minimum required length of shearwall.

4. **Attachment of wood structural panels to wall framing**

The wood structural panels shall be attached to wall framing along all four edges. The panels may be applied horizontally or vertically. Common panel edges shall occur over wall framing or blocking. The panels shall be fastened to the upper member of the double top plate.

5. **Attachment of Gypsum Wallboard.**

Gypsum wallboard shall be applied to the interior surfaces of the exterior walls. The wallboard shall be minimum ½ inch thick and shall be fastened to the wall framing with the fasteners specified in **Section 303.4.2**. The fasteners shall be spaced a maximum of 7 inches on center along panel edges and along interior framing.

6. **Determine the minimum number and capacity of holddown connectors required.**

Holddown connectors are required at all building corners and reentrant corners. Only one holddown connector is required at the corner. The required capacity of the holddown connectors shall be as specified in Table 303.4.5A. If a 6 inch on center panel edge nail spacing is used for the wood structural panels, then, based on an 8 foot wall height, the minimum required capacity for the holddown connectors is 3,580 lbs. The holddown connectors shall be installed in accordance with the manufacturer's recommendations.

7. **Sheathing Length Adjustments**

The minimum required shearwall lengths specified in Tables 303.4.2B-D may be adjusted to account for thicker wood structural panels, double-sided shearwall, and other factors. The minimum required shearwall lengths specified in Tables 303.4.2B-D shall be multiplied by the length adjustment factors specified in Table 303.4.2E. As an example, suppose the walls along the front and rear of the structure will be sheathed with 7/16 inch wood structural panels on both the exterior and interior surface of the wall. The fasteners are minimum 8d common nails and the panel edge nailing pattern is 6 inches on center. From Table 303.4.2E, the length adjustment factor is 0.69. Therefore the minimum required length of shearwall along the front and rear walls is 17 x 0.69 = 11.7 feet (Use 12 feet).

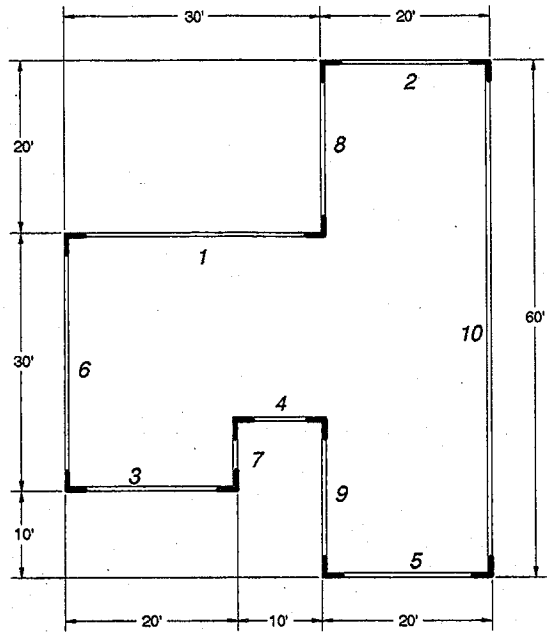


Figure H1

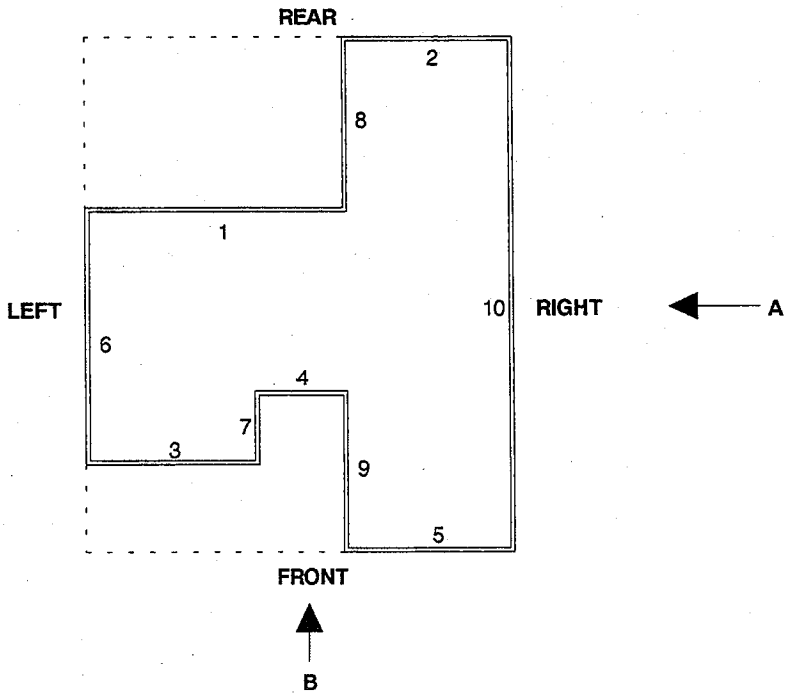


Figure H2

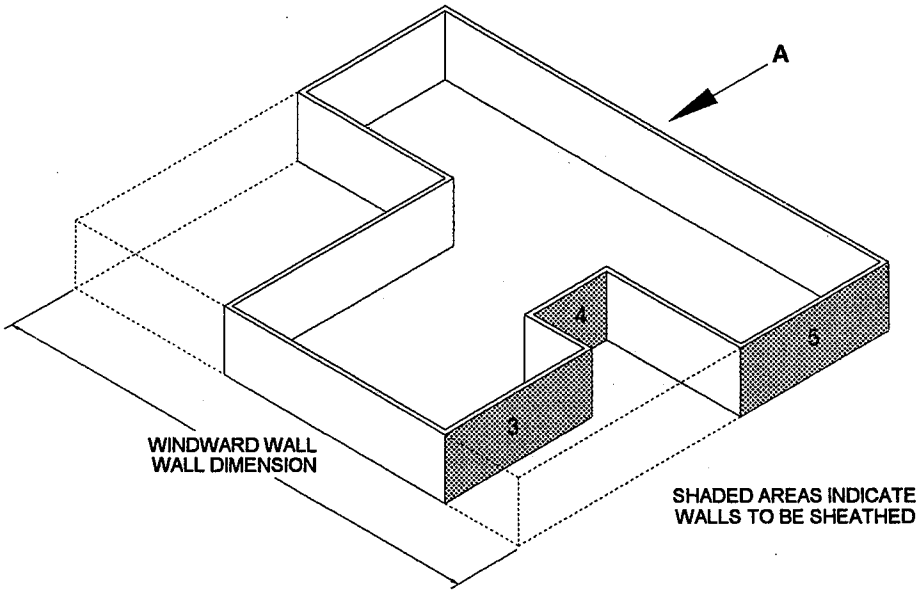


Figure H3

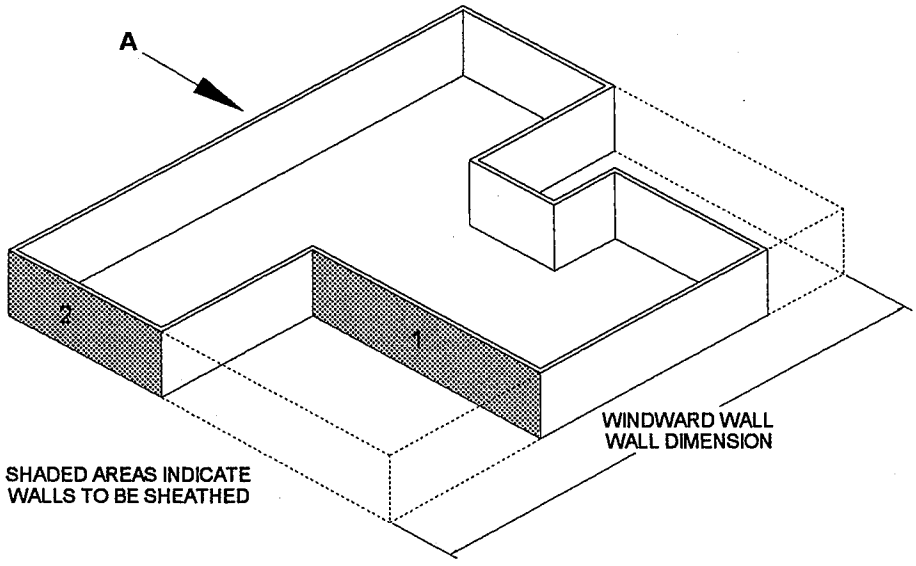


Figure H4

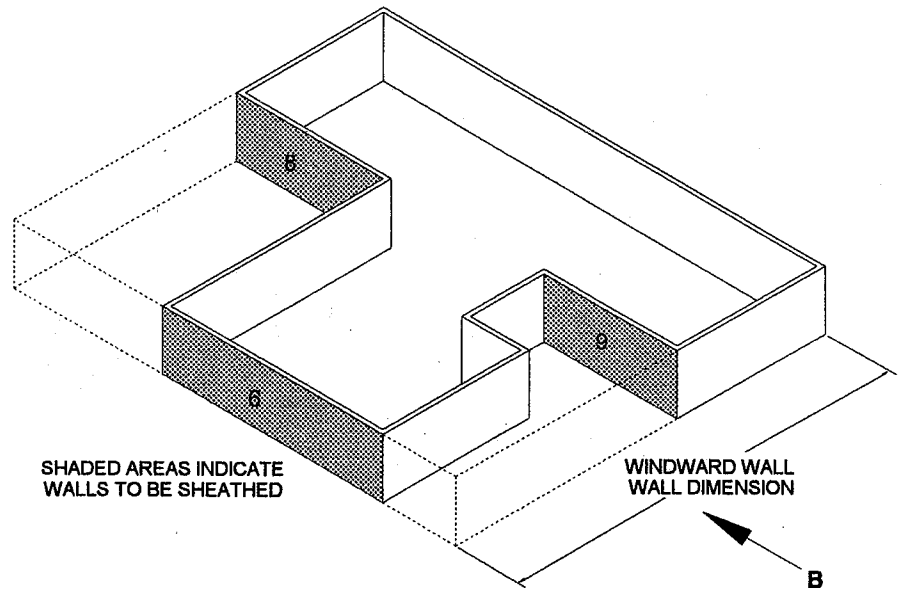


Figure H5

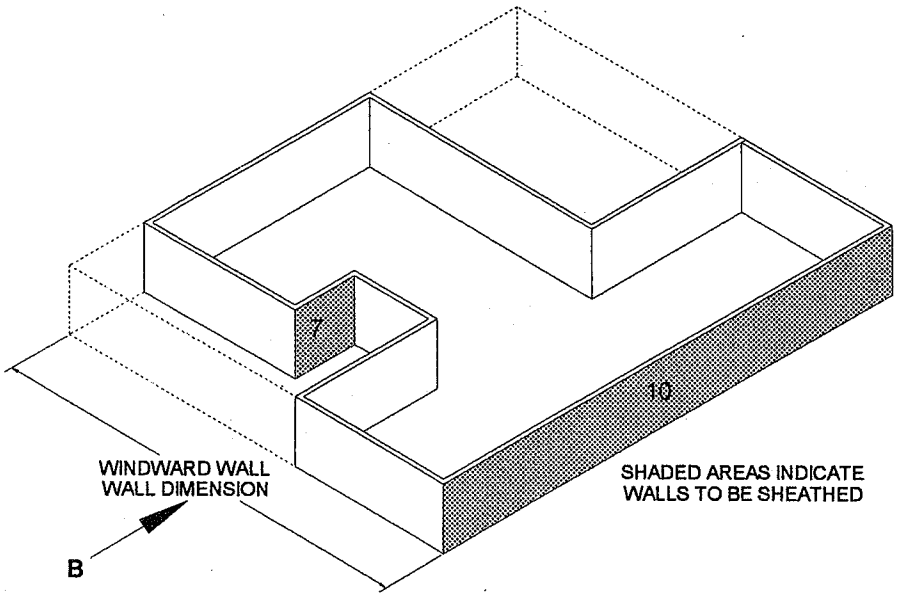


Figure H6

Example 2H: Shearwall Example for Masonry Construction (Section 304.4)

Example Building: One story slab-on-grade
8 foot wall height
Building Width: 50 feet
Building Length: 60 feet
Maximum Roof Span: 30 feet
Roof slope: 5:12
Building is located in the Inland region

1. **Determine the minimum required shearwall segment width.**

   The minimum shearwall segment width at building corners is 8 inches. Each end of the shearwall segment shall be reinforced with either one # 7 rebar or two # 5 rebar.

   The minimum shearwall segment away from building corners is a function of the pier height of the shearwall segment and the reinforcement provided at each end of the shearwall segment. If the pier height is 6 feet or less, and one # 5 rebar is provided at each end of the shearwall segment, then the minimum width of the shearwall segment is 2 feet. If the pier height is greater than 6 feet, but less than or equal to 10 feet, and either one # 7 rebar or two # 5 rebar is provided at each end of the shearwall segment, then the minimum width of the shearwall segment is 2 feet. If the pier height is greater than 6 feet, but less than or equal to 10 feet, and one # 5 rebar is provided at each end of the shearwall segment, then the minimum width of the shearwall segment is 4 feet.

2. **Determine the minimum length of shearwalls required along the exterior walls.**

   The minimum length of shearwalls required along each side of the building is determined from Tables 304.4A-C. The ends of each shearwall shall be reinforced. A three step process is required to determine the minimum length of shearwall required.

   Step One: Determine the Shearwall Location Code
   The shearwall location code is determined from Table 304.4A. The roof slope of the building is 5:12. The type of construction is "Walls Beneath Roof and Ceiling" since the structure is a one-story building. For walls beneath a roof and ceiling with a roof slope less than 7:12, the shearwall location code is 'A'.

   Step Two: Determine the minimum length of shearwalls required for walls facing the front and the rear.
   The walls facing the front are labeled 3, 4, and 5 in Figure H2. The walls facing the rear are labeled 1 and 2 in Figure H2. The "Windward Building Dimension" of the structure is the overall dimension of the structure perpendicular to the front and rear walls of the structure. In this example, the windward building dimension is 60 feet. The wind is applied to the windward building dimension as shown by the arrow labeled 'A' in Figure H2.

   Since the maximum roof span of the structure is 30 feet, Table 304.4.B must be used (maximum roof span of 36 feet). Enter Table 304.4B with a shearwall location code 'A' and a windward building dimension of 60 feet. If one #5 rebar is used at the end of each shearwall, then a minimum of 10 feet of shearwall is required on the walls facing the front and on the walls facing the rear. If one #7 or two #5 rebar are used, then a minimum of 6 feet of shearwall is required.

If we assume that one #5 rebar is used, then a minimum of 10 feet of shearwall is required along walls labeled 1 and 2 and a minimum of 10 feet of shearwall is required along walls labeled 3, 4, and 5. See Figures H3 and H4 for an illustration of the walls that require shearwalls.

The shearwalls may be located anywhere along the length of the wall. A minimum 8 inch wide shearwall segment width is required at each building corner.

Step Three: Determine the minimum length of shearwalls required for walls facing the left side and the right side.

The walls facing the left side are labeled 8, 6, and 9 in Figure H2. The walls facing the right side are labeled 7 and 10 in Figure H2. The "Windward Building Dimension" of the structure is the overall dimension of the structure perpendicular to the left and right side walls of the structure. In this example, the windward building dimension is 50 feet. The wind is applied to the windward building dimension as shown by the arrow labeled 'B' in Figure H2.

Since the maximum roof span of the structure is 30 feet, Table 304.4B must be used (maximum roof span of 36 feet). Enter Table 304.4B with a shearwall location code 'A' and a windward building dimension of 50 feet. If one #5 rebar is used for the shearwall, then a minimum of 8 feet of shearwall is required on the walls facing the front and on the walls facing the rear. If either one #7 or two #5 rebar are used, then a minimum of 5 feet of shearwall is required.

If we assume that one #5 rebar is used, then a minimum of 8 feet of shearwall is required along walls labeled 8, 6, and 9 and a minimum of 8 feet of shearwall is required along walls labeled 7 and 10. See Figures H5 and H6 for and illustration of the walls that require shearwalls.

The shearwalls may be located anywhere along the length of the wall. A minimum 8 inch wide shearwall segment width is required at each building corner. These segments shall count towards the minimum required length of shearwall.

Appendix I
Fastening Schedule

Fasteners shall be provided in accordance with the minimum requirements listed in this schedule unless otherwise specified in the T.W.I.A. *Building Code for Windstorm Resistant Construction* (Code), or a Texas Department of Insurance code interpretation or product evaluation. All fasteners shall comply with either **Federal Specification FF-N-105B** or **ASTM F 1667**. All fasteners shall be corrosion resistant as specified in the Code.

NOTES: The fastener requirements are presented in terms of the minimum required length and shank diameter of the nails. As an example, a fastener designation written as: 2½" x 0.131" means that the length of the nail is 2½ inches and the shank diameter is 0.131 inches.

ROOF FRAMING

- Rafter to Top Plate (Toe-nailed)
  - 3 nails: 2½" x 0.131" (8d common); 3" x 0.128" (10d box); 3" x 0.131"; 3¼" x 0.131"
  - 4 nails: 2⅜" x 0.113"; 3" x 0.120"; 3¼" x 0.120"
- Rafter to Ridge Board (Toe-nailed)
  - 2 nails: 3½" x 0.162" (16d common)
  - 3 nails: 3" x 0.131"; 3¼" x 0.131"; 3½" x 0.135" (16d box)
  - 4 nails: 3" x 0.120"; 3¼" x 0.120"
- Rafter to Ridge Board (Face-nailed)
  - 2 nails: 3½" x 0.162" (16d common)
  - 3 nails 3¼" x 0.131"; 3½" x 0.135" (16d box)
  - 4 nails: 3" x 0.120"; 3¼" x 0.120"; 3" x 0.131"
- Blocking Between Rafters or Trusses (Toe-nailed)
  - 4 nails, 2 at each end: 2½" x 0.131" (8d common); 3" x 0.128" (10 box); 3" x 0.131"; 3¼" x 0.131"
- Collar Tie or Rafter Tie to Rafter; Strongback to Rafter (Face-nailed)
  - 3 nails: 3½" x 0.162" (16d common)
  - 4 nails: 3" x 0.120"; 3¼" x 0.120"; 3¼" x 0.128" (12d box); 3" x 0.131"; 3¼" x 0.131"

FASTENING SCHEDULE FOR THE BUILDING CODE FOR WINDSTORM RESISTANT CONSTRUCTION

ROOF FRAMING (Continued)

- Ceiling Joist to Top Plate (Toe-nailed)
  - 3 nails: 2½" x 0.131" (8d common); 3" x 0.128" (10d box); 3" x 0.131"; 3¼" x 0.131"
  - 4 nails: 2⅜" x 0.113"; 3" x 0.120"; 3¼" x 0.120"
- Ceiling Joist to Parallel Rafter (Face-nailed)
  - 3 nails: 3½" x 0.162" (16d common)
  - 4 nails: 3" x 0.120"; 3¼" x 0.120"; 3¼" x 0.128" (12d box); 3" x 0.131"; 3¼" x 0.131"
- Ceiling Joist Laps over Partitions (Face-nailed)
  - 3 nails: 3½" x 0.162" (16d common)
  - 4 nails: 3" x 0.120"; 3¼" x 0.120"; 3¼" x 0.128" (12d box); 3" x 0.131"; 3¼" x 0.131"
- Strongback to Ceiling Joist or Bottom Chord of Truss
  - 2 nails: 3½" x 0.162" (16d common)
  - 3 nails: 3" x 0.120"; 3¼" x 0.120"; 3¼" x 0.128" (12d box); 3" x 0.131"; 3¼" x 0.131"
- Rafter Splice (Face-nailed)
  - 21 nails: 3½" x 0.162" (16d common)
  - 24 nails: 3" x 0.120"; 3¼" x 0.120"; 3¼" x 0.128" (12d box); 3" x 0.131"; 3¼" x 0.131"
- Rafter Brace to Rafter (Face-nailed)
  - 4 nails: 3½" x 0.162" (16d common)
  - 5 nails: 3" x 0.120"; 3¼" x 0.120"; 3¼" x 0.128" (12d box); 3" x 0.131"; 3¼" x 0.131"

FASTENING SCHEDULE FOR THE BUILDING CODE FOR WINDSTORM RESISTANT CONSTRUCTION

ROOF FRAMING (Continued)

- Purlin Brace to Rafter Brace (Face-nailed)
  Nailing Pattern: Maximum 12" o.c. along brace
  1 nail: 3½" x 0.162" (16d common) 3 nails: 3" x 0.120"
  3¼" x 0.120"
  3¼" x 0.128" (12d box)
  3" x 0.131"
  3¼" x 0.131"

- Rafter Purlin to Rafter Brace
  2 nails: 3½" x 0.162" (16d common) 3 nails: 3" x 0.120"
  3¼" x 0.120"
  3¼" x 0.128" (12d box)
  3" x 0.131"
  3¼" x 0.131"

- Rafter Brace to Ceiling Joist (Face-nailed)
  3 nails: 3½" x 0.162" (16d common) 4 nails: 3" x 0.120"
  3¼" x 0.120"
  3¼" x 0.128" (12d box)
  3" x 0.131"
  3¼" x 0.131"

- Rafter Brace to Top Plate (Toe-nailed)
  3 nails: 3½" x 0.162" (16d common) 4 nails: 3" x 0.120"
  3¼" x 0.120"
  3¼" x 0.128" (12d box)
  3" x 0.131"
  3¼" x 0.131"

CEILING FRAMING

- Block to Strongback - Gable Endwall Brace (Face Nailed)
  4 nails: 3½" x 0.162" (16d common) 6 nails: 3" x 0.120"
  3¼" x 0.120"
  3¼" x 0.128" (12d box)
  3" x 0.131"
  3¼" x 0.131"

- Strongback to Gable Endwall Stud - Gable Endwall Brace (Face Nailed)
  3 nails: 3½" x 0.162" (16d common) 4 nails: 3" x 0.120"
  3¼" x 0.120"
  3¼" x 0.128" (12d box)
  3" x 0.131"
  3¼" x 0.131"

FASTENING SCHEDULE FOR THE BUILDING CODE FOR WINDSTORM RESISTANT CONSTRUCTION

CEILING FRAMING (Continued)

- 20 gauge steel strap to Strongback; Gable Endwall Stud - Gable Endwall Brace
  10 nails each end: 2½" x 0.131" (8d common) 15 nails each end: 3" x 0.120"
  3¼" x 0.120"

WALL FRAMING

- Double Top Plate - Exterior Walls (Face-nailed)
  1 nail at 12" o.c.: 3½" x 0.162" (16d common)
  3" x 0.120"
  3¼" x 0.120"
  3" x 0.131"
  3¼" x 0.131"
  3½" x 0.135" (16d box)

- Double Top Plate - Interior Walls (Face-nailed)
  1 nail at 24" o.c.: 3½" x 0.162" (16d common)
  1 nail at 16" o.c.: 3" x 0.120"
  3¼" x 0.120"
  3" x 0.131"
  3¼" x 0.131"
  3½" x 0.135" (16d box)

- Top Plate Laps and Intersections (Face-nailed - number of nails each side of lap)
  2 nails: 3½" x 0.162" (16d common) 3 nails: 3" x 0.120"
  3¼" x 0.120"
  3¼" x 0.128" (12d box)
  3" x 0.131"
  3¼" x 0.131"

- Stud to Top Plate or Sole Plate (End-nailed)
  2 nails: 3½" x 0.162" (16d common) 3 nails: 3" x 0.131"
  3¼" x 0.131"
  3½" x 0.135" (16d box)

- Stud to Top Plate or Sole Plate (Toe-nailed)
  3 nails: 3½" x 0.162" (16d common) 4 nails: 2½" x 0.131" (8d common)
  3" x 0.128" (10d box)
  3" x 0.131"
  3¼" x 0.131"

FASTENING SCHEDULE FOR THE BUILDING CODE FOR WINDSTORM RESISTANT CONSTRUCTION

WALL FRAMING (Continued)

- Doubled Studs (Face-nailed)
  - 1 nail at 24" o.c.: 3½" x 0.162" (16d common)
  - 1 nail at 16" o.c.: 3" x 0.131"
    3¼" x 0.131"
    3½" x 0.135" (16d box)

- Bottom Plate to Band Joist (Face-nailed) – when not used for shear transfer
  - 1 nail at 16" o.c.: 3½" x 0.162" (16d common)
  - 1 nail at 12" o.c.: 3" x 0.131"
    3¼" x 0.131"
    3½" x 0.135" (16d box)

- Bottom Plate to Band Joist (Face-nailed) – when used for shear transfer
  - 1 nail at 6" o.c.: 3½" x 0.162" (16d common)
  - 1 nail at 4" o.c.: 3" x 0.131"
    3¼" x 0.131"
    3½" x 0.135" (16d box)

- Blocking Between Wall Studs (Toe-nailed)
  - 4 nails, 2 at each end: 2½" x 0.131" (8d common)
    3" x 0.128" (10 box)
    3" x 0.131"
    3¼" x 0.131"

- Nominal 1-inch thick brace to studs and plates (Face-nailed)
  - 2 nails at each stud or plate: 2½" x 0.131" (8d common)
    3" x 0.128" (10d box)
    3" x 0.131"
    3¼" x 0.131"
  - 3 nails at each stud or plate: 3" x 0.120"
    3¼" x 0.120"

- Gable Offset L-Shaped Member to Gable Studs
  - 1 nail at 5" o.c.: 3 ½" x 0.162" (16d common wire nail)
  - 1 nail at 4" o.c.: 3 ½" x 0.131"
    3 ½" x 0.120" deformed shank

- Gable Offset 2x Member to 2x4 Member (fastened to form vertical L-shaped member)
  - 1 nail at 18" o.c. 3½" x 0.162" (16d common wire nail)
  - 1 nail at 18" o.c. 3½" x 0.128" (12d box nail)
  - 1 nail at 16" o.c. 3" x 0.120"
  - 1 nail at 12" o.c. 2½" x 0.131"

FASTENING SCHEDULE FOR THE BUILDING CODE FOR WINDSTORM RESISTANT CONSTRUCTION

FLOOR FRAMING

- Joist to Sill, Top Plate, Beam, or Girder (Toe-nailed)

3 nails:	2½" x 0.131" (8d common)	4 nails:	3" x 0.120"
	3" x 0.128" (10d box)		3¼" x 0.120"
	3" x 0.131"		
	3¼" x 0.131"		

FASTENING SCHEDULE FOR THE BUILDING CODE FOR WINDSTORM RESISTANT CONSTRUCTION

FLOOR FRAMING (Continued)

- Band Joist to Sill or Top Plate (Toe-nailed)
  - 1 nail at 6" o.c.: 3½" x 0.162" (16d common)
  - 1 nail at 4" o.c.: 3" x 0.131"
    3¼" x 0.131"
    3½" x 0.135" (16d box)

- Joist Laps over Beams or Partitions (Face-nailed)
  - 3 nails: 3½" x 0.162" (16d common)
  - 4 nails: 3" x 0.120"
    3¼" x 0.120"
    3¼" x 0.128" (12d box)
    3" x 0.131"
    3¼" x 0.131"

- Blocking Between Floor Joists (Toe-nailed)
  - 4 nails, 2 at each end: 2½" x 0.131" (8d common)
    3" x 0.128" (10 box)
    3" x 0.131"
    3¼" x 0.131"

- Bridging to Joist (Toe-nailed), number of nails at each end
  - 2 nails: 2½" x 0.131" (8d common)
    3" x 0.128" (10d box)
  - 3 nails: 3" x 0.120"
    3¼" x 0.120"
  - 4 nails: 2" x 0.113"
    2⅜" x 0.113"

- Band Joist to Joist (End-nailed)
  - 3 nails: 3½" x 0.162" (16d common)
  - 5 nails: 3" x 0.131"
    3¼" x 0.131"
    3½" x 0.135" (16d box)
  - 6 nails: 3" x 0.120"
    3¼" x 0.120"

- Ledger Strip to Beam or Band Joist (Face-nailed)
  - Note: Fasteners are required below each floor joist
    16d fasteners shall be spaced a minimum of 2½ inches on center
    All other fasteners shall be spaced a minimum of 2 inches on center
  - 3 nails: 3½" x 0.162" (16d common)
  - 4 nails: 3" x 0.131"
    3¼" x 0.131"
    3½" x 0.135" (16d box)
    3" x 0.120"
    3¼" x 0.120"

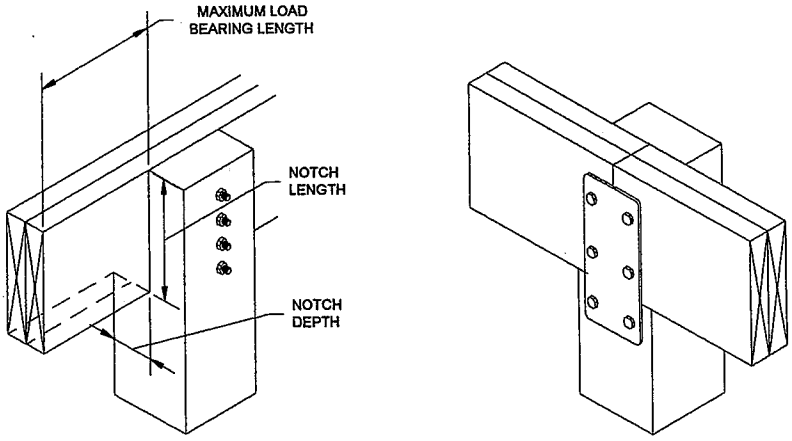


Figure 301.2.1
Beam Attachment to Pile

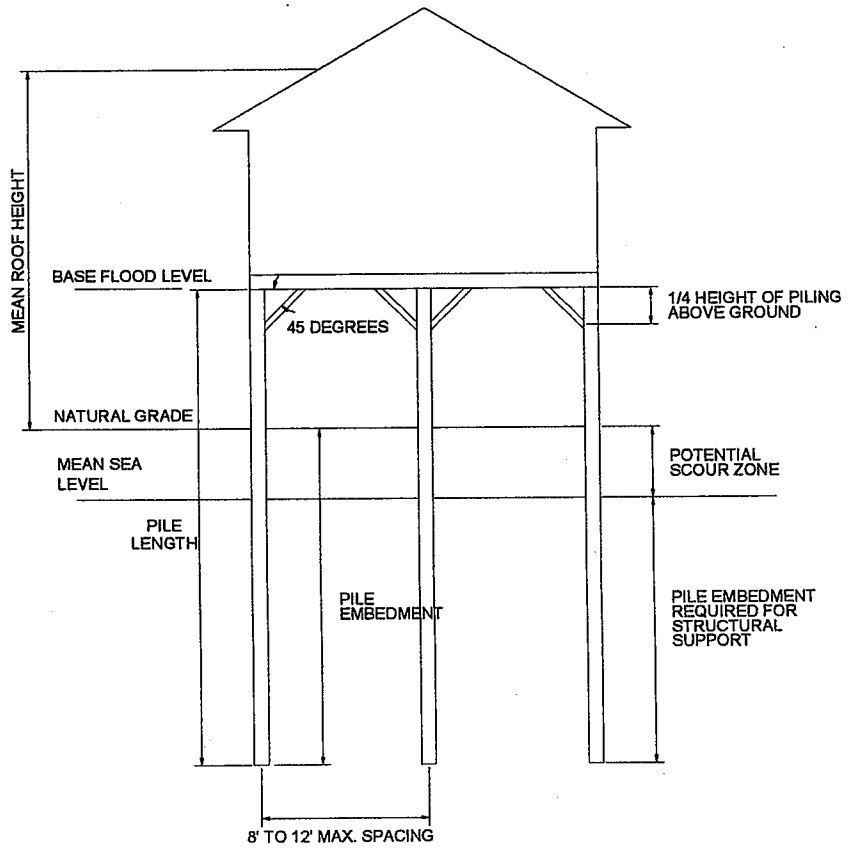


Figure 301.2.2
Pile Embedment

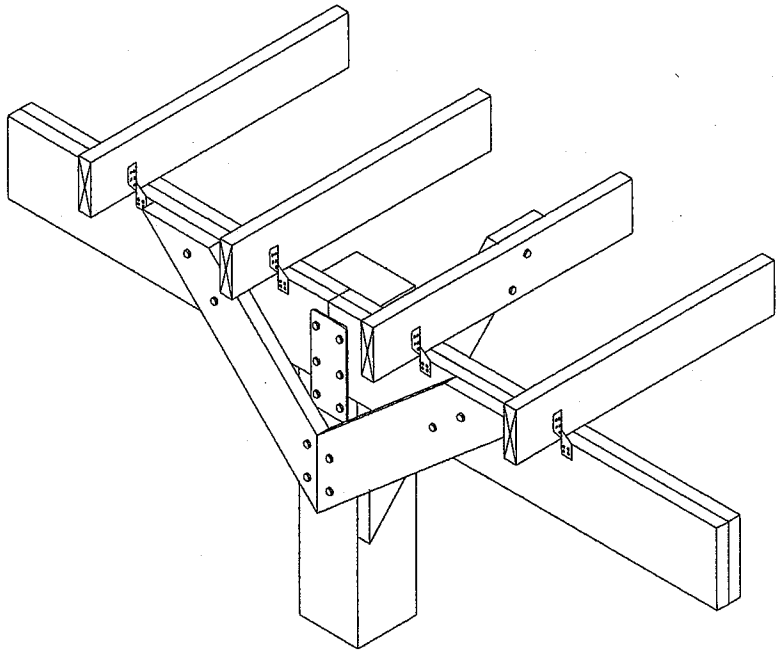


Figure 301.2.3A
Double Beam with 2 x 8 Knee Brace
and Uplift Connectors

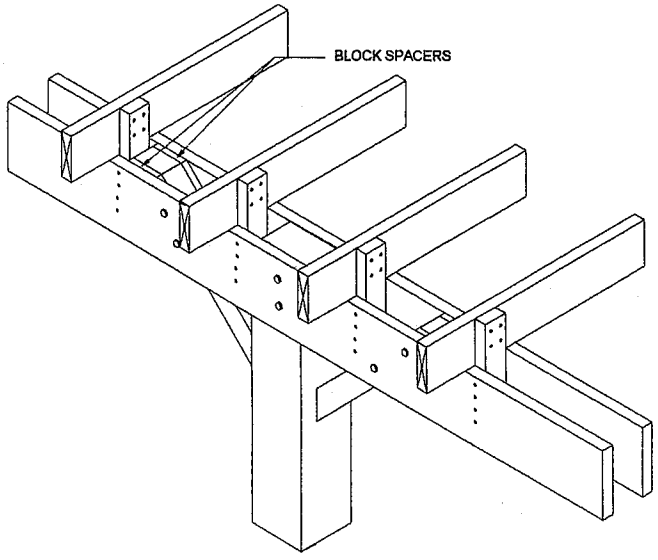
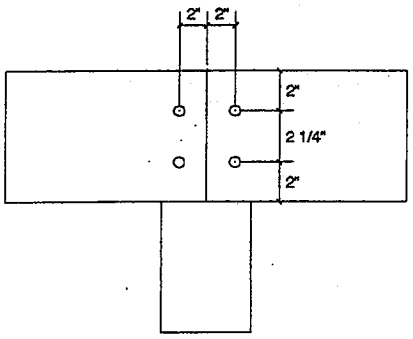
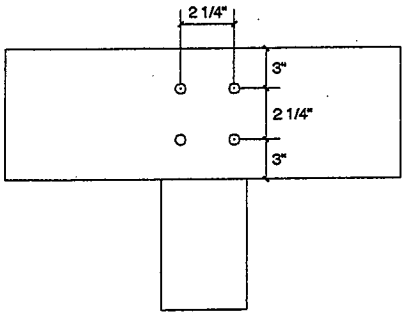


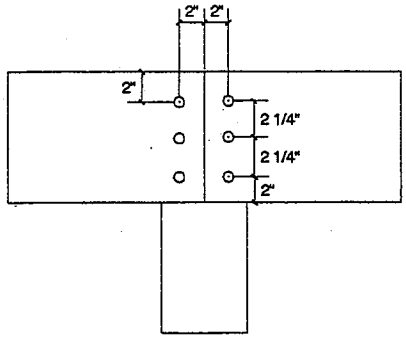
Figure 301.2.3B
Spaced Beam with Wood Framing
Anchors and 4 x 4 Knee Brace



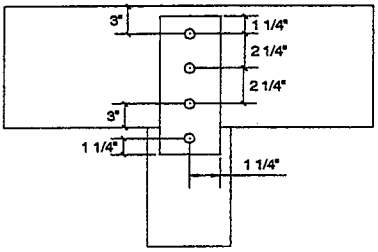
One Story with Splice



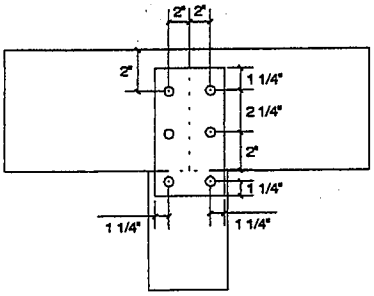
One Story Without Splice



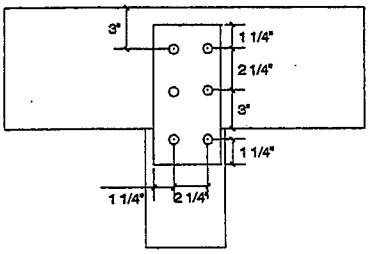
Two- Story With Splice



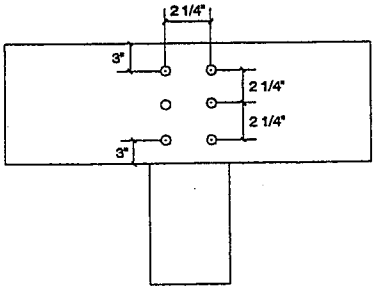
One Story No Splice



One- Story and Two- Story with Splice



Two- Story No Splice



Two- Story without Splice

Note: Dimensions shown are minimum spacings between bolts, beams edges, beam ends, and plate edges.

Figure 301.2.3C
Minimum Bolt Spacing

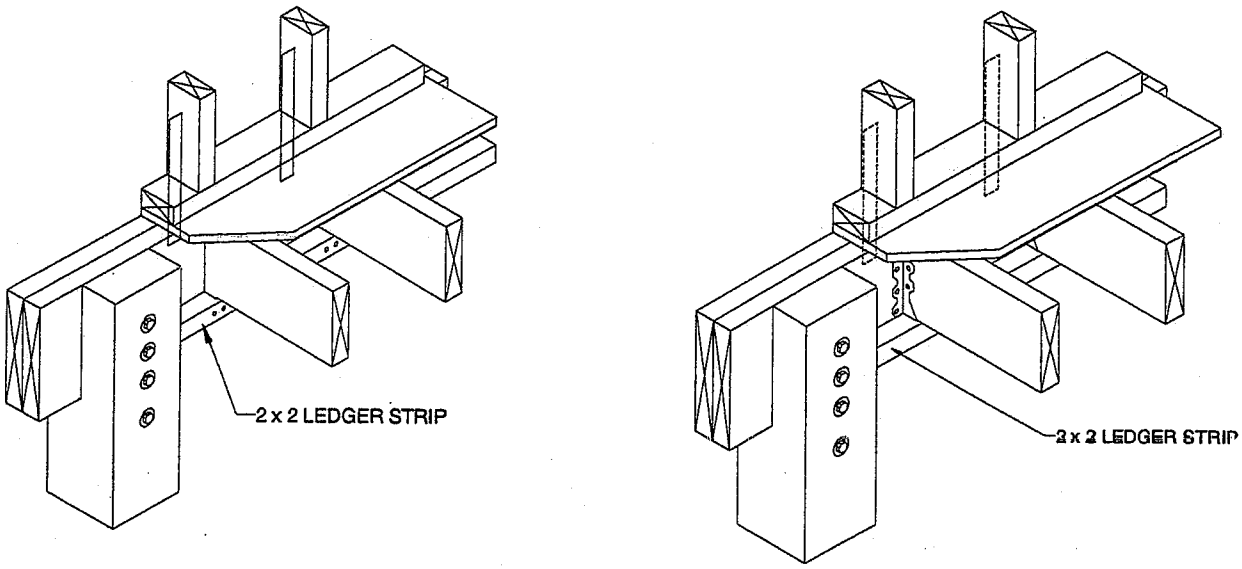


Figure 301.2.5A
Floor Joists Framing into Beams Supported with Either Framing Connectors or a Ledger Strip

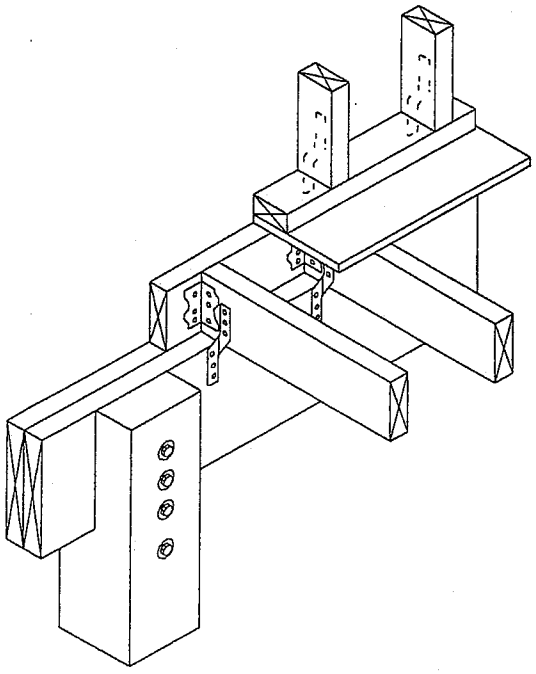


Figure 301.2.5B
Floor Joist on Top of Beam with Framing Anchors

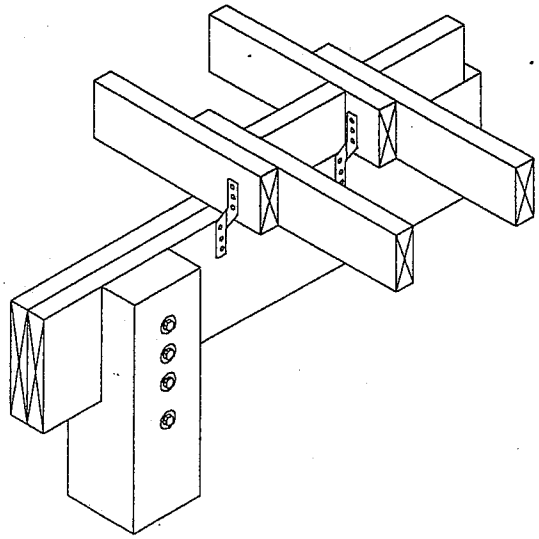


Figure 301.2.5C
Floor Joist Splice on Top of Beam with Framing Anchor

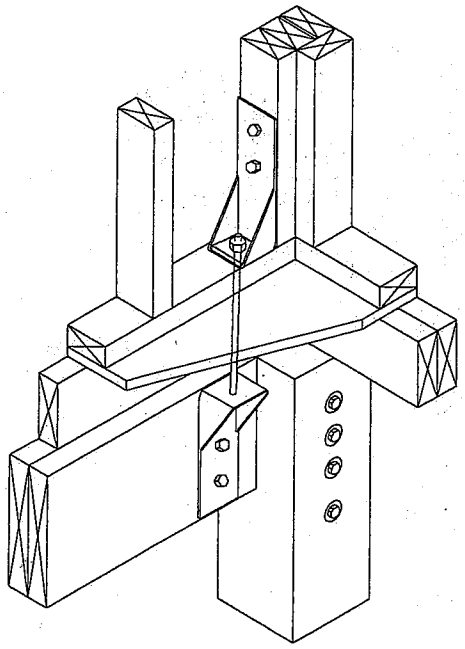


Figure 301.2.6
Attachment of Holddown Connector for Buildings on Piles or Piers

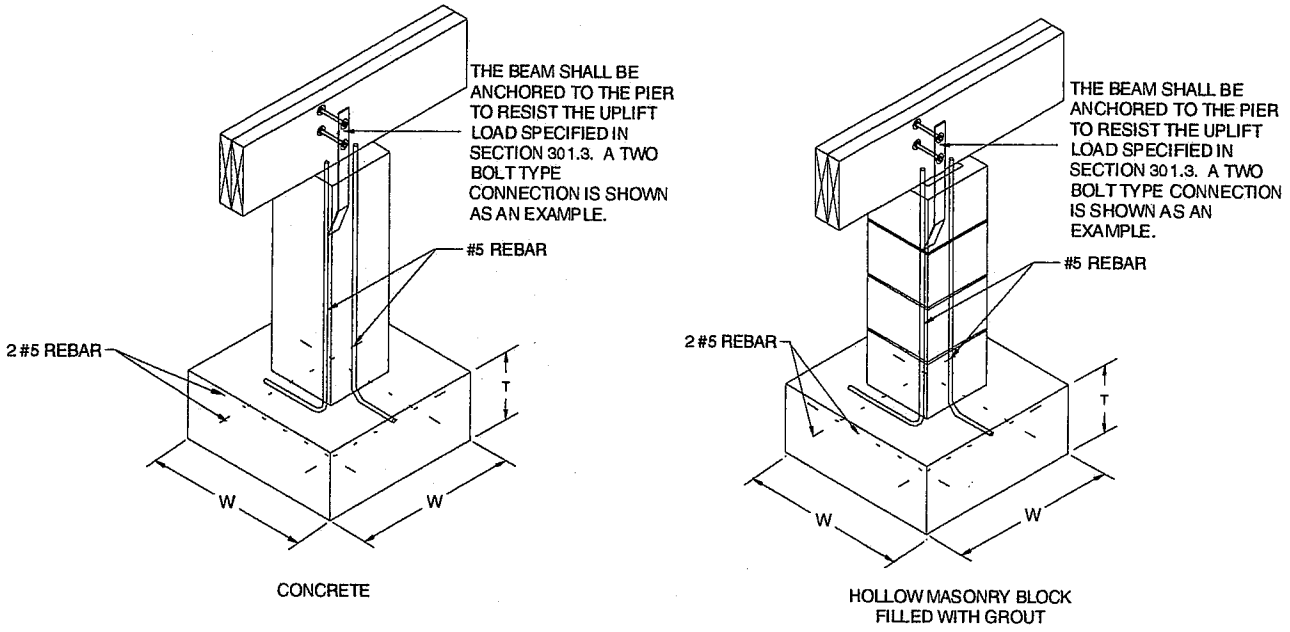


Figure 301.3A
Pier and Beam Foundation

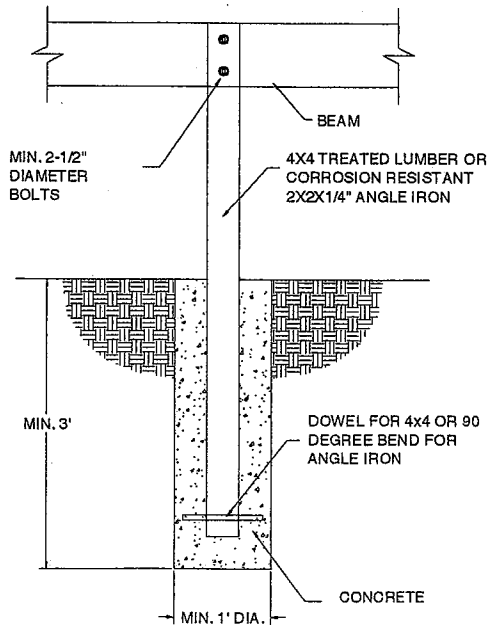


Figure 301.3B
Alternate Method to Anchor Pier and Beam Foundations

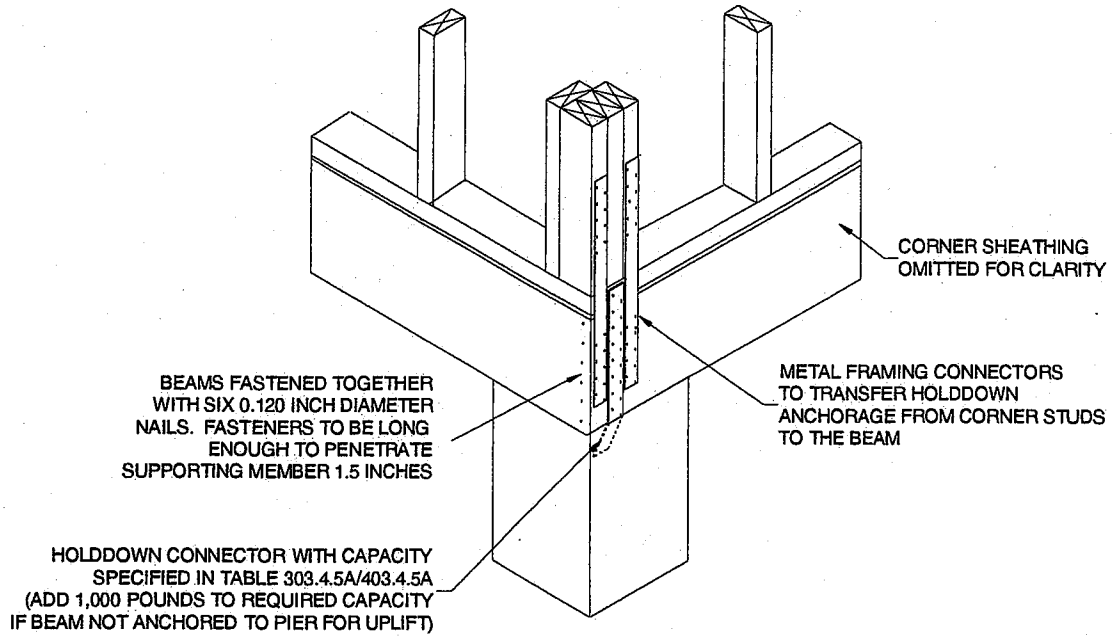


Figure 301.3C
Holddown Anchorage from Pier to Beam
and Beam to Corner Studs

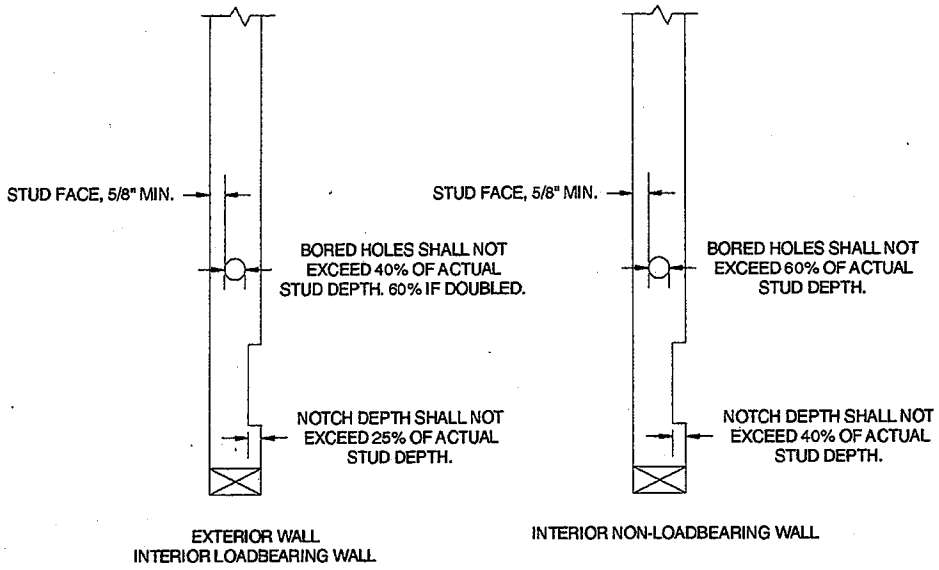


Figure 303.1.1.1
Allowances for Notching and Boring of Wall Studs

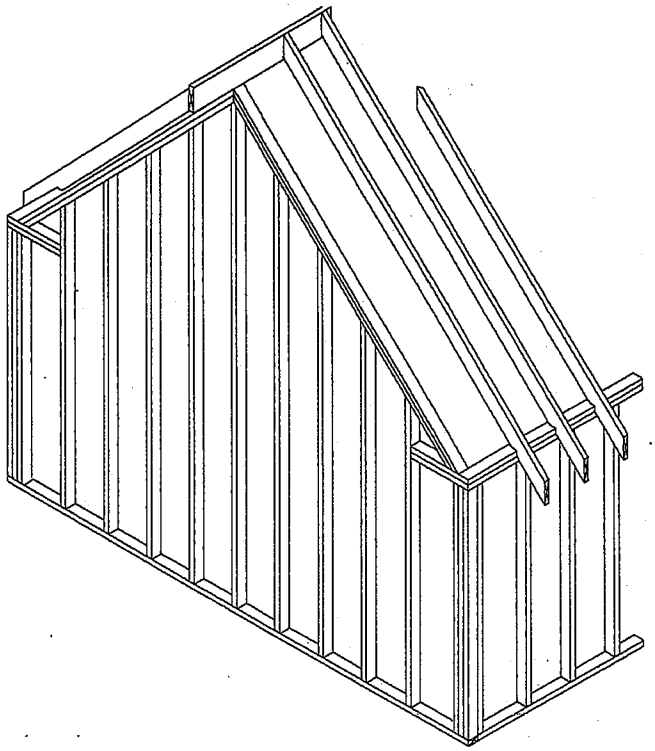


Figure 303.1.2.1A
Balloon Framing at Gable Endwall – Dropped Gable End Option
(Gable Endwall Overhang Framing Omitted for Clarity)

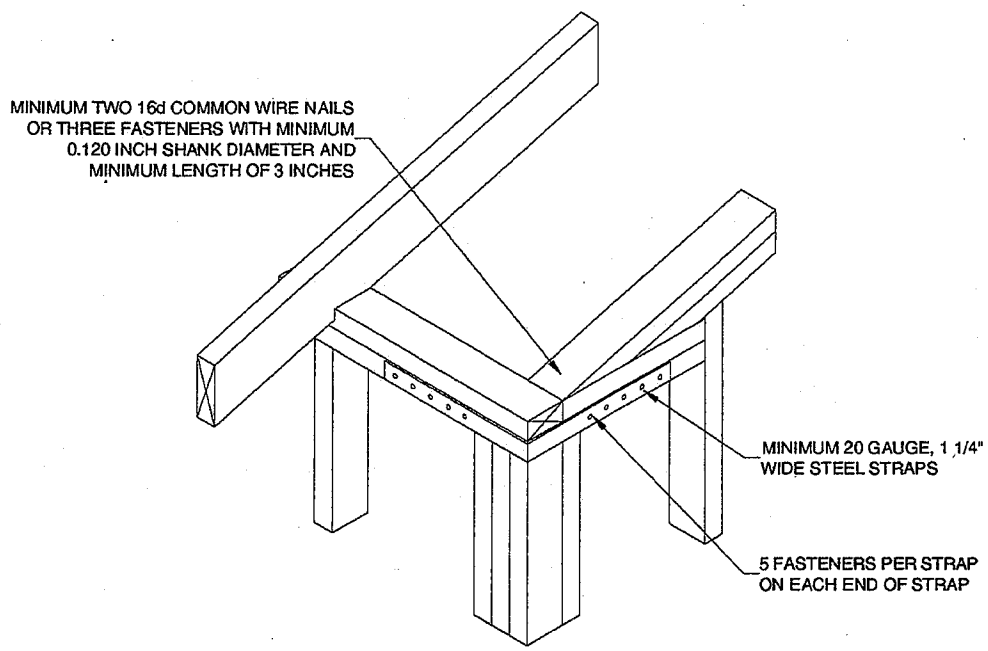


Figure 303.1.2.1B
Balloon Framing Corner Detail – Dropped Gable End Option
(Gable Endwall Overhang Framing Omitted for Clarity)

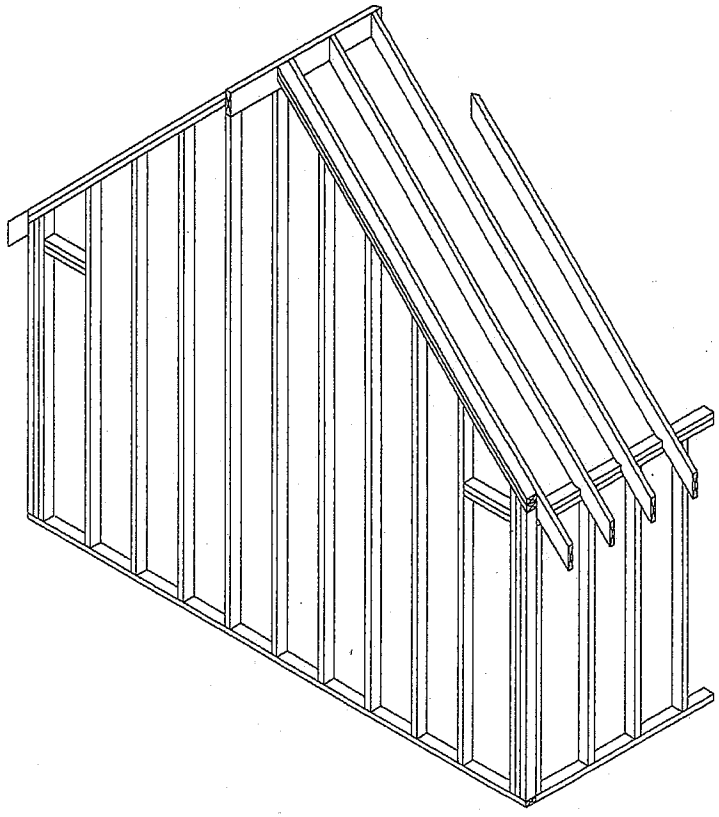


Figure 303.1.2.1C
Balloon Framing at Gable Endwall – Full-Height Gable End Option
(Gable Endwall Overhang Framing Omitted for Clarity)

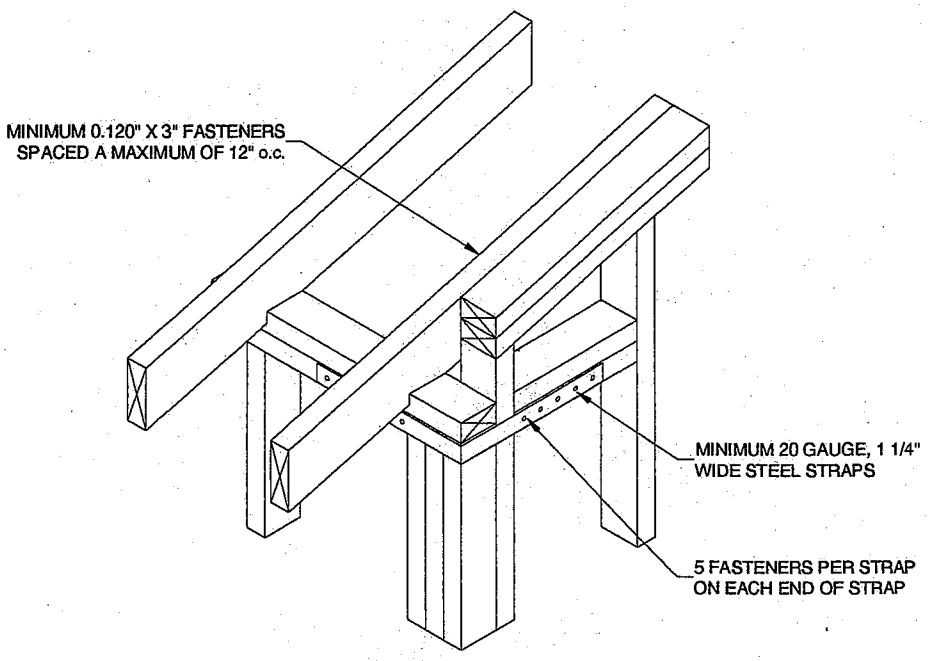


Figure 303.1.2.1D
Balloon Framing Corner Detail – Full-Height Gable End Option
(Gable Endwall Overhang Framing Omitted for Clarity)

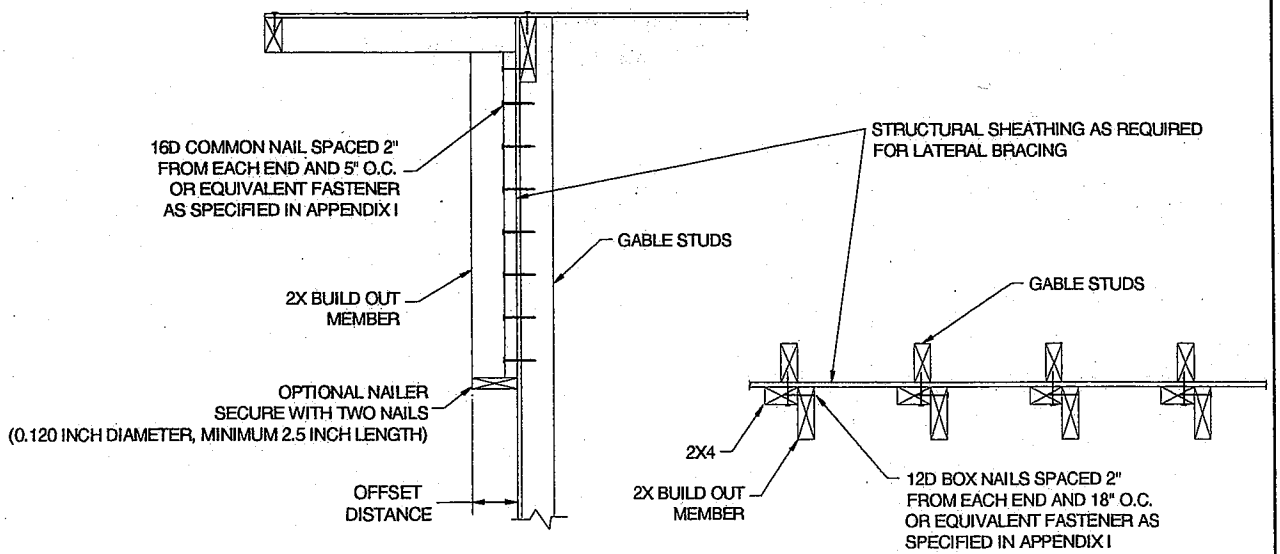


Figure 303.1.2.3
Gable Endwall Offset
(Balloon Framing Shown)

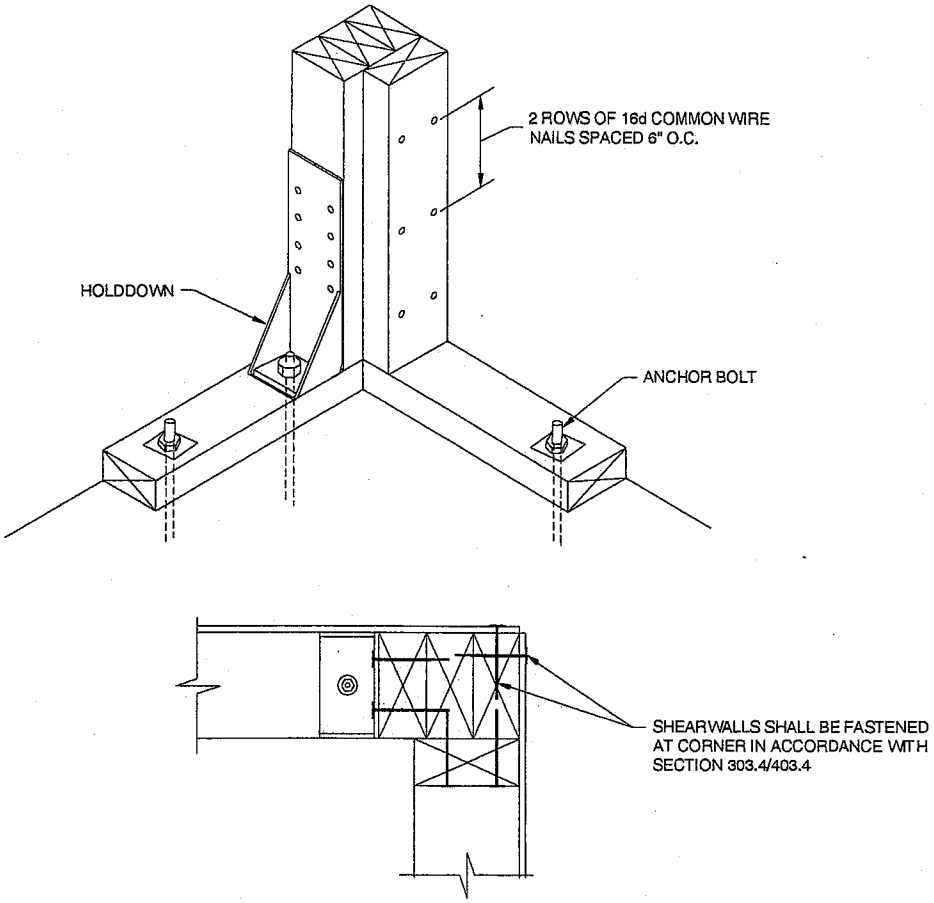


Figure 303.1.4
Corner Stud Detail

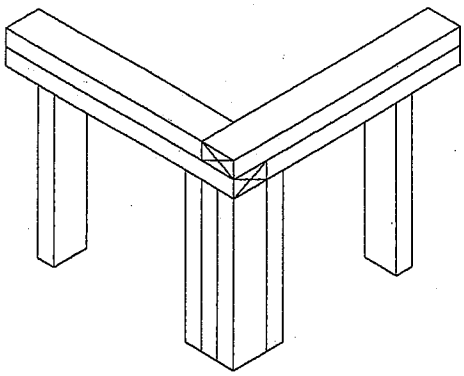


Figure 303.1.5A
Top Plate Corner Connection

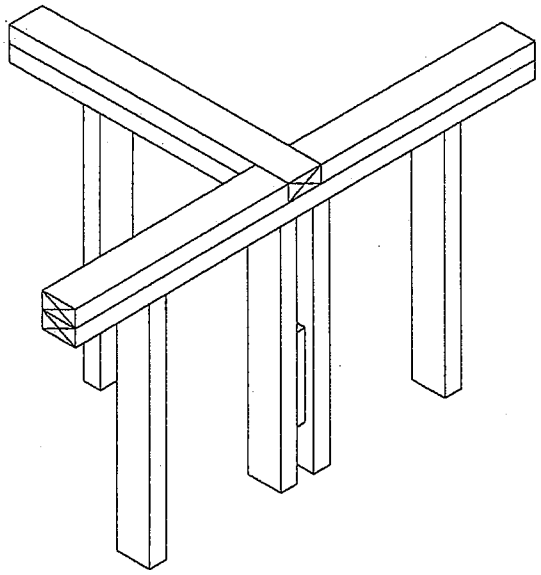


Figure 303.1.5B
Top Plate Connection for Intersection of Interior Wall with Exterior Wall

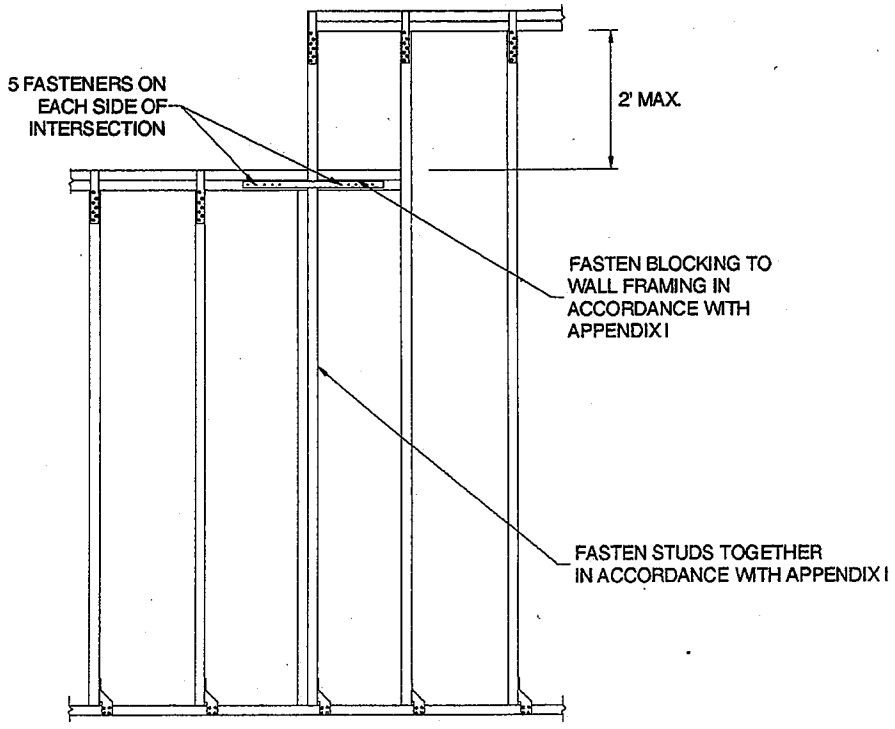


Figure 303.1.5.2.1A
Construction of Multi-Level Top Plate Intersection

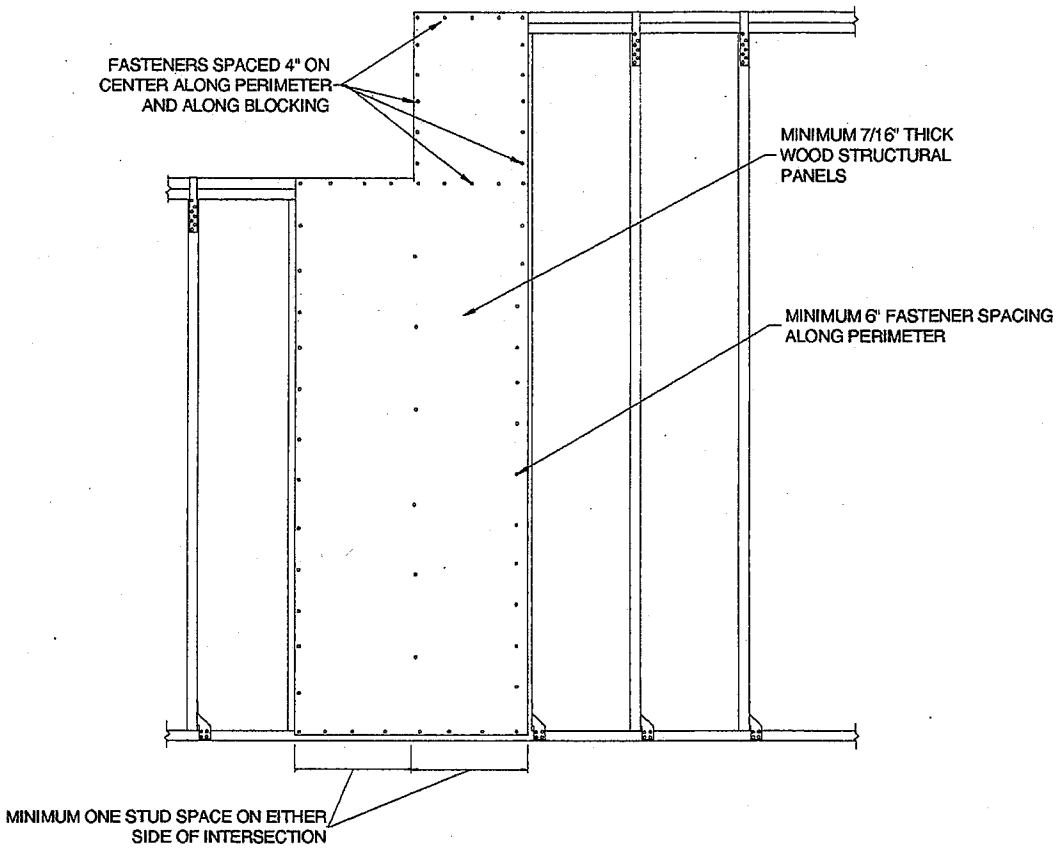


Figure 303.1.5.2.1B
Multi-level Top Plate Intersection Application of Sheathing

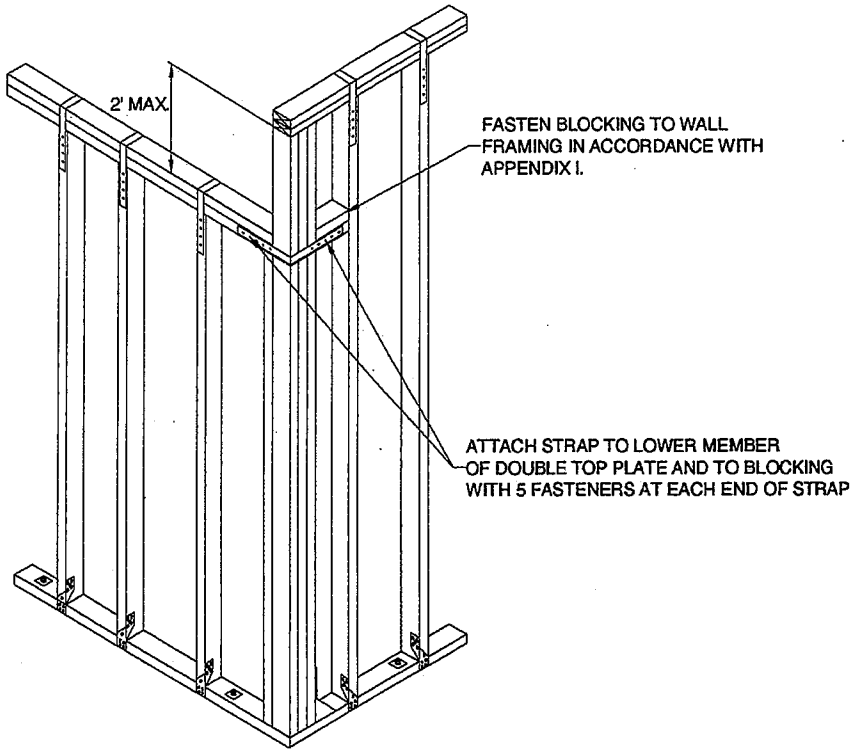


Figure 303.1.5.2.2A
Connection of Multi-level Top Plates at Building Corner

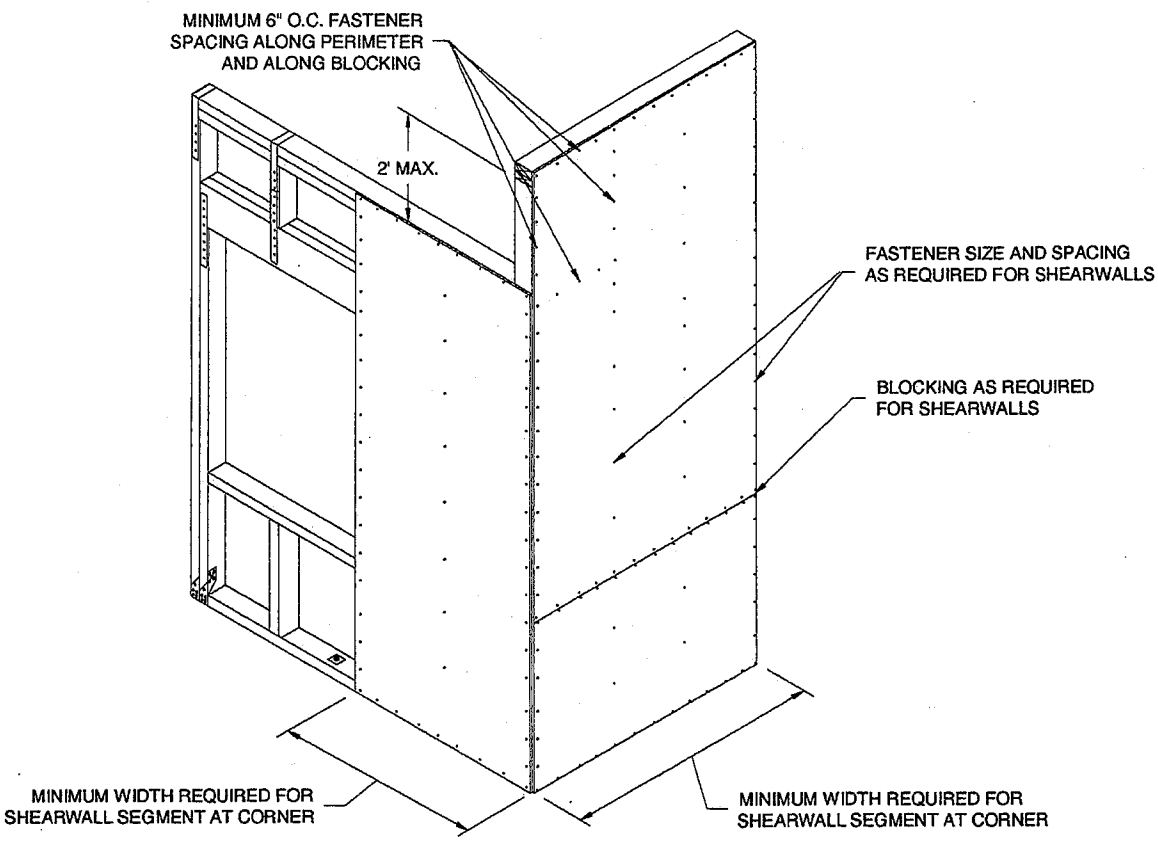


Figure 303.1.5.2.2B
Application of Wood Structural Panels at Building Corner
(Multi-level Top Plate Intersection)

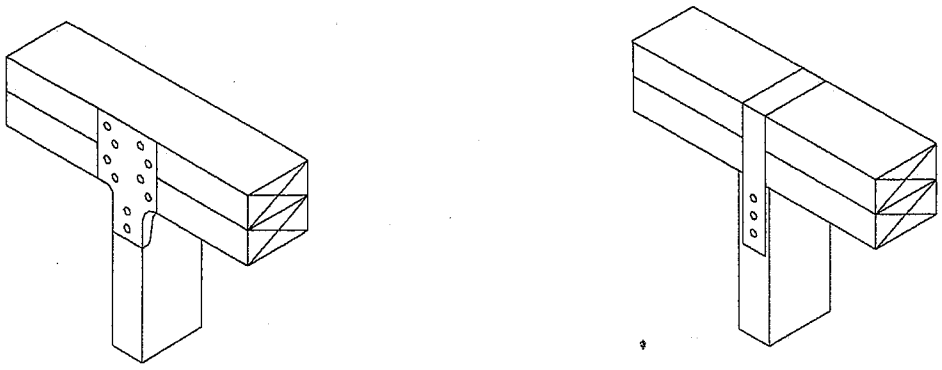


Figure 303.2A
Top Plate to Stud Connection

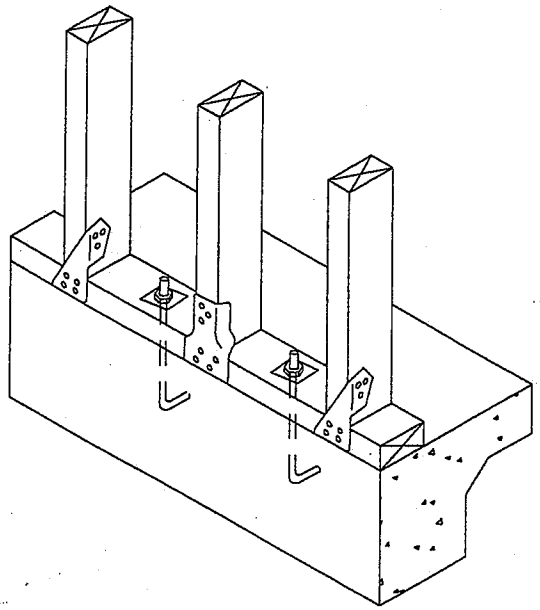


Figure 303.2B
Stud to Sole Plate Connections

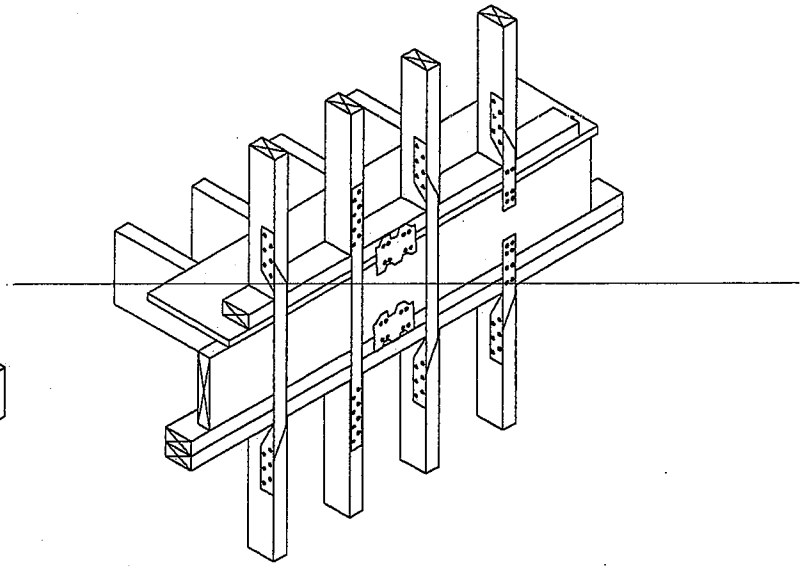


Figure 303.2C
First Story to Second Story or Second Story to Third Story Uplift and Shear Transfer Connections

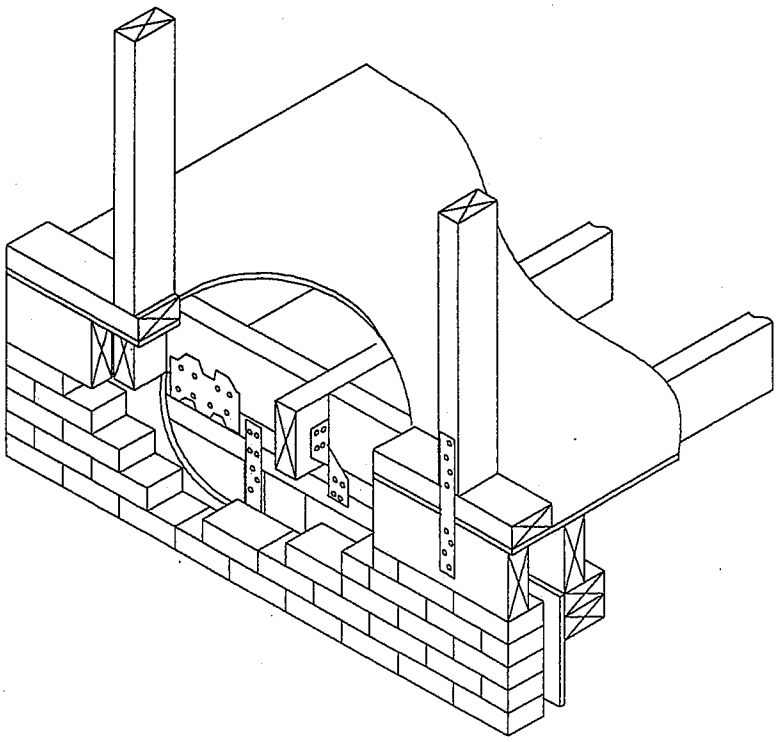


Figure 303.2D
First Story Offset from Second Uplift and Shear Transfer Connections

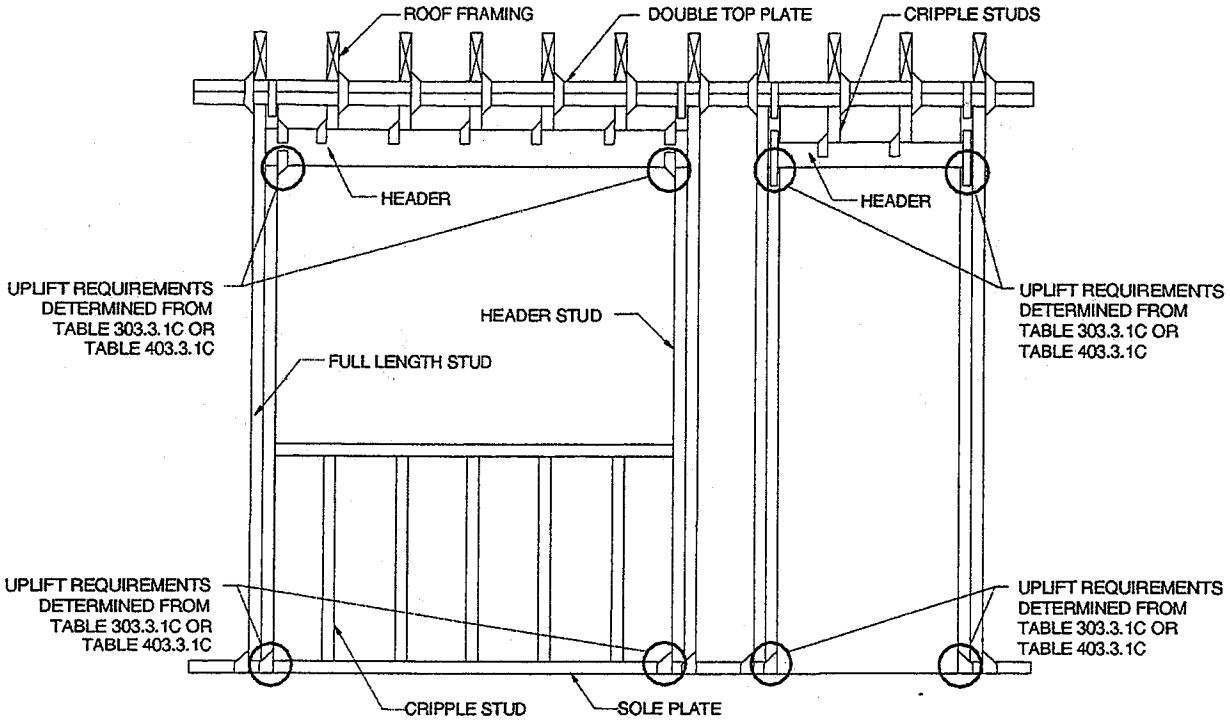


Figure 303.3.1
Framing and Connections for Openings

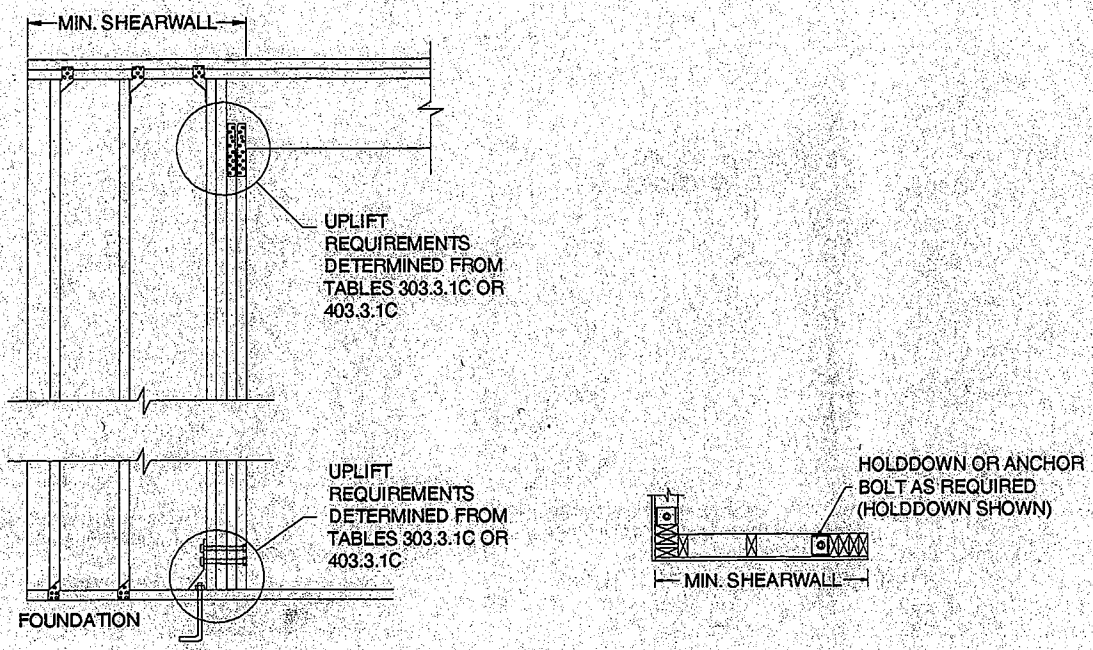


Figure 303.3.2.2A
Garage Door Corner Detail with a Minimum Shearwall Segment Length Return

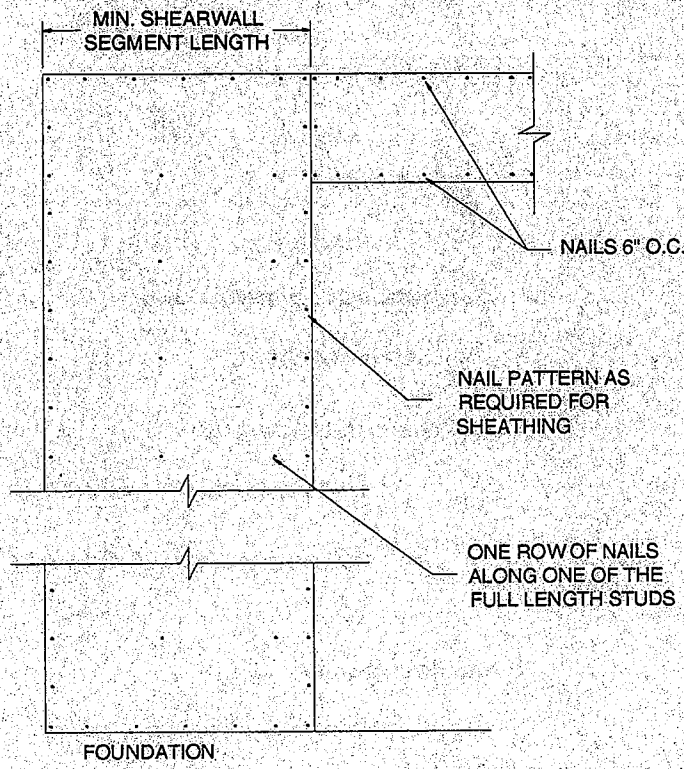


Figure 303.3.2.2B
Sheathing Detail for a Minimum Shearwall Segment Length Return at Corner

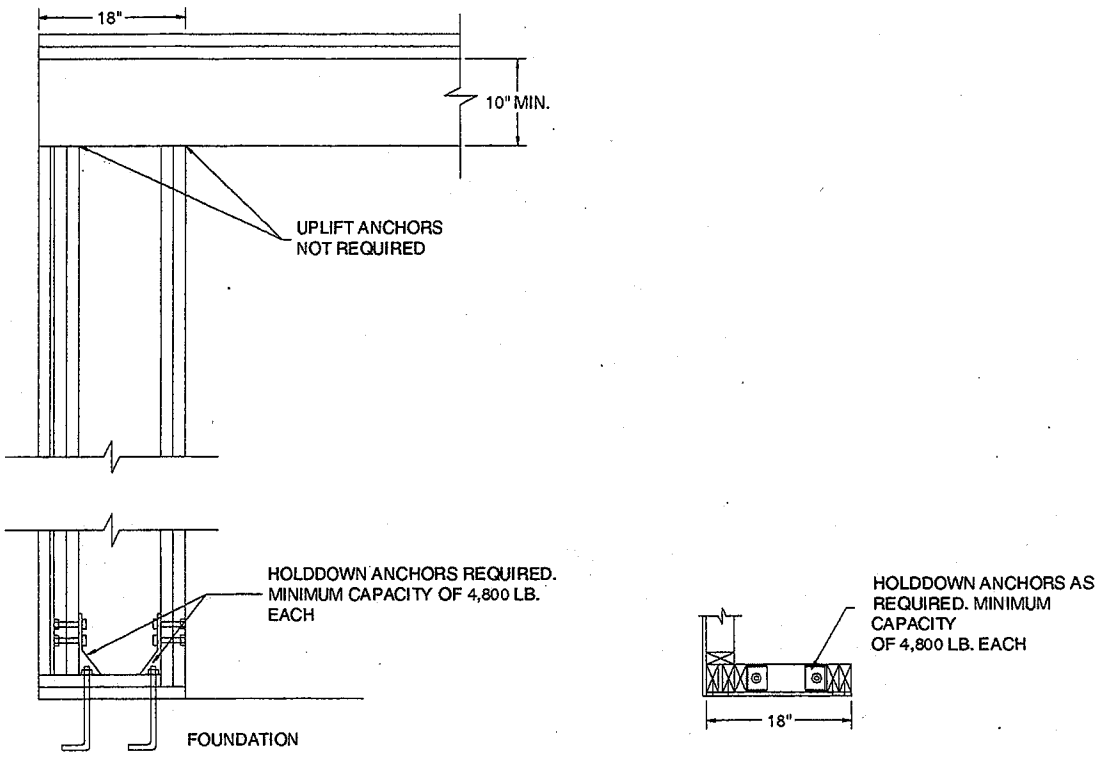


Figure 303.3.2.2C
Garage Door Corner Detail with an 18 Inch Minimum Return

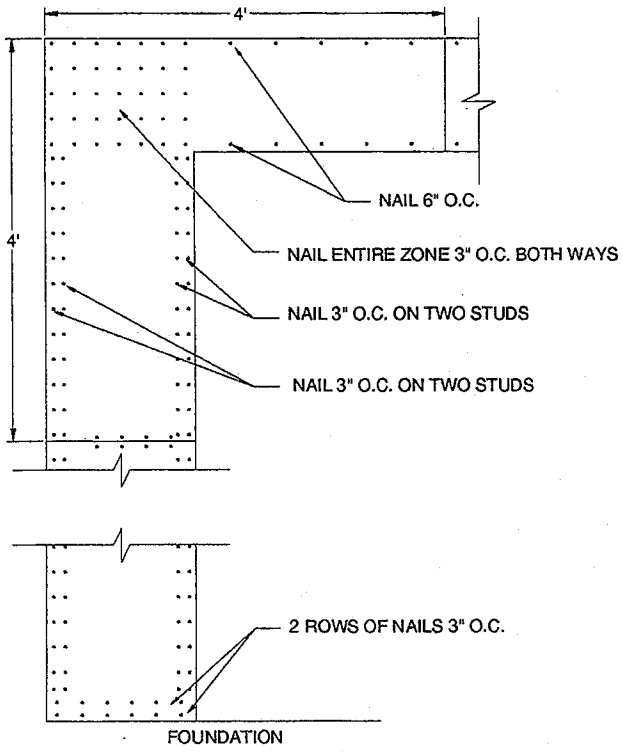


Figure 303.3.2.2D
Sheathing Detail for an 18 Inch Minimum Return at Corner

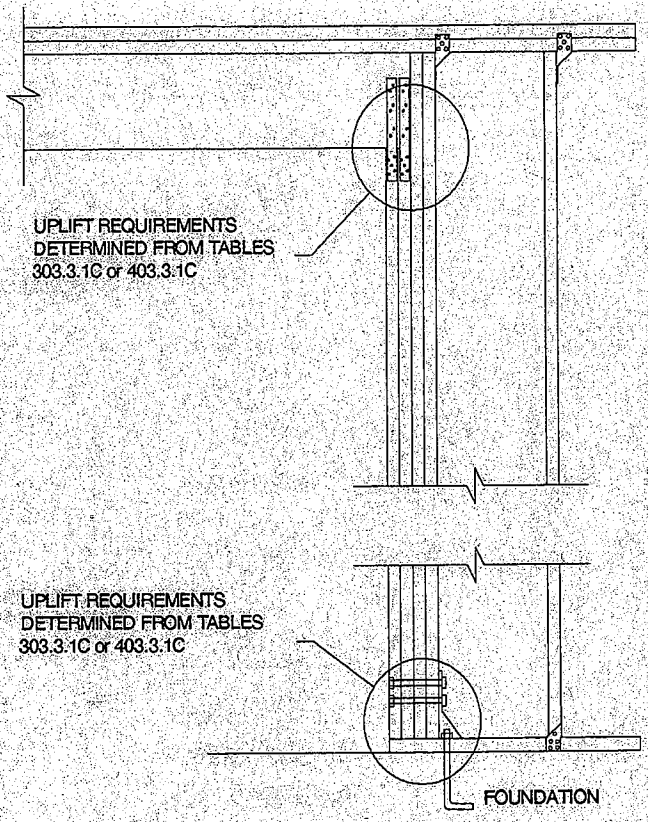


Figure 303.3.2.3A
Garage Door Header Detail for a Non-Corner Location

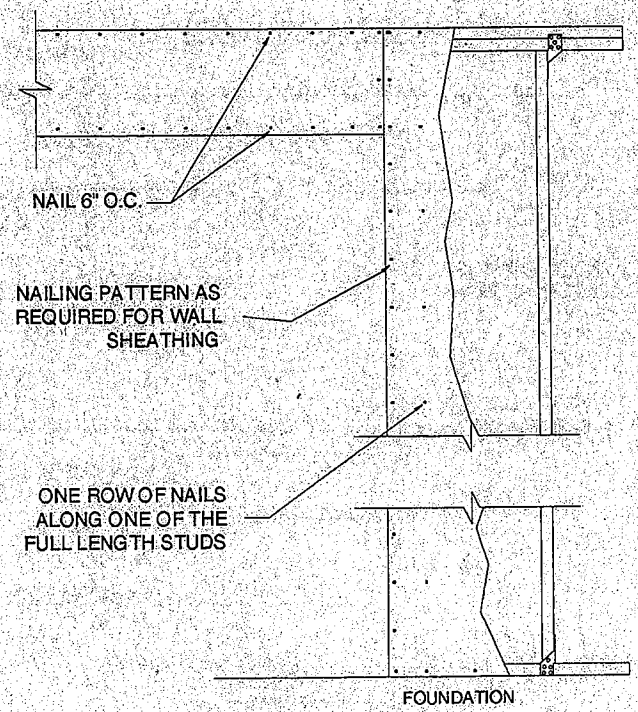


Figure 303.3.2.3B
Sheathing Detail for a Non-Corner Location

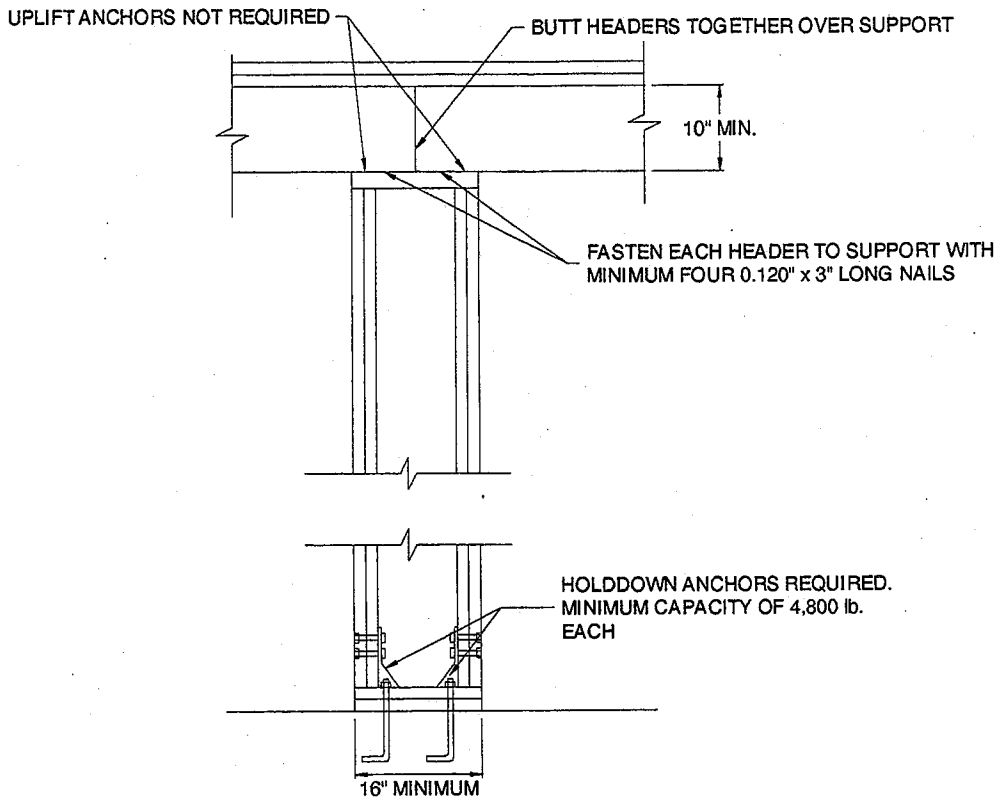


Figure 303.3.2.4A
Support for Multiple Garage Door Openings

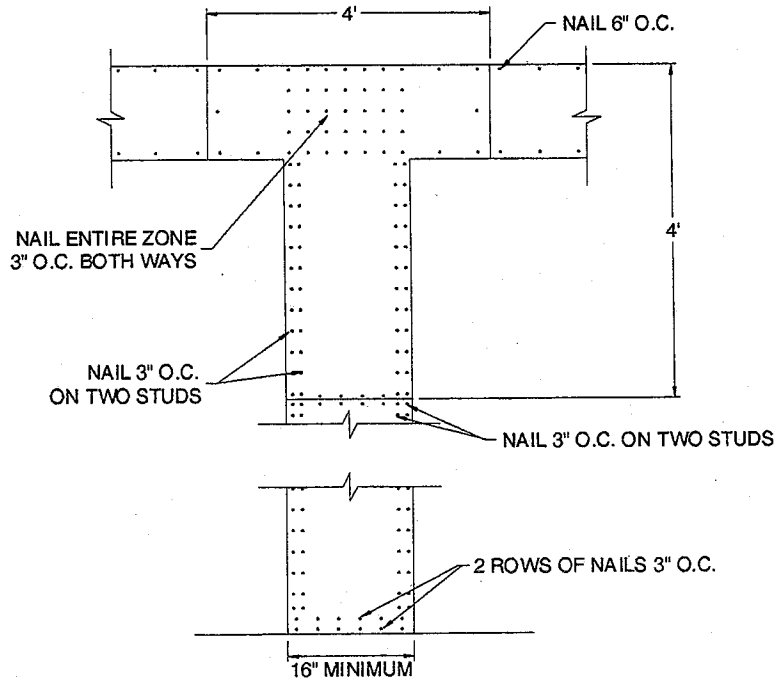
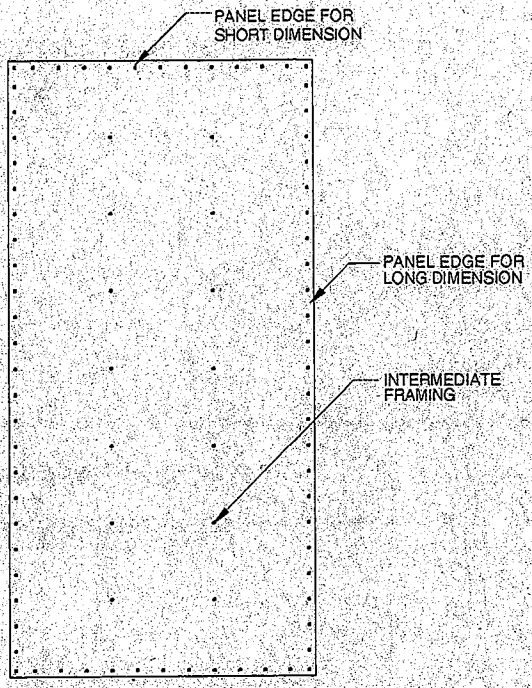


Figure 303.3.2.4B
Sheathing Detail for Multiple Garage Door Openings



Panel Edges Nail Spacing	Int. Framing Nail Spacing	Minimum Number of Nails Along: Panel Edges Long Dimension	Panel Edges Short Dimension	Intermediate Framing
3"	12"	33	17	7
4"	12"	25	13	7
6"	12"	16	9	7

Figure 303.4.2A
Nailing Patterns for Wall Sheathing

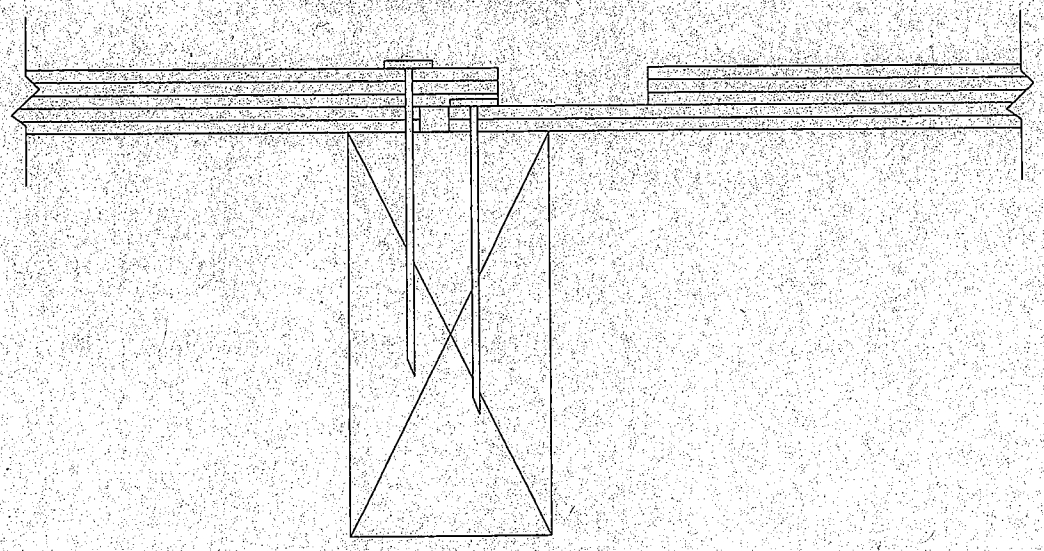
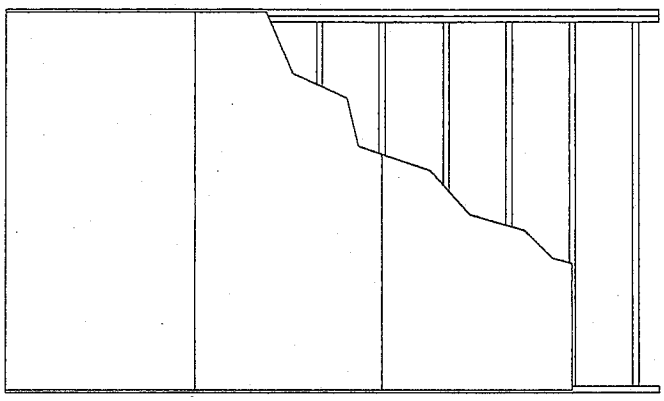
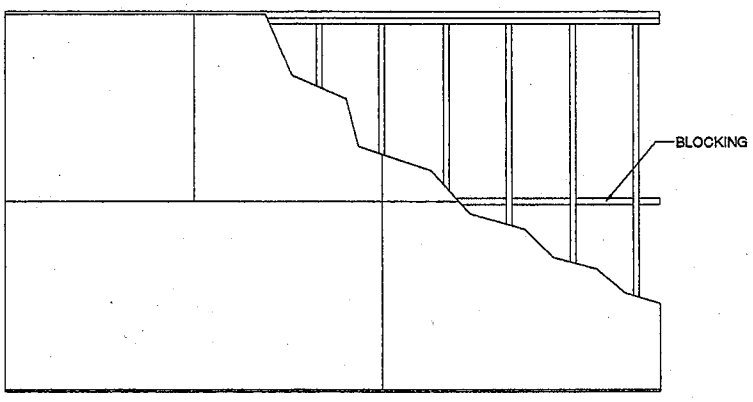


Figure 303.4.2B
Fastener Locations for Panels With Shiplap Edges



NO BLOCKING REQUIRED



BLOCKING REQUIRED

Figure 303.4.2C
Wall Blocking Requirements

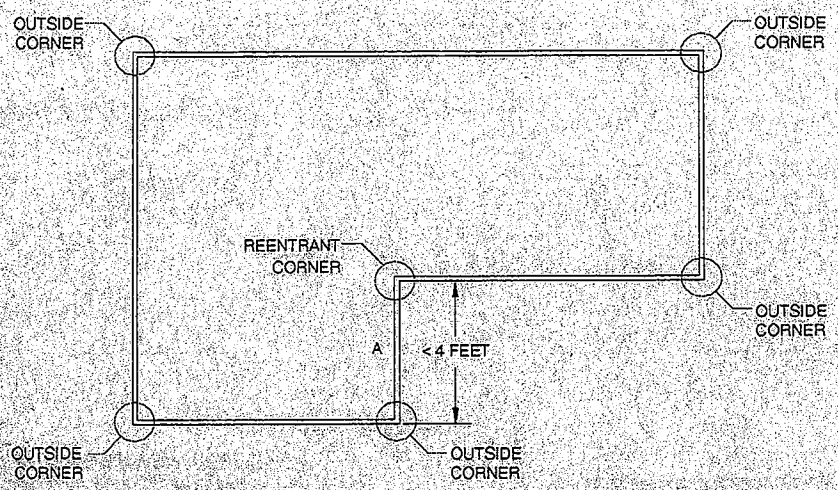


Figure 303.4.2D
Outside and Reentrant Corners

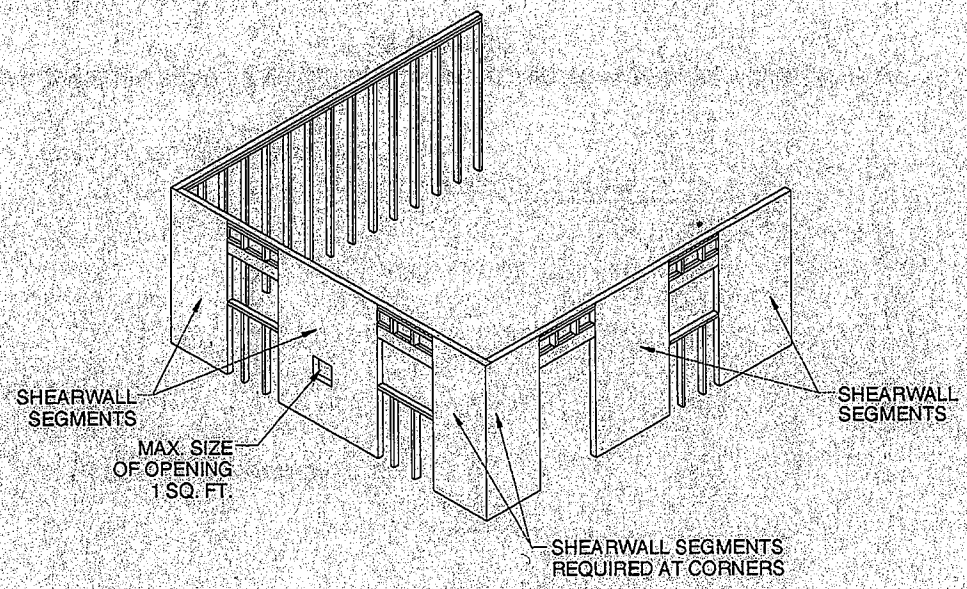


Figure 303.4.2E
Shearwall Segment Requirements

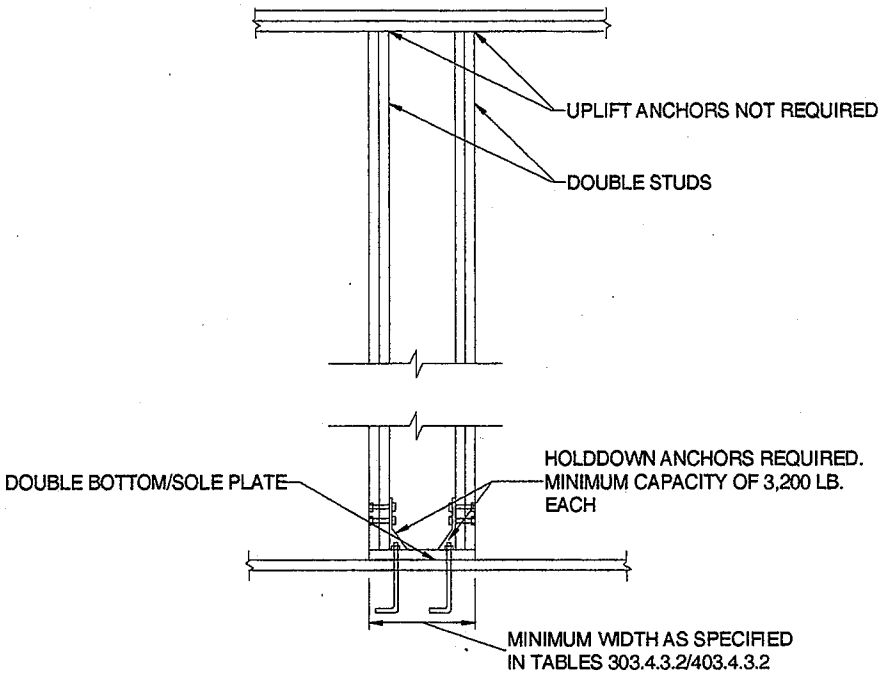


Figure 303.4.3.2A
Framing Detail for Narrow-Width Shearwall Segment Without an Integral Header

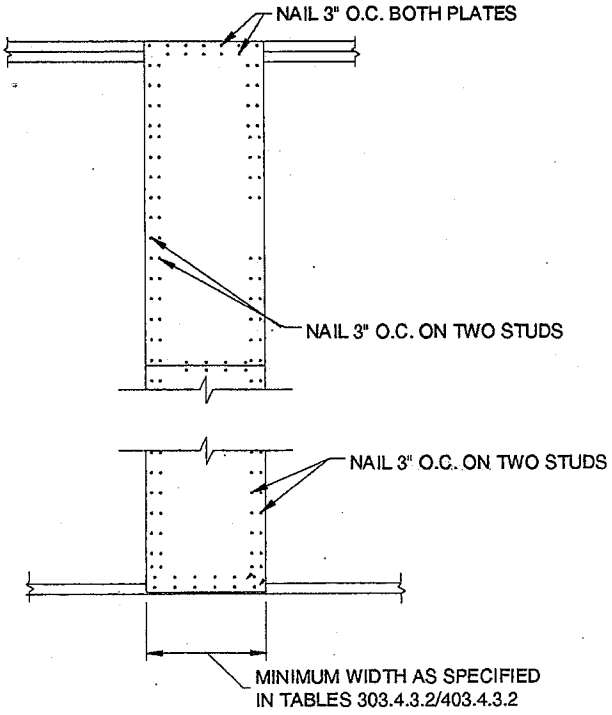


Figure 303.4.3.2B
Sheathing Detail for Narrow-Width Shearwall Segment Without an Integral Header

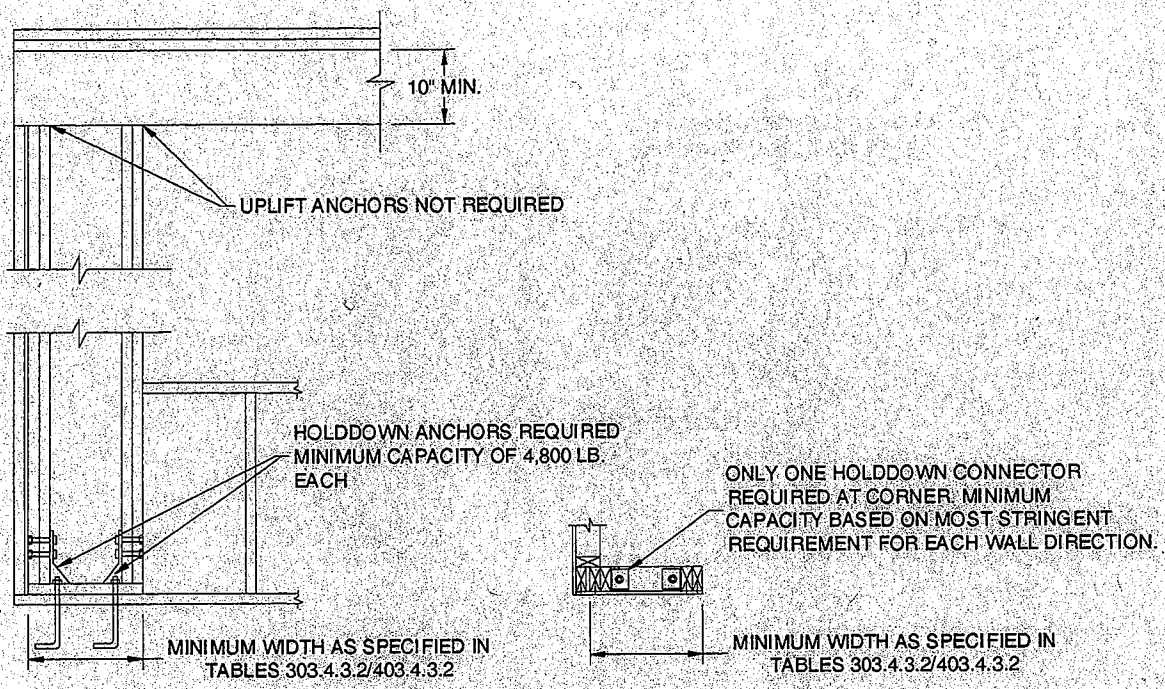


Figure 303.4.3.3A
Framing Detail for Narrow-Width Shearwall Segment
With an Integral Header

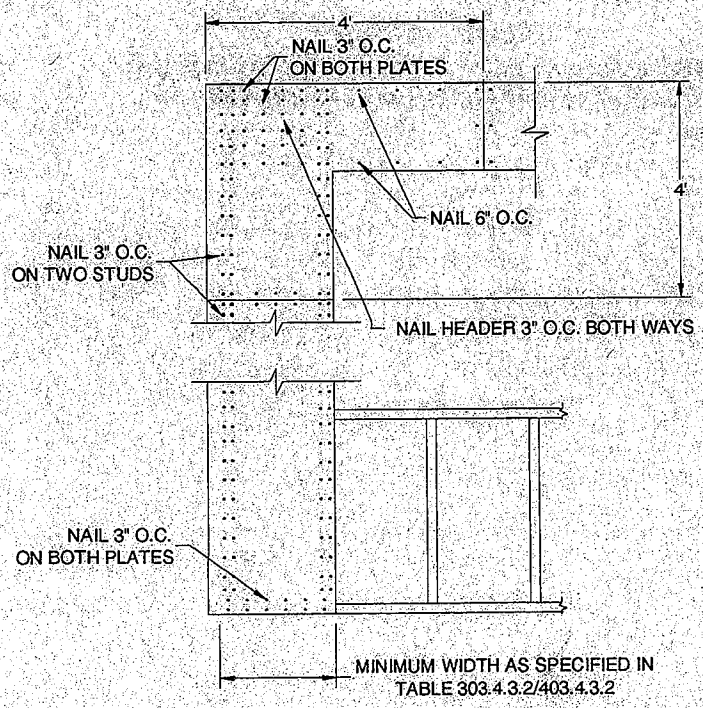


Figure 303.4.3.3B
Sheathing Detail for Narrow-Width Shearwall Segment
With an Integral Header

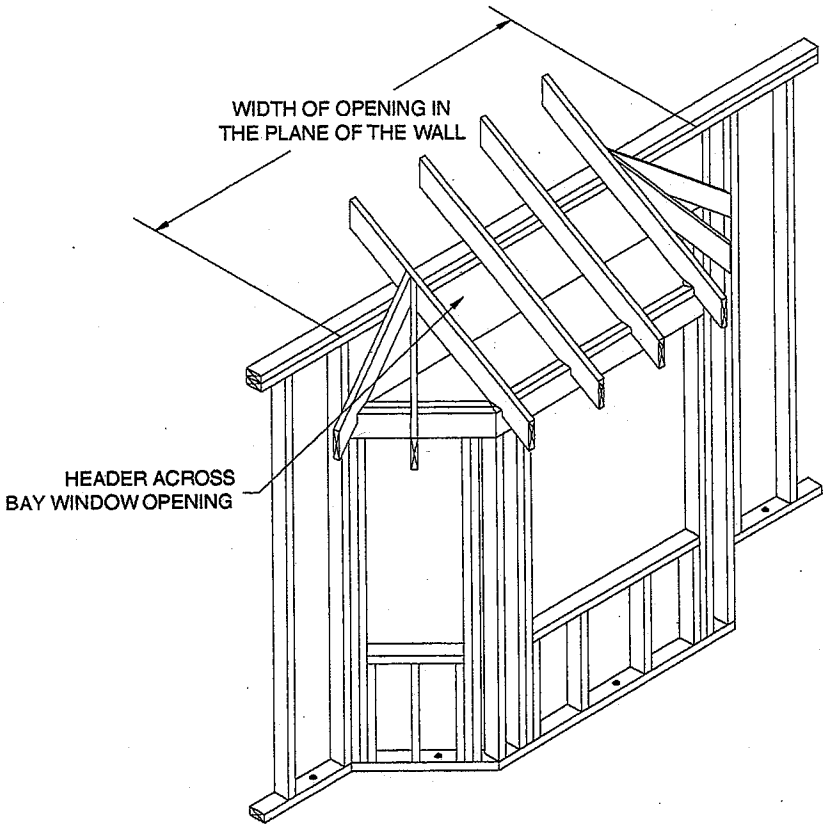


Figure 303.4.4.1A
Bay Window With a Top Plate and Header Extending
Across the Opening in the Plane of the Wall

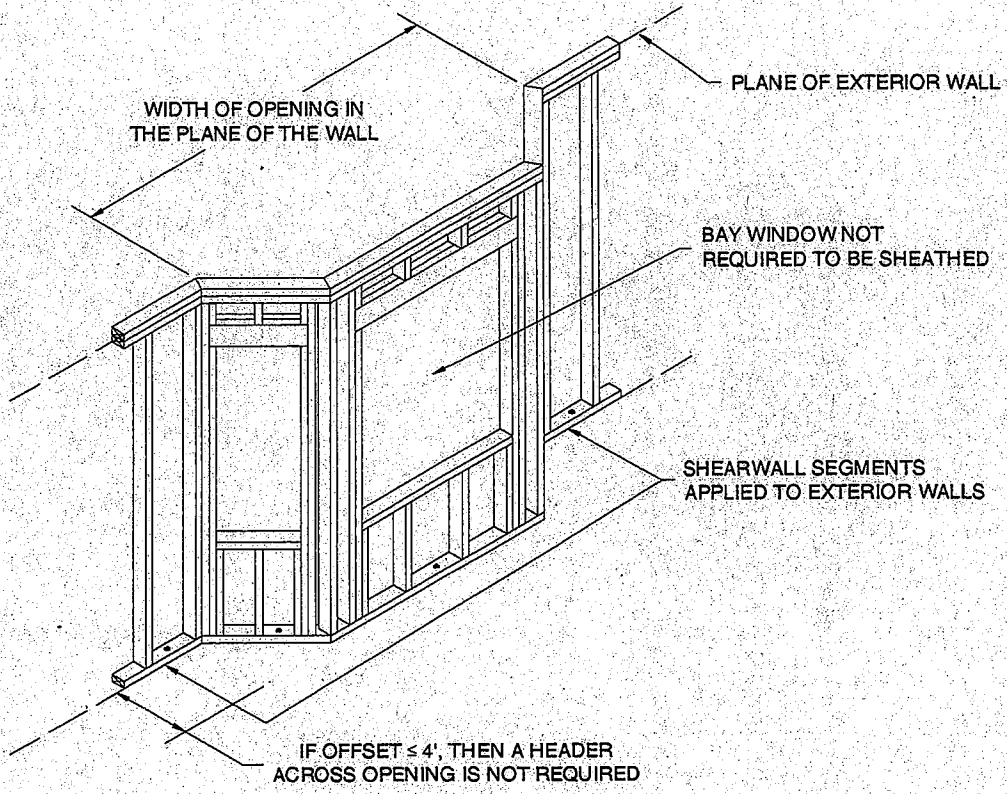
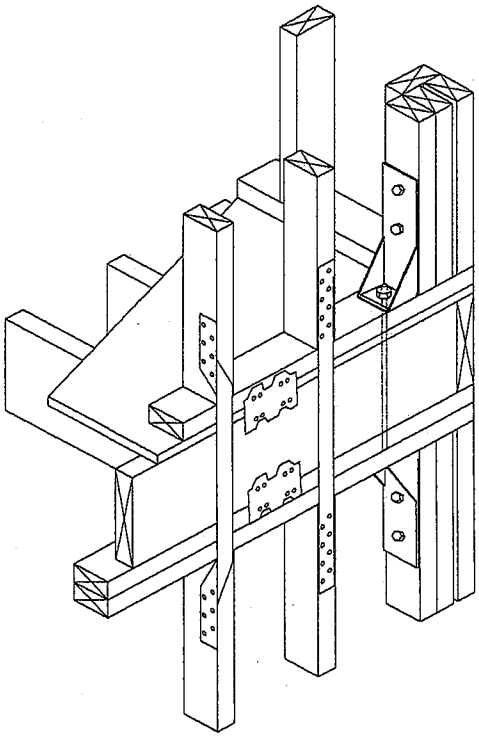
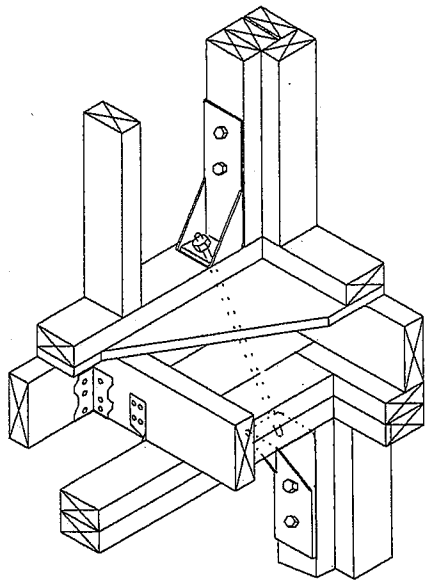


Figure 303.4.4.1B
Exterior Walls Constructed in the Shape of a Bay Window





Note: Second Story Offset From First

Figure 303.4.5
First Story to Second Story or Second Story to Third Story Holddown and Shear Transfer Connections

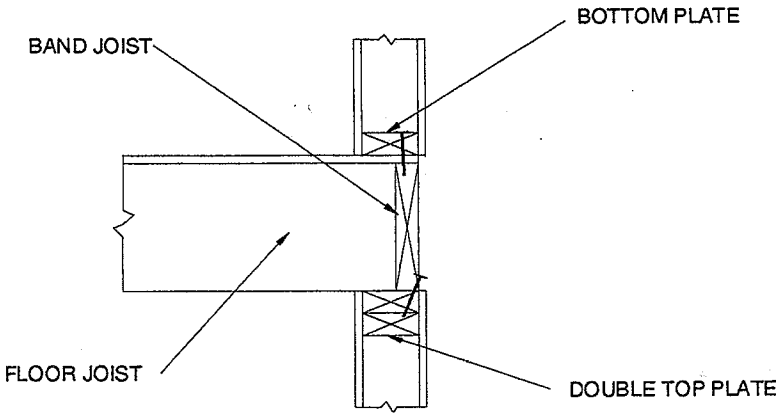


Figure 303.4.6.2
Fasteners Used for Shear Transfer

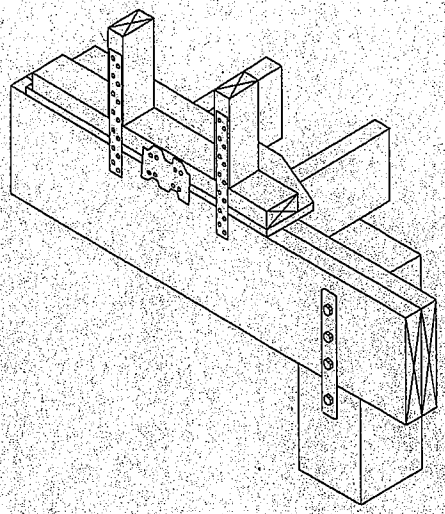


Figure 303.4.6.3
Transfer of Shear Using Shear Transfer Framing Connectors
for House on Piles or Piers

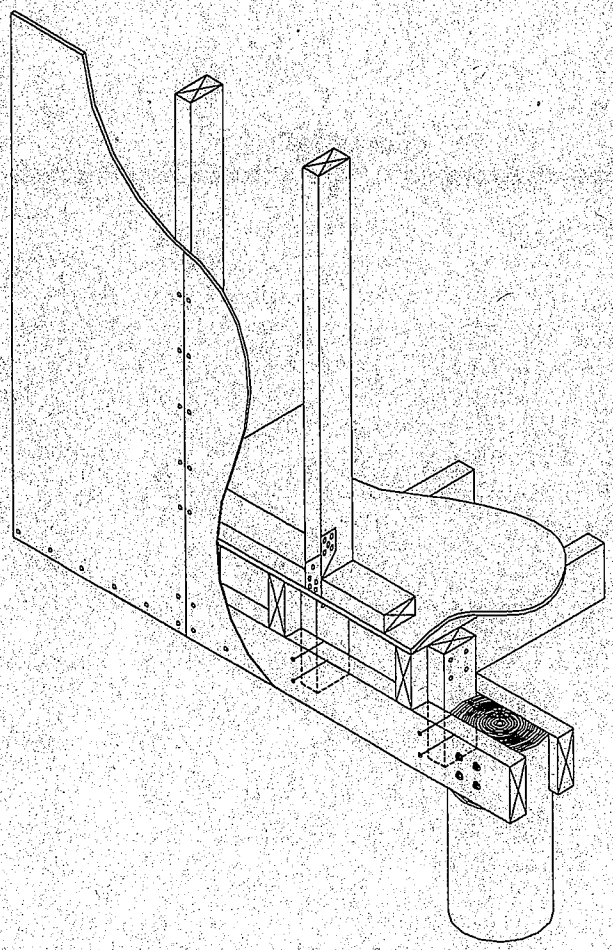


Figure 303.4.6.4A
Wall Sheathing Application for House on Piles or Piers

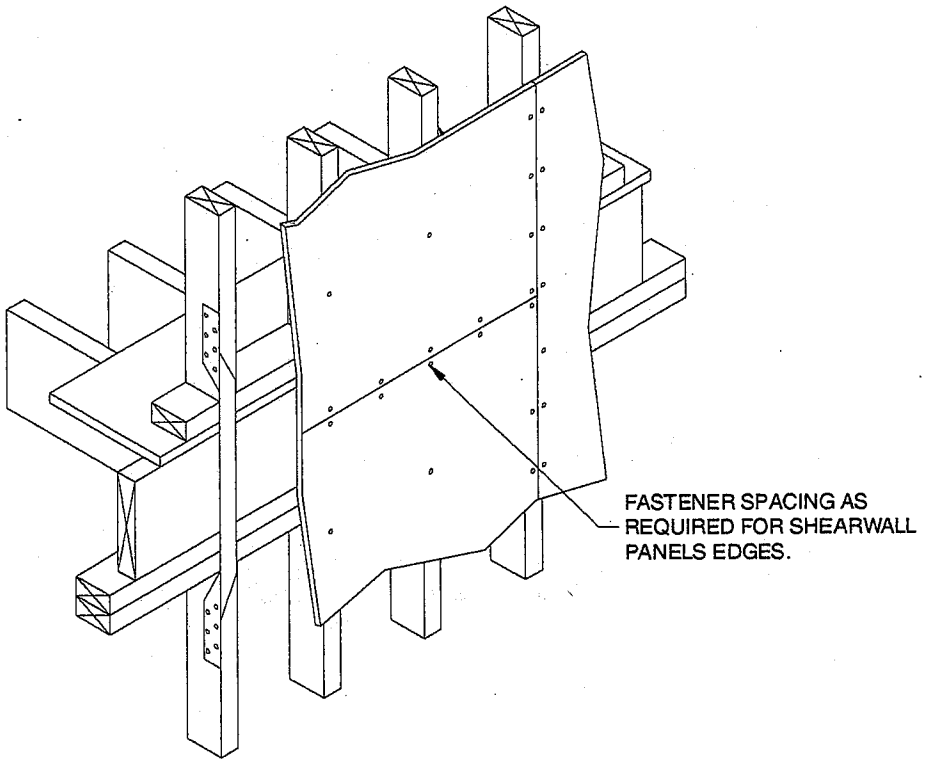


Figure 303.4.6.4B
Wall Sheathing Application for Two and Three Story Buildings

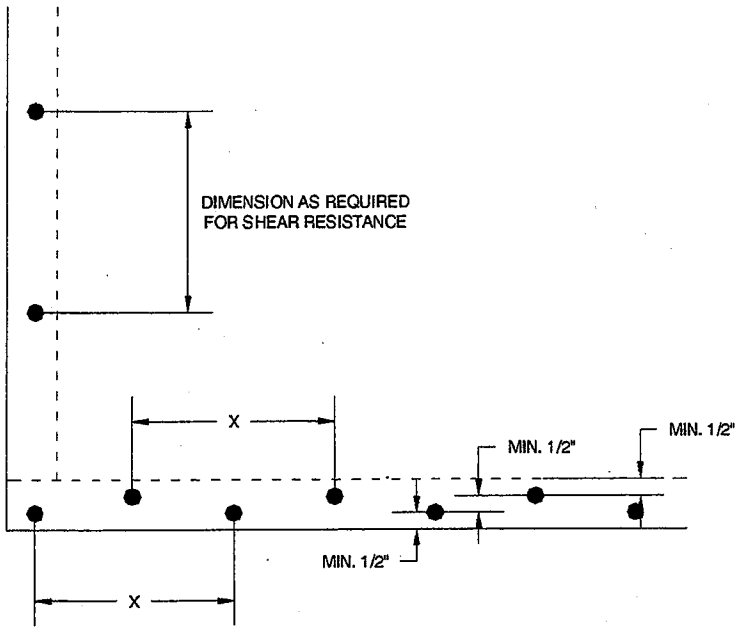


Figure 303.4.7A
Sheathing Attachment for Combined Shear and Uplift Resistance

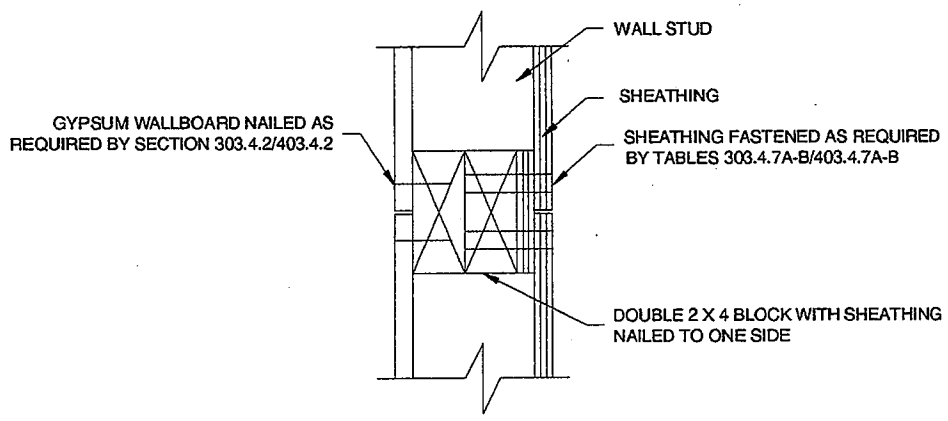


Figure 303.4.7B
Blocking Detail For Wood Structural Panels Used to Resist Both Shear and Uplift Loads – Horizontal Panel Edge of the Gypsum Wallboard Occur at the Same Location as the Horizontal Panel Edge of the Wood Structural Panel

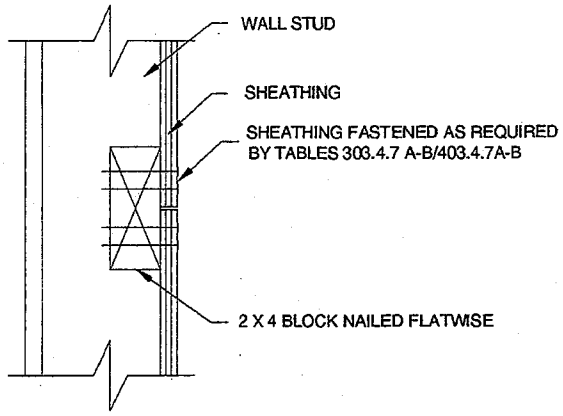
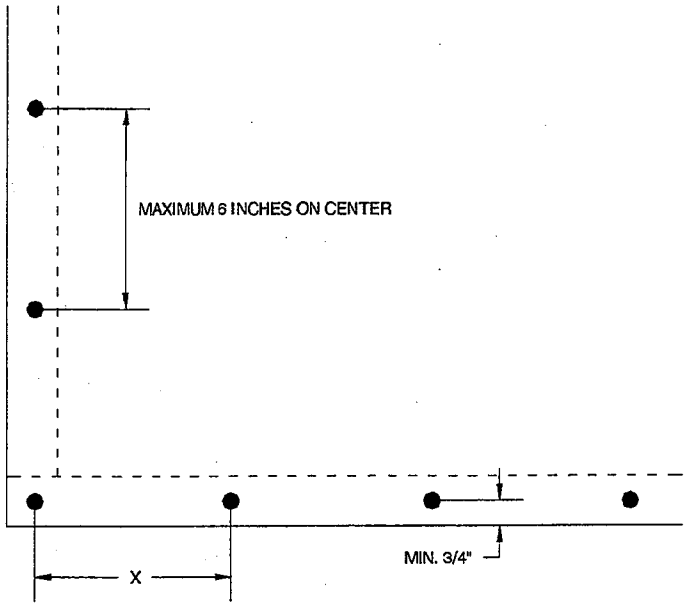
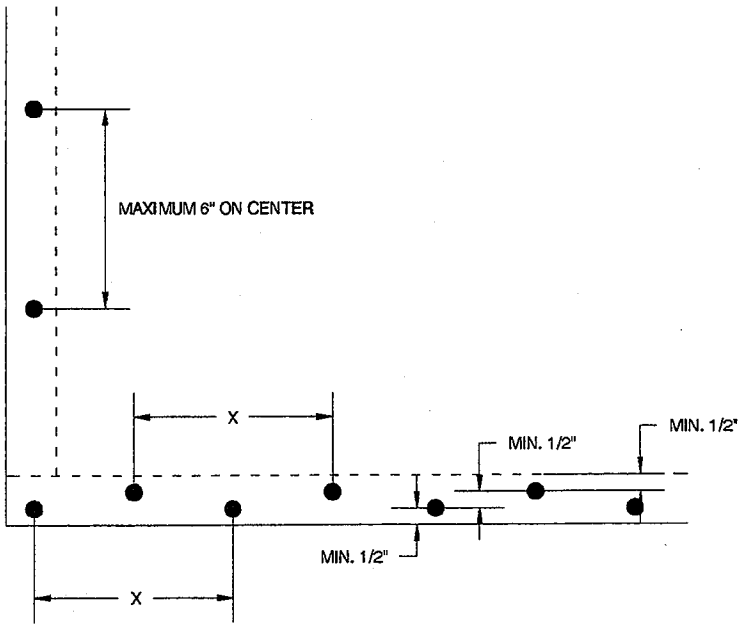


Figure 303.4.7C
Blocking Detail For Wood Structural Panels Used to Resist Both Shear and Uplift Loads – Horizontal Panel Edge of the Gypsum Wallboard Occurs at a Different Location from the Horizontal Panel Edge of the Wood Structural Panel



X= SPACING AS REQUIRED BY TABLES 303.4.8A-B/403.4.8A-B
FOR A SINGLE ROW OF FASTENERS

Figure 303.4.8A
Sheathing Attachment for Uplift Resistance
(Single Row of Fasteners)



X = SPACING AS REQUIRED BY TABLES 303.4.8A-B/403.4.8A-B
FOR A DOUBLE ROW OF FASTENERS

Figure 303.4.8B
Sheathing Attachment for Uplift Resistance
(Double Row of Fasteners)

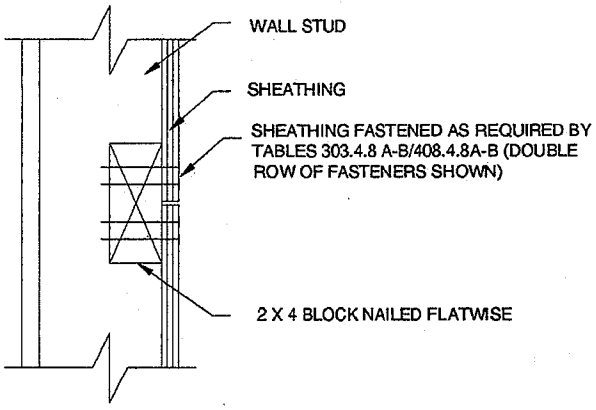


Figure 303.4.8C
Blocking Detail for Wood Structural Panels Used Only to Resist Uplift Loads

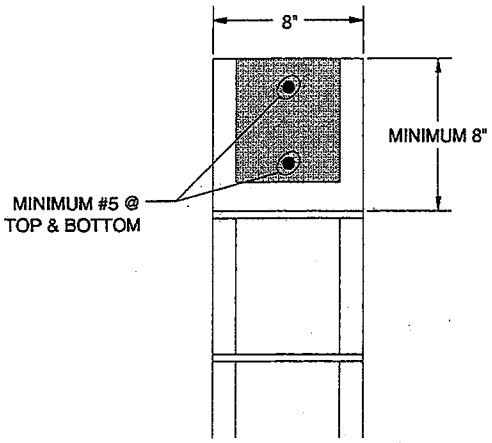


Figure 304.2A
Bond Beam Detail

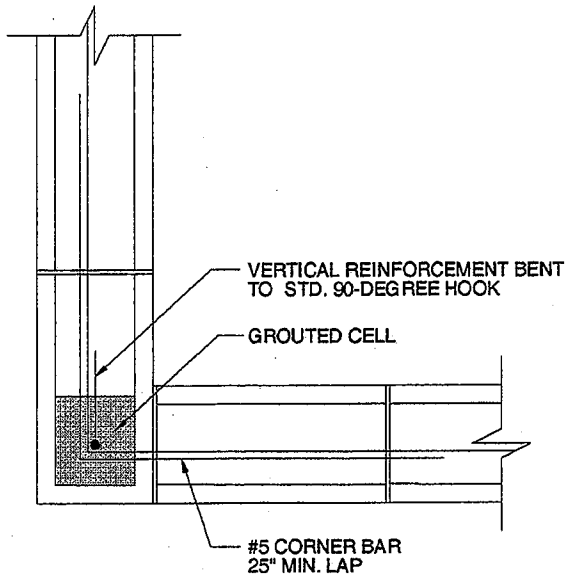


Figure 304.2B
Continuous Reinforcement Around Corners for
Bond Beams

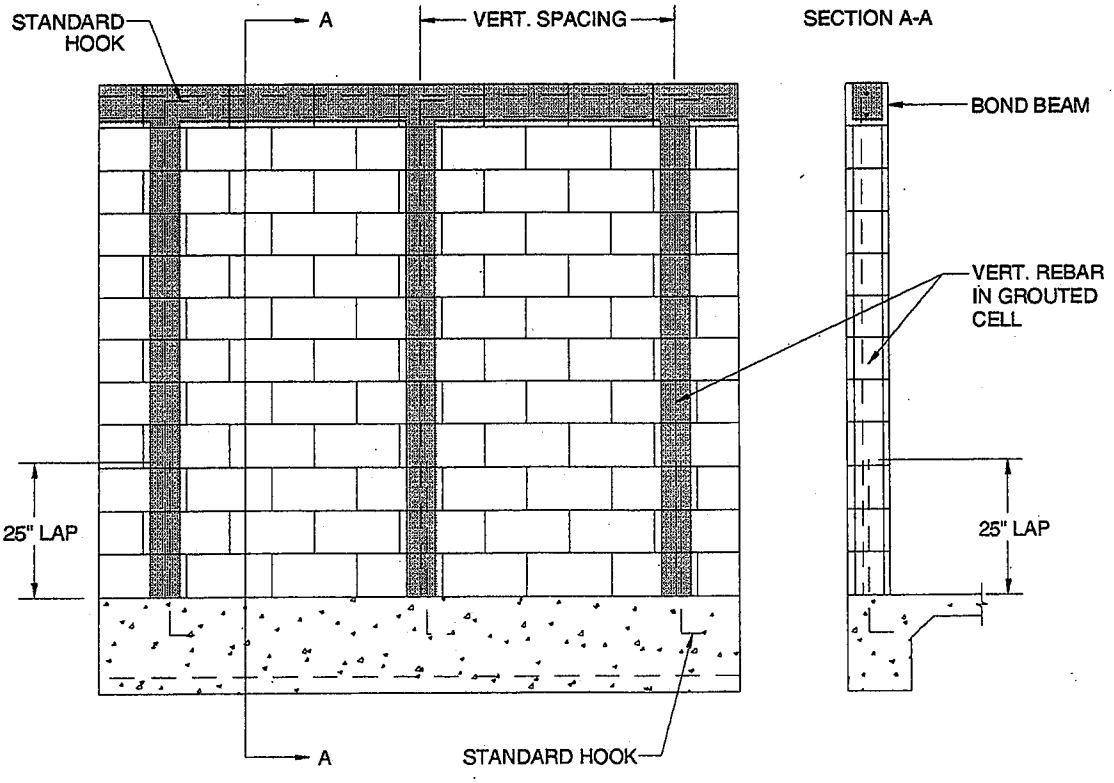


Figure 304.3A
One Story Masonry Wall Detail

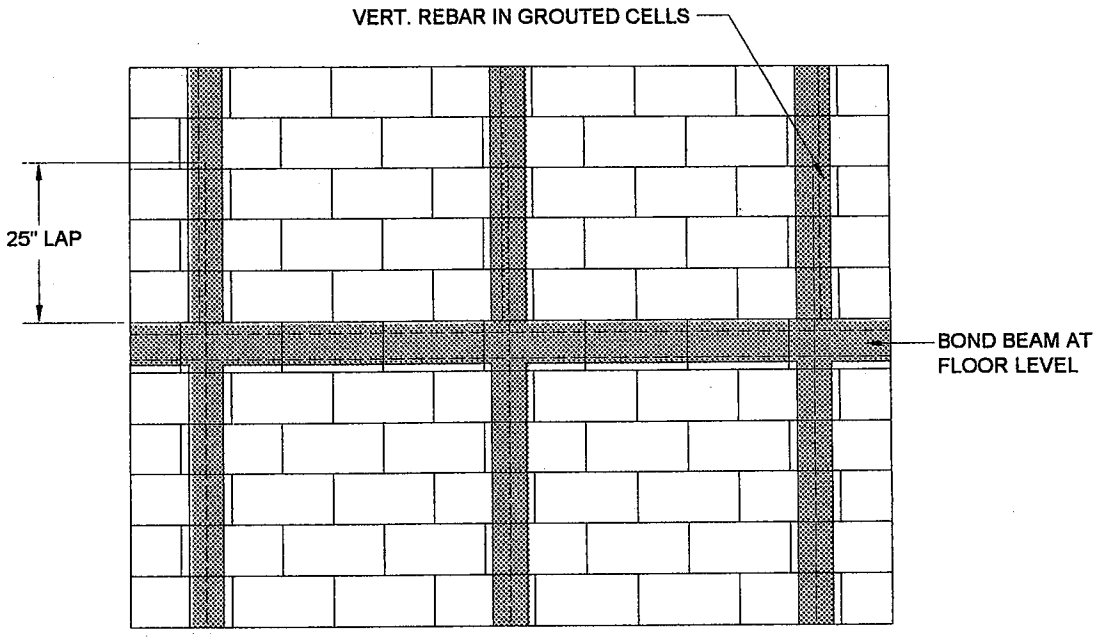


Figure 304.3B
Continuous Reinforcement Between First and Second Floors

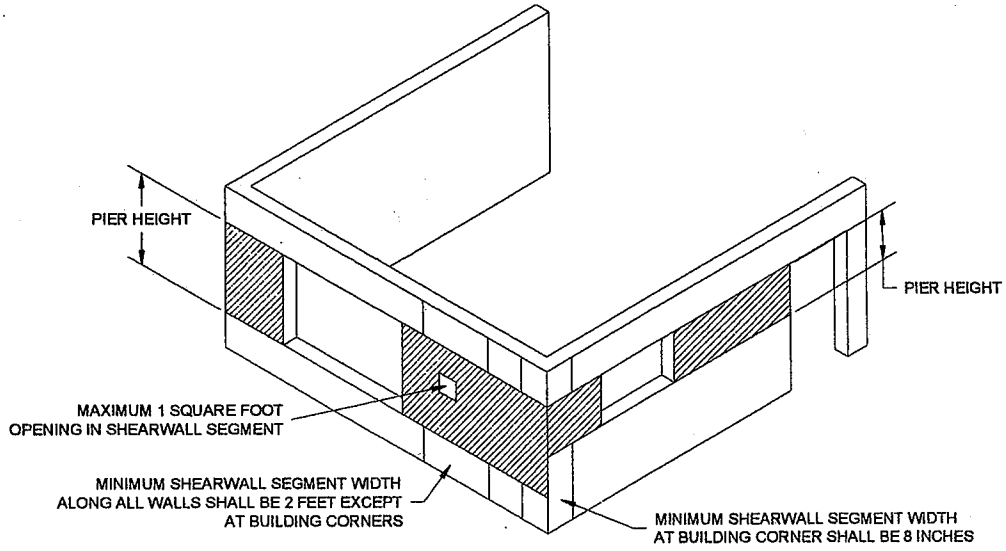


Figure 304.4
Pier Height and Minimum Shearwall Segments
for Masonry Walls

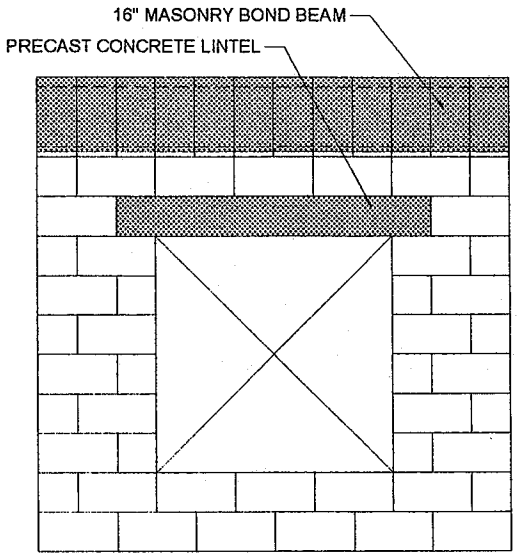


Figure 304.5A
Precast Concrete Lintel

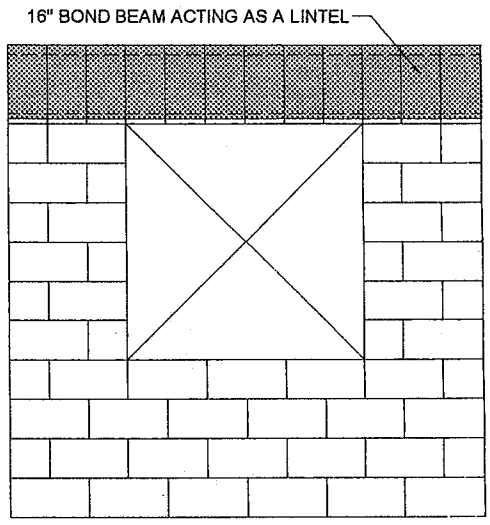


Figure 304.5B
Bond Beam Acting as a Lintel

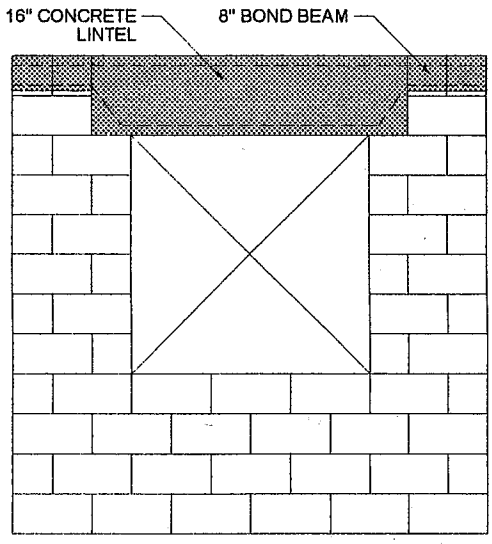


Figure 304.5C
Cast-in-Place Concrete Lintel

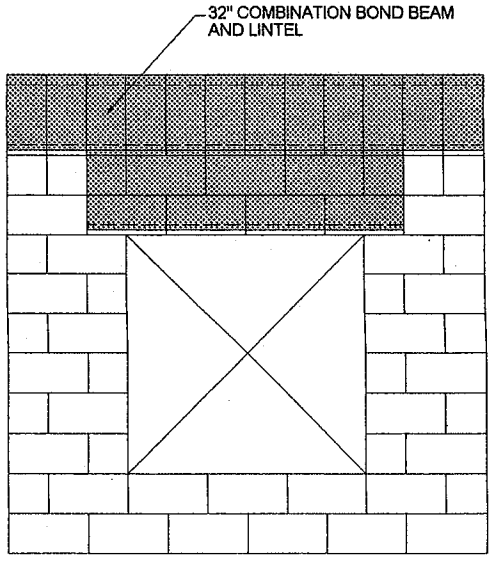


Figure 304.5D
Combination Bond Beam and Lintel

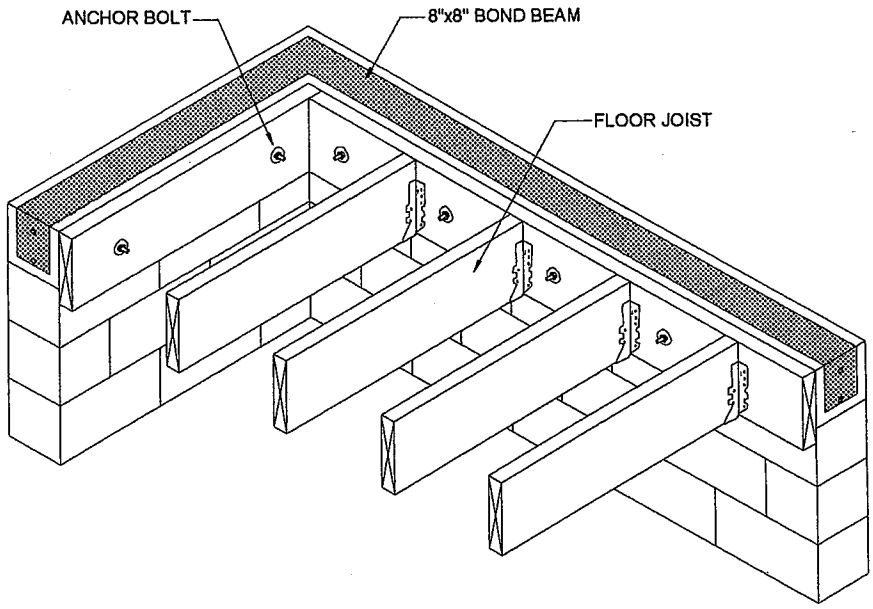


Figure 304.6.1
Bolted Ledger Connection

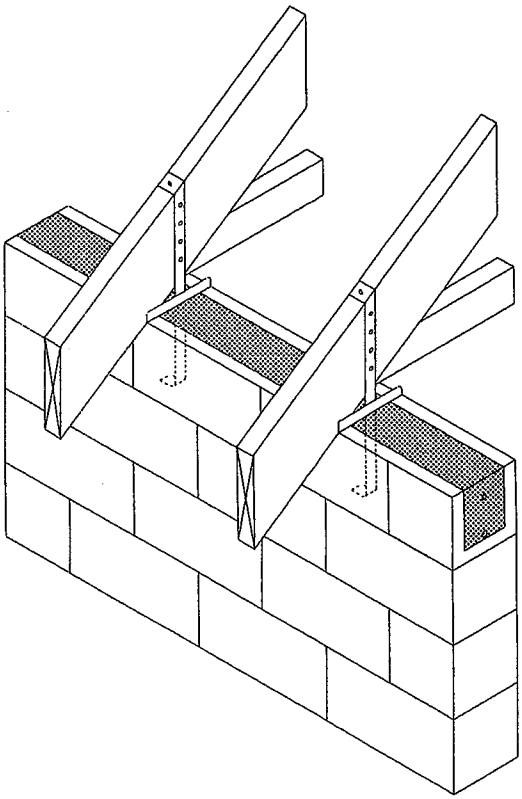


Figure 304.6.2A
Roof Framing Connected Directly to Bond Beam

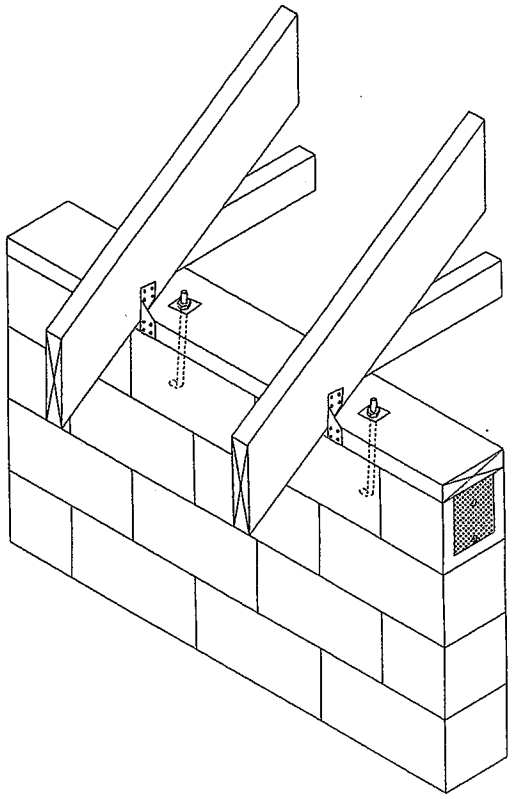


Figure 304.6.2B
Roof Framing Connected to Bolted Top Plate

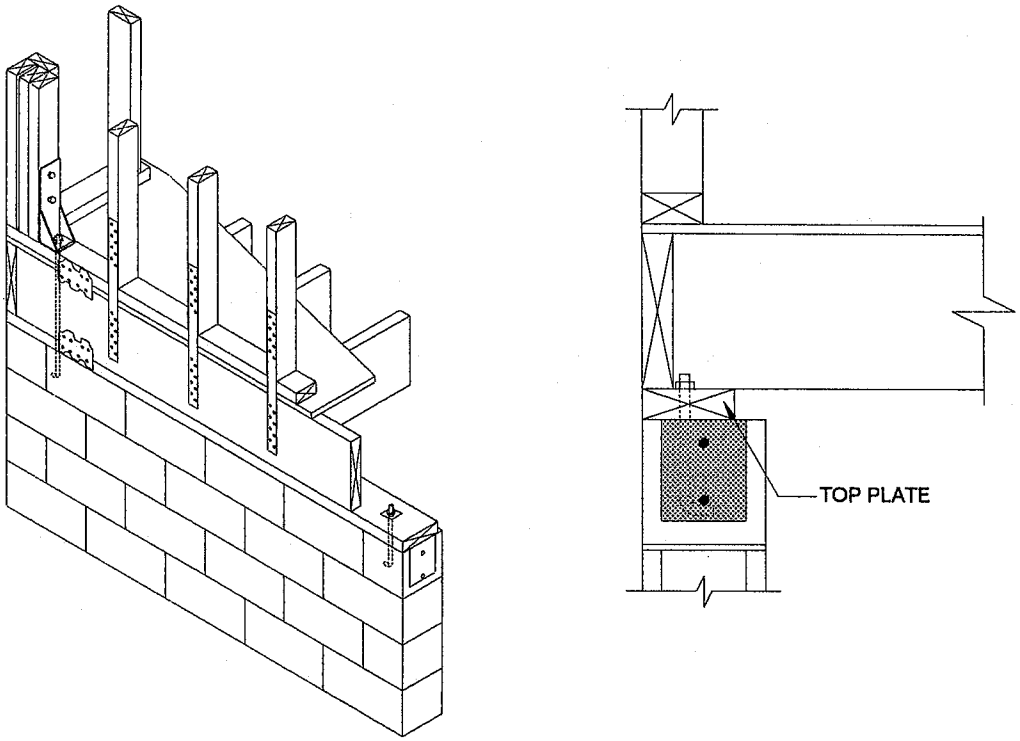


Figure 304.6.3
Masonry Wall to Wood Framed Wall Connection

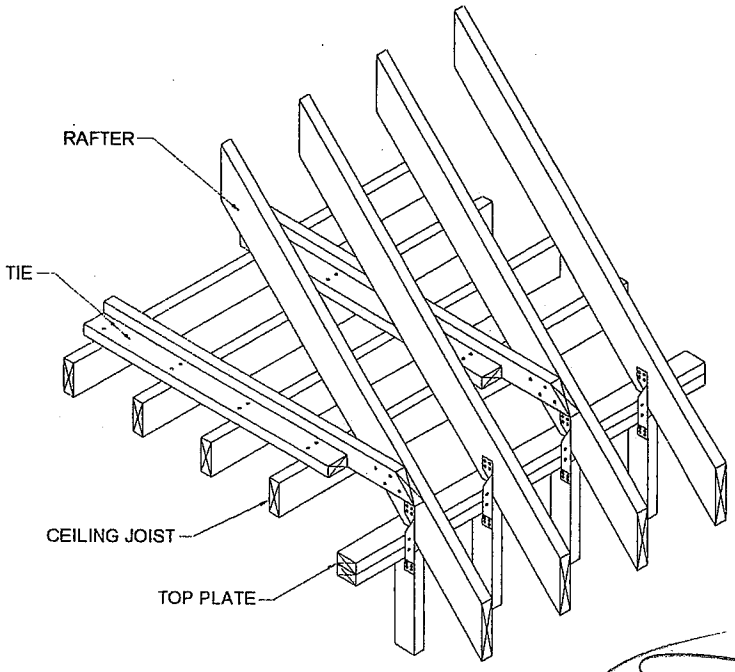


Figure 305.1 C
Tying Rafters to Perpendicular Ceiling Joist

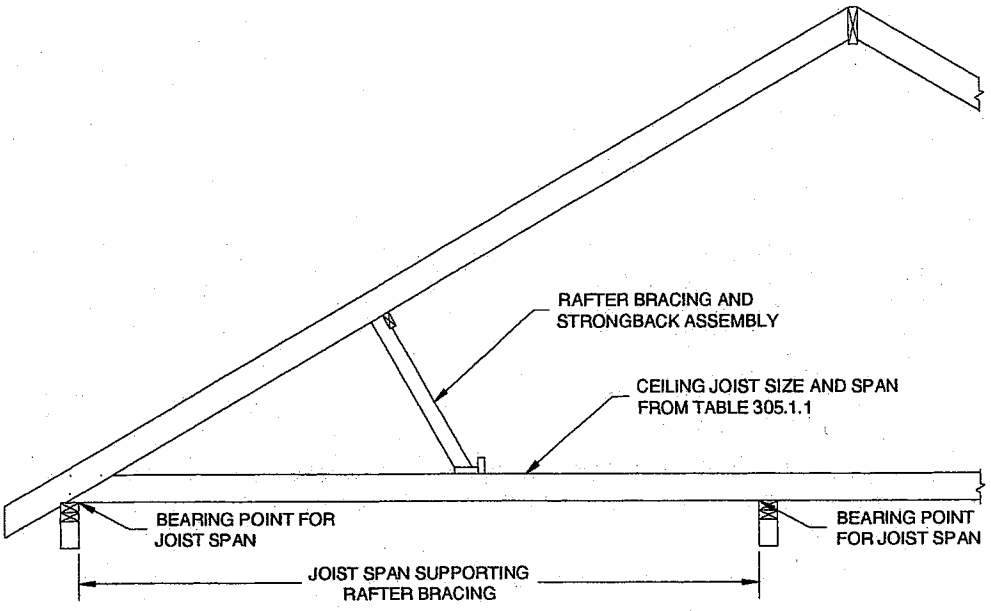


Figure 305.1.1
Ceiling Joists Supporting Rafter Braces

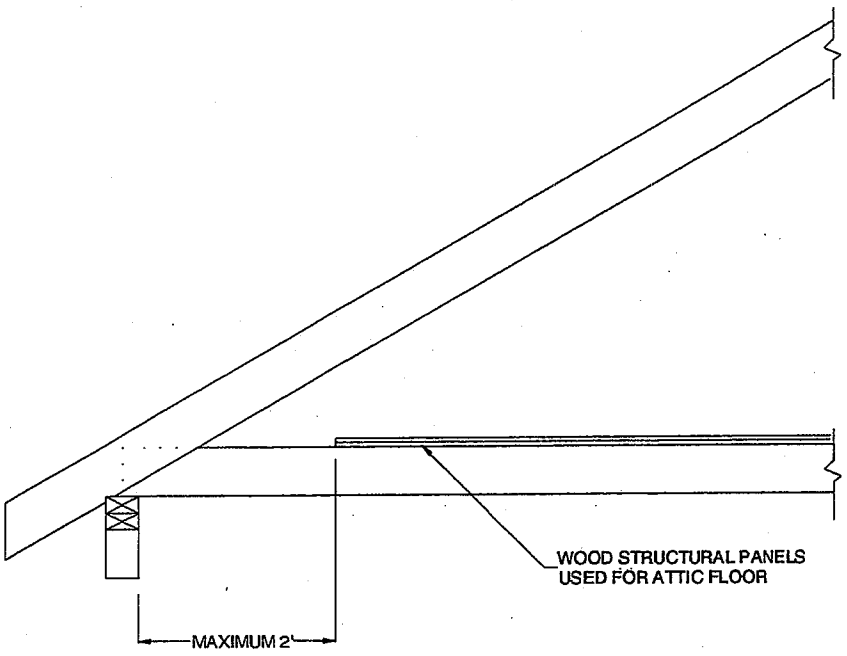


Figure 305.2.1.2
Maximum Allowable Distance of Attic Floor
Diaphragm from Sidewall

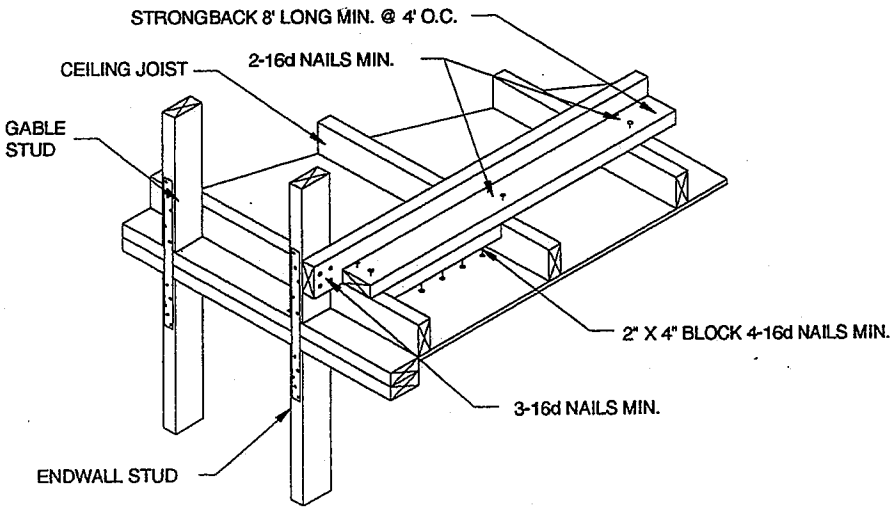


Figure 305.2.2A
Gable Endwall Detail for Wood Stud Walls Using Rafter Framing

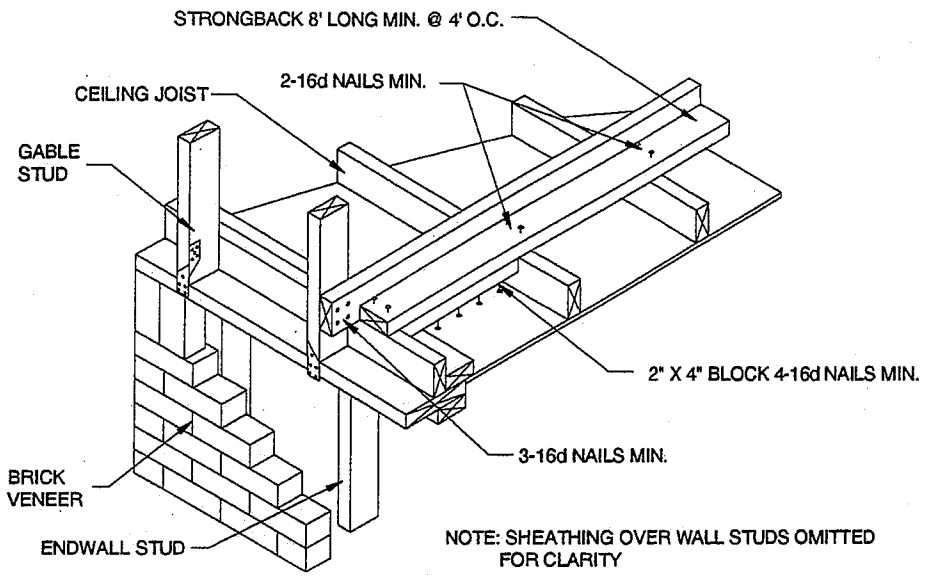


Figure 305.2.2B
Offset Gable Endwall Detail for Wood Stud Walls Using Rafter Framing

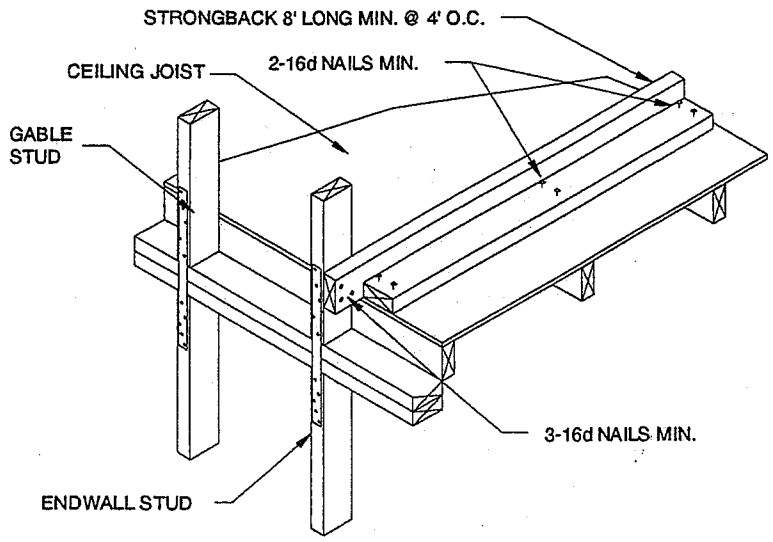


Figure 305.2.2C
Gable Endwall Detail with Attic Sheathing
Using Rafter Framing

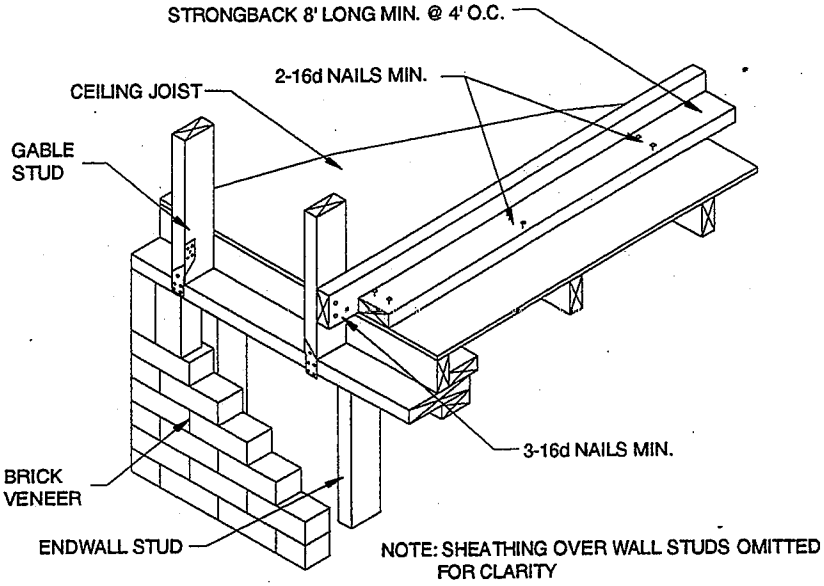


Figure 305.2.2D
Offset Gable Endwall Detail with Attic Sheathing
Using Rafter Framing

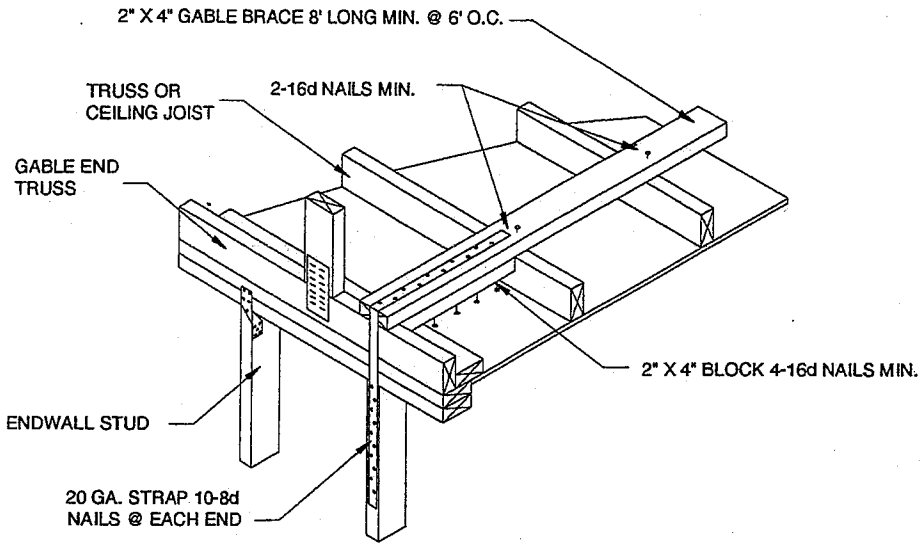


Figure 305.2.3A
Gable Endwall Detail for Wood Stud Walls Using Truss Framing

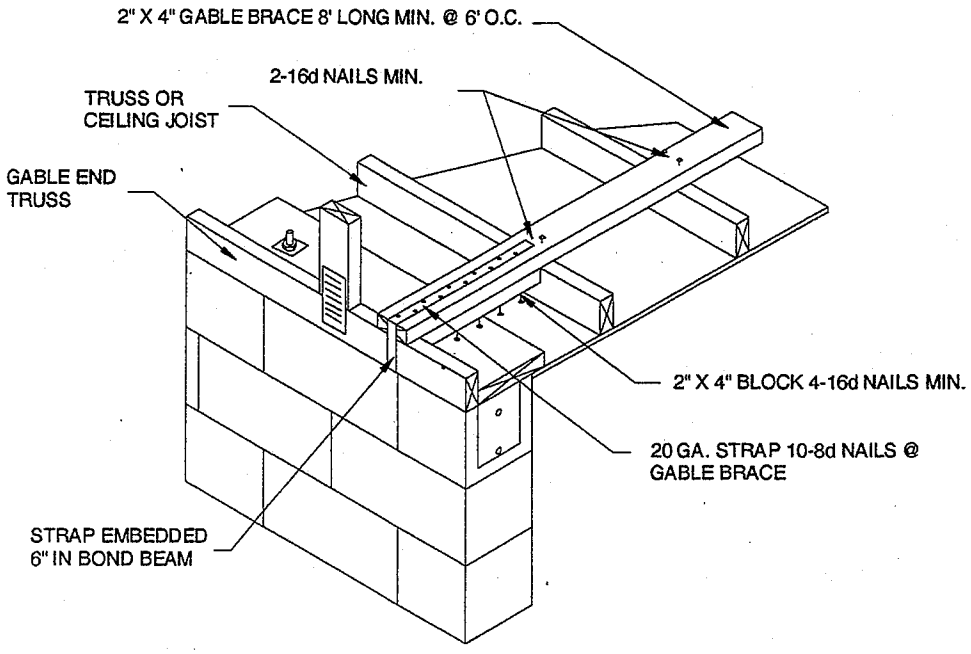


Figure 305.2.3B
Gable Endwall Detail for Masonry Walls Using Truss Framing

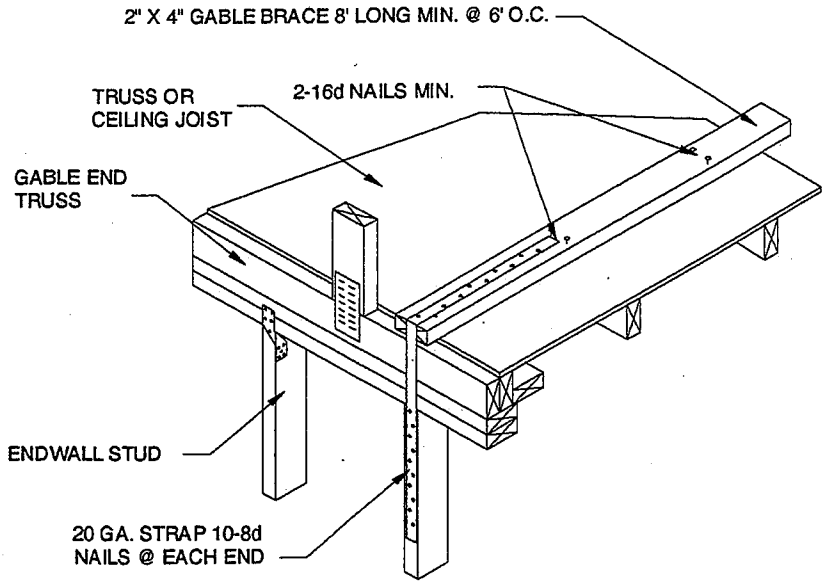


Figure 305.2.3C
Gable Endwall Detail with Attic Sheathing
Using Truss Framing

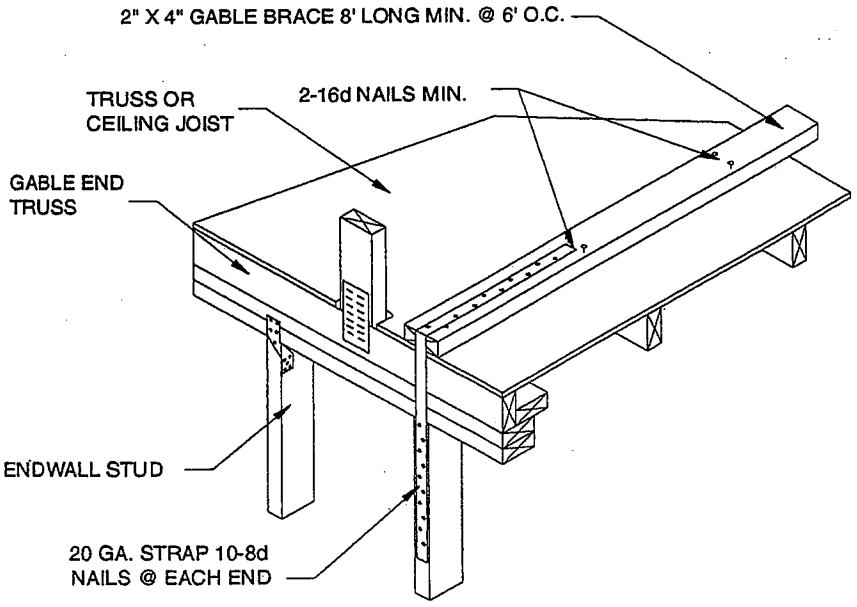


Figure 305.2.3D
Gable Endwall with Attic Sheating
Sheathing Notched Around Truss Stud

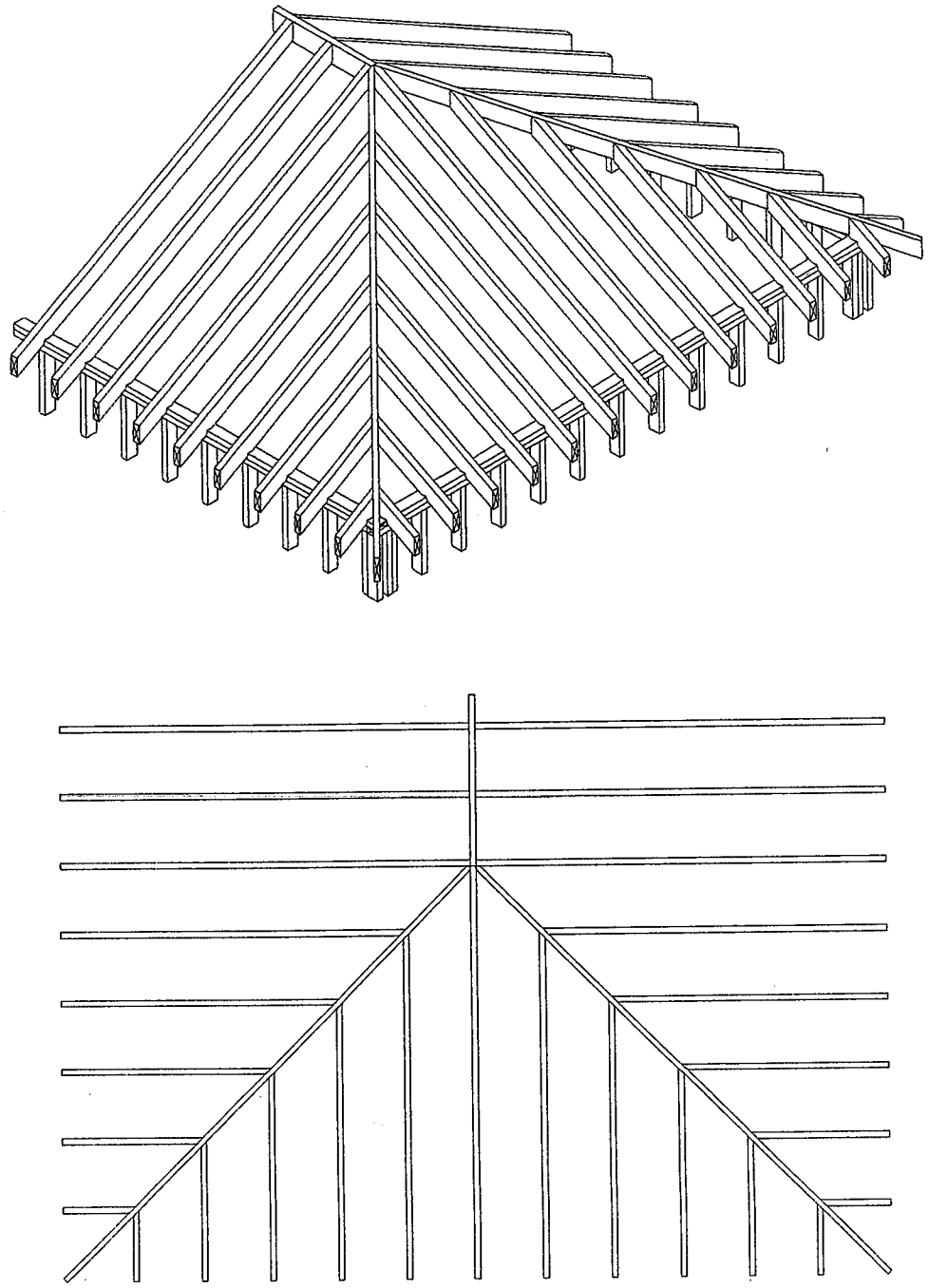


Figure 306.1.1A
Hip Rafters and Roof Framing
Three Dimensional View and Plan Detail

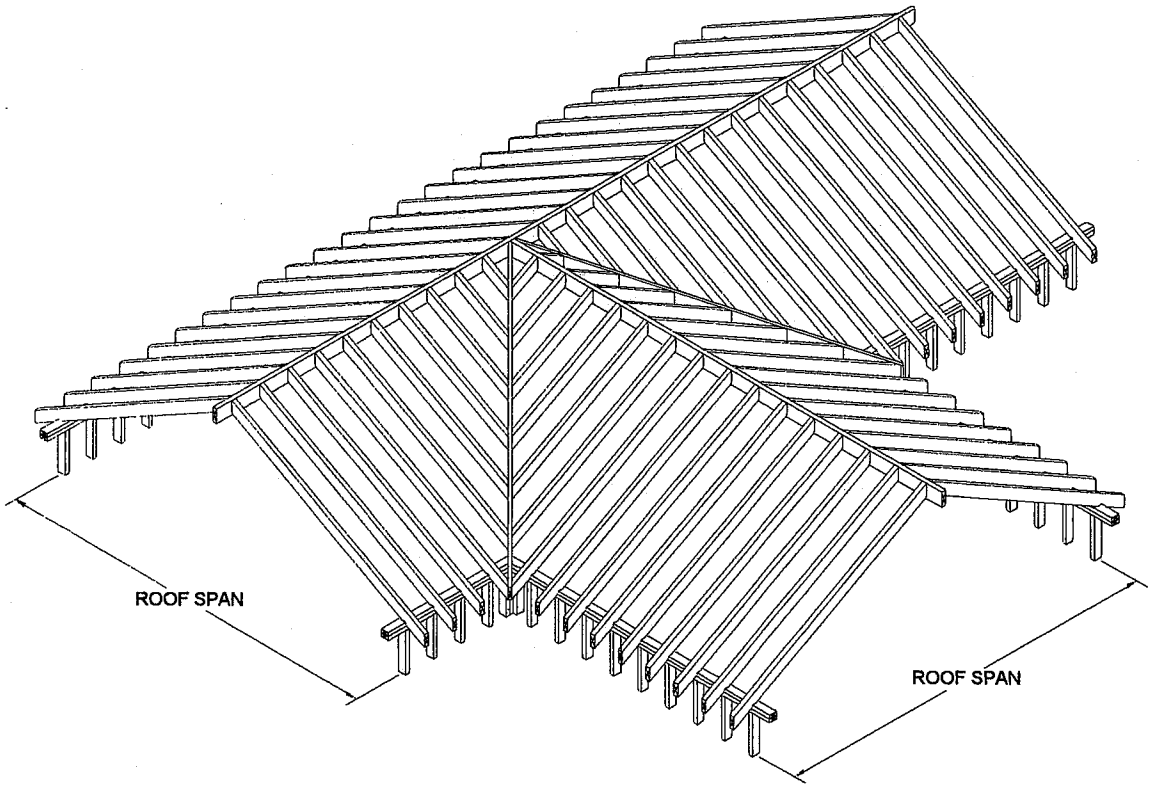


Figure 306.1.1B
Valley Rafters and Roof Framing

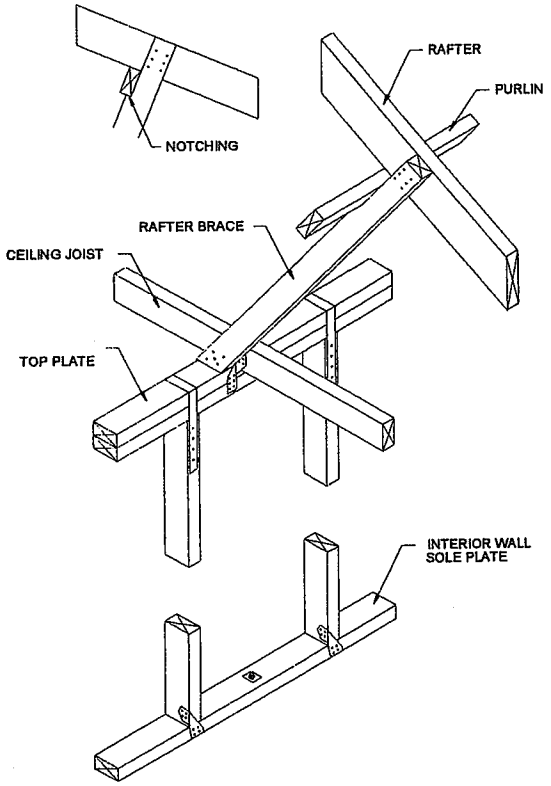


Figure 306.1.2A
Rafter Brace Connection

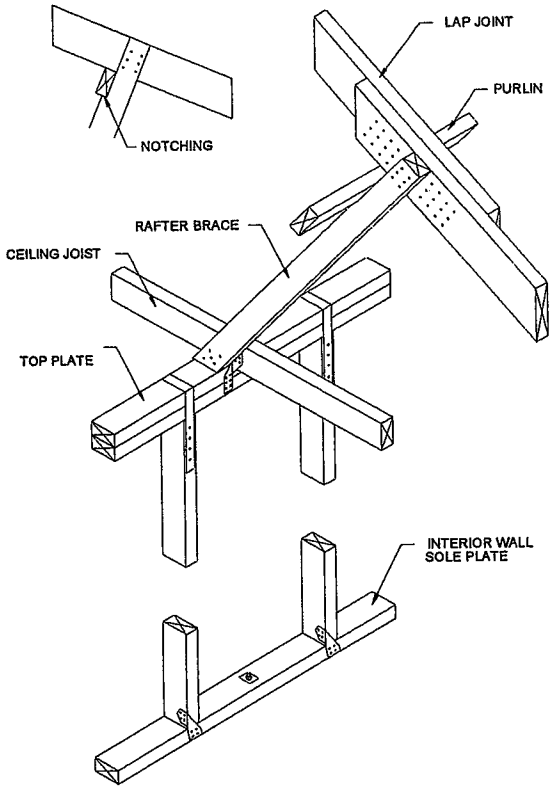


Figure 306.1.2B
Rafter Brace Connection with Lap Spliced Rafter

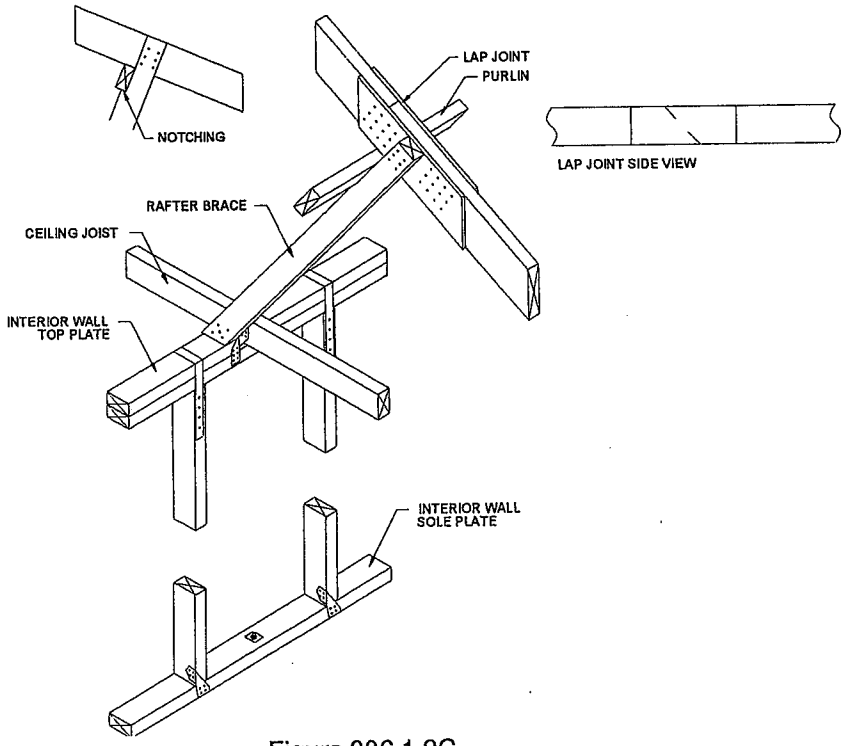


Figure 306.1.2C
Rafter Brace Connection with Butt Spliced Rafter

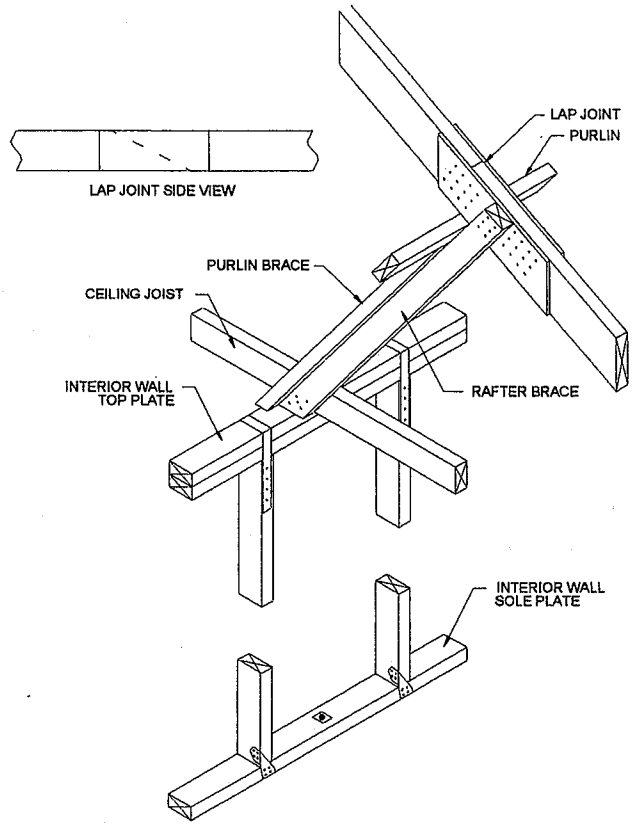


Figure 306.1.2D
Rafter Brace with Purlin Brace
(Butt Spliced Rafter Shown)

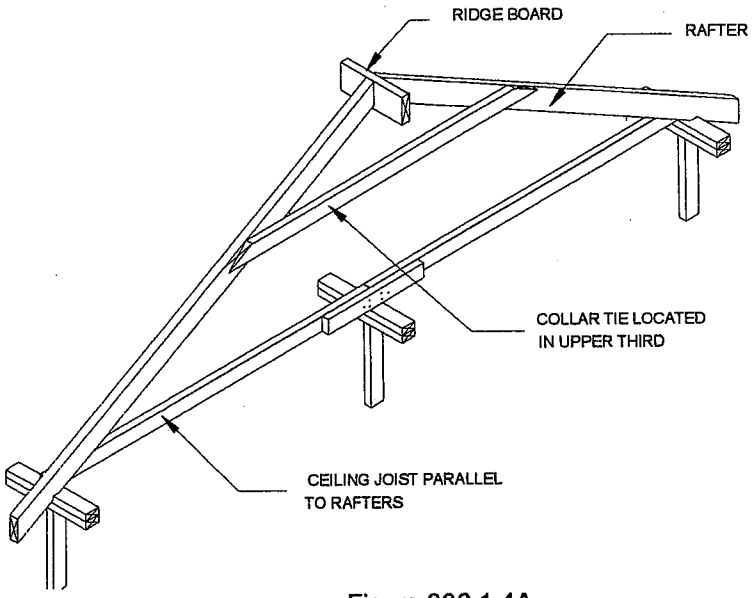


Figure 306.1.4A
Collar Ties and Ceiling Joist Framing

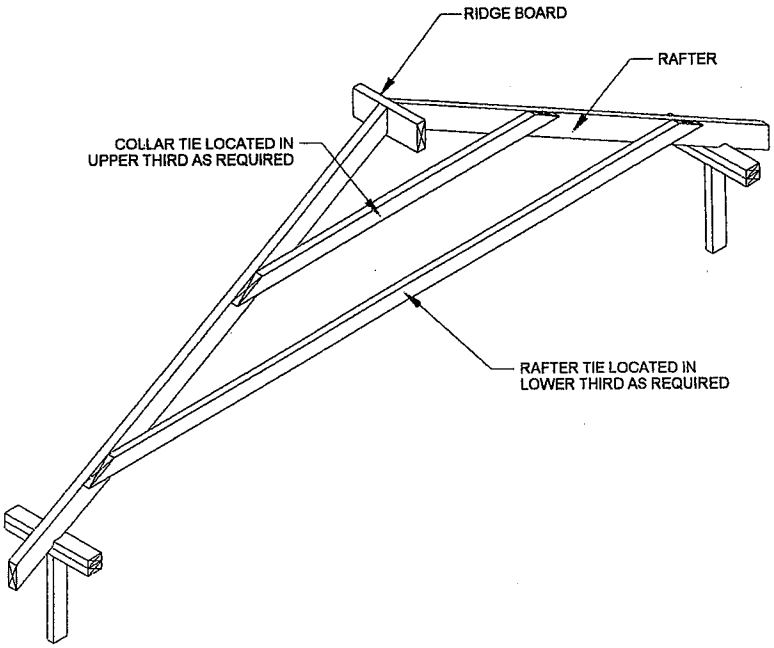


Figure 306.1.4B
Rafter Tie

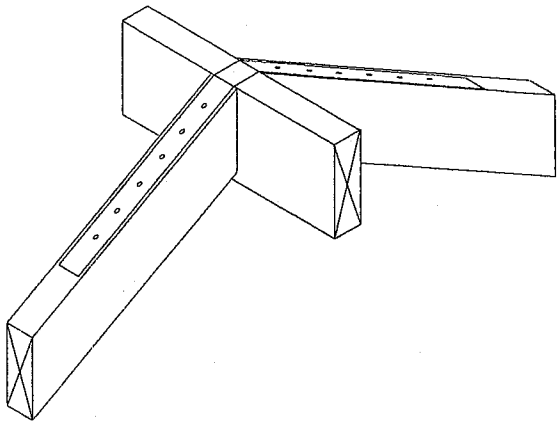


Figure 306.1.5
Ridge Strap

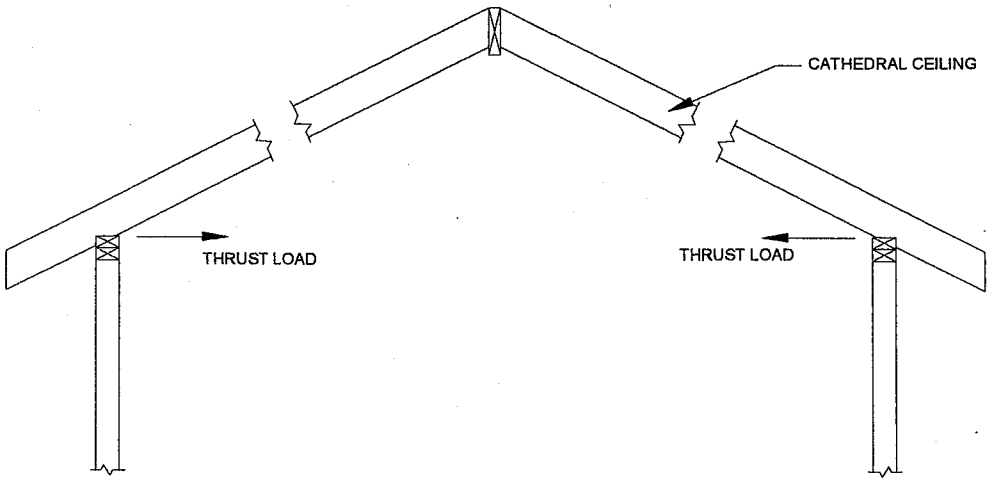


Figure 306.1.6
Thrust Loads at Connection of Rafters to Top Plate in
Cathedral Ceilings

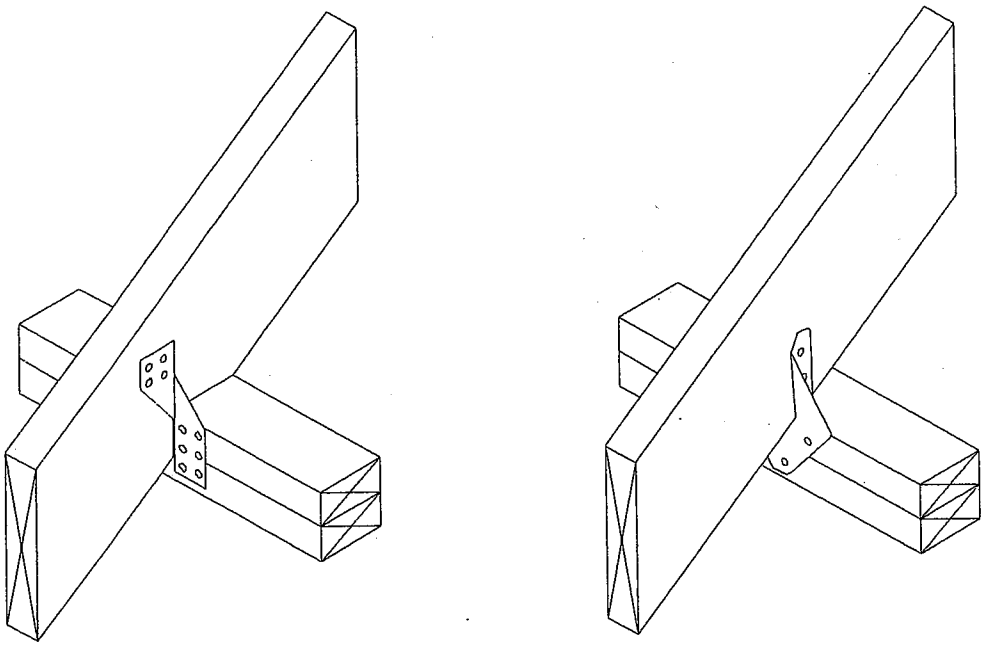


Figure 306.1.7A
Rafter to Top Plate Connection

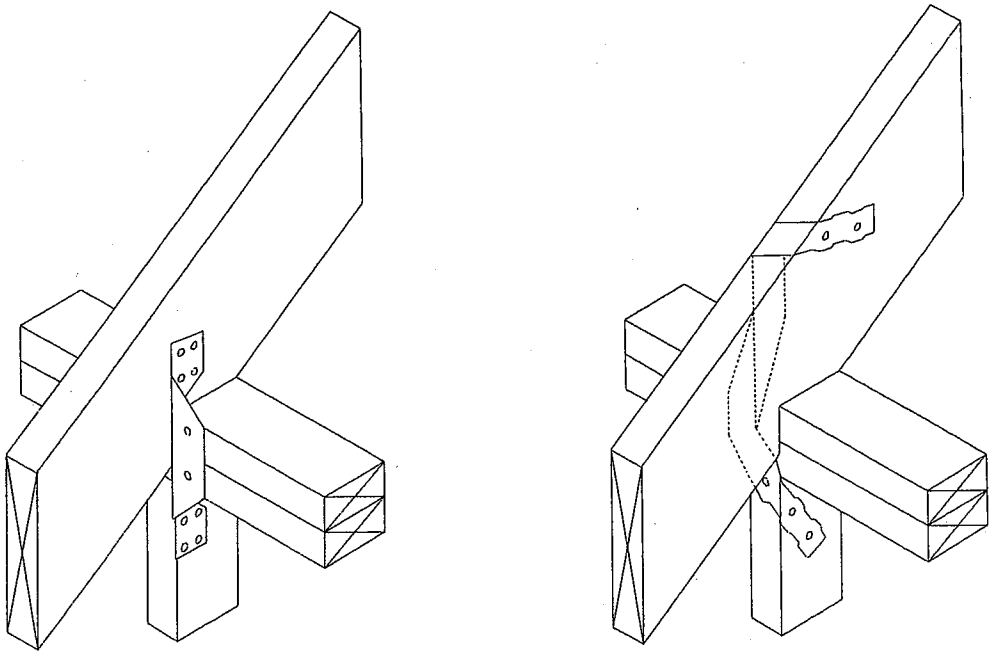


Figure 306.1.7B
Rafter to Top Plate to Stud Connection

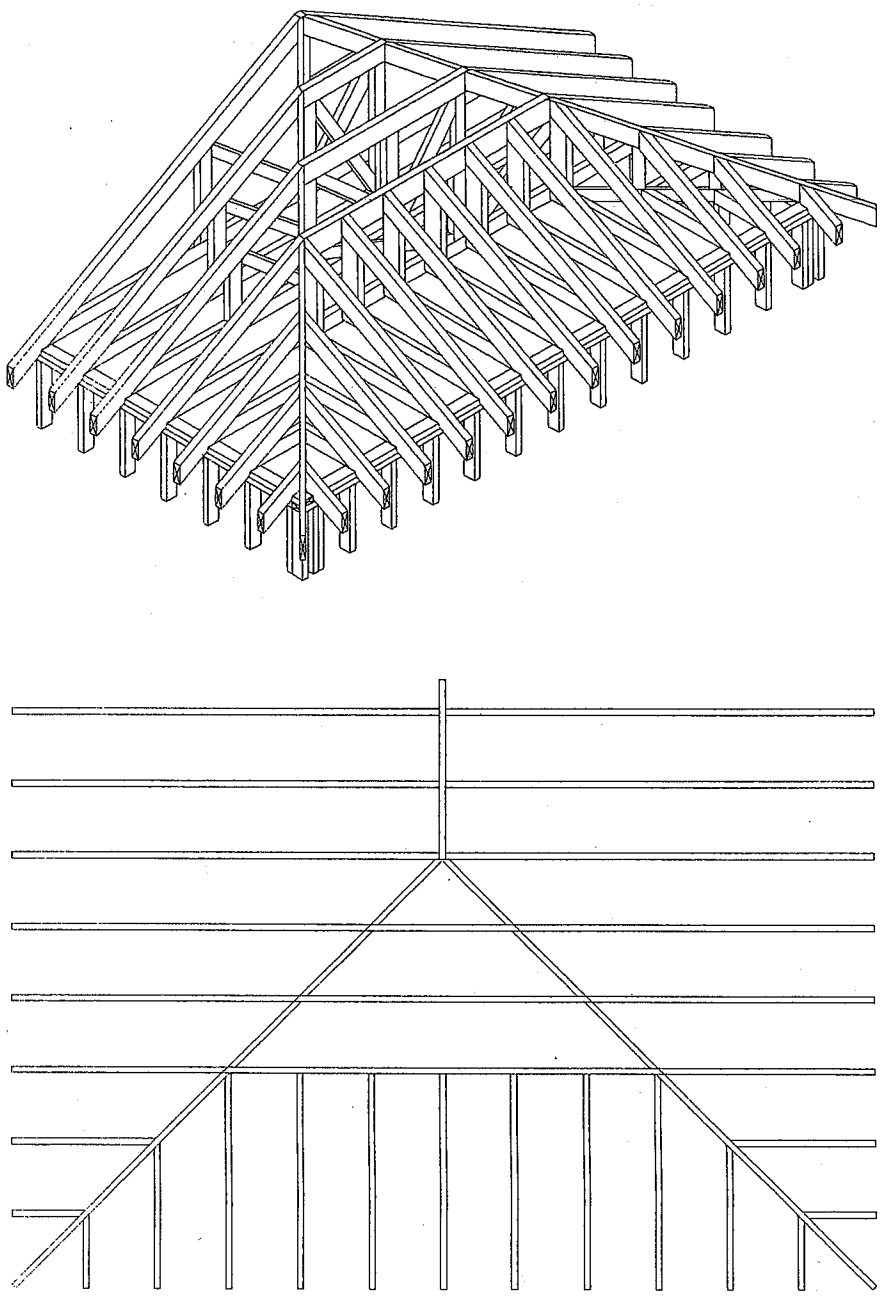


Figure 306.2.1
Hip Roof System Formed with Trusses
Three Dimensional View and Plan Detail

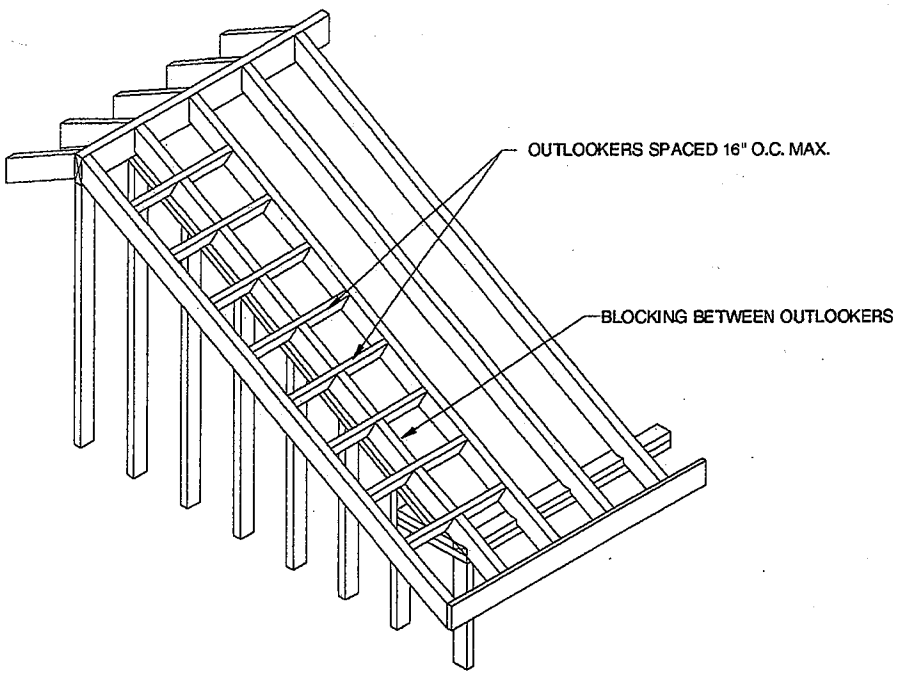


Figure 306.3.2A
Gable Endwall Overhang Using Outlookers (Laid on End)
(Balloon Framing Option Shown)

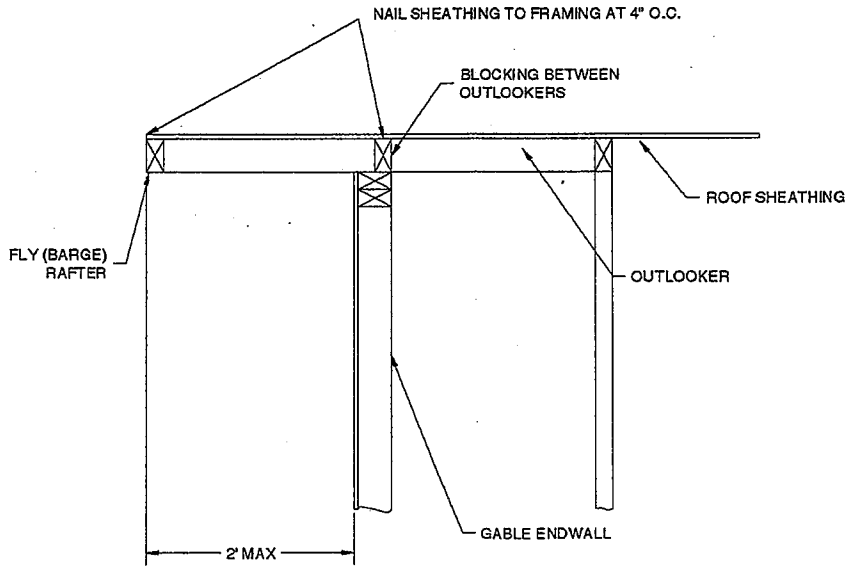


Figure 306.3.2B
Gable Endwall Overhang Using Outlookers (Laid on End)
(Balloon Framing Option Shown)

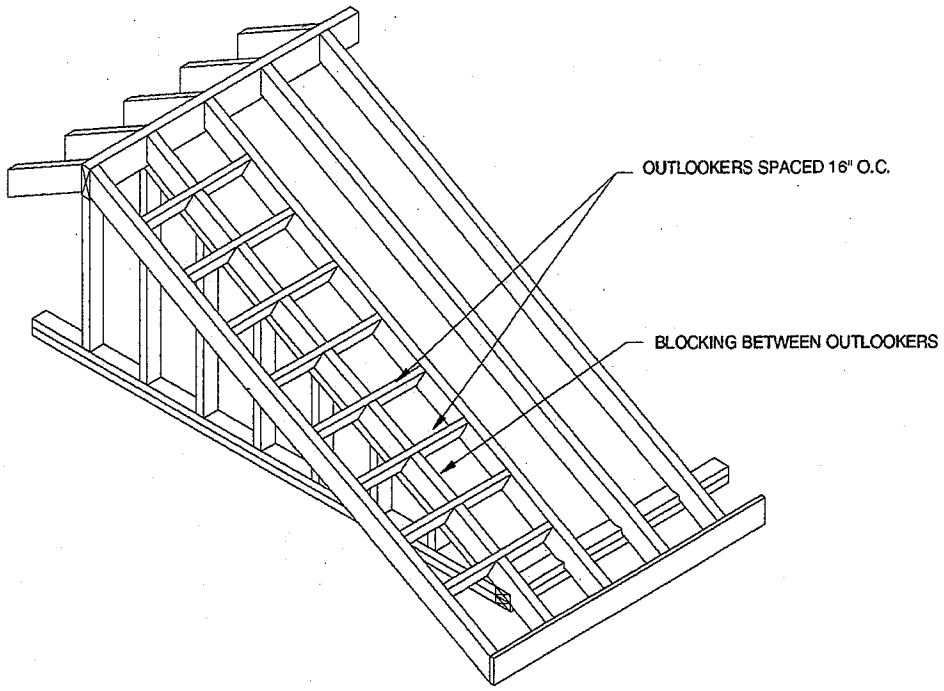


Figure 306.3.2C
Gable Endwall Overhang Using Outlookers (Laid on End)
(Platform Framing Option Shown)

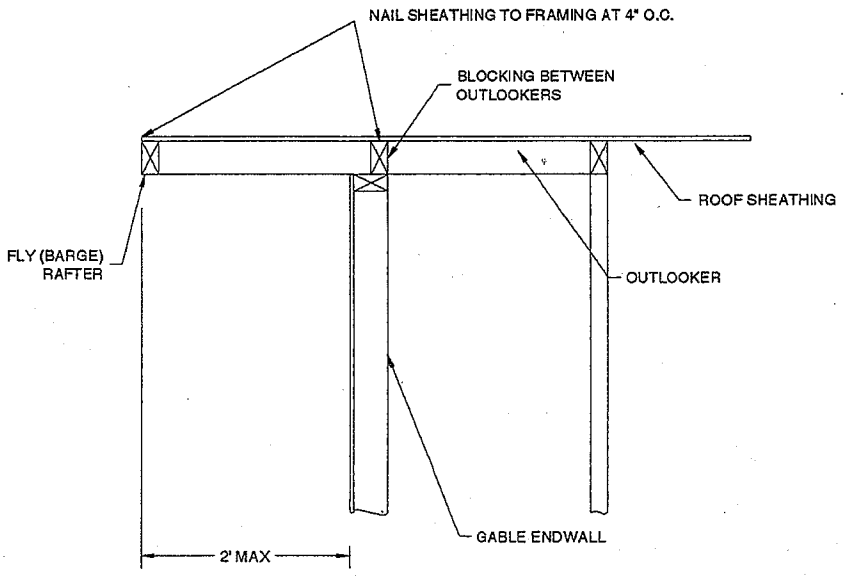


Figure 306.3.2D
Gable Endwall Overhang Using Outlookers (Laid on End)
(Platform Framing Option Shown)

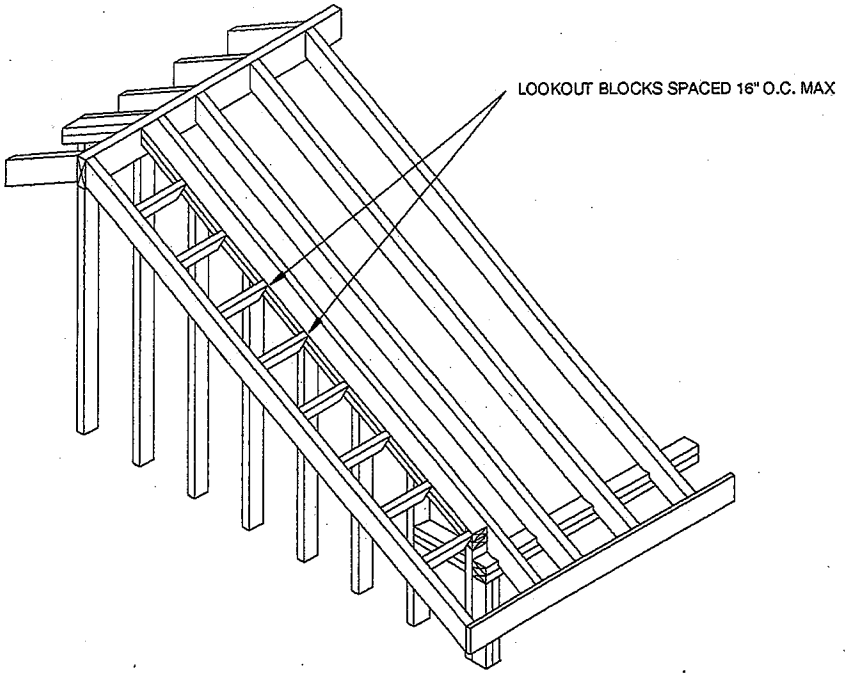


Figure 306.3.1A
Gable Endwall Overhang Using Lookout Blocks
(Balloon Framing Option Shown)

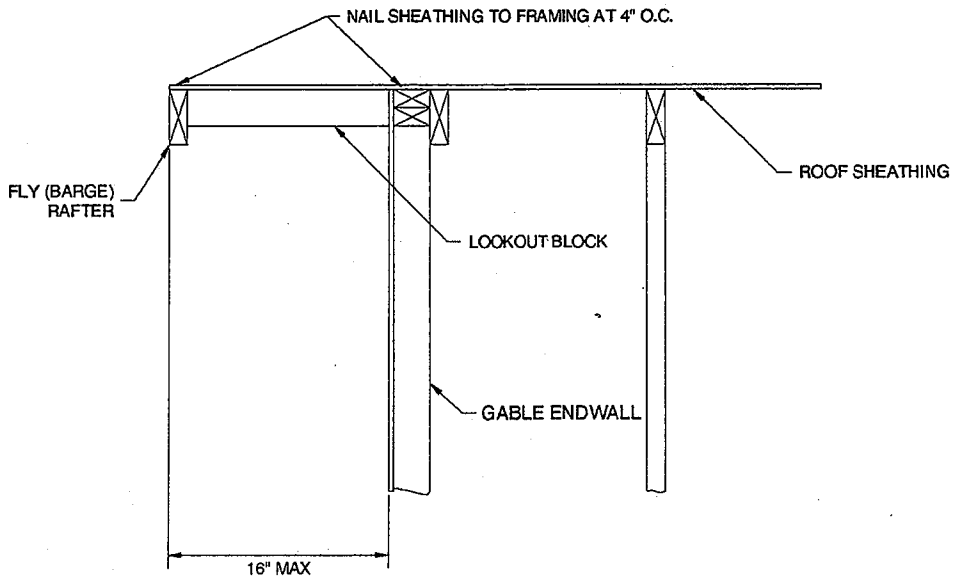


Figure 306.3.1B
Gable Endwall Overhang Using Lookout Blocks
(Balloon Framing Option Shown)

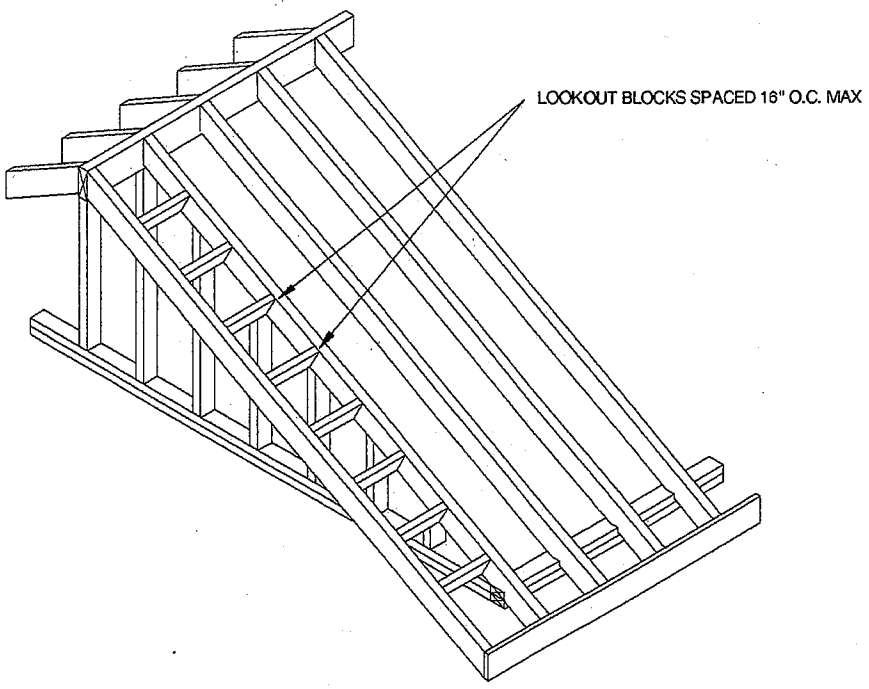


Figure 306.3.1C
Gable Endwall Overhang Using Lookout Blocks
(Platform Framing Option Shown)

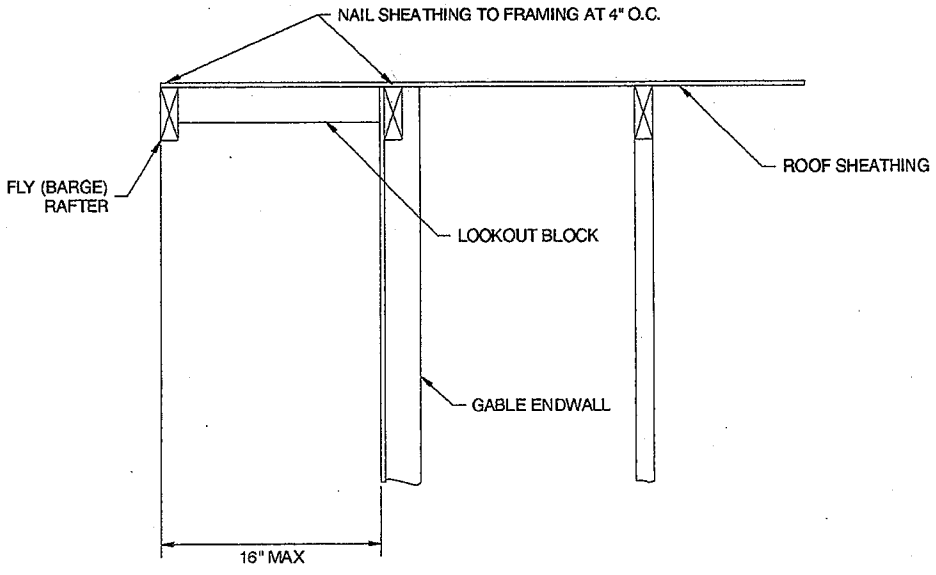


Figure 306.3.1D
Gable Endwall Overhang Using Lookout Blocks
(Platform Framing Option Shown)

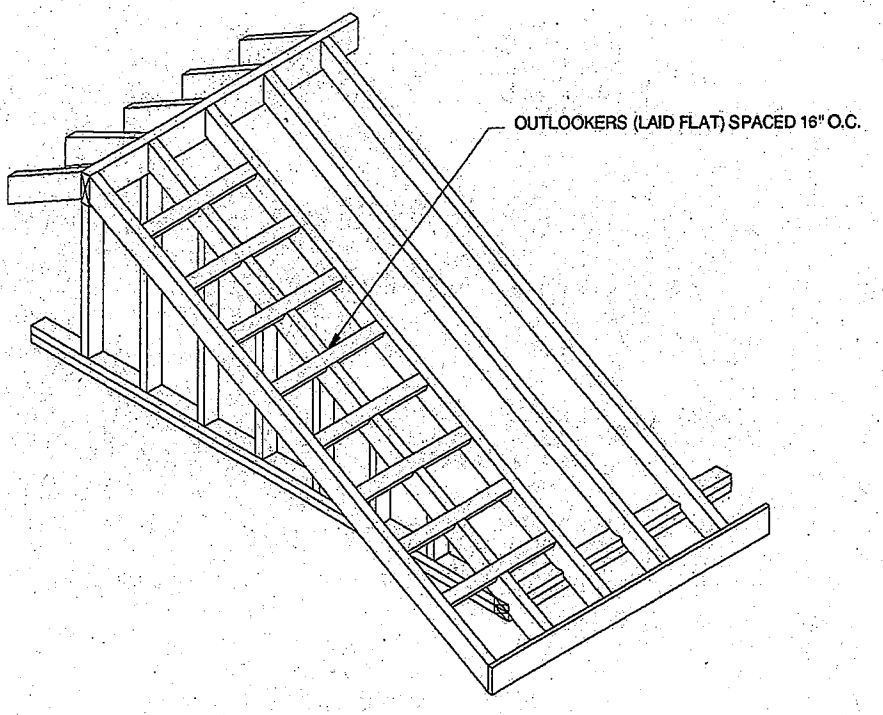


Figure 306.3.3A
Gable Endwall Overhang Using Outlookers (Laid Flat)
(Platform Framing Construction Required)

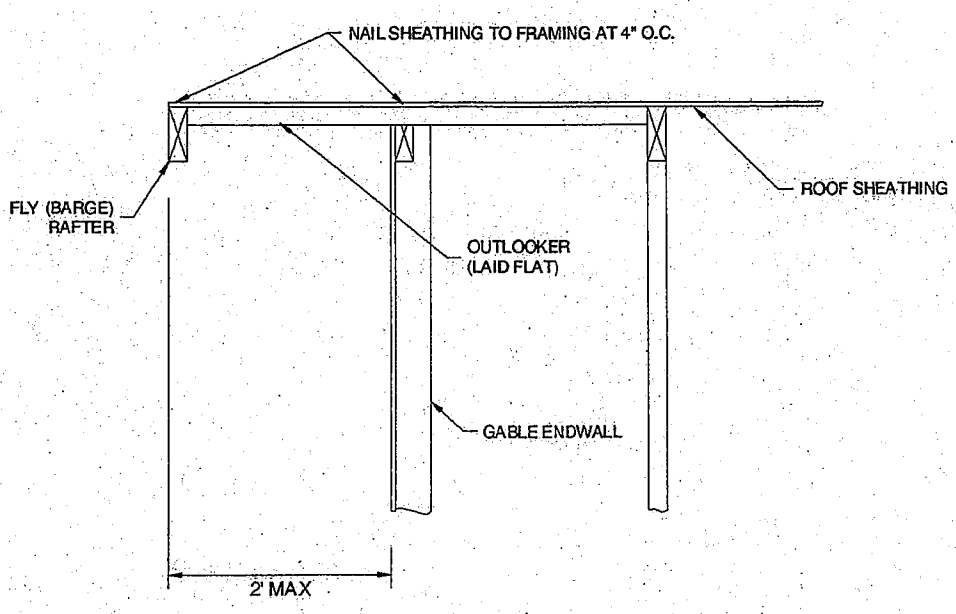


Figure 306.3.3B
Gable Endwall Overhang Using Outlookers (Laid Flat)
(Platform Framing Construction Required)

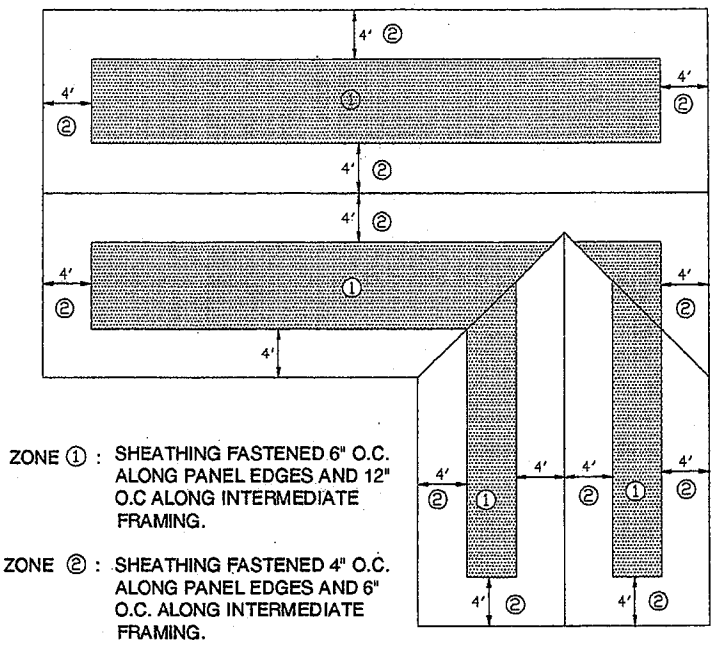


Figure 306.4
Roof Sheathing Attachment

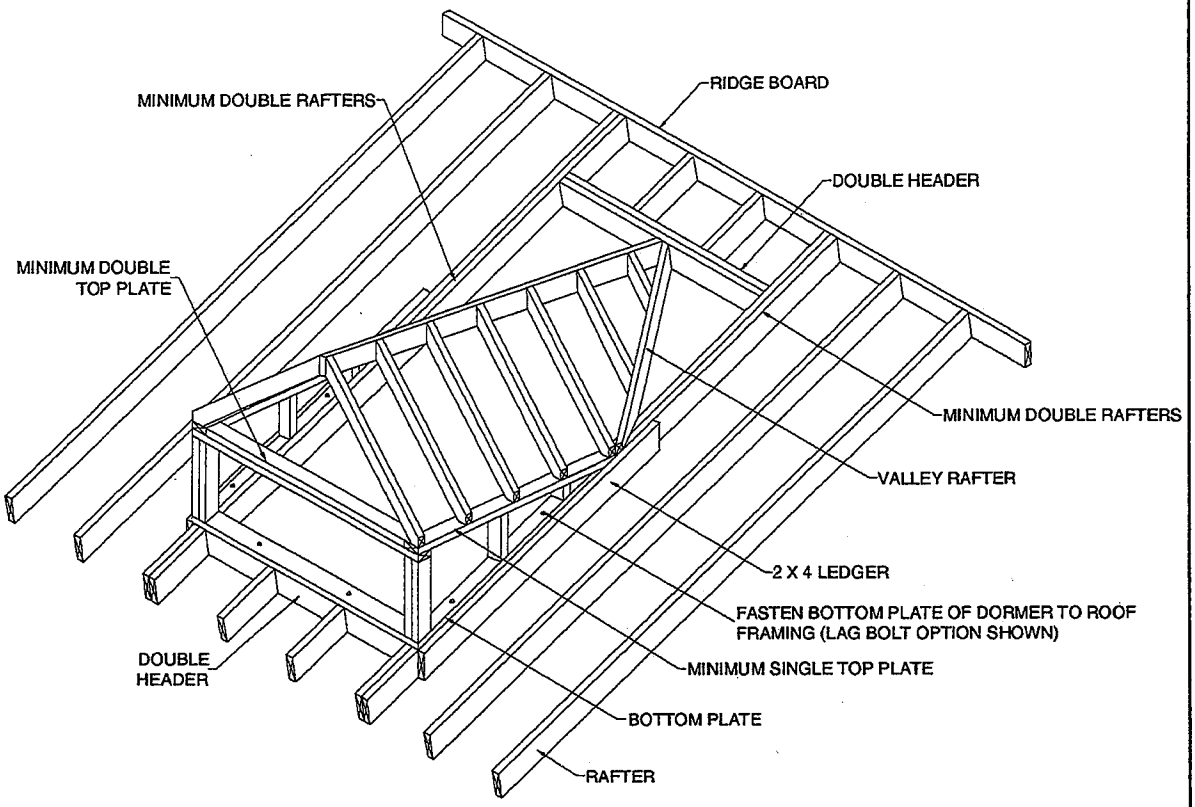


Figure 306.5.1
Framing for Dormers

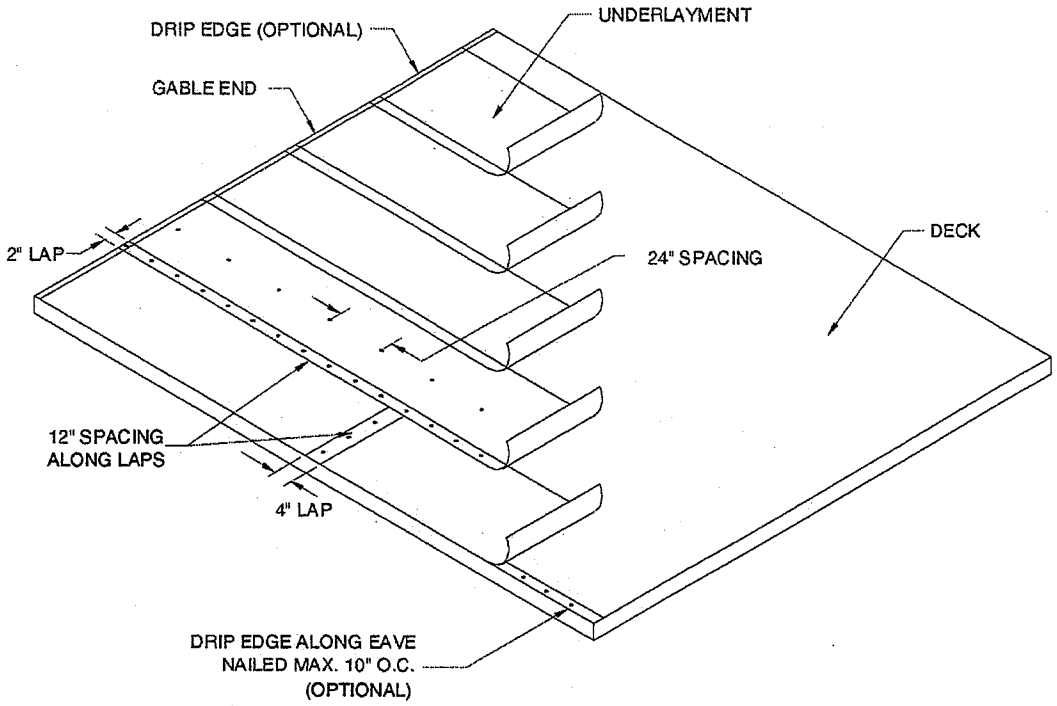


Figure 307.1.1A
Single Layer Underlayment Application

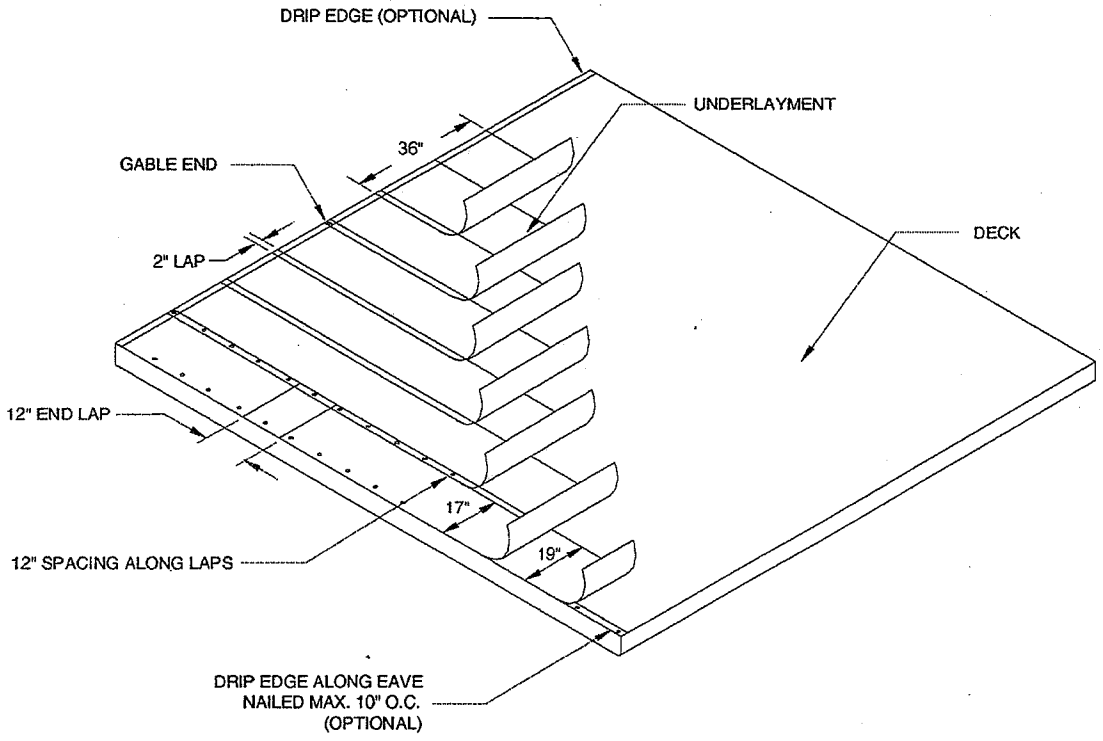


Figure 307.1.1B
Double Layer Underlayment Application

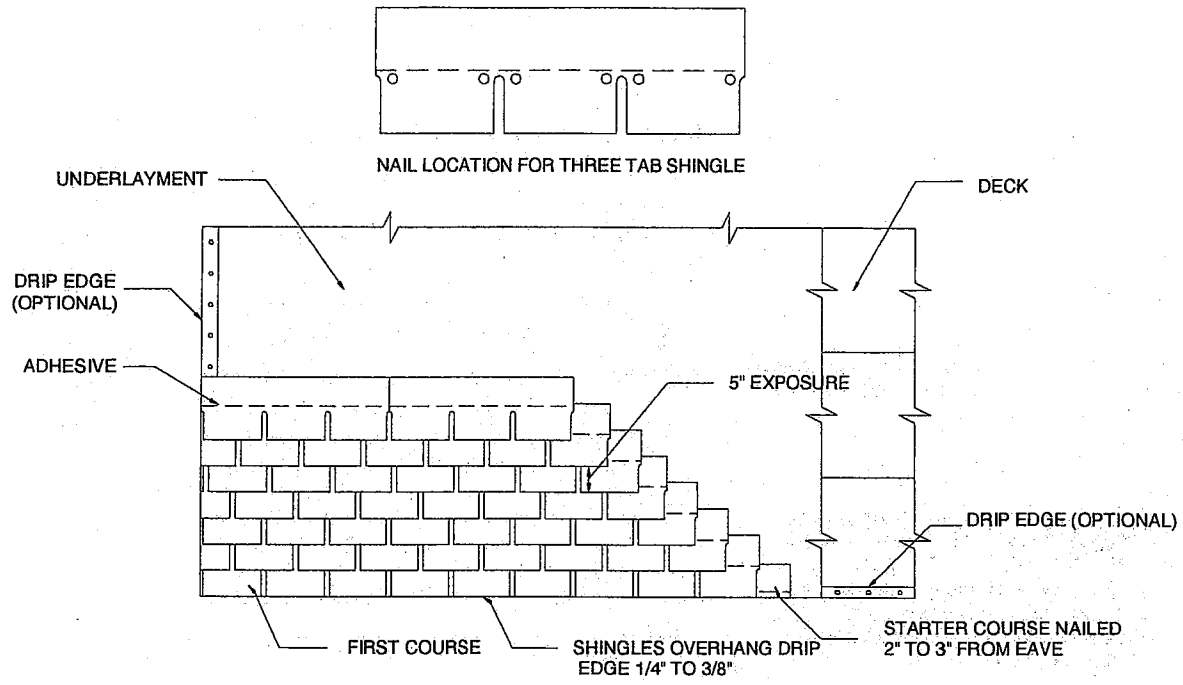


Figure 307.1.3A
Composition Shingle Application

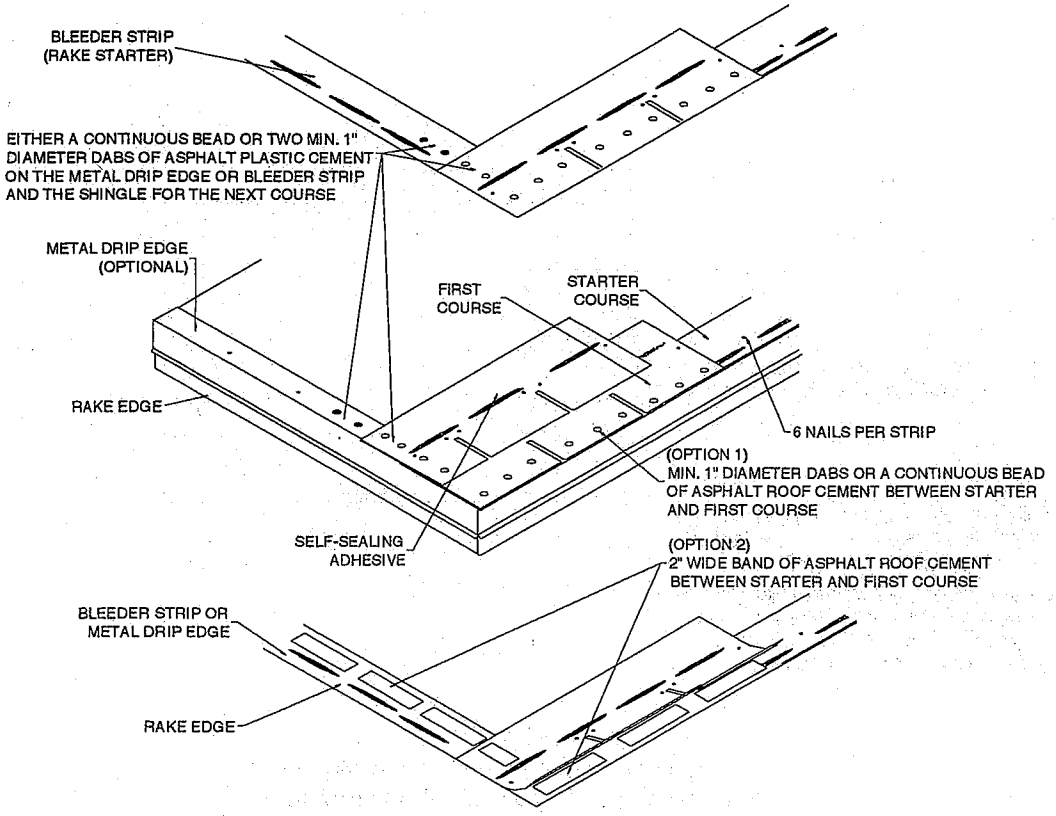


Figure 307.1.3B
Composition Shingle Application

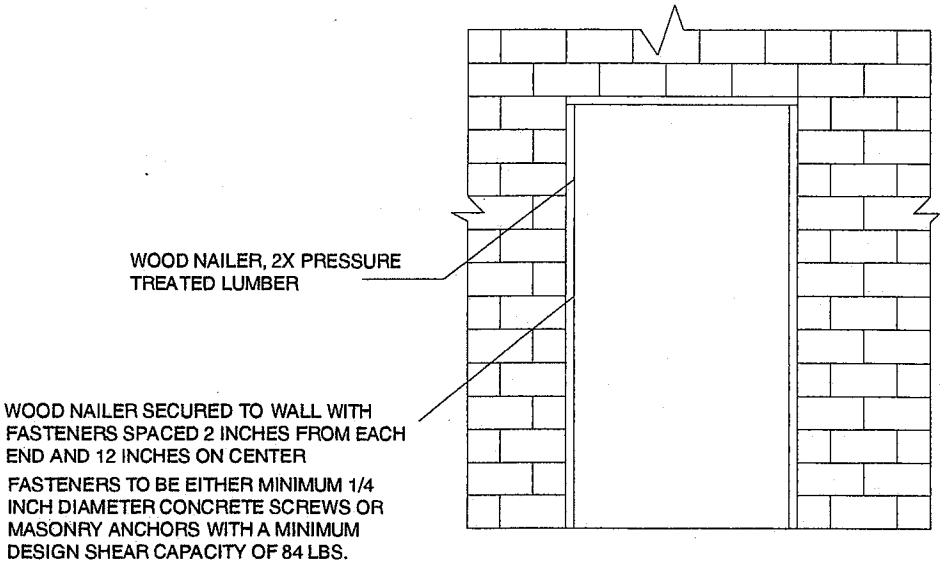


Figure 308.1
Attachment of Wood Nailer Along the
Perimeter of the Masonry Wall Door Opening

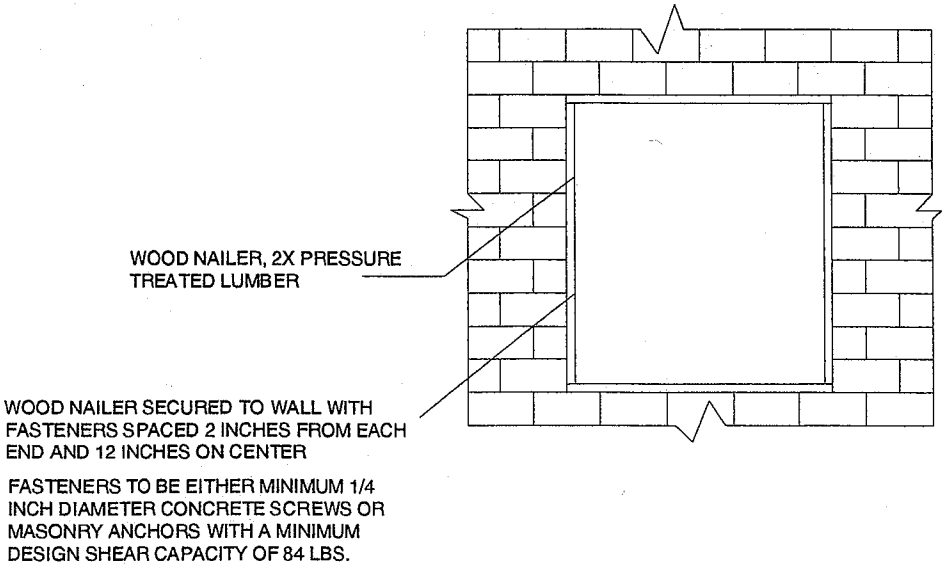


Figure 308.3
Attachment of Wood Nailer Along the
Perimeter of the Masonry Wall Window Opening

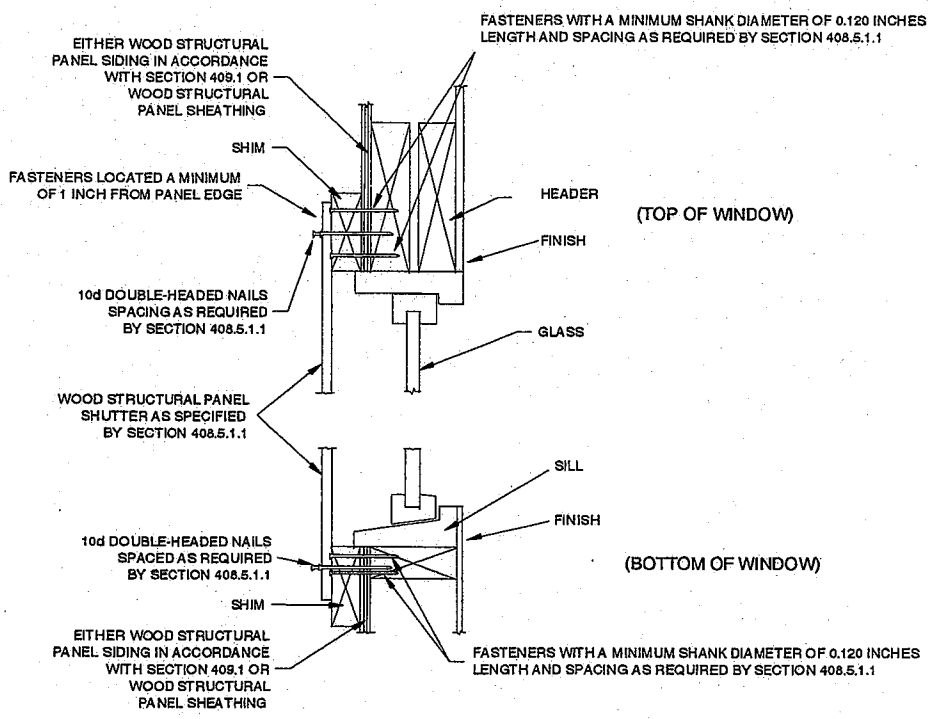
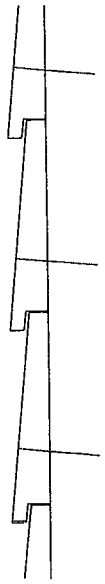


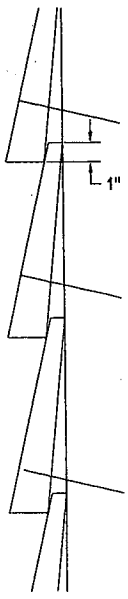
Figure 408.5.1.1
Attachment of Wood Structural Panel
Shutter to Wood Opening

6" AND NARROWER

RABBETED EDGE



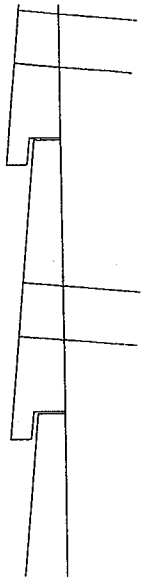
DOLLY VARDEN
HORIZONTAL APPLICATION



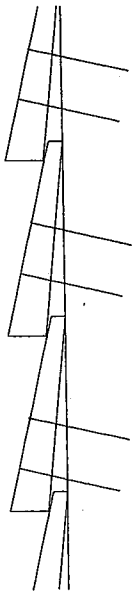
BEVEL OR BUNGALOW
HORIZONTAL APPLICATION

8" AND WIDER

RABBETED EDGE



DOLLY VARDEN
HORIZONTAL APPLICATION

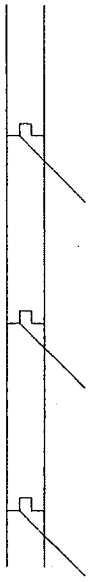


BEVEL OR BUNGALOW
HORIZONTAL APPLICATION

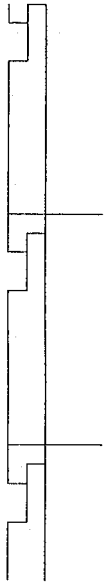
Figure 309.2
Exterior Siding Patterns and Nailing Requirements

6" AND NARROWER

PLAIN



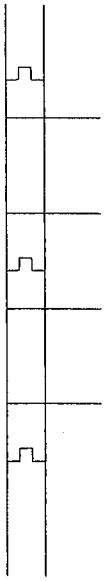
TONGUE AND GROOVE
HORIZONTAL OR VERTICAL APPLICATION



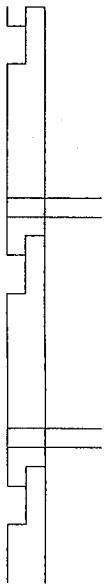
CHANNEL RUSTIC
HORIZONTAL OR VERTICAL APPLICATION

8" AND WIDER

PLAIN



TONGUE AND GROOVE
HORIZONTAL OR VERTICAL APPLICATION



CHANNEL RUSTIC
HORIZONTAL OR VERTICAL APPLICATION

Figure 309.2
(Continued)

6" AND NARROWER

T & G PATTERN

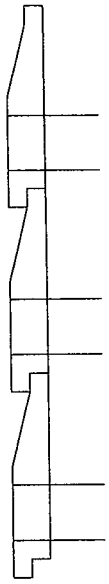
SHIPLAP PATTERN

DROP
HORIZONTAL OR VERTICAL APPLICATION

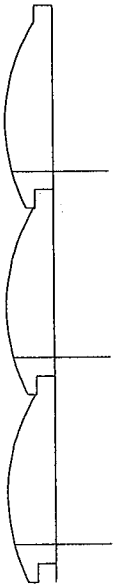
8" AND WIDER

T & G PATTERN

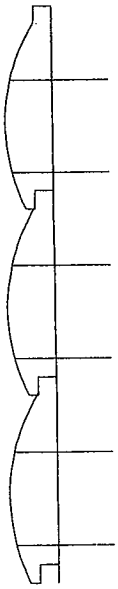
SHIPLAP PATTERN



DROP
HORIZONTAL OR VERTICAL APPLICATION



LOG CABIN
HORIZONTAL OR VERTICAL APPLICATION



LOG CABIN
HORIZONTAL OR VERTICAL APPLICATION

Figure 309.2
(Continued)

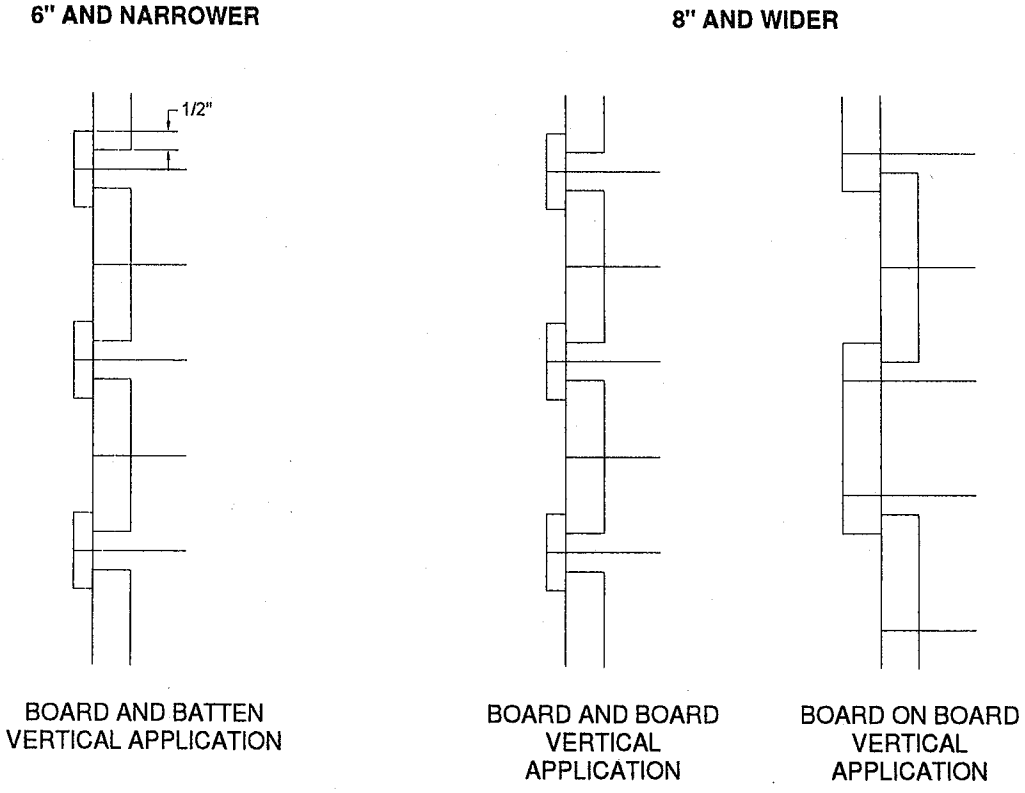


Figure 309.2
(Continued)

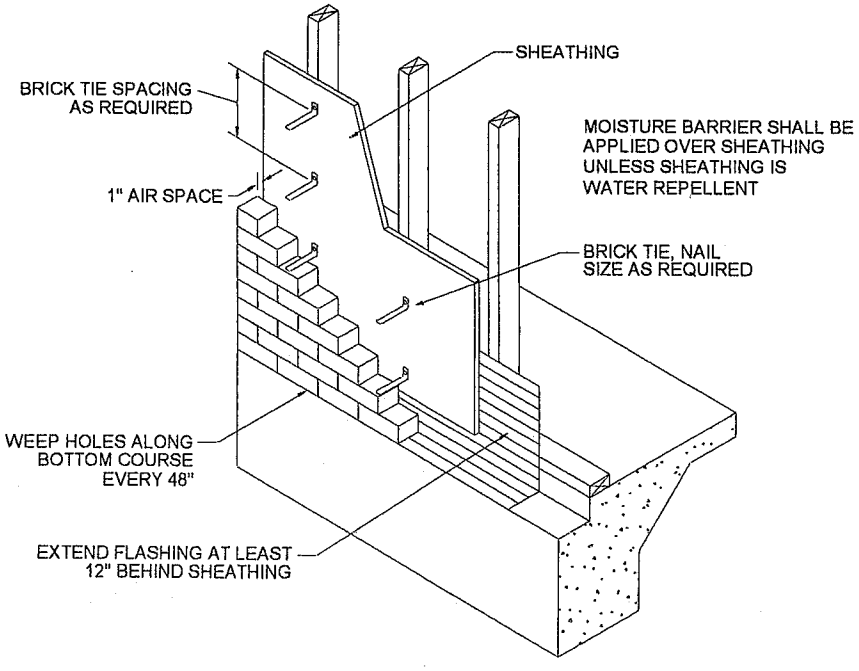


Figure 309.5
Brick Veneer

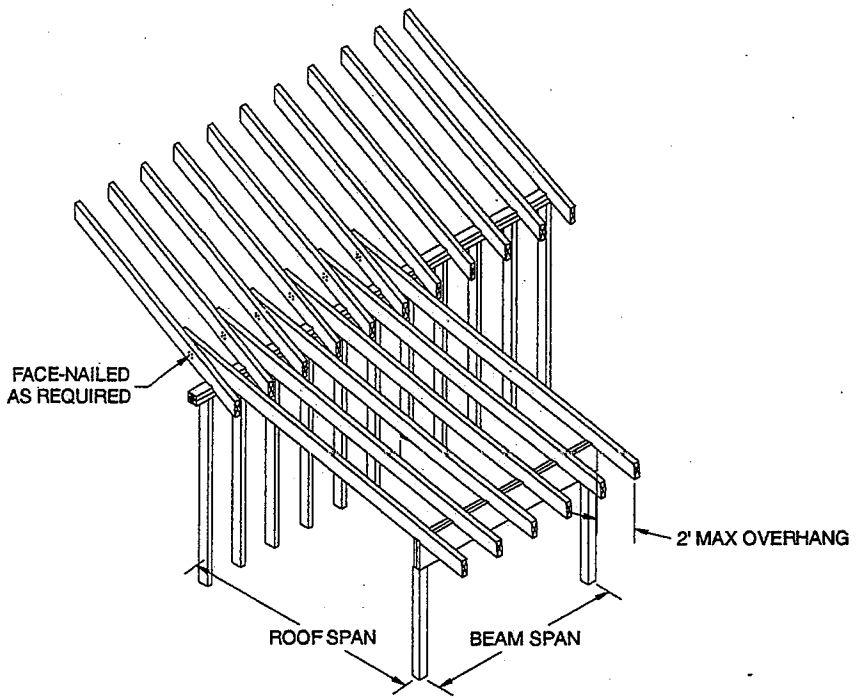


Figure 311.4.2A
Roof Framing for Monoslope Supported Overhang
(New Construction)

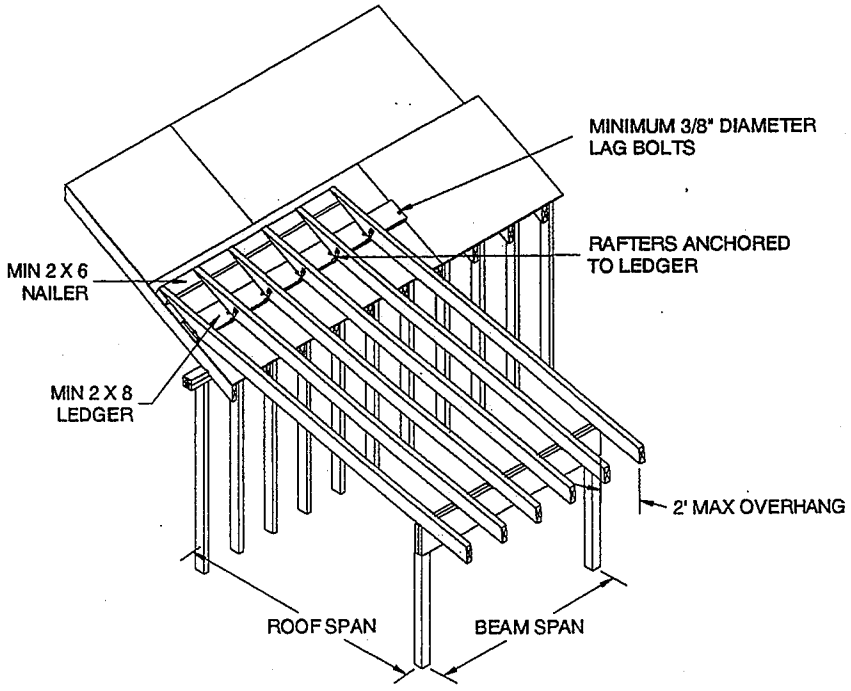


Figure 311.4.2B
Roof Framing of Monoslope Supported Overhang
(Existing Construction)

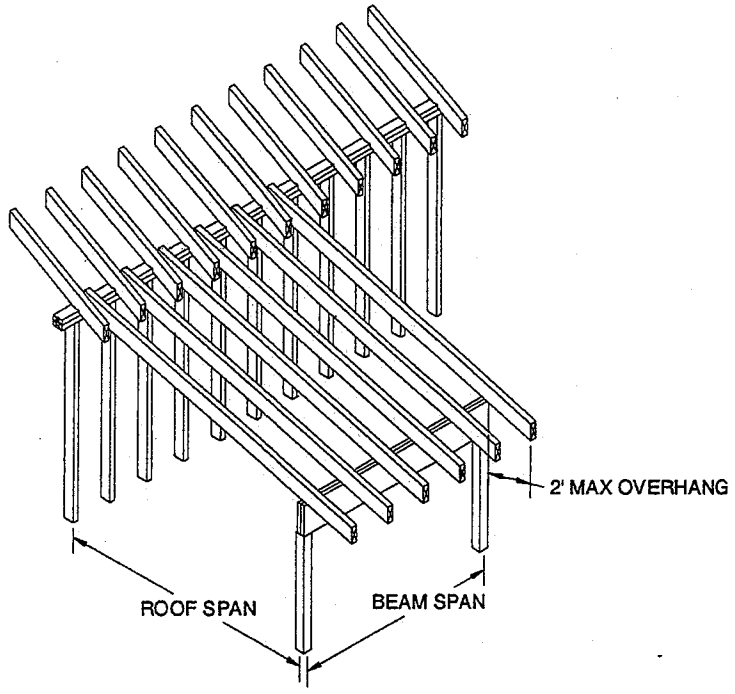


Figure 311.4.2C
Roof Framing Monoslope Roof Supported Overhang
(New or Existing Construction)

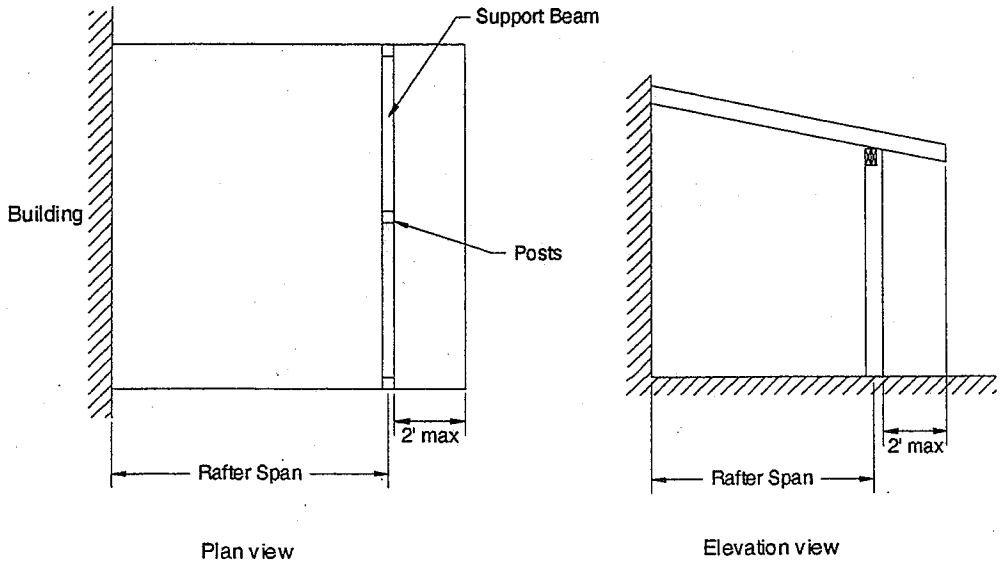


Figure 311.4.4A
Supported Overhang or Covered Porch
(Monoslope Roof)

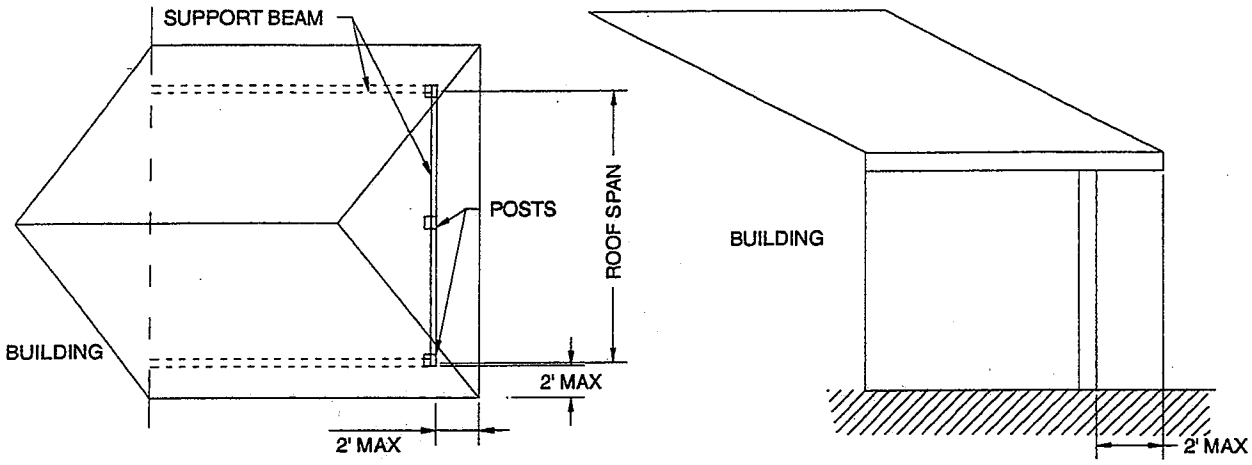


Figure 311.4.4B
Supported Overhang or Covered Porch
(Gable or Hip Roof)

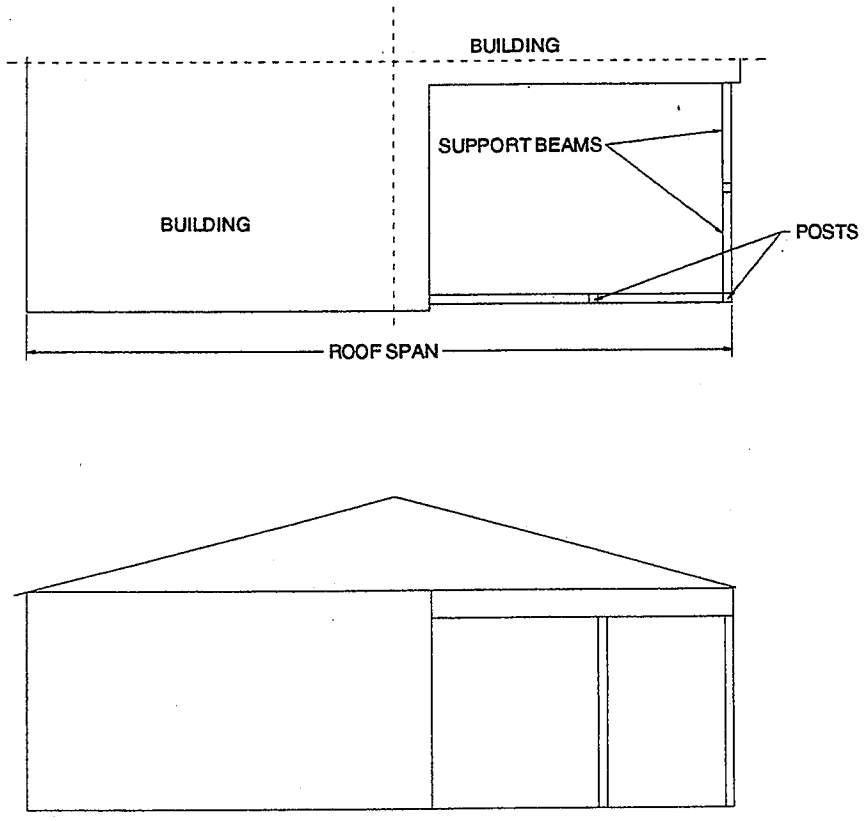


Figure 311.4.4C
Supported Overhang or Covered Porch
(Gable or Hip Roof)

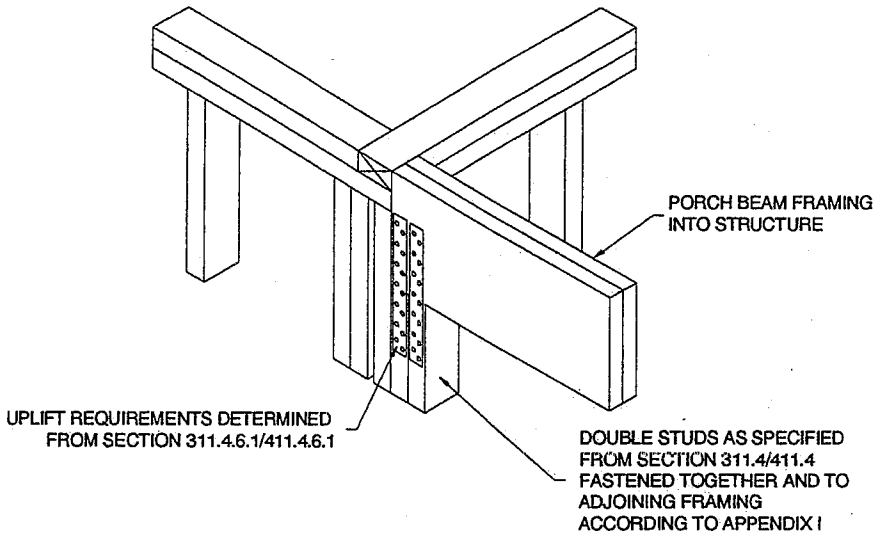


Figure 311.4.7
Connection of New Support Beam to an Existing Structure

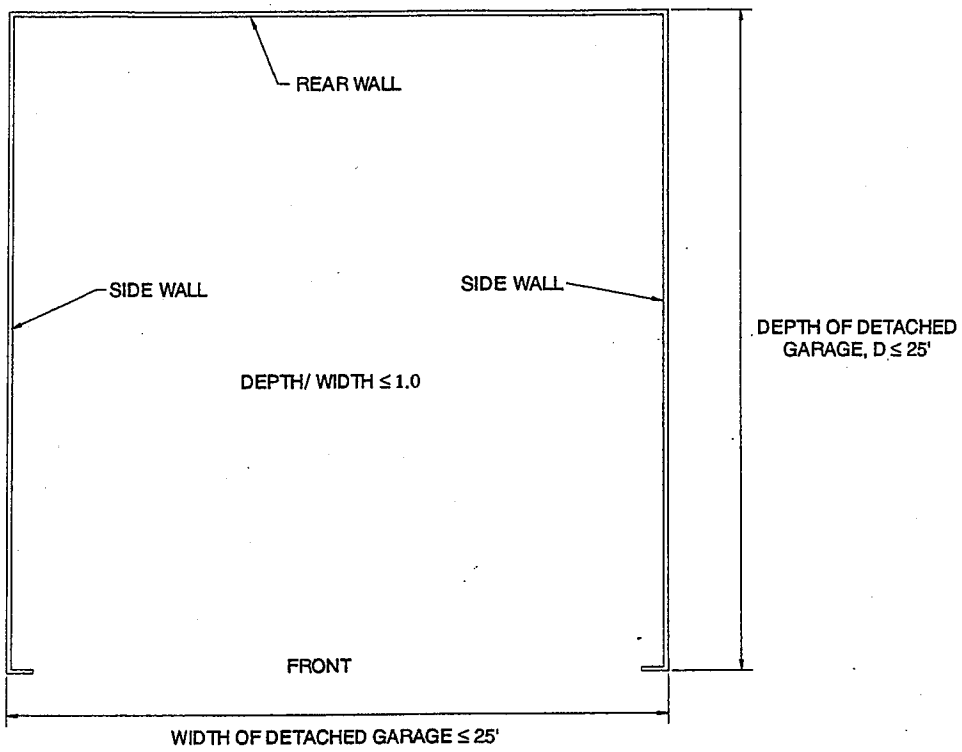


Figure 311.5.1
Plan View Detached Garage

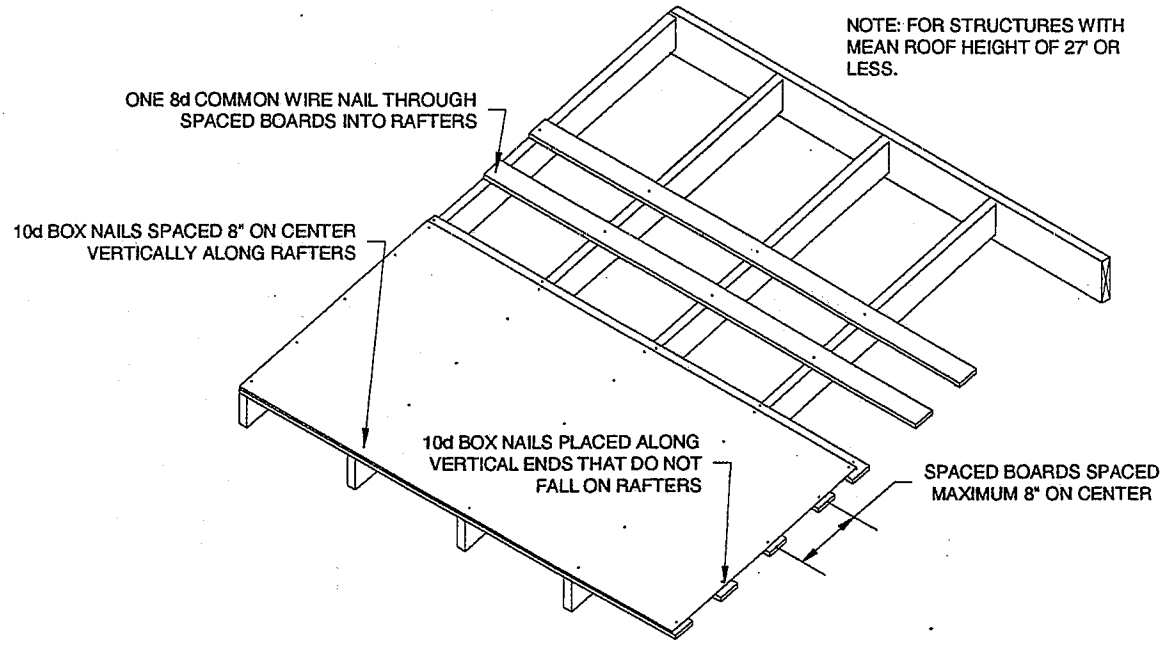


Figure 312.2.1.2A
Sheathing Applied Over
Spaced Boards (Method 1)

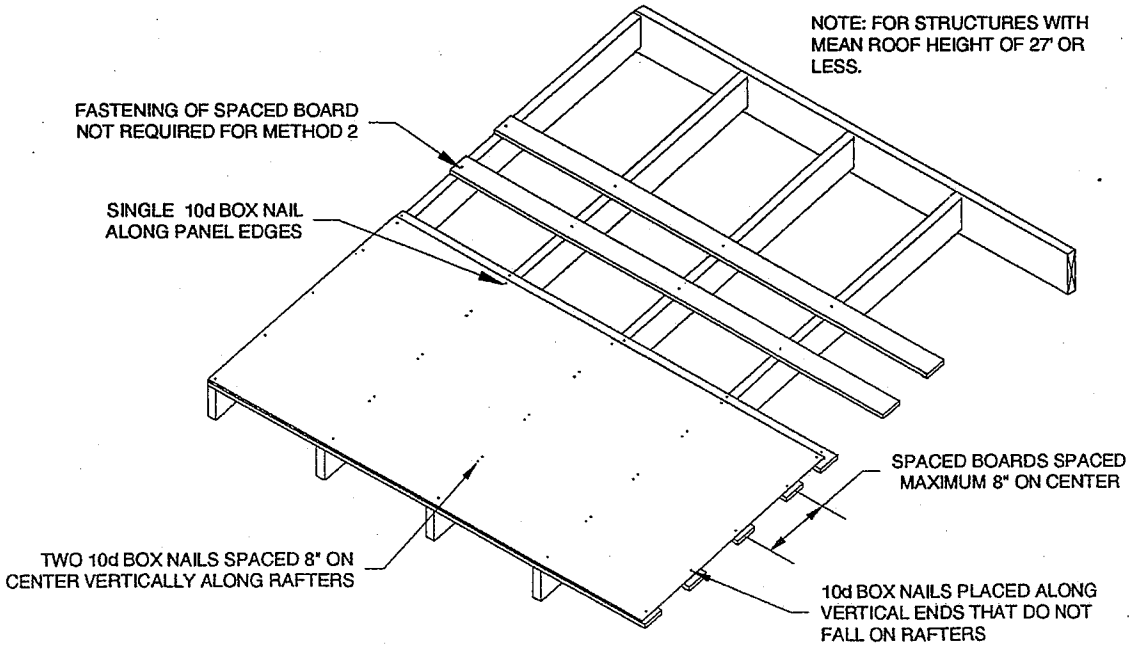


Figure 312.2.1.2B
Sheathing Applied Over
Spaced Boards (Method 2)

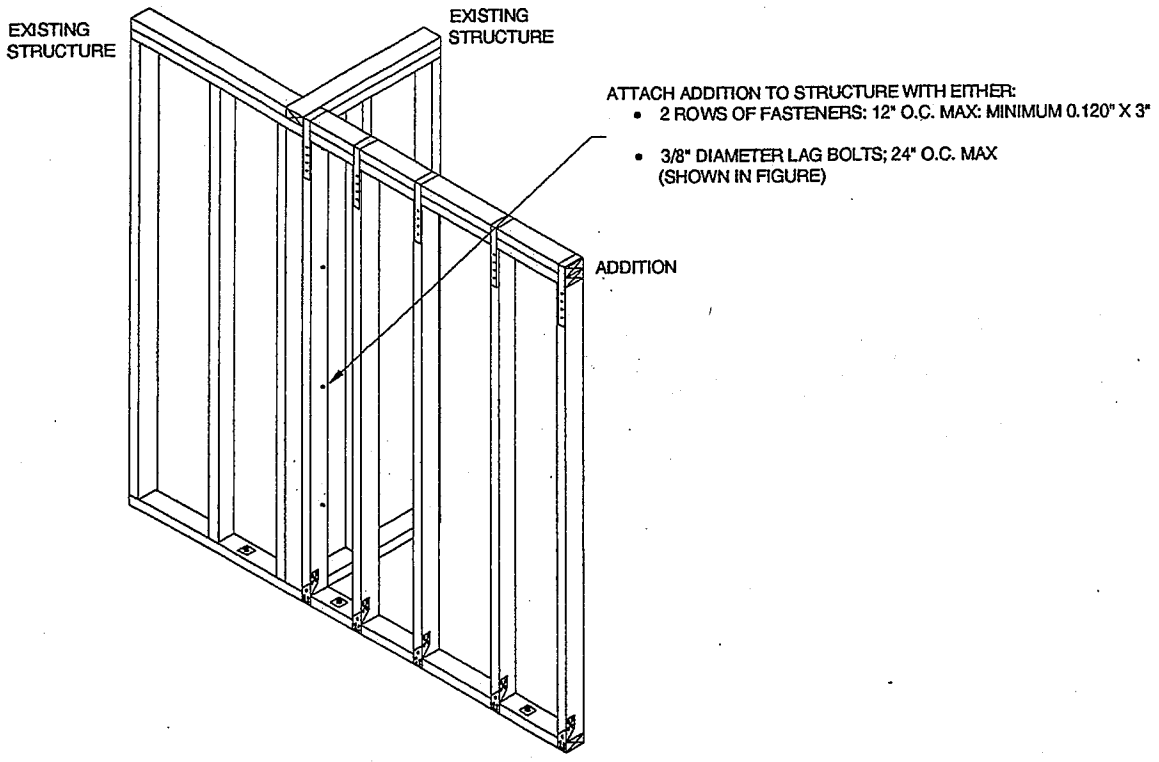


Figure 313.1.2.1
Wall Addition - Framing into Corner of an Existing Structure

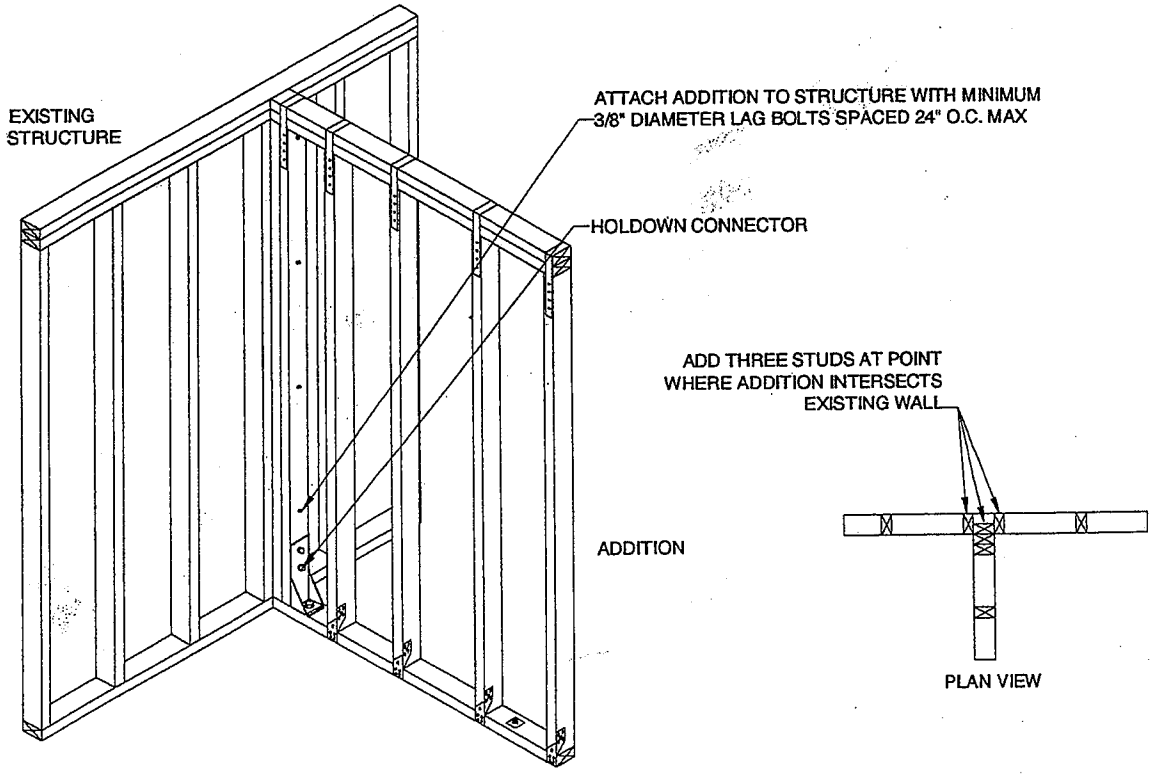


Figure 313.1.2.2
Wall Addition - Framing into Continuous Wall of an Existing Structure

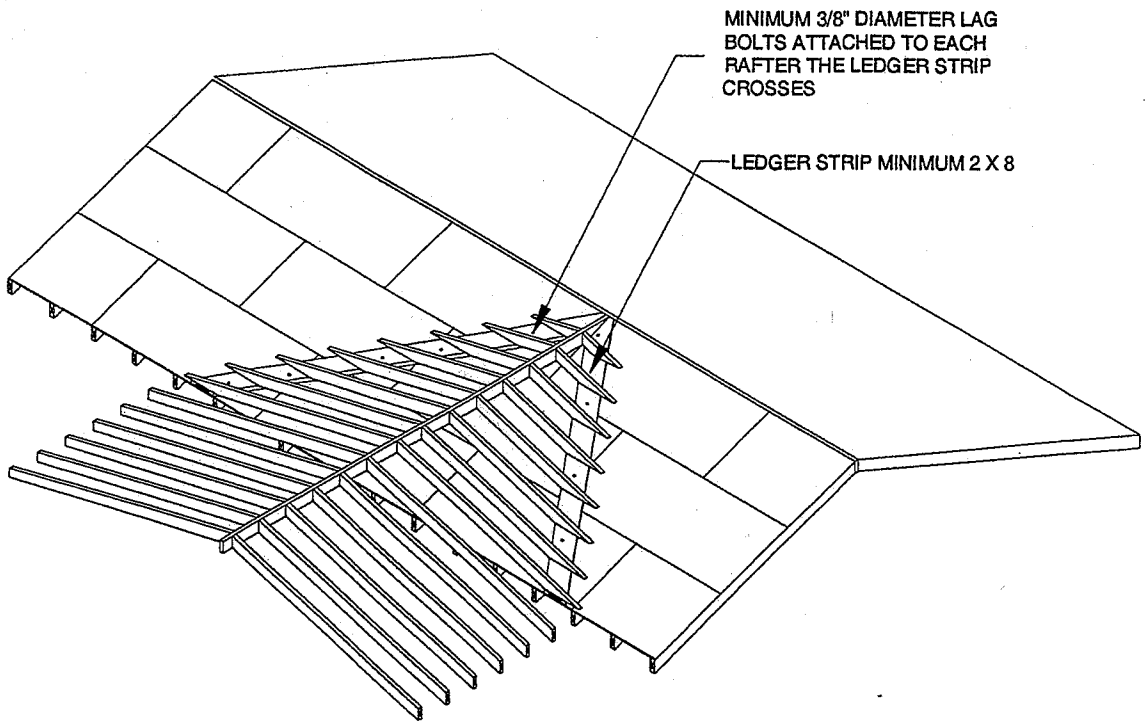


Figure 313.1.3
Framing New Roof Addition to Existing Structure

- Wood Block Anchor (number of nails into joist and beam)
  4 nails: 3½" x 0.162" (16d common)
  3¼" x 0.131"
  3½" x 0.135" (16d box)

FASTENING SCHEDULE FOR THE BUILDING CODE FOR WINDSTORM RESISTANT CONSTRUCTION

WALL SHEATHING
(sheathing not used for lateral resistance)

- Wood Structural Panels (Plywood or OSB) or Structural Panel Siding; ½ inch thick or less

  Nailing Pattern: 6" o.c. along panel edges and 12" o.c. along interior framing

  1 nail:
  - 2" x 0.113" (6d common)
  - 2" x 0.113" deformed shank
  - 2½" x 0.113" (8d box)
  - 2⅜" x 0.113"
  - 2⅜" x 0.113" deformed shank
  - 2½" x 0.120" deformed shank
  - 3" x 0.120"
  - 3" x 0.120" deformed shank
  - 3¼" x 0.120"
  - 2½" x 0.131"
  - 2½" x 0.131" deformed shank
  - 3" x 0.131"
  - 3¼" x 0.131"

- Wood Structural Panels (Plywood or OSB) or Structural Panel Siding; 19/32 inch thick or greater

  Nailing Pattern: 6" o.c. along panel edges and 12" o.c. along interior framing

  1 nail:
  - 2½" x 0.131" (8d common)
  - 2½" x 0.131" deformed shank
  - 2½" x 0.120" deformed shank
  - 3" x 0.120"
  - 3" x 0.120" deformed shank
  - 3" x 0.128" (10d box)
  - 3" x 0.131"
  - 3¼" x 0.131"

WALL SHEATHING
(sheathing used for lateral resistance)

- Wood Structural Panels (Plywood or OSB) or Structural Panel Siding

  NOTE: If 8d common nails are specified, then the following alternatives are permitted:

  Nailing Pattern: As required for shear resistance using 8d common nails

  1 Nail:
  - 2½" x 0.131" (8d common)
  - 2½" x 0.131" deformed shank
  - 2½" x 0.120" deformed shank
  - 3" x 0.120" deformed shank
  - 3" x 0.128" (10d box)
  - 3" x 0.131"
  - 3¼" x 0.131"

FASTENING SCHEDULE FOR THE BUILDING CODE FOR WINDSTORM RESISTANT CONSTRUCTION

ROOF SHEATHING

- Wood Structural Panels (Plywood or OSB); $\frac{5}{8}$ inch thick or less
  Nailing Pattern: As required for shear resistance when using 8d common nails
  1 Nail: 2½" x 0.131" (8d common)
  2½" x 0.131" deformed shank
  2½" x 0.120" deformed shank
  3" x 0.120" deformed shank
  3" x 0.128" (10d box)
  3" x 0.131"
  3¼" x 0.131"

- Spaced Boards to Rafters
  1 Nail: 2½" x 0.131" (8d common)
  2½" x 0.131" deformed shank
  2½" x 0.120" deformed shank
  3" x 0.120" deformed shank
  3" x 0.128" (10d box)
  3" x 0.131"
  3¼" x 0.131"

- Wood Structural Panels (Plywood or OSB); $\frac{5}{8}$ inch thick or less (Applied Over Spaced Boards)
  Nailing Pattern: As required when using 10d box nails
  1 Nail: 3" x 0.128" (10d box)
  3¼" x 0.128" (12d box)
  3" x 0.120" deformed shank
  3" x 0.131"
  3¼" x 0.131"

FLOOR SHEATHING

- Wood Structural Panels (Plywood or OSB); $\frac{19}{32}$ inch thick
  Nailing Pattern: As required for shear resistance when using 8d common nails
  1 Nail: 2½" x 0.131" (8d common)
  2½" x 0.131" deformed shank
  2½" x 0.120" deformed shank
  3" x 0.120" deformed shank
  3" x 0.128" (10d box)
  3" x 0.131"
  3¼" x 0.131"

Appendix J
Figures

Figure 303.4.3.3B	Sheathing Detail for Narrow-Width Shearwall Segment With an Integral Header
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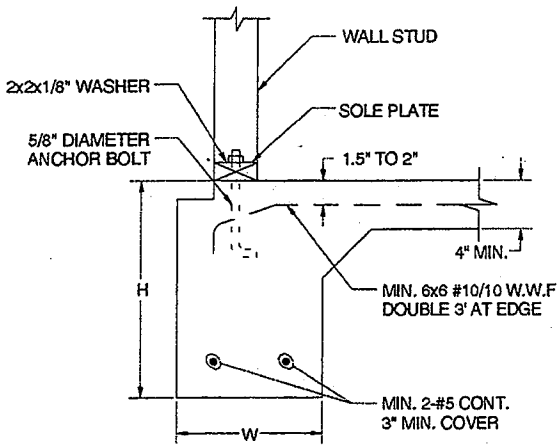

Figure 301.1.1A
Slab on Grade Exterior Grade Beam
(Wood Frame Construction)

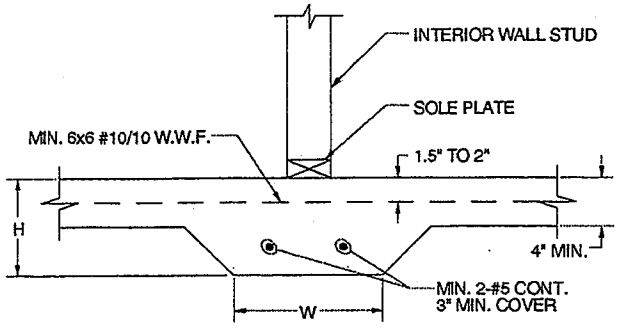

Figure 301.1.1B
Slab on Grade Interior Grade Beam
(Wood Frame Construction)

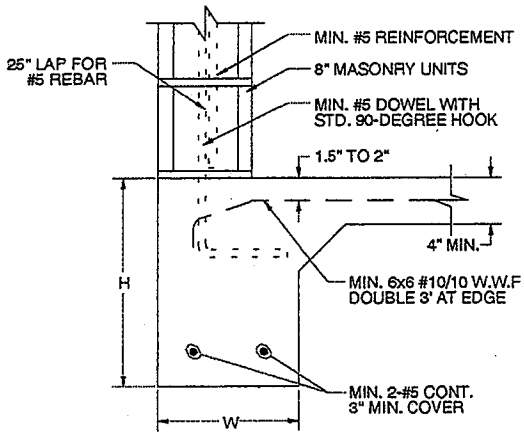

Figure 301.1.1C
Slab on Grade Exterior Grade Beam
(Masonry Wall Construction)

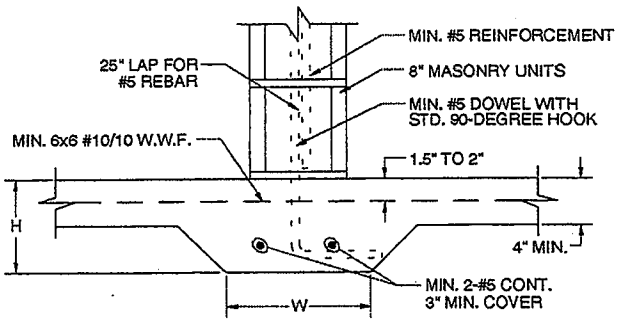

Figure 301.1.1D
Slab on Grade Interior Grade Beam
(Masonry Wall Construction)

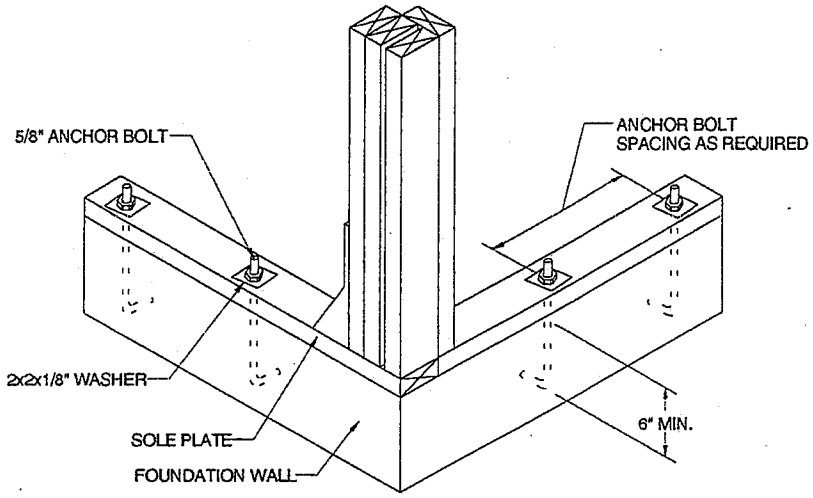

Figure 301.1.2 A
Sole Plate Anchorage

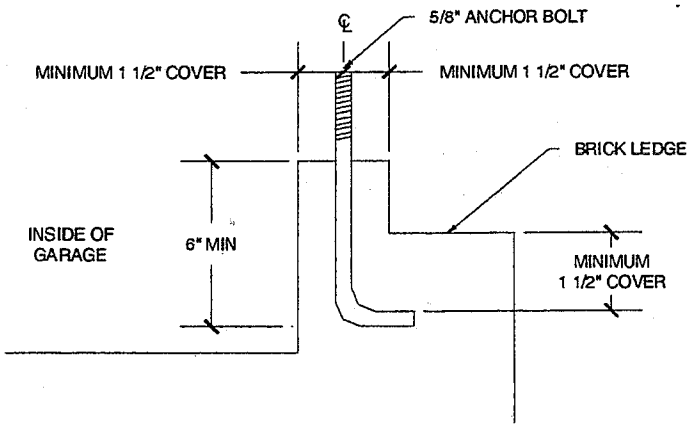

Figure 301.1.2B
Embedment of Anchor Bolt Along
Raised Curb of Garage

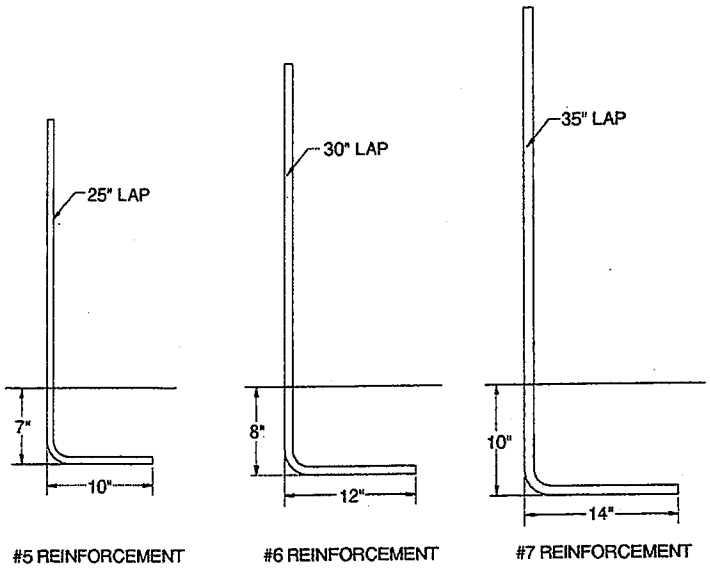

Figure 301.1.3
Standard 90-Degree Hook