

CHAPTER A3

PRESCRIPTIVE PROVISIONS FOR SEISMIC STRENGTHENING OF CRIPPLE WALLS AND SILL PLATE ANCHORAGE OF LIGHT, WOOD-FRAME RESIDENTIAL BUILDINGS

SECTION A301 GENERAL

A301.1 Purpose. The provisions of this chapter are intended to promote public safety and welfare by reducing the risk of earthquake-induced damage to existing wood-frame residential buildings. The requirements contained in this chapter are prescriptive minimum standards intended to improve the seismic performance of residential buildings; however, they will not necessarily prevent earthquake damage.

This chapter sets standards for strengthening that may be approved by the building official without requiring plans or calculations prepared by an architect or engineer. The provisions of this chapter are not intended to prevent the use of any material or method of construction not prescribed herein. The building official may require that construction documents for strengthening using alternative materials or methods be prepared by an architect or engineer.

A301.2 Scope. The provisions of this chapter apply to residential buildings of light-frame wood construction assigned to Seismic Design Category C, D or E of the *International Building Code* containing one or more of the structural weaknesses specified in Section A303.

Exception: The provisions of this chapter do not apply to the buildings, or elements thereof, listed below. These buildings or elements require analysis by an engineer or architect in accordance with Section A301.3 to determine appropriate strengthening:

1. Group R-1, R-2 or R-4 occupancies with more than four dwelling units.
2. Buildings with a lateral-force-resisting system using poles or columns embedded in the ground.
3. Cripple walls that exceed 4 feet (1219 mm) in height.
4. Buildings exceeding three stories in height and any three-story building with cripple wall studs exceeding 14 inches (356 mm) in height.
5. Buildings where the building official determines that conditions exist that are beyond the scope of the prescriptive requirements of this chapter.
6. Buildings or portions thereof constructed on concrete slabs on grade.

The details and prescriptive provisions herein are not intended to be the only acceptable strengthening methods permitted. Alternative details and methods may be used when approved by the building official. Approval of alternatives shall be based on test data showing that the method or material used is at least equivalent in terms of strength, deflection and capacity to that provided by the prescriptive methods and materials.

The provisions of this chapter may be used to strengthen historic structures, provided they are not in conflict with other related provisions and requirements that may apply.

A301.3 Alternative design procedures. When analysis by an engineer or architect is required in accordance with Section A301.2, such analysis shall be in accordance with all requirements of the building code, except that the base shear may be taken as 75 percent of the horizontal forces specified in the building code.

SECTION A302 DEFINITIONS

For the purpose of this chapter, in addition to the applicable definitions in the building code, certain additional terms are defined as follows:

CHEMICAL ANCHOR. An assembly consisting of a threaded rod, washer, nut and chemical adhesive approved by the building official for installation in existing concrete or masonry.

COMPOSITE PANEL. A wood structural panel product composed of a combination of wood veneer and wood-based material, and bonded with waterproof adhesive.

CRIPPLE WALL. A wood-frame stud wall extending from the top of the foundation to the underside of the lowest floor framing.

EXPANSION BOLT. A single assembly approved by the building official for installation in existing concrete or masonry. For the purpose of this chapter, expansion bolts shall contain a base designed to expand when properly set, wedging the bolt in the pre-drilled hole. Assembly shall also include appropriate washer and nut.

ORIENTED STRAND BOARD (OSB). A mat-formed wood structural panel product composed of thin rectangular wood strands or wafers arranged in oriented layers and bonded with waterproof adhesive.

PERIMETER FOUNDATION. A foundation system that is located under the exterior walls of a building.

PLYWOOD. A wood structural panel product composed of sheets of wood veneer bonded together with the grain of adjacent layers oriented at right angles to one another.

SNUG-TIGHT. As tight as an individual can torque a nut on a bolt by hand, using a wrench with a 10-inch-long (254 mm) handle, and the point at which the full surface of the plate washer is contacting the wood member and slightly indenting the wood surface.

WAFERBOARD. A mat-formed wood structural panel product composed of thin rectangular wood wafers arranged in random layers and bonded with waterproof adhesive.

WOOD STRUCTURAL PANEL. A structural panel product composed primarily of wood and meeting the requirements of United States Voluntary Product Standard PS 1 and United States Voluntary Product Standard PS 2. Wood structural panels include all-veneer plywood, composite panels containing a combination of veneer and wood-based material, and mat-formed panels such as oriented strand board and waferboard.

SECTION A303 STRUCTURAL WEAKNESSES

For the purpose of this chapter, structural weaknesses shall be as specified below.

1. Sill plates or floor framing that are supported directly on the ground without an approved foundation system.
2. A perimeter foundation system that is constructed only of wood posts supported on isolated pad footings.
3. Perimeter foundation systems that are not continuous.

Exceptions:

1. Existing single-story exterior walls not exceeding 10 feet (3048 mm) in length, forming an extension of floor area beyond the line of an existing continuous perimeter foundation.
2. Porches, storage rooms and similar spaces not containing fuel-burning appliances.
4. A perimeter foundation system that is constructed of unreinforced masonry or stone.
5. Sill plates that are not connected to the foundation or that are connected with less than what is required by the building code.

Exception: When approved by the building official, connections of a sill plate to the foundation made with other than sill bolts may be accepted if the capacity of the connection is equivalent to that required by the building code.
6. Cripple walls that are not braced in accordance with the requirements of Section A304.4 and Table A3-A, or cripple walls not braced with diagonal sheathing or wood structural panels in accordance with the building code.

SECTION A304 STRENGTHENING REQUIREMENTS

A304.1 General.

A304.1.1 Scope. The structural weaknesses noted in Section A303 shall be strengthened in accordance with the requirements of this section. Strengthening work may include both new construction and alteration of existing construction. Except as provided herein, all strengthening work and materials shall comply with the applicable provisions of the building code. Alternative methods of strength-

ening may be used, provided such systems are designed by an engineer or architect and are approved by the building official.

A304.1.2 Condition of existing wood materials. All existing wood materials that will be a part of the strengthening work (sills, studs, sheathing, etc.) shall be in a sound condition and free from defects that substantially reduce the capacity of the member. Any wood material found to contain fungus infection shall be removed and replaced with new material. Any wood material found to be infested with insects or to have been infested with insects shall be strengthened or replaced with new materials to provide a net dimension of sound wood at least equal to its undamaged original dimension.

A304.1.3 Floor joists not parallel to foundations. Floor joists framed perpendicular or at an angle to perimeter foundations shall be restrained either by an existing nominal 2-inch-wide (51 mm) continuous rim joist or by a nominal 2-inch-wide (51 mm) full-depth blocking between alternate joists in one- and two-story buildings, and between each joist in three-story buildings. Existing blocking for multi-story buildings must occur at each joist space above a braced cripple wall panel.

Existing connections at the top and bottom edges of an existing rim joist or blocking need not be verified in one-story buildings. In multistory buildings, the existing top edge connection need not be verified; however, the bottom edge connection to either the foundation sill plate or the top plate of a cripple wall shall be verified. The minimum existing bottom edge connection shall consist of 8d toenails spaced 6 inches (152 mm) apart for a continuous rim joist, or three 8d toenails per block. When this minimum bottom edge-connection is not present or cannot be verified, a supplemental connection installed as shown in Figure A3-8 shall be provided.

Where an existing continuous rim joist or the minimum existing blocking does not occur, new $\frac{3}{4}$ -inch (19 mm) wood structural panel blocking installed tightly between floor joists and nailed as shown in Figure A3-8 shall be provided at the inside face of the cripple wall. In lieu of $\frac{3}{4}$ -inch (19 mm) wood structural panel blocking, tightfitting, full-depth 2-inch (51 mm) blocking may be used. New blocking may be omitted where it will interfere with vents or plumbing that penetrates the wall.

A304.1.4 Floor joists parallel to foundations. Where existing floor joists are parallel to the perimeter foundations, the end joist shall be located over the foundation and, except for required ventilation openings, shall be continuous and in continuous contact with the foundation sill plate or the top plate of the cripple wall. Existing connections at the top and bottom edges of the end joist need not be verified in one-story buildings. In multistory buildings, the existing top edge connection of the end joist need not be verified; however, the bottom edge connection to either the foundation sill plate or the top plate of a cripple wall shall be verified. The minimum bottom edge connection shall be 8d toenails spaced 6 inches (152 mm) apart. If this minimum bottom edge connection is not present or cannot be verified,

a supplemental connection installed as shown in Figure A3-9 shall be provided.

A304.2 Foundations.

A304.2.1 New perimeter foundations. New perimeter foundations shall be provided for structures with the structural weaknesses noted in Items 1 and 2 of Section A303. Soil investigations or geotechnical studies are not required for this work unless the building is located in a special study zone as designated by the jurisdiction or other public agency.

A304.2.2 Foundation evaluation by an engineer or architect. Partial perimeter foundations or unreinforced masonry foundations shall be evaluated by an engineer or architect for the force levels noted in Section A301.3. Test reports or other substantiating data to determine existing foundation material strengths shall be submitted for review. When approved by the building official, these foundation systems may be strengthened in accordance with the recommendations included with the evaluation in lieu of being replaced.

Exception: In lieu of testing existing foundations to determine material strengths, and when approved by the building official, a new nonperimeter foundation system designed for the forces noted in Section A301.3 may be used to resist all exterior wall lateral forces.

A304.2.3 Details for new perimeter foundations. All new perimeter foundations shall be continuous and constructed according to one of the details shown in Figure A3-1 or A3-2.

Exceptions:

1. When approved by the building official, the existing clearance between existing floor joists or girders and existing grade below the floor need not comply with the building code.
2. When approved by the building official, and when designed by an engineer or architect, partial perimeter foundations may be used in lieu of a continuous perimeter foundation.

A304.2.4 Required compressive strength. New concrete foundations shall have a minimum compressive strength of 2,500 pounds per square inch (17.24 MPa) at 28 days.

A304.2.5 New hollow-unit masonry foundations. New hollow-unit masonry foundations shall be solidly grouted. Mortar shall be Type M or S, and the grout and masonry units shall comply with the building code.

A304.2.6 Reinforcing steel. Reinforcing steel shall comply with the requirements of the building code.

A304.3 Foundation sill plate anchorage.

A304.3.1 Existing perimeter foundations. When the building has an existing continuous perimeter foundation, all perimeter wall sill plates shall be bolted to the foundation with chemical anchors or expansion bolts in accordance with Table A3-A.

Anchor bolts shall be installed in accordance with Figure A3-3, with the plate washer installed between the nut

and the sill plate. The nut shall be tightened to a snug-tight condition after curing is complete for chemical anchors and after expansion wedge engagement for expansion bolts. The installation of nuts on all bolts shall be subject to verification by the building official. Where existing conditions prevent anchor or bolt installation through the sill plate, this connection may be made in accordance with Figure A3-4A, A3-4B or A3-4C. The spacing of these alternate connections shall comply with the maximum spacing requirements of Table A3-A. Expansion bolts shall not be used when the installation causes surface cracking of the foundation wall at the location of the bolt.

A304.3.2 Placement of chemical anchors and expansion bolts. Chemical anchors or expansion bolts shall be placed within 12 inches (305 mm), but not less than 9 inches (229 mm), from the ends of sill plates and shall be placed in the center of the stud space closest to the required spacing. New sill plates may be installed in pieces when necessary because of existing conditions. For lengths of sill plate greater than 12 feet (3658 mm), anchors or bolts shall be spaced along the sill plate as noted in Table A3-A. For other lengths of sill plate, see Table A3-B. For lengths of sill plate less than 30 inches (762 mm), a minimum of one anchor or bolt shall be installed.

Exception: Where physical obstructions such as fireplaces, plumbing or heating ducts interfere with the placement of an anchor or bolt, the anchor or bolt shall be placed as close to the obstruction as possible, but not less than 9 inches (229 mm) from the end of the plate. Center-to-center spacing of the anchors or bolts shall be reduced as necessary to provide the minimum total number of anchors required based on the full length of the wall. Center-to-center spacing shall not be less than 12 inches (305 mm).

A304.3.3 New perimeter foundations. Sill plates for new perimeter foundations shall be bolted as required by Table A3-A and as shown in Figure A3-1 or A3-2.

A304.4 Cripple wall bracing.

A304.4.1 General. Exterior cripple walls not exceeding 4 feet (1219 mm) in height shall use the prescriptive bracing method listed below. Cripple walls over 4 feet (1219 mm) in height require analysis by an engineer or architect in accordance with Section A301.3.

A304.4.1.1 Sheathing installation requirements. Wood structural panel sheathing shall not be less than $1\frac{5}{32}$ -inch (12 mm) thick and shall be installed in accordance with Figure A3-5 or A3-6. All individual pieces of wood structural panels shall be nailed with 8d common nails spaced 4 inches (102 mm) on center at all edges and 12 inches (305 mm) on center at each intermediate support with not less than two nails for each stud. Nails shall be driven so that their heads are flush with the surface of the sheathing and shall penetrate the supporting member a minimum of $1\frac{1}{2}$ inches (38 mm). When a nail fractures the surface, it shall be left in place and not counted as part of the required nailing. A new 8d nail shall be located within 2 inches (51 mm) of the discounted nail and be hand-driven flush with the sheathing surface. All hori-

zontal joints must occur over nominal 2-inch by 4-inch (51 mm by 102 mm) blocking installed with the nominal 4-inch (102 mm) dimension against the face of the plywood.

Vertical joints at adjoining pieces of wood structural panels shall be centered on existing studs such that there is a minimum $\frac{1}{8}$ inch (3.2 mm) between the panels, and such that the nails are placed a minimum of $\frac{1}{2}$ inch (12.7 mm) from the edges of the existing stud. Where such edge distances cannot be maintained because of the width of the existing stud, a new stud shall be added adjacent to the existing studs and connected in accordance with Figure A3-7.

A304.4.2 Distribution and amount of bracing. See Table A3-A and Figure A3-10 for the distribution and amount of bracing required for each wall line. Each braced panel length must be at least two times the height of the cripple stud. Where the minimum amount of bracing prescribed in Table A3-A cannot be installed along any walls, the bracing must be designed in accordance with Section A301.3.

Exception: Where physical obstructions such as fireplaces, plumbing or heating ducts interfere with the placement of cripple wall bracing, the bracing shall then be placed as close to the obstruction as possible. The total amount of bracing required shall not be reduced because of obstructions.

A304.4.3 Stud space ventilation. When bracing materials are installed on the interior face of studs forming an enclosed space between the new bracing and the existing exterior finish, each braced stud space must be ventilated. Adequate ventilation and access for future inspection shall be provided by drilling one 2-inch to 3-inch-diameter (51 mm to 76 mm) round hole through the sheathing, nearly centered between each stud at the top and bottom of the cripple wall. Such holes should be spaced a minimum of 1 inch (25 mm) clear from the sill or top plates. In stud spaces containing sill bolts, the hole shall be located on the center line of the sill bolt but not closer than 1 inch (25 mm) clear from the nailing edge of the sheathing. When existing blocking occurs within the stud space, additional ventilation holes shall be placed above and below the blocking, or the existing block shall be removed and a new nominal 2-inch by 4-inch (51 mm by 102 mm) block shall be installed with the nominal 4-inch (102 mm) dimension against the face of the plywood. For stud heights less than 18 inches (457 mm), only one ventilation hole need be provided.

A304.4.4 Existing underfloor ventilation. Existing underfloor ventilation shall not be reduced without providing equivalent new ventilation as close to the existing ventilation as possible. Braced panels may include underfloor ventilation openings when the height of the opening, measured from the top of the foundation wall to the top of the opening, does not exceed 25 percent of the height of the cripple stud wall; however, the length of the panel shall be increased a distance equal to the length of the opening or one stud space minimum. Where an opening exceeds 25 percent of the

cripple wall height, braced panels shall not be located where the opening occurs. See Figure A3-7.

Exception: For homes with a post and pier foundation system where a new continuous perimeter foundation system is being installed, new ventilation shall be provided in accordance with the building code.

A304.5 Quality control. All work shall be subject to inspection by the building official including, but not limited to:

1. Placement and installation of new chemical anchors or expansion bolts installed in existing foundations. Special inspection is not required for chemical anchors installed in existing foundations regulated by the prescriptive provisions of this chapter.
2. Installation and nailing of new cripple wall bracing.
3. Any work may be subject to special inspection when required by the building official in accordance with the building code.

A304.6 Phasing of the strengthening work. When approved by the building official, the strengthening work contained in this chapter may be completed in phases. The strengthening work in any phase shall be performed on two parallel sides of the structure at the same time.

TABLE A3-A—SILL PLATE ANCHORAGE AND CRIPPLE WALL BRACING

NUMBER OF STORIES ABOVE CRIPPLE WALLS	MINIMUM SILL PLATE CONNECTION AND MAXIMUM SPACING ^{a, b}	AMOUNT OF BRACING FOR EACH WALL LINE ^{c, d, e}	
		A Combination of Exterior Walls Finished with Portland Cement Plaster and Roofing Using Clay Tile or Concrete Tile Weighing More than 6 psf (287 N/m ²)	All Other Conditions
One story	1/2 inch (12.7 mm) spaced 6 feet, 0 inch (1829 mm) center-to-center with washer plate	Each end and not less than 50 percent of the wall length	Each end and not less than 40 percent of the wall length
Two stories	1/2 inch (12.7 mm) spaced 4 feet, 0 inch (1219 mm) center-to-center with washer plate; or 5/8 inch (15.9 mm) spaced 6 feet, 0 inch (1829 mm) center-to-center with washer plate	Each end and not less than 70 percent of the wall length	Each end and not less than 50 percent of the wall length
Three stories	5/8 inch (15.9 mm) spaced 4 feet, 0 inch (1219 mm) center-to-center with washer plate	100 percent of the wall length ^f	Each end and not less than 80 percent of the wall length ^f

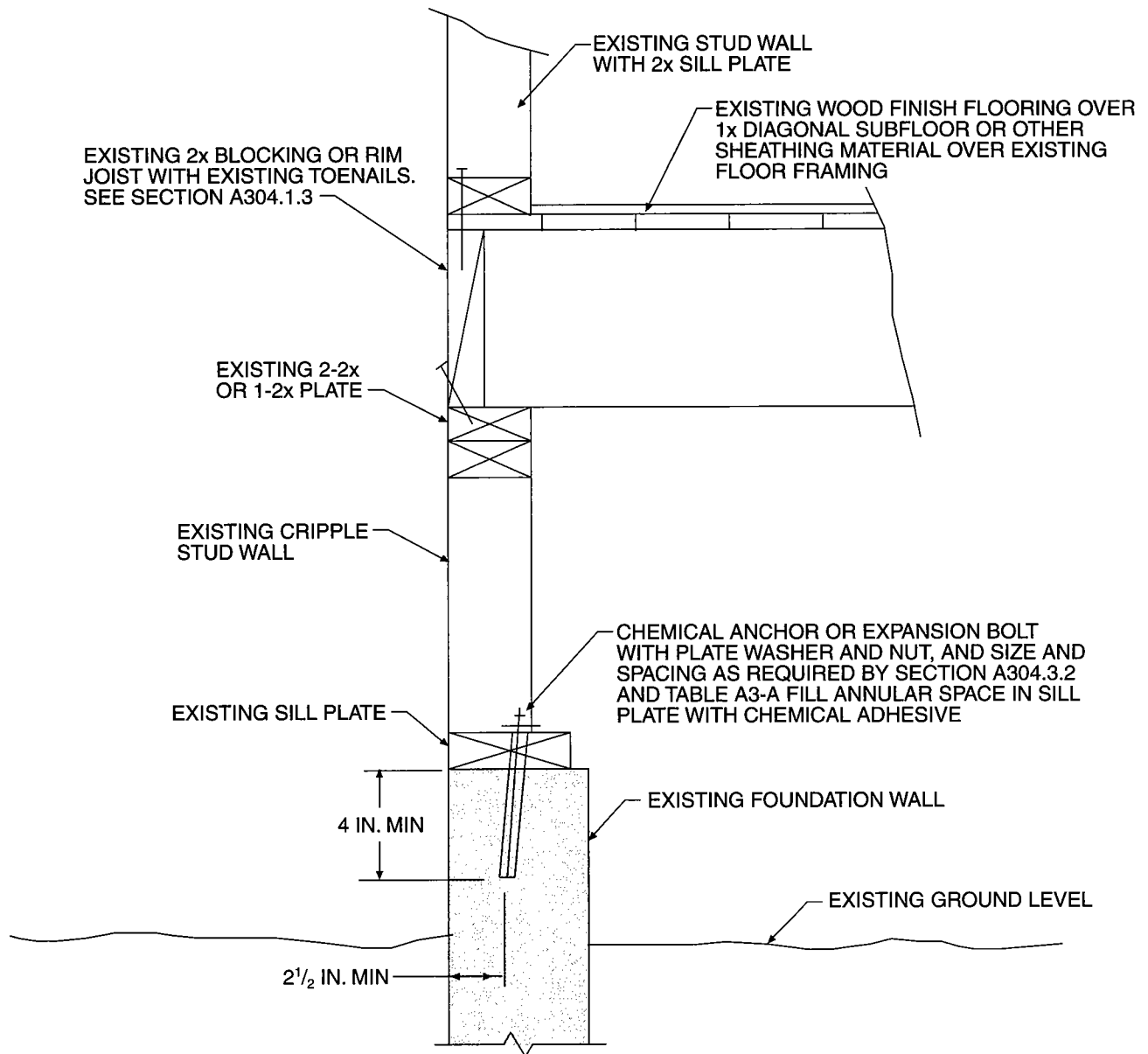
- a. Sill plate anchors shall be chemical anchors or expansion bolts in accordance with Section A304.3.1.
- b. All washer plates shall be 2 inches by 2 inches by 3/16 inch (51 mm by 51 mm by 4.8 mm) minimum.
- c. See Figure A3-10 for braced panel layout.
- d. Braced panels at ends of walls shall be located as near to the end as possible.
- e. All panels along a wall shall be nearly equal in length and shall be nearly equal in spacing along the length of the wall.
- f. The minimum required underfloor ventilation openings are permitted in accordance with Section A304.4.4.

TABLE A3-B—SILL PLATE ANCHORAGE FOR VARIOUS LENGTHS OF SILL PLATE^{a, b}

NUMBER OF STORIES	LENGTHS OF SILL PLATE		
	Less than 12 feet (3658 mm) to 6 feet (1829 mm)	Less than 6 feet (1829 mm) to 30 inches (762 mm)	Less than 30 inches footnote (762 mm) ^c
One story	Three connections	Two connections	One connection
Two stories	Four connections for 1/2-inch (12.7 mm) anchors or bolts or Three connections for 5/8-inch (15.9 mm) anchors or bolts	Two connections	One connection
Three stories	Four connections	Two connections	One connection

- a. Connections shall be either chemical anchors or expansion bolts.
- b. See Section A304.3.2 for minimum end distances.
- c. Connections shall be placed as near to the center of the length of plate as possible.

TABLE A3-C—NOT USED

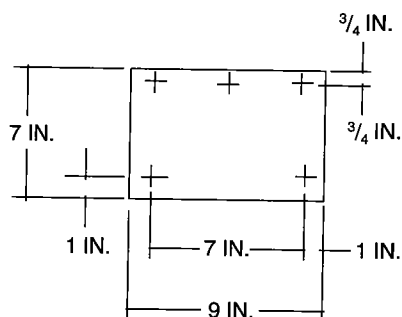
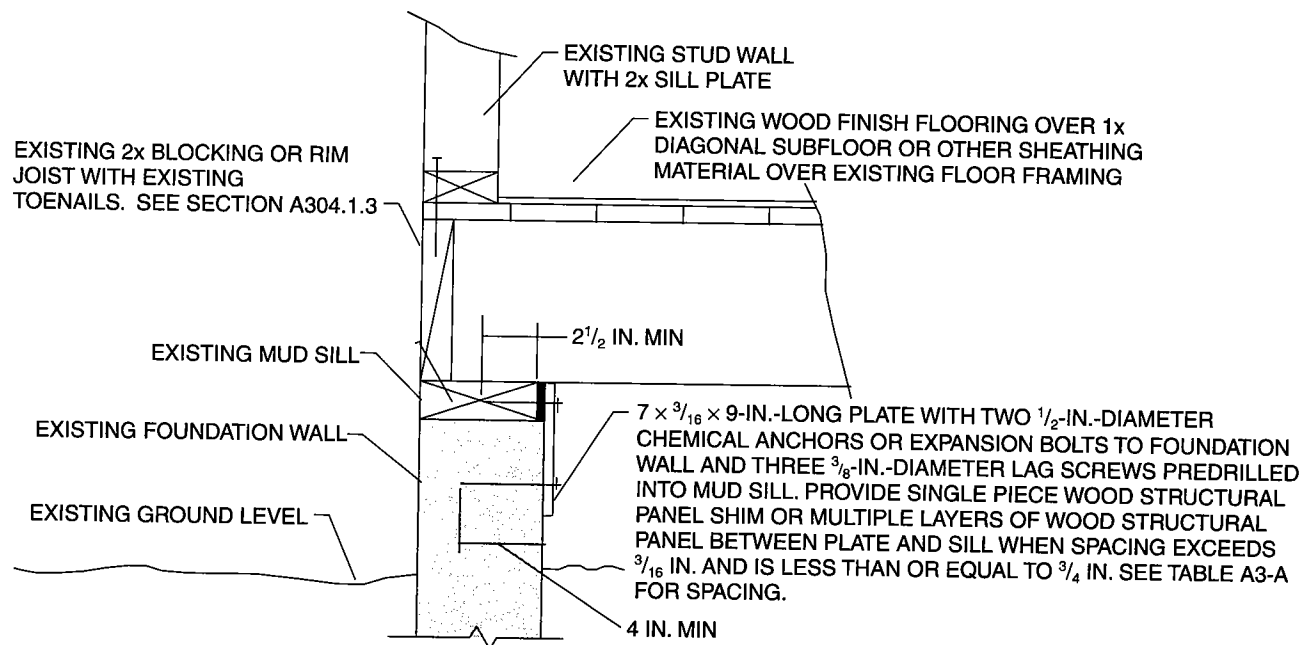


For SI: 1 inch = 25.4 mm.

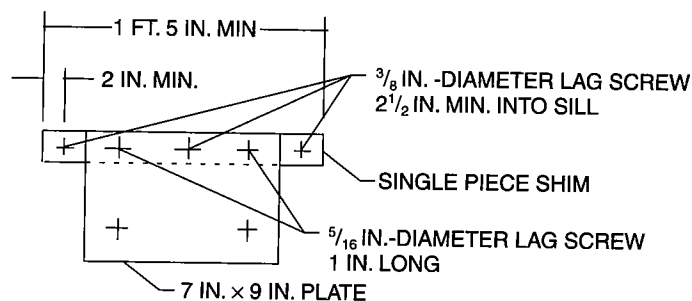
NOTES:

1. Plate washers shall comply with the following:
 $\frac{1}{2}$ in. anchor or bolt—2 in. x 2 in. x $\frac{3}{16}$ in.
 $\frac{5}{8}$ in. anchor or bolt—2 in. x 2 in. x $\frac{3}{16}$ in.
2. See Figure A3-5 or A3-6 for cripple wall bracing.

FIGURE A3-3—SILL PLATE BOLTING TO EXISTING FOUNDATION



HOLE DIAMETER SHALL NOT EXCEED CONNECTOR DIAMETER BY MORE THAN 1/16 IN.

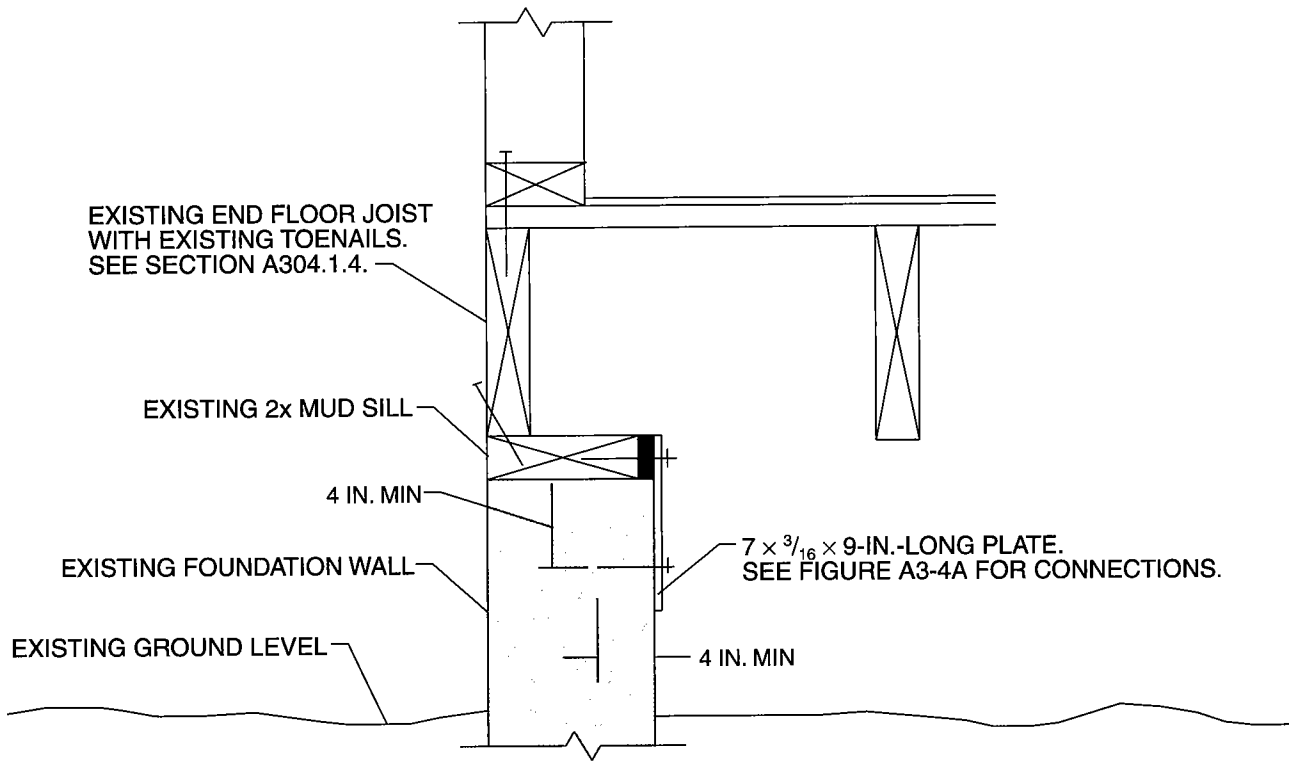


CONNECTION WHEN SHIM SPACE EXCEEDS 3/4 IN. IN WIDTH UP TO 2 1/2 IN.

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

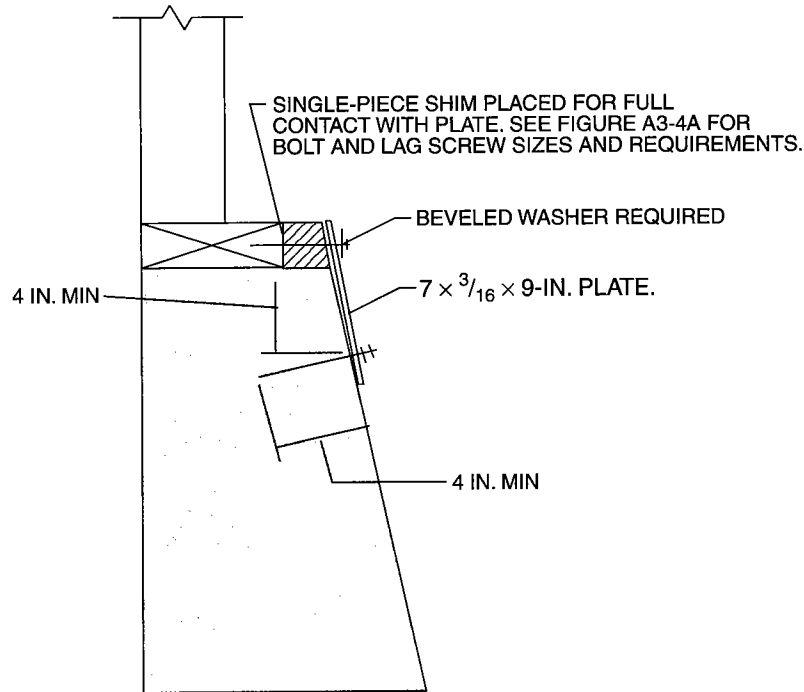
NOTE: If shim space exceeds 2 1/2 in., alternate details will be required.

FIGURE A3-4A—SILL PLATE BOLTING IN EXISTING FOUNDATION—ALTERNATE



For SI: 1 inch = 25.4 mm.

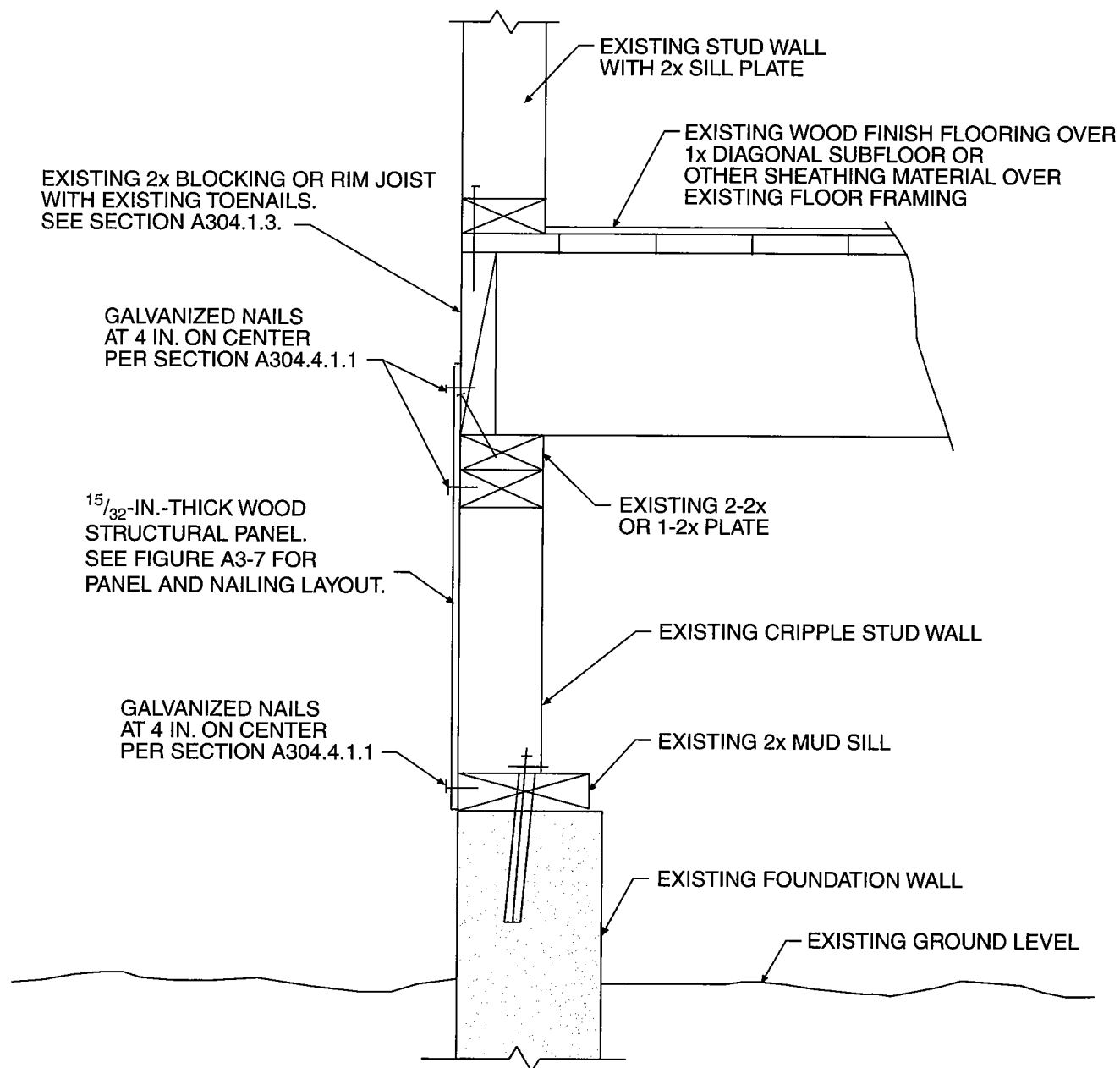
FIGURE A3-4B—SILL PLATE BOLTING TO EXISTING FOUNDATION WITHOUT CRIPPLE WALL AND FRAMING PARALLEL TO THE FOUNDATION WALL



ALTERNATE CONNECTION FOR BATTERED FOOTING

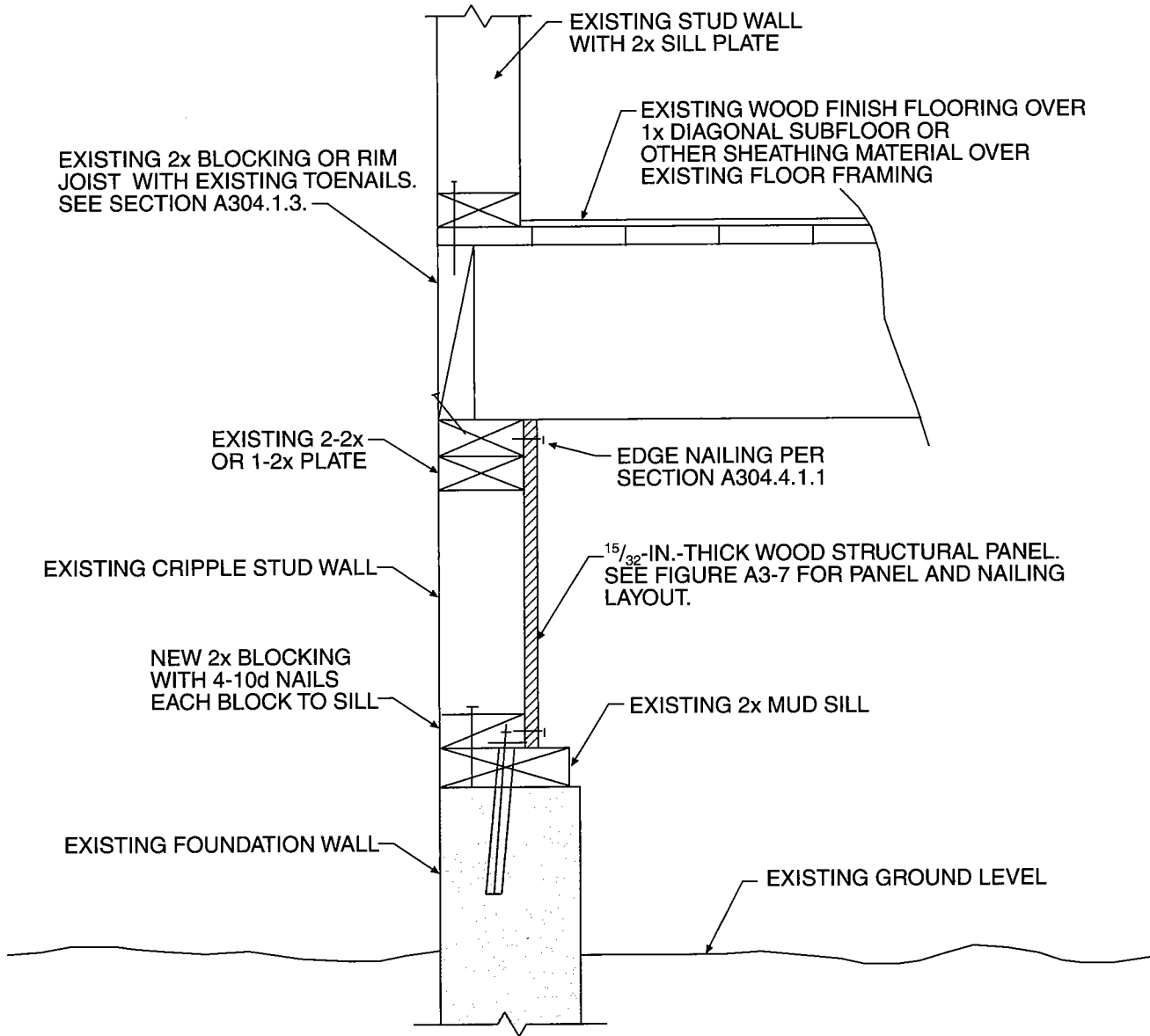
For SI: 1 inch = 25.4 mm.

FIGURE A3-4C—SILL PLATE BOLTING IN EXISTING FOUNDATION—ALTERNATE



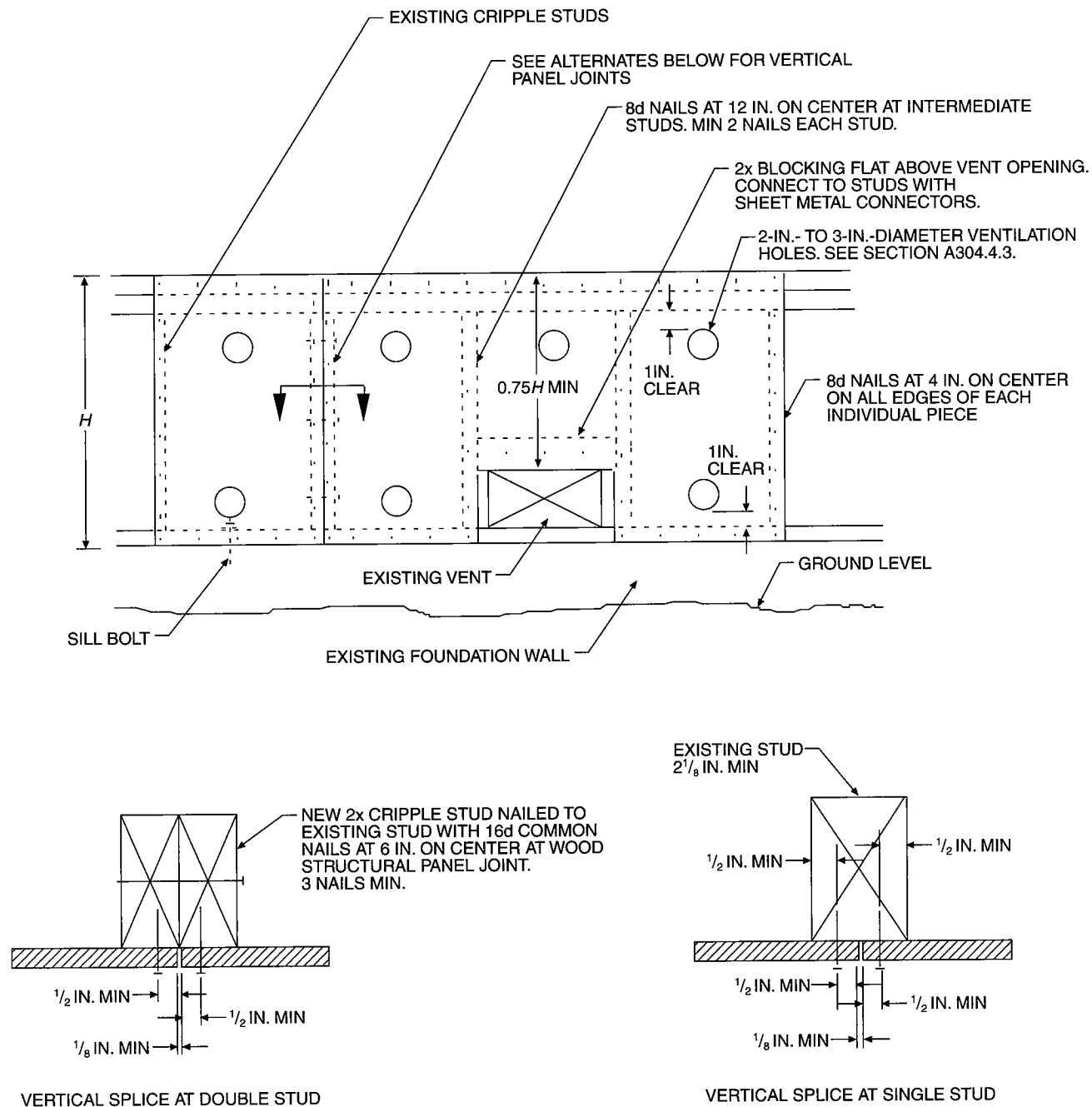
For SI: 1 inch = 25.4 mm.
 NOTE: See Figure A3-3 for sill plate bolting.

FIGURE A3-5—CRIPPLE WALL BRACING WITH WOOD STRUCTURAL PANEL ON EXTERIOR FACE OF CRIPPLE STUDS



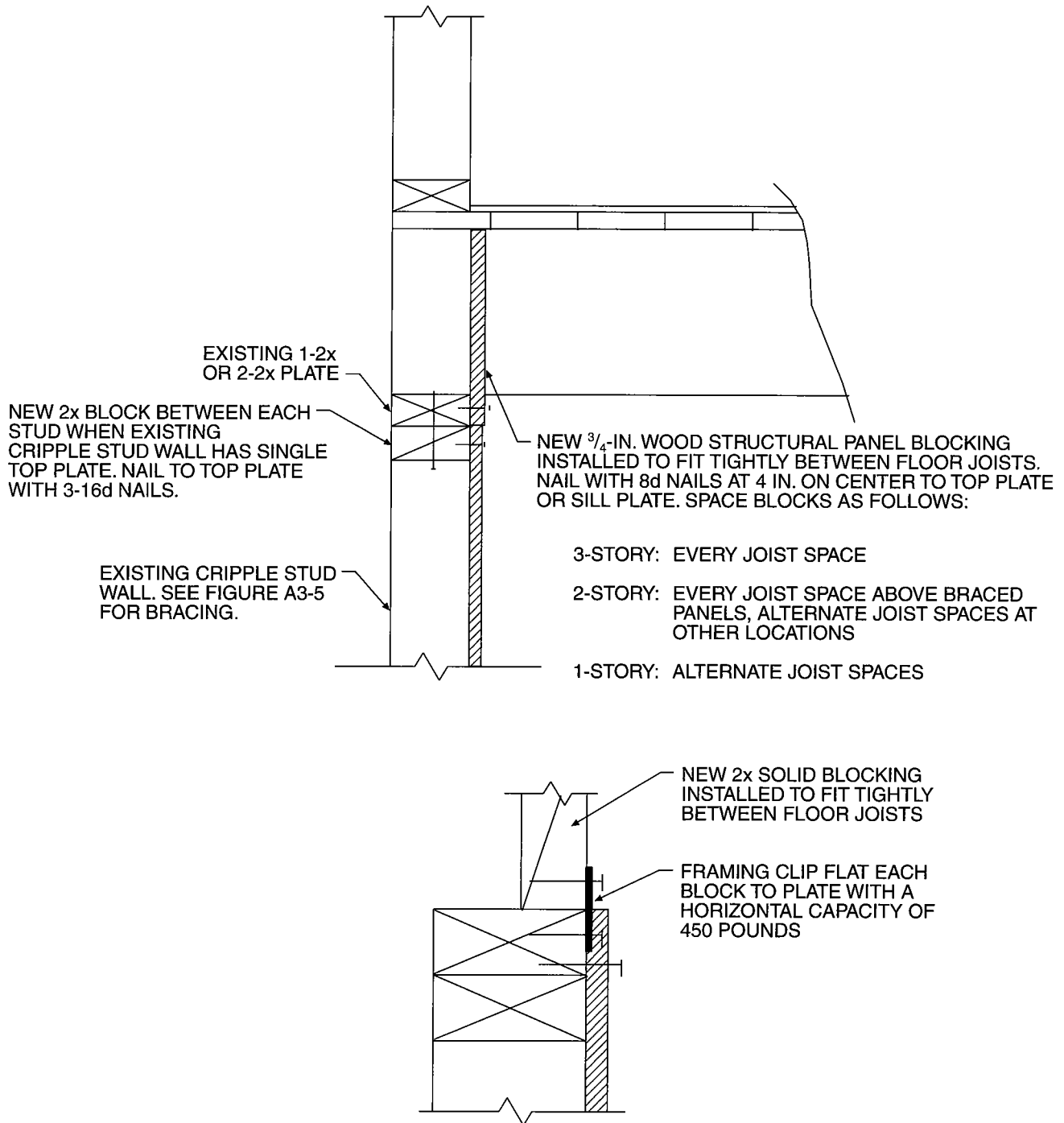
For SI: 1 inch = 25.4 mm.
 NOTE: See Figure A3-3 for sill plate bolting.

FIGURE A3-6—CRIPPLE WALL BRACING WITH WOOD STRUCTURAL PANEL ON INTERIOR FACE OF CRIPPLE STUDS



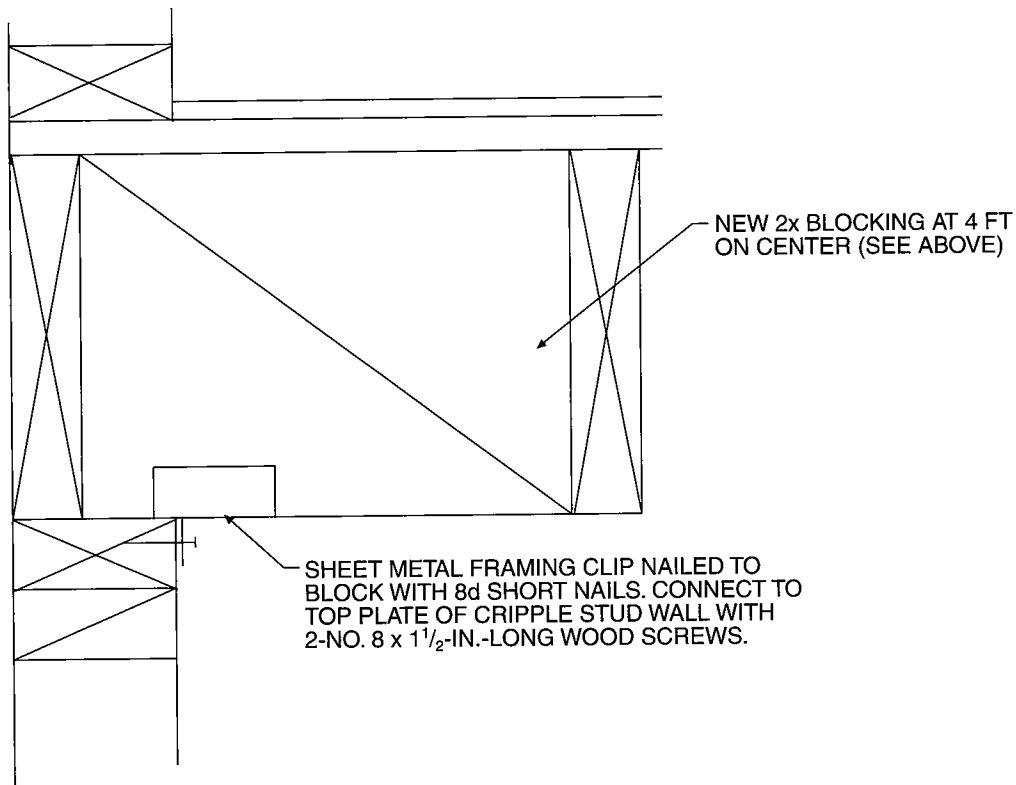
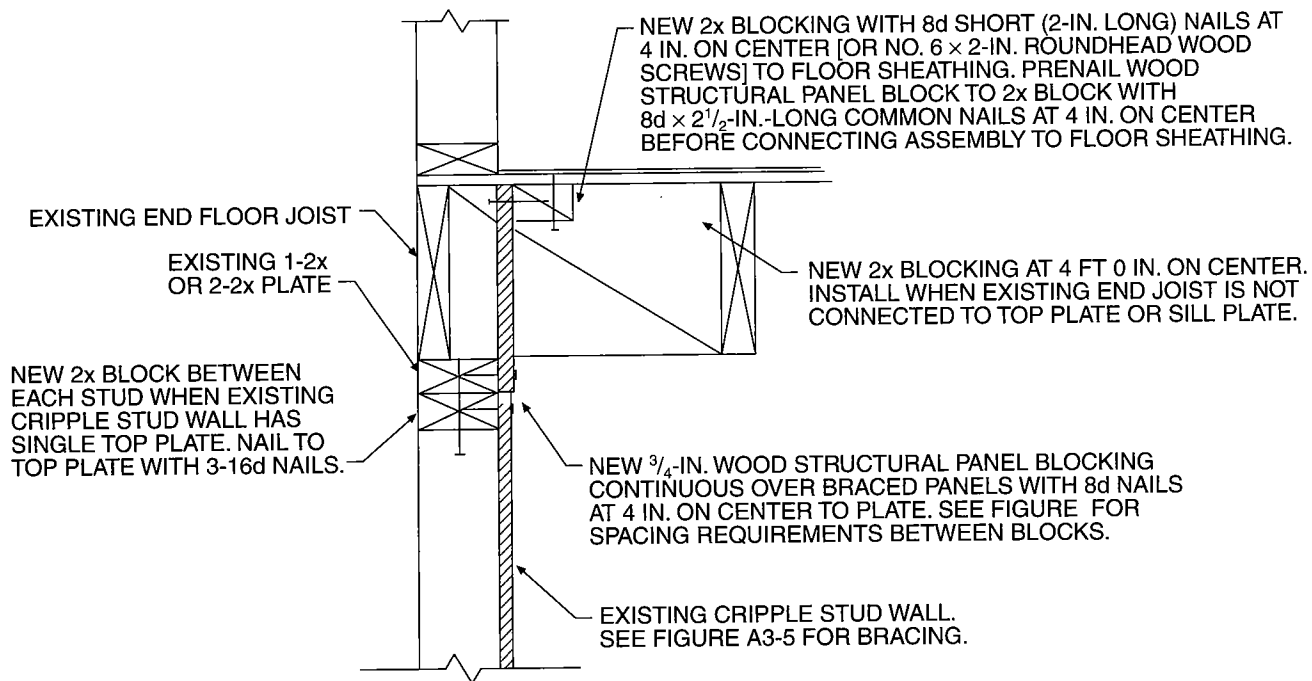
For SI: 1 inch = 25.4 mm.

FIGURE A3-7—PARTIAL CRIPPLE STUD WALL ELEVATION



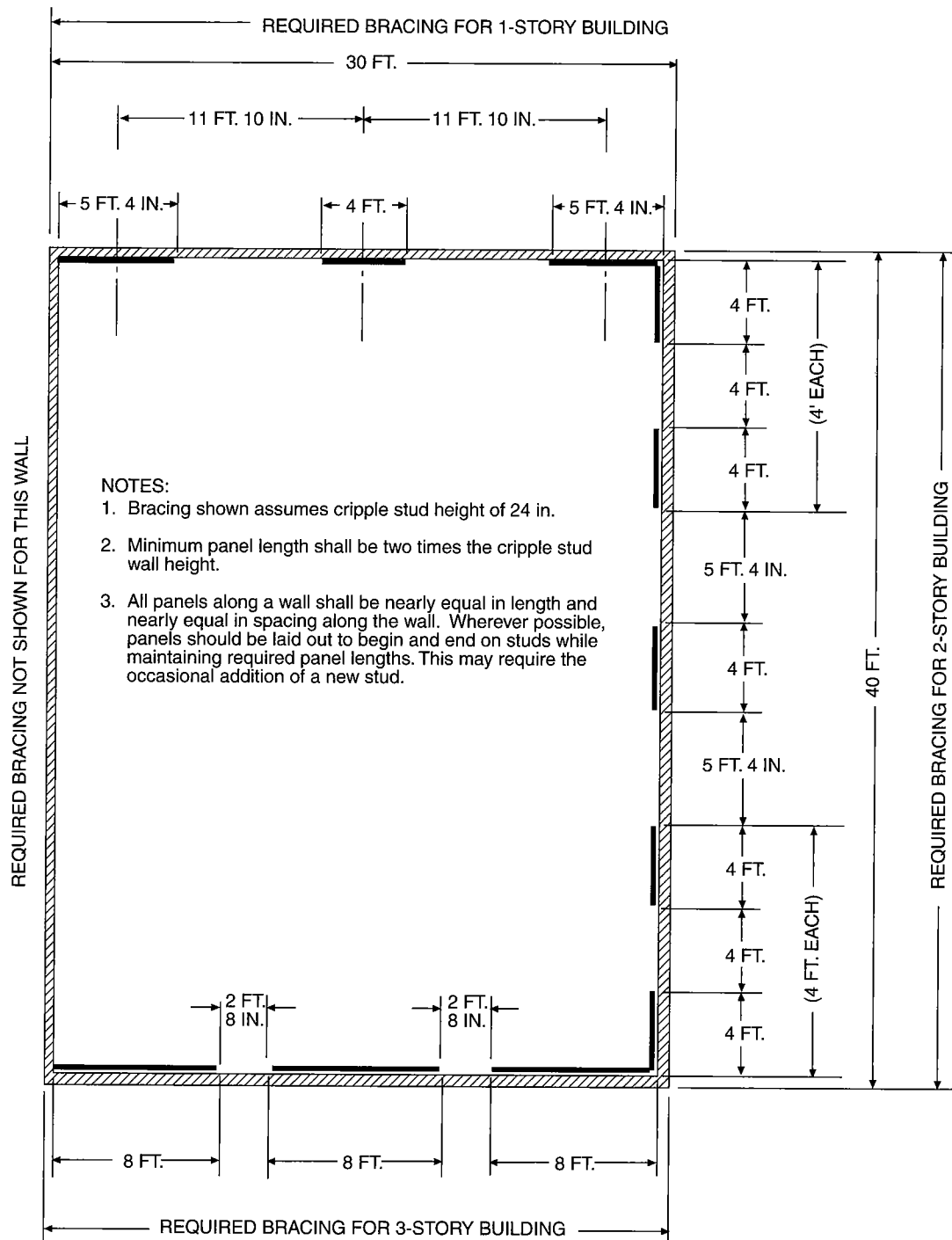
For SI: 1 inch = 25.4 mm, 1 pound = 4.4 N.

FIGURE A3-8—ALTERNATE BLOCKING WHERE RIM JOIST OR BLOCKING HAS BEEN OMITTED



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

FIGURE A3-9—CONNECTION OF CRIPPLE WALL TO FLOOR SHEATHING WHEN FLOOR FRAMING IS PARALLEL TO WALL



Bracing determination:

- 1-story building—each end and not less than 40% of wall length.¹
 Transverse wall—30 ft. × 0.40 = 12 ft. minimum panel length = 4 ft. 0 in.
 - 2-story building—each end and not less than 50% of wall length.¹
 Longitudinal wall—40 ft. × 0.50 = 20 ft. 0 in. minimum of bracing.
 - 3-story building—each end and not less than 80% of wall length.¹
 Transverse wall—30 ft. × 0.80 = 24 ft. 0 in. minimum of bracing.
- ¹See Table A3-A for buildings with both plaster walls and roofing exceeding 6 psf (287 N/m²).

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

FIGURE A3-10—FLOOR PLAN—CRIPPLE WALL BRACING LAYOUT